SECTION

I

AMA Overview

Chapter 1 Water Management Approach

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Preface

Section I of the Third Management Plan provides an overview of the Arizona Department of Water Resources' (Department) water management approach, a description of the physiographic and hydrologic conditions, and water resources of the Phoenix Active Management Area (AMA), and a detailed description of water use characteristics of the various water use sectors within the AMA. The physical water resources data presented in Chapter 2 and the historic water use and associated water use trends described in Chapter 3 provided the Department with important information from which it developed a baseline water budget. Information presented in this section was also used in developing water management programs which are presented in Section II and the future conditions and directions presented in Section III.

In Section I, the Department intends to provide the reader with a better understanding of the management approach, the water resources, and the water use characteristics of the Phoenix AMA. Such an overview is necessary to better appreciate the reasoning, perspective, and methods being taken by the Department as it continues to develop a long-term water management strategy, with particular emphasis on the third management period (2000 to 2010).

CHAPTER

1

Water Management Approach

1.1 INTRODUCTION

This chapter describes the goals, objectives, and contents of the Third Management Plan for the Phoenix Active Management Area (AMA). It also provides an overview of the Arizona Groundwater Code and water management problems experienced in AMAs. The following topics are discussed:

- Arizona Department of Water Resources' mission
- Overview of the Code and some of its key provisions
- An institutional overview of the Phoenix AMA
- The principles, objectives, and content of the Third Management Plan
- Emerging challenges for the Phoenix AMA

1.2 THE ARIZONA DEPARTMENT OF WATER RESOURCES' MISSION

The Arizona Department of Water Resources (Department) was created by the 1980 Groundwater Code (Code) to manage the water resources of Arizona. The Department administers state laws, explores methods of augmenting water supplies to meet future demands, and works to develop public policies which promote efficient use and equitable allocation of available water supplies. To secure long-term water supplies for Arizona, the Department oversees the use of surface water and groundwater in the state and represents the state's interests in interstate and federal issues. The mission of the Department is:

> *To ensure a long-term, sufficient and secure water supply for the state; to develop public policy which promotes efficient use and equitable distribution of water in an environmentally and economically sound manner; and, to promote the management of floodplains and dams to reduce loss of life and damage to property.*

1.3 THE ARIZONA GROUNDWATER CODE

In 1980, Arizona made a commitment to the long-term management of its limited groundwater supplies through the passage of the Code. The goals of the Code are to eliminate severe groundwater overdraft in areas of the state where groundwater supplies have been rapidly diminishing and to provide the means for allocating Arizona's limited groundwater resources to most effectively meet the state's changing water needs.

The Code limits withdrawals of groundwater within AMAs to holders of grandfathered rights, service area rights, groundwater withdrawal permits, and small domestic users. Under the Code, groundwater uses existing at some time between 1975 and 1980 were allowed to continue within the limits established under a new water rights system, and new uses were required to be consistent with AMA management plans and goals. Readers who are not familiar with the different types of groundwater rights established by the Code are encouraged to read the Glossary of Terms attached as a supplement to the management plan. The Code also contains provisions to minimize and to replace groundwater use through conservation and use of renewable sources. The full text of the Code can be found on the following Web site: www.azleg.state.az.us

1.3.1 The Groundwater Problem

The Code was enacted in response to serious water level declines in the aquifers in central and southern parts of the state. Groundwater overdraft in certain areas of Arizona has resulted in the lowering of groundwater levels by as much as 600 feet. Groundwater depletion has made it economically infeasible to pump water in some cases, has caused the lowering and cracking of the land surface (subsidence and earth fissuring), has caused aquifer compaction resulting in the loss of aquifer storage space, and has resulted in

water quality problems due to the migration of poor quality water and general deterioration of aquifer water quality with depth. Continued overdraft of groundwater supplies will exacerbate these problems.

1.3.2 Provisions of the Groundwater Code

The regulatory provisions of the Code are focused primarily on areas of the state that have been designated as AMAs. These areas are located where competition for groundwater supplies is most severe, primarily in the central and southern parts of the state.

Statewide, there are provisions addressing well drilling, well registration, and construction requirements; water adequacy requirements for new subdivisions; and limitations on transportation of groundwater across watershed boundaries.

Within AMAs, the Code established a new groundwater rights system which strictly limits groundwater withdrawals; prohibits the development of new irrigated farmland; requires new subdivisions to have long-term, dependable supplies; and requires measuring and reporting of groundwater withdrawals. Management goals are established for each AMA, and a series of five management plans containing mandatory conservation requirements for industrial, municipal, and agricultural water users must be developed. Other programs within AMAs include conservation assistance, augmentation, and monitoring of the water supplies.

The Code also established Irrigation Non-Expansion Areas (INAs). Within these areas there can be no new irrigated land, and owners of large wells are required to meter their water use and file annual reports with the Department. Otherwise, groundwater management in INAs is not highly structured.

1.3.2.1 Creation of the Active Management Areas and Irrigation Non-Expansion Areas

Upon enactment of the Code, four AMAs were established where overdraft was most severe: Phoenix, Tucson, Pinal, and Prescott. In 1994, the Santa Cruz AMA was created from the southern portion of the Tucson AMA. The Code also established two INAs: Douglas and Joseph City. A third INA, Harquahala, was designated by the director in June 1982. Figure 1-1 shows the location of the five AMAs and the three INAs. Groundwater management programs in AMAs are focused on the protection of groundwater supplies for current and future users. Programs in INAs are limited to a restriction on new agricultural lands and water measuring and reporting requirements. The Joseph City and Harquahala INAs are managed from the Phoenix AMA office.

1.3.2.2 The Management Goals

For three of the AMAs, Prescott, Tucson, and Phoenix, the management goal to be reached by the year 2025 or earlier is safe-yield. The attainment of this goal is expected to occur incrementally over the five management periods. However, it is clear that from a supply-availability perspective the goal will be easier to attain in the early years while Colorado River supplies are in surplus. Maintaining the safe-yield goal beyond 2025 may become more difficult over time as demand increases for municipal and industrial growth and renewable supply surpluses decrease.

To address the unique hydrologic nature of the Santa Cruz AMA, the goal identified for that AMA is to maintain safe-yield and prevent local water tables from experiencing long-term declines. In the Pinal AMA, where a predominately agricultural economy exists, the goal is to protect the agricultural economy as long as feasible and preserve water supplies for future non-agricultural purposes.

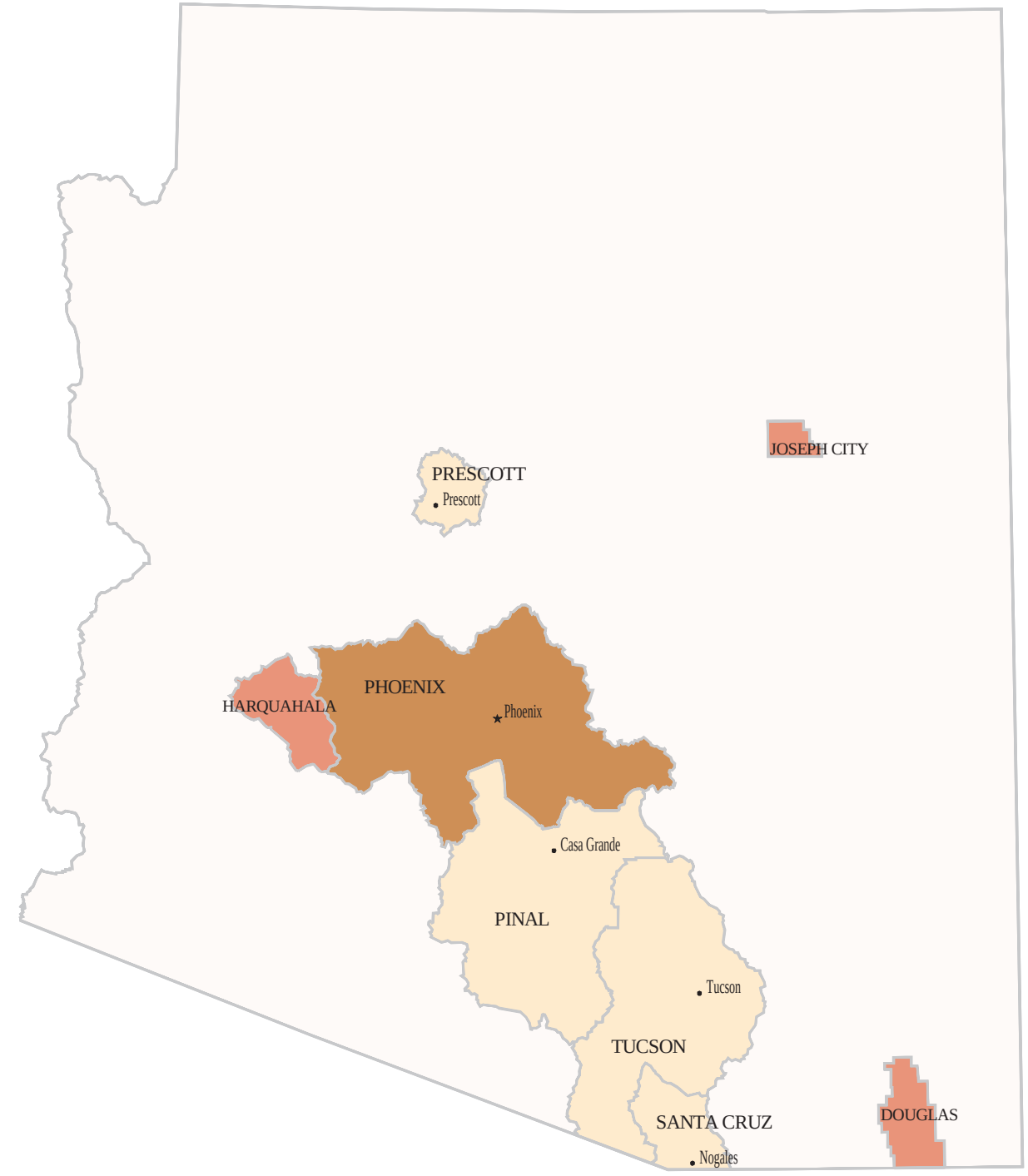


Figure 1- 1

Active Management Areas
and Irrigation Non-Expansion Areas

ORIGINAL SOURCE
Arizona Department of Water Resources
Geographic Information System

Achieving safe-yield, as defined in the Code, means "to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial groundwater recharge in the active management area." A.R.S. § 45-561(12). The volume of groundwater that can be withdrawn while maintaining a safe-yield condition in the AMA will not be a fixed amount; it will change due to annual variations in incidental recharge, natural recharge, and safe-yield recharge. If long-term water level trends (after adjusting for stored credits) show declining water tables on an AMA-wide average basis, groundwater withdrawals will have to be reduced and the safe-yield volume estimate adjusted accordingly. If long-term water levels rise (after adjusting for stored credits) above the level expected due to variations in incidental recharge, natural recharge, and safe-yield recharge, groundwater withdrawals may be increased. These evaluations of the impacts of withdrawals on long-term water levels could be made at regular intervals to ensure long-term groundwater level stability.

Information from annual water use reports is used to estimate the volume of groundwater withdrawals, water stored, and recovered water in an AMA. Water budgets are constructed to illustrate the total supply and demand picture. At the point in time where water budget estimates indicate groundwater withdrawals have been reduced to a safe-yield volume, groundwater levels will need to be monitored in the context of a hydrologic model to ensure that a safe-yield condition is maintained and to understand the effects of stored water. Hydrologic models can be used to predict changes in water levels based on projected groundwater pumping and credit recovery patterns and to verify assumptions in the water budget. The Department's subsidence monitoring and gravity surveys will be increasingly useful in verifying whether water level rises result from increases in storage or from changes in aquifer compaction over time.

Safe-yield is achieved on an AMA-wide basis; the Code does not recognize localized achievement of safe-yield. The amount of groundwater pumped under safe-yield conditions is not allocated on a subbasin or local basis. It is recognized that as safe-yield conditions are attained on an AMA-wide basis some areas could be depleted, some areas of active recharge could be in surplus, and other areas could achieve a localized balance between the amount of water recharged and pumped.

Since the development of the Second Management Plan, new information has become available regarding the physical availability and distribution of water supplies. For example, recent publications by the United States Geological Survey have heightened awareness of the potential for land subsidence in the AMAs. This improved understanding of the risks associated with ongoing pumpage in certain areas brings a new perspective to safe-yield. It is clear that a more site-specific, local resource management approach is needed. Additional tools may be required to develop a more resource-based, localized water management program.

During the third management period, a critical area management strategy will be evaluated that establishes additional water management goals for specific geographic areas within the AMA. These goals may relate to mitigation of subsidence, water supply reliability, water quality management, implementation of Indian water rights settlements, or other groundwater supply-related considerations.

1.3.2.3 Management Plans

To achieve the management goal for each AMA, water management requirements are established in each of the five management periods. The five management periods are:

First Management Period:	1980-1990
Second Management Period:	1990-2000
Third Management Period:	2000-2010
Fourth Management Period:	2010-2020
Fifth Management Period:	2020-2025

Requirements for each management period are described in separate management plans prepared for each AMA. Management plans include water conservation requirements for agricultural, municipal, and industrial groundwater users; a water quality assessment and management program; an augmentation and recharge program; conservation and augmentation assistance programs; and other management programs which define how the AMA will achieve its management goal. In each successive period, the preparation of a management plan provides the Department and AMA water users with the opportunity to analyze the effectiveness of water management efforts and address unresolved water issues in the AMA. Adjustments in water management strategies and conservation requirements are made in each successive plan to help achieve the management goals.

The First Management Plan (adopted at the end of 1984) was the first step toward a comprehensive and effective management program. The plan initiated conservation programs and focused attention on important water management issues. The Second Management Plan expanded on the conservation programs of the First Management Plan and initiated the integration of water augmentation into the AMA management strategy. The Second Management Plan placed a strong focus on the implementation of water conservation measures to achieve cost-effective levels of efficient water use. New programs for conservation and augmentation assistance were included as well.

Even after the implementation of two management plans, groundwater remains a significant source of supply for municipal, agricultural, and industrial uses. The total groundwater overdraft in the Phoenix AMA decreased from 597,000 acre-feet in 1985 to 360,019 acre-feet in 1995, but remains a significant problem.

The third management period constitutes the midpoint in Arizona's effort to achieve its groundwater management goals. After the end of the third management period in 2010, there will only be 15 years left to achieve safe-yield by 2025. The Third Management Plan must identify a water management strategy that encompasses the use of water conservation, augmentation, recharge, and water quality management by the agricultural, municipal, and industrial sectors to achieve the safe-yield goal. Further, the plan must prescribe those actions and programs necessary to achieve the water management strategy during the third management period. All water users must continue to commit to using available water supplies efficiently and to making additional use of renewable supplies to replace existing groundwater use and to meet growing water demands.

Water conservation requirements in the Second Management Plan provide the basic structure of the requirements to be applied during the third management period. Incentives for renewable resource utilization remain. Perhaps the most significant component of the Third Management Plan is the identification of the water management issues requiring resolution during the third management period that are preconditions to safe-yield attainment. In addition, the Third Management Plan introduces the proposal to address water management issues from a local area perspective. The Third Management Plan describes the developing role the Department and the water-using community must play in meeting water management objectives. It also addresses the resources and commitment needed from both the Department and water users to achieve the safe-yield goal.

1.3.2.4 Assured Water Supply Program

The Assured Water Supply Program (AWS Program) plays a key role in achievement of the management goal, since it requires what will soon be the largest water use sector to move from dependence on mined groundwater to the use of renewable supplies. The Code prohibits the sale or lease of subdivided land in an AMA without the demonstration of an assured water supply. The AWS Program was instituted in 1980, but substantially strengthened in 1995 with the adoption of the Assured Water Supply Rules (AWS Rules). Under these AWS Rules, new development within an AMA must demonstrate that sufficient water supplies of adequate quantity and quality are available to meet the proposed new development uses for 100

years. Only after demonstration of a sufficient water supply can a development be approved for sale to the public. AWS Rules apply to developers who seek a Certificate of Assured Water Supply (Certificate of AWS) for an individual subdivision and to water providers (cities, towns, and private water companies) seeking a Designation of Assured Water Supply (Designation of AWS). A Designation of AWS results from a demonstration that there are adequate water supplies available to the water provider to meet current and future demands on their entire system for 100 years. While exclusive use of groundwater was allowed historically (pre-1995) to demonstrate an assured water supply, the new AWS Rules require that water supplies used to demonstrate an assured water supply must be renewable water sources such as surface water, effluent, imported groundwater, credits from extinguishment of groundwater rights, and water stored pursuant to an underground storage project. However, some groundwater is allowed in the demonstration through the groundwater phase-in allowance.

1.3.2.5 Revisions to the Groundwater Code

Since 1980, the Code has undergone numerous changes to address emerging water management issues. Sections have been added to limit use of water in artificial lakes, address underground storage and recovery of water, limit transfer of groundwater between groundwater basins statewide, establish groundwater replenishment districts, establish the water conservation assistance program, and to provide alternative municipal and agricultural conservation programs. In addition, numerous changes have been made to expand or clarify previous language and to deregulate small groundwater users.

Throughout this process, the fundamental concepts of allocating the right to use groundwater and planning for the efficient and economic use of the water have been preserved. The Code, as comprehensive as it is, does not contain detailed instructions on how to manage water resources. Instead, it provides a framework from which water management decisions are made in the AMAs. It is up to the Department and water users, through the development and implementation of the management plans, to establish the management strategies that lead to achieving safe-yield and related management goals.

1.4 GOVERNMENTAL AND INSTITUTIONAL SETTING

Water management activities within the Phoenix AMA are carried out by a number of entities. City, county, and regional governmental functions include flood control, water supply and wastewater management, water quality management, and planning and zoning. Several user groups, advisory committees, citizens' groups, and other organizations play significant roles in developing legislative and policy guidelines and educational programs relating to water use and conservation. The Groundwater Users Advisory Council (GUAC) advises the director of the AMA and the director of the Department on issues relating to groundwater management in the AMA.

The Arizona Municipal Water Users Association (AMWUA) is a planning and lobbying group that addresses water resource issues of the larger municipalities in the Phoenix metropolitan area.

The West Valley Central Arizona Project Subcontractors (WestCAPs) is a group of community leaders that evaluate water resource issues and plan for the needs of the western Phoenix metropolitan area.

The Northwest Valley Water Resource Advisory Board, created in 1996, provides a forum to examine water issues facing the Sun Cities.

The Agri-Business Council (ABC) is a lobbying group representing agricultural interests in the state.

The Central Arizona Water Conservation District (CAWCD), also known as the Central Arizona Project (CAP), is a multi-county governmental agency that was formed to reimburse federal CAP canal construction costs, operate the CAP canal, and deliver CAP water to users in AMAs. The CAWCD is

overseen by an elected board of 15 members, which represents the three-county service area of the district. The Central Arizona Groundwater Replenishment District (CAGRD) is a tax-exempt public improvement district authorized by state legislation to acquire water supplies to replenish aquifers depleted by district members. It is an organizational unit of the CAWCD and is overseen by the CAWCD board.

The Arizona Water Banking Authority (AWBA) was created in 1996, primarily to ensure that Arizona's municipal and industrial allocations of Colorado River water will be protected in times of shortage. The AWBA uses several funding sources to buy excess CAP water and recharge it for the future benefit of users both inside and outside of the CAP service area. The AWBA is authorized to store water to support the management objectives of the AMAs and to engage in interstate water banking under specific conditions. The AWBA has a five-member appointed board chaired by the director of the Department. The AWBA staff are housed in the Department's offices.

The Arizona Water Protection Fund (AWPF) was established in 1994 to provide grant monies for implementation of projects to protect or restore the state's riparian areas. The AWPF may be used to purchase CAP water or effluent for riparian enhancement. The AWPF Commission oversees the grants process; the director of the Department serves as an ex-officio member on the Commission and the staff are located within the Department.

At the state level, the Arizona Department of Environmental Quality (ADEQ) develops and enforces water quality regulations. Through recent legislation (amending provisions of the Water Quality Assurance Revolving Fund, or WQARF), the Department and ADEQ jointly participate in specified activities related to protection of groundwater quality and remediation.

The Arizona Corporation Commission (ACC) regulates the activities of private water companies, particularly those related to rate-setting.

The Arizona Department of Real Estate works with the Department to assure availability of water for new subdivisions under the AWS Rules.

Federal water management activities in the Phoenix area include the Bureau of Reclamation's involvement in regional water supply planning and participation in negotiations to provide water resources to Indian communities on behalf of the Secretary of the Interior. Additional federal water management activities include Army Corps of Engineers' studies, the Environmental Protection Agency's Superfund program, and the National Pollutant Discharge Elimination System permit program. The United States Geological Survey works independently and in conjunction with the Department in the collection and analysis of hydrologic and subsidence-related data and flood warning information.

The Gila River Indian Community, Salt River Pima-Maricopa Indian Community, and Fort McDowell Indian Community are also actively involved with issues related to the use of groundwater and renewable water supplies. These communities are governed by their respective tribal councils and, similar to municipalities or counties, have responsibility for water and wastewater management, planning, and zoning.

1.5 DEVELOPMENT OF THE THIRD MANAGEMENT PLAN

Preparation of the Third Management Plan has been guided by a set of overriding principles and specific objectives. These principles and objectives and the specific contents of the plan chapters are described below.

1.5.1 Guiding Principles for Program Development

The Code provides the Department with many management tools that vary in their flexibility and approach. In addition to the Code, general management principles have been developed to guide the operations of the Department and the preparation of the Third Management Plan. These are:

- **The authorities granted to the Department must be integrated into a comprehensive strategy for meeting the management goals of the AMA.** Numerous tools are provided by the statutory structure to assist in meeting water management objectives. These tools include: (1) water rights components of the Code, (2) assured water supply provisions, (3) underground storage and recovery provisions, (4) permitting requirements and conditions, (5) authority to develop well-spacing rules, (6) AWBA and AWPF programs, (7) conservation and augmentation assistance programs, and (8) water use reporting and enforcement authorities. All of these activities must be integrated and focused toward meeting the goal.

- **Effective water management must include both supply augmentation and demand management programs.** Supply augmentation includes substitution of renewable supplies for non-renewable groundwater resources, storage of excess renewable water for future use, utilization of effluent, and meeting new demands with renewable supplies. The major focuses of demand management are water conservation and restrictions on certain users such as lakes, which extend the availability of existing water supplies to serve more uses over a longer time frame.

- **Effective and efficient water management must establish a long-term perspective and be regional in scope.** The Department is responsible for ensuring sustainable supplies for future generations. If possible, safe-yield should be achieved sooner than 2025, and efforts to ensure that the goal can be maintained after 2025 should be required.

- **Water users must have an integral role in management program development and implementation.** Water users with expertise in their own water use sector must play a major role in development and implementation of water management programs to ensure the success of these programs.

- **All water sources need to be included in any long-term, comprehensive water management strategy.** As groundwater use reductions are dependent on the efficient utilization of groundwater and non-groundwater sources of water, the eventual inclusion of all sources of water in the development of water management programs is essential.

- **Water management efforts must consider economic impacts and feasibility.** Attaining water management goals requires the expenditure of public and private funds that must be used as effectively and efficiently as possible. Therefore, water management strategies must be developed using sound economic principles.

- **Educating the public on water issues and involving the public in developing management programs is essential to building and sustaining an effective water management effort.** It is ultimately the members of the public who are asked to accept and commit to implementing water management strategies. It is essential to provide them with the information they need to become and stay informed and to provide them with the opportunity to participate in developing water management programs.

- **Water management efforts should be consistent with, and enhance, the quality of life in the community.** Those of us who live in the State of Arizona and within AMAs will be the beneficiaries of wise water management. Social values and environmental quality considerations

are integral to the development of water management approaches in Arizona. Adverse impacts on the quality of life and the potential for economic development must be avoided to the greatest extent possible.

- **Water supplies available today must be used to meet the needs of the future.** Excess effluent and CAP water available during the third management period must be managed to meet growing AMA demands and to provide adequate supplies during future water shortages. Underground storage of effluent and excess CAP water by the AWBA and by AMA water users is an important component of successful water management.

- **Water management programs should provide a stable institutional framework that creates an environment of certainty in water resource decision-making.** Groundwater right holders, individual water use customers, and the development community are key decision-makers who must commit to, and implement, long-range plans in a world of evolving regulations. The provision of a predictable framework within which these programs will evolve reduces the uncertainty for the community and increases the likelihood of success. Additionally, management programs must be clearly understood and free of ambiguity.

- **Local water management issues must be addressed as regional and statewide strategies are developed.** There must be recognition of the impacts that regional or statewide water management programs can have on local water users, as well as the ability to identify and assist in developing programs designed to specifically address local area water management problems.

- **Water management programs should be based on the premise that the future issues are unlikely to be the same as those we have encountered in the past, and that the pace of change is likely to increase.** In order to provide maximum flexibility for the future, databases must be enhanced and tools developed to identify trends early and to test scenarios that vary from current conditions.

1.5.2 Third Management Plan Objectives

The following objectives must be achieved during the third management period to develop the necessary management tools.

- The Department will establish and implement Third Management Plan water conservation requirements and groundwater replenishment requirements equitably among all groundwater users.

- The Department will maintain Second Management Plan conservation efforts which were effective, expand them where appropriate, and will recognize existing conservation efforts in setting Third Management Plan conservation standards.

- The Department will be flexible when addressing unique circumstances associated with conservation program compliance.

- The Department will provide financial and technical assistance to implement water conservation, augmentation, and monitoring programs that are beneficial to the AMA.

- The Department will expand public assistance and public education efforts to reach a larger portion of the public.

- The Department will provide incentives to encourage water conservation that are consistent with water management objectives.

- The Department will strive to take maximum advantage of excess renewable water supplies while the opportunities exist.

- Department staff will actively participate in regional and local water management planning and cooperative projects.

- The Department will encourage recharge activities in areas where storage of renewable supplies will be beneficial from a water management perspective. Management of both storage and recovery activities will be required to protect future water supplies and the storage capacity of the aquifers.

- The Department will collect, analyze, and maintain data to provide the information necessary to identify water management issues and propose appropriate and timely solutions.

- The Department will encourage coordination between the many agencies that affect water policy, particularly activities of the AWBA, the CAWCD, CAGRD, ACC, and ADEQ.

- The Department will endeavor to enhance water quality management efforts to preserve the quality and quantity of water available for existing and future needs.

- The Department will work with the state's political leadership, water users, and the public to identify and develop the tools and additional statutory authority necessary to achieve water management goals and objectives, including reaching safe-yield by 2025.

1.5.3 Third Management Plan Development Process

1.5.3.1 Program Development and Implementation

This Third Management Plan is the result of a three-staged work effort that began in 1994. The first stage involved data collection and analysis culminating in development of a "State of the AMA" (SOAMA) assessment. In the second stage, issues identified in the SOAMA assessment and those raised by the community were addressed in issue papers describing background information and identifying recommended alternatives to address the issues. The third stage involved developing recommended alternatives into program concepts and, ultimately, into the program components presented in the Third Management Plan. Throughout preparation of the Third Management Plan, public input and technical research have been used to identify issues, objectives, and solutions.

1.5.3.2 Public Participation

Multiple levels of public input have been utilized in the development of the Third Management Plan. The Code established a five-member GUAC for each AMA. AMA directors and staff have met regularly with the GUAC to obtain member opinions and recommendations on all components of this plan. These meetings were open to the public, and interested groups and individuals communicated their views and recommendations in this forum. Pursuant to A.R.S. § 45-421(1), the GUAC must comment on the proposed management plan before it is promulgated.

The Department also consulted with numerous technical advisory committees (TACs) comprised of technical experts, water providers, industry representatives, agricultural representatives, scientists, and other organizations and individuals concerned with water use and water resource issues. These TACs were established to review material and identify issues in the following areas:

- Municipal (Phoenix and Tucson AMAs)
- Agriculture (Phoenix, Pinal, and Tucson AMAs)
- Turf-related Facilities (Phoenix and Tucson AMAs)
- Metal Mining Facilities (Tucson AMA)
- Sand and Gravel Facilities (Joint committee for the Tucson, Phoenix, and Pinal AMAs)
- Large-scale Power Plants and Cooling Facilities (Joint committee for the Tucson and Phoenix AMAs)
- Dairy and Feedlot Operations (Joint committee for the Tucson, Phoenix, and Pinal AMAs)
- Augmentation and Recharge (Phoenix and Tucson AMAs)

The TACs met over approximately a two-year period, and members spent considerable time reviewing data, discussing issues, and assisting in developing regulatory programs. Participation by the TACs was critical in development of the management plan. Technical review was also provided by outside committees and experts on the water quality, water resources, and water budget chapters. Public comments were received in meetings with interested parties and during and following presentations to civic organizations and the general public. The Department's philosophy is to maximize public input on the content of the management plans to ensure that the public's concerns and ideas are adequately incorporated.

Additional public input was obtained through public hearings conducted pursuant to A.R.S. § 45-570. In these hearings, the Department presented information in support of the plan and obtained comments regarding the plan. Before the plan was adopted, the Department's director reviewed all written and oral comments submitted as part of the hearing process, made revisions to the plan when warranted, and prepared a written response.

1.6 THIRD MANAGEMENT PLAN CONTENT

The Third Management Plan addresses water conservation, water augmentation, water quality, and related water management programs for the years 2000 to 2010, and comprises the following primary elements:

- Assessment of the status of water supplies and demands in the AMA
- Mandatory conservation requirements for agricultural, municipal, and industrial groundwater users and groundwater distribution systems
- Water supply augmentation and recharge program
- Water quality assessment and management program
- Conservation, augmentation, and monitoring assistance program
- Future directions for third management period (2000 to 2010)

Statutory guidelines provided in A.R.S. §§ 45-566 and 566.02 direct that the following components be included in the Third Management Plan:

- New irrigation water duties for each farm unit
- An alternative agricultural program for Irrigation Grandfathered Right holders
- Additional reasonable reductions in per capita use to those specified in the Second Management Plan for municipal providers
- A Non-Per Capita Conservation Program for municipal providers
- Appropriate conservation measures for individual users on municipal systems
- Conservation or rate-of-use requirements for deliveries of untreated water
- Reasonable conservation requirements for small municipal providers
- Additional economically reasonable requirements for groundwater distribution by cities, towns, private water companies, and irrigation districts

- Conservation requirements for industrial uses based on latest commercially available conservation technology consistent with reasonable economic return
- A program for additional augmentation of water supplies by AMAs, including incentives for artificial groundwater recharge
- Cooperation with the Arizona Department of Environmental Quality in developing a groundwater quality assessment for the AMAs, including suggestions for groundwater protection
- A program for conservation assistance to water users within the AMA
- At the discretion of the director, a program subsequent to January 1, 2006 for the purchase and retirement of grandfathered rights
- A determination of historic annual net recharge for AMAs in which a groundwater replenishment district is located
- Recommendations to the Arizona Water Banking Authority regarding storage capacities within the AMA, priority storage locations, and extinguishment of long-term storage credits

In addition, the Department will describe in the Third Management Plan the water management issues emerging in the AMA and the programs or changes in statute or rule that may be required to resolve these issues.

The Third Management Plan contains a great deal of information on water use characteristics, water supply and demand projections, water quality, local water management issues, needs for water supply augmentation, and the Department's management approach to these issues. This information is provided to explain the plan's development, educate interested individuals regarding the water management issues facing the AMA, and develop future water management policies for the AMA. Throughout the document significant policy statements exist regarding how the Department proposes to manage the AMA's water supplies pursuant to the provisions of the Code and the provisions of this plan. The regulatory requirements for groundwater users and water distribution systems are printed in italics for easy reference and are located at the end of Chapters 4 and 5 and after each industrial use sector in Chapter 6. Chapters 8 and 9 contain eligibility criteria for underground storage and recovery facilities and for conservation, augmentation, and monitoring assistance projects.

1.7 EMERGING CHALLENGES FOR THE PHOENIX AMA

Several major challenges are emerging as the AMA moves into the third management period. They are:

- The amount of groundwater pumping allowed under the Code, the Second Management Plan, and the AWS Rules through grandfathered rights, groundwater withdrawal permits, designated and undesignated providers, and untreated providers creates a significant obstacle toward our efforts to achieve safe-yield. The burden of reducing mined groundwater does not apply proportionately or equitably to all water-using sectors.

- Groundwater and non-groundwater sources are managed under different statutes with limited integration and consistency in approach. In a rapidly growing AMA with multiple water sources, sound management of only one source may be problematic.

- During times of water surpluses (excess/surplus CAP and excess effluent), a water management strategy should be implemented that is progressive and responsible. Either direct use of surplus renewable supplies or recharge should be actively pursued, while the Department continues to require reasonable use efficiencies. In later years, these excess supplies will be fully utilized and current surpluses may turn to shortages. Stabilizing our supplies through conversion from groundwater to excess/surplus renewable supplies and maximizing our supplies through conservation should be emphasized.

- The Phoenix AMA is characterized by divergent water use patterns and divergent groundwater conditions. Municipal and industrial growth is occurring at nationally recognized rates, while agricultural demand has and will continue to moderately decline. While the AMA in general continues to record significant groundwater level declines, certain areas within the AMA are experiencing declines so severe that they restrict the potential for further growth and development. Other limited areas are exhibiting water-logging conditions that cause other types of problems. While recognizing that the goal of the Phoenix AMA is to achieve safe-yield on an AMA-wide basis, localized water management may be necessary to fully achieve the Code's stated policy of "protecting and stabilizing the general economy and welfare of this state and its citizens." A.R.S. § 45-401(B).

1.8 CONCLUSION

Much has been accomplished in the area of water management during the second management period. Conservation is incorporated into the programs of more water users than ever before. Augmentation of traditional water sources has concentrated on accelerated CAP importation, full utilization of other surface water, and greater utilization of effluent. Conversion from groundwater to renewable resources has been required by AWS Rules and aided through the proliferation of groundwater recharge projects and wetlands, and the formation of the CAGRD and the Arizona Water Banking Authority. Financial and technical assistance in the areas of conservation and augmentation, provided by the Department to water users, has provided needed resources and research to carry out various beneficial programs. The Third Management Plan represents continuation and expansion of programs found to be successful in the First Management Plan and Second Management Plan, as well as additional efforts to encourage conservation, augmentation, and conversion to renewable resources.

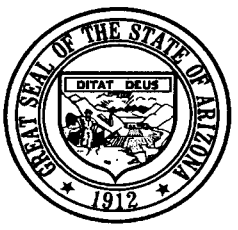
These efforts alone, although impressive, will not result in the attainment of the safe-yield goal. Based on this conclusion, the Third Management Plan identifies unresolved issues, the obstacles to their resolution, and the direction we must take during the third management period and beyond to meet the mandates of the Code.

The Third Management Plan is designed to present the Department's blueprint for working with water users and policy-makers to achieve the Phoenix AMA's water management goals and objectives. Continued commitment will be needed from the Department, the water-using community, and the public. With this support, the Department can respond to changing water issues and needs while maintaining a management structure that ensures a dependable water supply for Arizona's future.

CHAPTER

2

Overview of Water Resources



2.1 INTRODUCTION

This chapter provides an overview of the physical, climatic, and demographic characteristics that shape water use in the Phoenix Active Management Area (AMA), as well as a description of the four main water supplies available to the AMA:

- groundwater
- surface water, primarily from the Salt, the Verde, the Agua Fria, and the Gila Rivers
- Central Arizona Project (CAP) water
- effluent or treated wastewater

To achieve safe-yield in the Phoenix AMA by 2025, it is necessary to increase the use of renewable water supplies and decrease groundwater withdrawals in conjunction with efficient water use. Each of these water sources has characteristics that limit the volumetric and geographic availability of the usable supply. The amount of groundwater present within water-holding alluvial deposits underground is vast. However, most groundwater is too deep to be pumped efficiently. In addition, manmade and natural causes have rendered much groundwater of insufficient quality for many uses without costly treatment. Historically, the greatest pumping of groundwater has occurred in many areas where groundwater of sufficient quality is readily accessible to groundwater right holders. This has often led to drops in groundwater levels and occasionally, land subsidence and earth fissures in those areas. Artificial recharge of the aquifers may mitigate depletion, but excessive pumping can cause permanent compaction of the aquifer and its water storing capacity.

Flows of surface water from the Salt, the Verde, the Agua Fria, and the Gila Rivers have long been stored in reservoirs for users downstream. Only portions of the AMA have users with land who have appropriated rights to surface water. Large areas, including many municipal, agricultural, and industrial users, are ineligible to receive surface water. Despite the control over supply afforded by the regulatory storage reservoirs, surface water availability is variable from year to year. Annual surface water flows vary greatly with weather patterns. In years of drought, insufficient surface water is often augmented by pumping additional groundwater. Since 1985, CAP water has been delivered by aqueduct from the Colorado River. Although use has increased rapidly, high costs and lack of infrastructure have hindered direct use. Effluent or treated wastewater is an underutilized supply in the AMA. Generally, effluent is used for non-potable uses such as landscape watering. Effluent has the potential to replace potable supply when potable water is not necessary for the use. Currently, however, the AMA's largest treatment facility is located downstream from most users and a portion of the effluent produced at the facility flows out of the AMA.

2.2 OVERVIEW OF ACTIVE MANAGEMENT AREA CHARACTERISTICS

The Phoenix AMA is located in central Arizona and is one of the five AMAs mandated by the Groundwater Code (Code). The Pinal, Prescott, Santa Cruz, and Tucson AMAs are the others. The Phoenix AMA covers 5,646 square miles and consists of seven groundwater subbasins (Figure 2-1). They are the East Salt River Valley (East SRV) Subbasin, the West Salt River Valley (West SRV) Subbasin, the Rainbow Valley Subbasin, the Hassayampa Subbasin, Lake Pleasant Subbasin, Carefree Subbasin, and the Fountain Hills Subbasin. The AMA is in the basin and range physiographic province, which is characterized by broad, gently sloping alluvial plains separated by predominately north to northwest trending mountains. Elevations range from less than 800 feet above mean sea level (msl) at Gillespie Dam to over 6,000 feet above msl in the Superstition Mountains in the eastern portion of the AMA.

The Phoenix AMA is drained by the Gila River and four principal tributaries: the Salt, the Verde, the Agua Fria, and the Hassayampa Rivers. Other tributaries include Queen Creek, New River, Skunk Creek, Cave Creek, Waterman Wash, and Centennial Wash. Regulatory water storage reservoirs have been

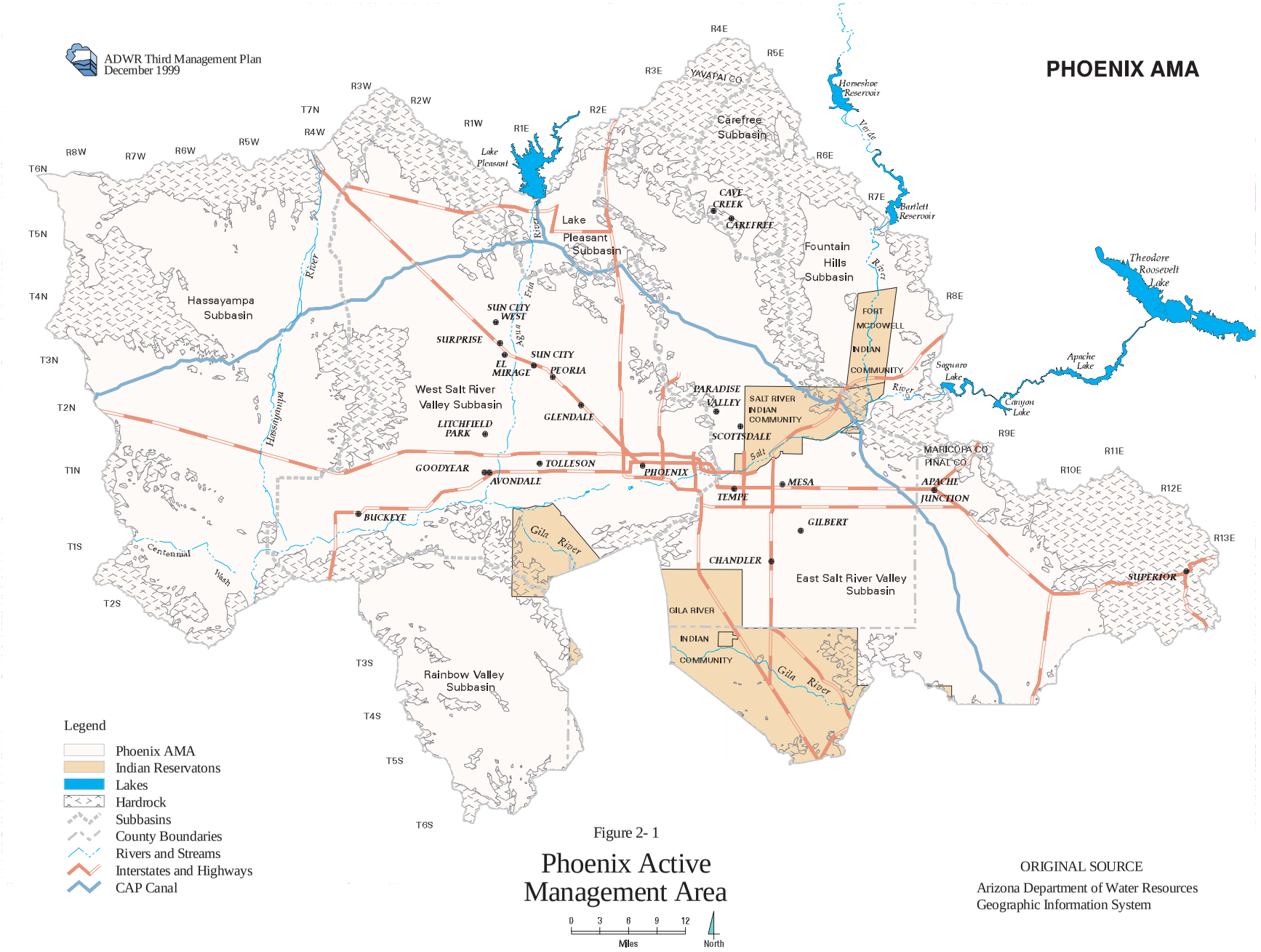


Figure 2- 1

Phoenix Active Management Area

ORIGINAL SOURCE

Arizona Department of Water Resources
Geographic Information System

constructed on the Salt, Verde, and Gila Rivers and for the Agua Fria River, allowing for a relatively high proportion of surface water use in some areas of the Phoenix AMA. Figure 2-1 shows the major rivers and washes in the AMA. All of the streams and washes within the AMA are ephemeral either naturally or due to upstream diversion. The Gila and Salt Rivers have sustained flow in their lower reaches due to return flows from nearby agricultural areas and discharges from wastewater treatment facilities.

Water may be transported within the AMA by canals and pipelines from points of diversion or from withdrawal to principal users. Groundwater withdrawn from adjacent wells; surface water diverted from the Gila, Salt, Verde, and Agua Fria Rivers; water from the CAP aqueduct; and, in some cases, effluent are all transported by canals and pipelines. Major canals include the Arizona Canal, Grand Canal, Beardsley Canal, Buckeye Canal, Arlington South Extension, Western Canal, Highline Canal, South Canal, Consolidated Canal, Eastern Canal, and the Roosevelt Water Conservation District Canal. The CAP aqueduct, transporting water from the Colorado River, cuts across the AMA from west to east. Pipeline distribution systems that connect with the canals and the CAP aqueduct have been developed by the larger municipalities and private water companies of the Phoenix metropolitan area. In certain instances, the water distribution systems interconnect with each other. Separate, dedicated pipelines to transport untreated CAP water or effluent have also been developed by several water providers in the AMA.

2.2.1 Climate

Located primarily in subtropical desert, the climate of the AMA is semi-arid. Long-term average temperature and precipitation are relatively uniform throughout the AMA due to the low topographic relief. Differences in elevation account for most variations.

The AMA has hot summers and mild winters. During July, the hottest month, daytime high temperatures are generally between 100° F and 110° F, with nighttime lows usually between 75° F and 85° F. January, the coolest month, generally has daytime high temperatures between 60° F and 70° F. Nighttime lows are usually between 35° F and 45° F.

Annual precipitation is limited, averaging seven to eight inches across the AMA, although higher elevations receive more rainfall. There are two distinct precipitation periods during the year, both of which are erratic and variable from year to year. In July and August, tropical air from the Gulf of Mexico is carried to the AMA by upper level winds from the southeast, frequently resulting in thunderstorms. Heavier late summer rains sometimes result from tropical storms moving north along the Sierra Madre of Mexico. During the winter months, precipitation comes from storms originating in the northern Pacific carried southward and eastward by the jet stream across the continent. Winter precipitation is generally less intense but is more widespread and of longer duration than summer precipitation. Spring runoff from melting winter snow along the Mogollon Rim and in the White Mountains north and northeast of the AMA provides most of the surface water collected by the major regulatory storage reservoirs for use in the AMA.

Since records have been kept by the National Weather Service weather station in Phoenix, annual precipitation has ranged from less than 3 inches to nearly 20 inches. Prolonged periods of relatively wet or dry weather are common. Extensive droughts have occurred in the early 1900s, 1930s, and 1950s. Many shorter drought periods have occurred since records have been kept from the 1890s. During years of winter drought, less snowpack in the Salt, the Gila, and the Verde River watersheds results in less runoff into regulatory water storage systems on these rivers. This reduces surface water availability in the AMA during those periods, resulting in higher groundwater pumping to make up for the surface water shortage.

Average annual evapotranspiration (vegetative water loss from plant transpiration and soil evaporation) is approximately 79 inches per year (Arizona Meteorological Network, 1998). Despite late summer rains, summer is the period of greatest evaporation potential and peak water demand for irrigation of landscapes, crops, and golf courses.

2.2.2 Demographic, Economic, and Land Use Characteristics

The Phoenix AMA includes large portions of Maricopa County and smaller sections of Pinal and Yavapai Counties. Most of the area is undeveloped, remaining in native desert habitat. Urban and agricultural development within the AMA is concentrated in the East SRV and West SRV Subbasins. Phoenix, the state's largest city, and its surrounding metropolitan area, the largest and most populous urban area in Arizona, are centrally located in the AMA. The densely populated urban area extends several miles east and west of Phoenix and includes the cities of Mesa, Glendale, Scottsdale, Tempe, Chandler, Peoria, Gilbert, Goodyear, and many smaller communities. Outside the East SRV and West SRV Subbasins, most of the remaining population in the AMA inhabit outlying areas of metropolitan Phoenix, which extends into the Fountain Hills Subbasin (Town of Fountain Hills) and the Carefree Subbasin (the communities of Carefree and Cave Creek). Urban population growth in the AMA has been rapid since World War II. During the 1990 to 1995 period, the population of the AMA grew from 2,133,915 to 2,549,931 and is expected to grow to 4,482,876 by the year 2025.

Extensive agricultural development is located primarily in the central and southern East SRV Subbasin and the central and southern portions of the West SRV Subbasin. Localized areas of agricultural development are located in the southern portion of the Hassayampa Subbasin and the northern portion of the Rainbow Valley Subbasin. All crops grown in the AMA require irrigation.

In addition to agriculture, other industries that make up the Phoenix AMA's economy include tourism and recreation, power generation, manufacturing, government, health, and research. Each of these industries, along with the area's municipalities and agriculture, depends upon groundwater resources to varying degrees.

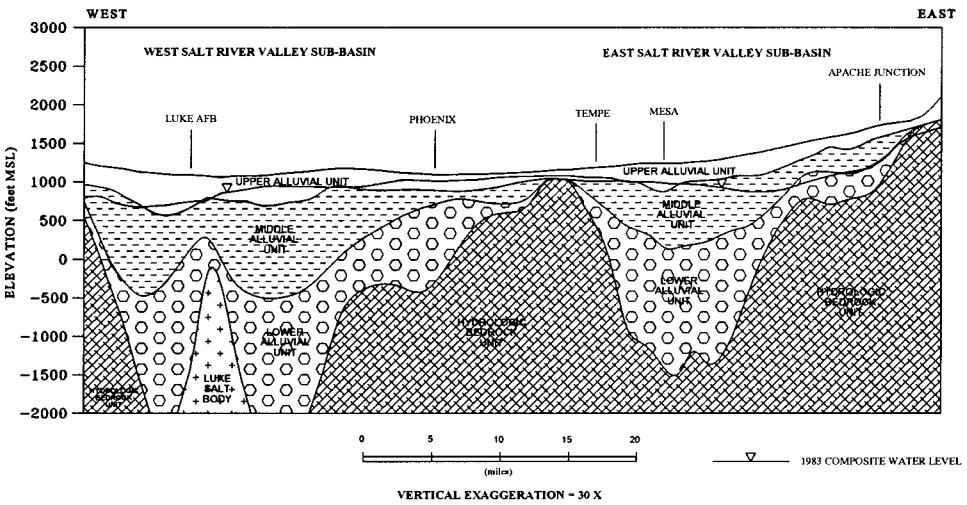
2.3 GROUNDWATER

There are seven groundwater subbasins in the AMA: the East Salt River Valley Subbasin, the West Salt River Valley Subbasin, the Hassayampa Subbasin, the Rainbow Valley Subbasin, the Fountain Hills Subbasin, the Lake Pleasant Subbasin, and the Carefree Subbasin. Each subbasin has its own unique hydrogeologic characteristics, and a number of factors influence groundwater conditions in each. These include groundwater inflow and outflow, depth to groundwater, withdrawals and recharge, surface water conditions, subsidence potential, and quality of groundwater in different locations. The use of renewable water supplies is one of the most important factors in counteracting groundwater declines in the AMA.

The primary sources of groundwater in the Phoenix AMA are basin-fill sediments. While the basin-fill sediments that underlie much of the AMA are extremely heterogenous, three distinct water bearing units are identified for most of the subbasins of the AMA: an upper alluvial unit, a middle fine-grained unit, and a lower conglomerate unit. These units are illustrated in Figure 2-2, which shows a hydrogeologic cross-section with exaggerated vertical scale running west to east across the East SRV and West SRV Subbasins. Although conditions and circumstances vary across the AMA, most groundwater is pumped from the middle alluvial unit. At ideal locations, large capacity wells in the basin-fill sediments can yield up to a few thousand gallons of water per minute. Bedrock, consisting of various metamorphic and igneous rock, underlies the basin-fill sediments. The bedrock has little groundwater storage or production capacity and is not considered to be an aquifer.

Groundwater conditions change over time due to natural and human-induced fluctuations in the amount of water being added or removed. Because groundwater flows very slowly underground, the effects of pumping and recharge can alter the shape of the water table for long periods of time. Water that is naturally or artificially recharged can mound up underground, while pumping can create a cone of

FIGURE 2-2
SCHEMATIC DIAGRAM OF THE SALT RIVER VALLEY SUBBASINS
PHOENIX ACTIVE MANAGEMENT AREA



depression in the water table. Major changes in water level elevations occurred after the development of more effective well technology in the 1940s. The new well pumps allowed a much greater volume of groundwater to be pumped than had been possible earlier. These conditions are occurring in the Phoenix AMA and are described according to each subbasin in the following sections. Figures 2-3 through 2-6 are among several types of maps used to illustrate groundwater conditions in the Phoenix AMA. These are based on the location of the water table–the "surface" of the layer of groundwater–relative to either land surface, sea level, or the water table at a different point in time. When this information is known for a number of wells in an area, contour lines can be drawn around areas with similar conditions. Depth-to-water maps indicate the distance from the surface of the land to the top of the water table at different locations in the AMA. Water level elevation maps are used to show the level of the water table relative to a fixed reference point: mean sea level. The slope of the water table and the direction of groundwater flow can be determined using a water level elevation map. Water level change maps show areas where the water table has fallen or risen during a given time period.

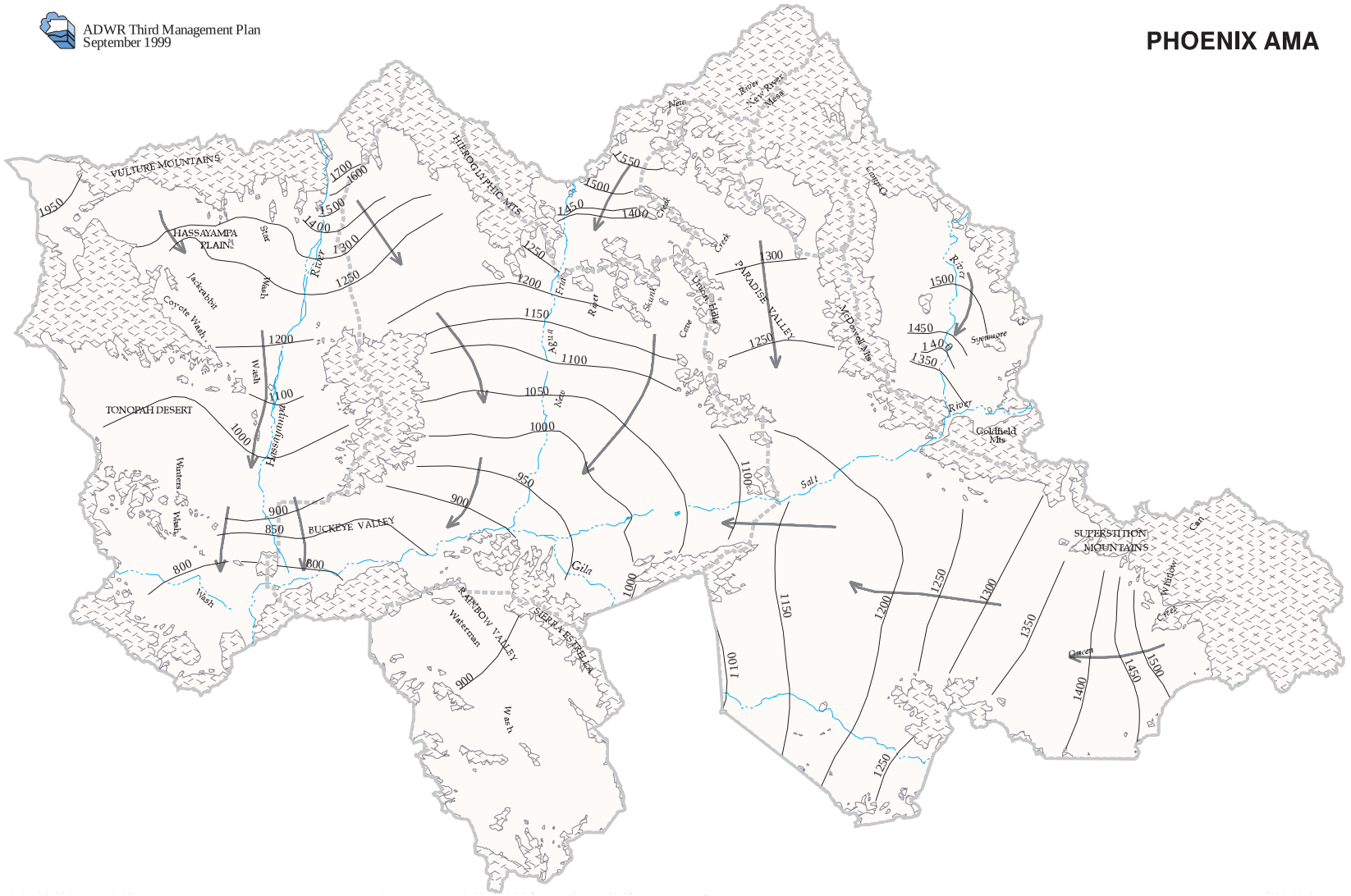
Figure 2-3 shows 1900 water level elevations above msl, changes in water level elevations from 1900 to 1998 are shown on Figure 2-4, and 1998 water level elevations and depth to water below land surface are shown on Figures 2-5 and 2-6, respectively.

2.3.1 Data Sources

Data sources from within the Department and from outside sources are used to evaluate groundwater conditions. The Department's Land Subsidence and Aquifer Storage Unit is a newly established unit of the Hydrology Division. The unit has recently conducted a baseline Global Positioning Survey of land surface elevation in the Apache Junction area. In the future, the unit will establish land subsidence and aquifer storage monitoring networks in the Phoenix, Pinal, and Tucson AMAs.

ADWR Third Management Plan
September 1999

PHOENIX AMA



Phoenix AMA Boundary
Water Elevation Isolines (Feet Above Mean Sea level)
Hardrock
River
Groundwater Subbasins
Direction of Groundwater Flow

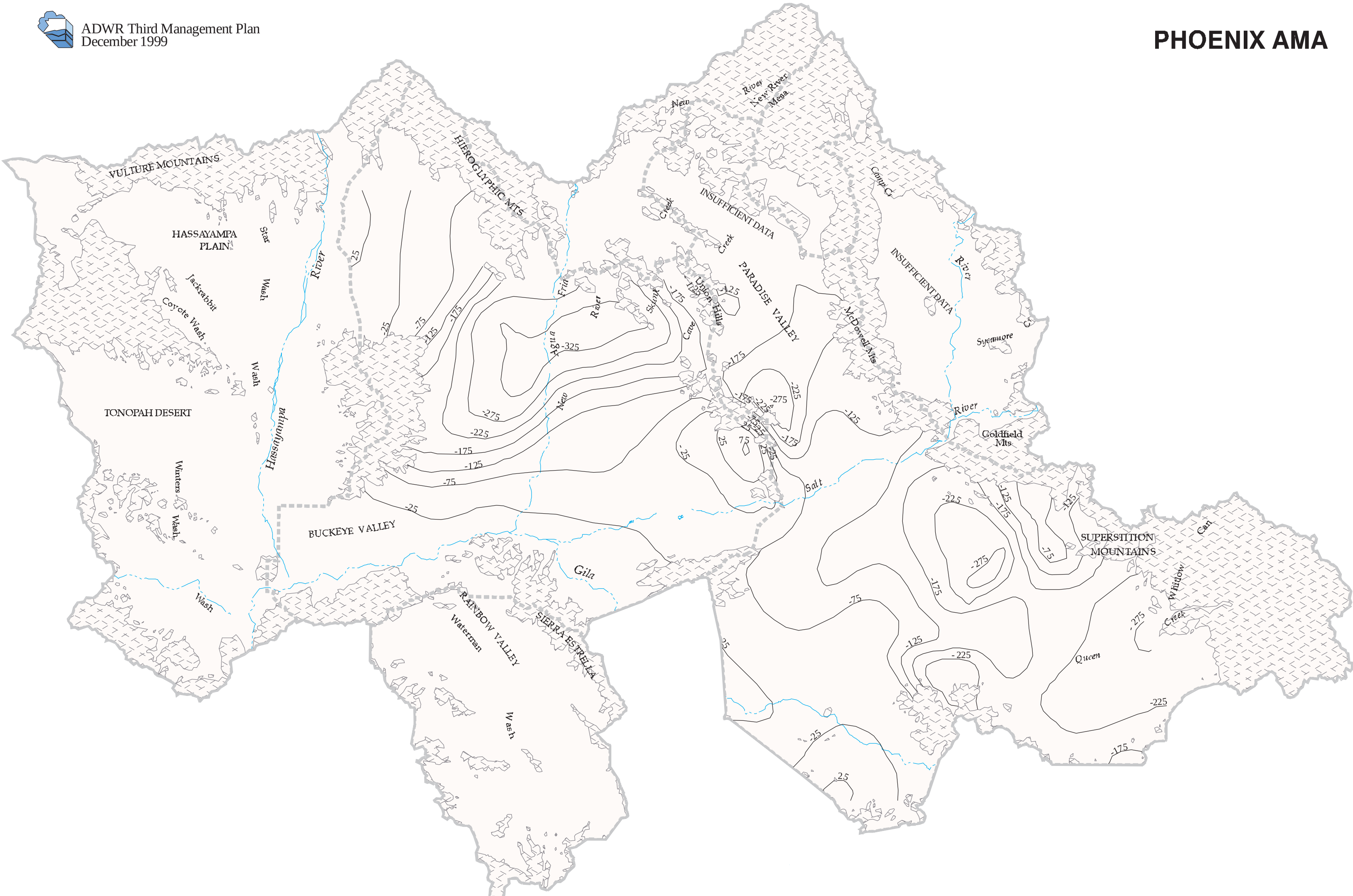
Figure 2 - 3

Water Elevations
1900

0 3 6 9 12
Miles
North

ORIGINAL SOURCE
Arizona Department of Water Resources
Hydrology Division

PHOENIX AMA



Phoenix AMA Boundary
Water Elevation Change Isolines (Feet)
- 20 Water Level Decline
20 Water Level Rise
Hardrock
River
Groundwater Subbasins

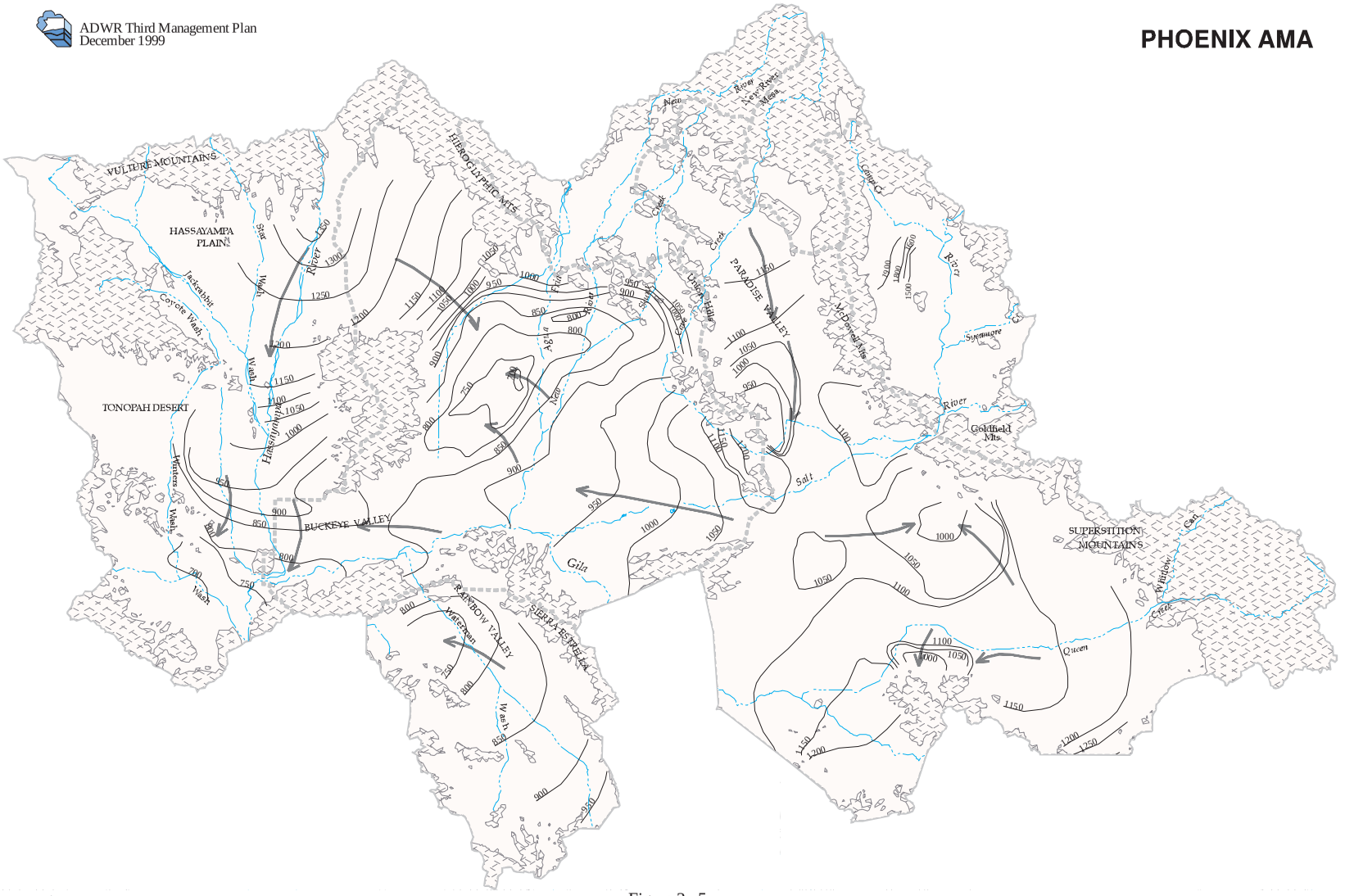
Figure 2- 4
Water Elevation Change
1900 - 1998 Lower Aquifer

0 3 6 9 12 Miles — North

ORIGINAL SOURCE
Arizona Department of Water Resources
Hydrology Division

ADWR Third Management Plan
December 1999

PHOENIX AMA



Phoenix AMA Boundary
Water Elevation Isolines (Feet Above Mean Sea Level)
Hardrock
River
ADWR Sub Basins
Direction of Ground Water Flow

Figure 2 - 5

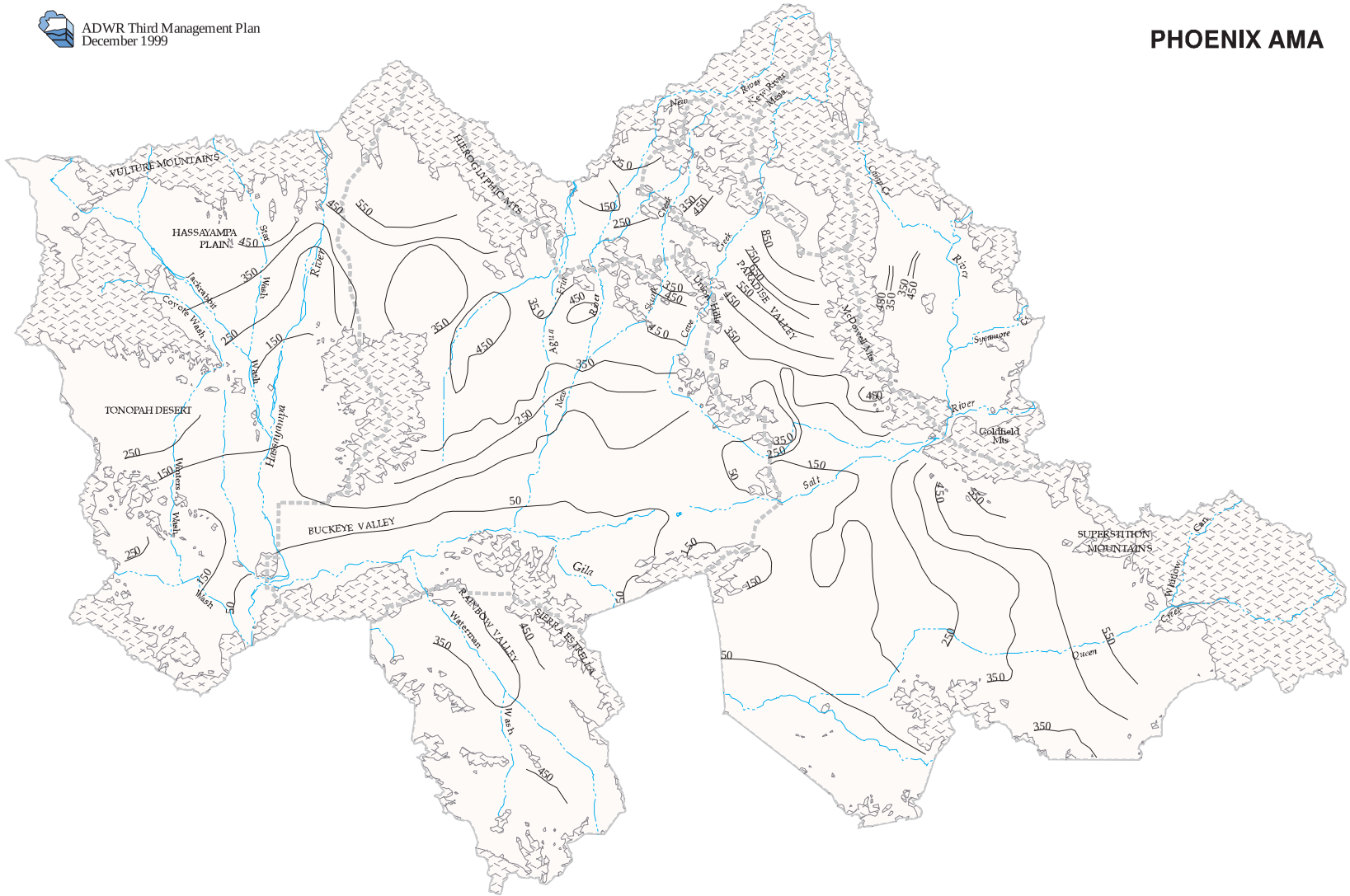
Water Elevations
1998

0 3 6 9 12
Miles
North

ORIGINAL SOURCE
Arizona Department of Water Resources
Hydrology Division

ADWR Third Management Plan
December 1999

PHOENIX AMA



Phoenix AMA Boundary
Depth to Water, Feet Below Land Surface
Inferred Depth to Water, Feet Below Land Surface
Hardrock
River
ADWR Sub Basins

Figure 2 - 6

Depth to Water

0 3 6 9 12
Miles

North

ORIGINAL SOURCE
Arizona Department of Water Resources
Hydrology Division

The Basic Data Section of the Department conducts yearly water level measurements at designated index wells throughout the AMA. More in-depth analysis occurs every five years when a broader cross-section of wells is measured for water levels and tested for inorganic constituents. These data are periodically used to prepare hydrologic maps addressing water levels and water quality in the AMA subbasins. Phoenix AMA map series of 1991-1992 water levels for the entire AMA have been published.

A three-dimensional transient flow groundwater model of the Salt River Valley (2,240 square miles of the East SRV and West SRV Subbasins) has been developed by the Department to provide a tool to simulate future groundwater conditions. This is done by testing various water management strategies designed to optimize the use of renewable water resources and conserve groundwater resources. The model area includes the cities of Phoenix, Tempe, Scottsdale, Mesa, Chandler, Glendale, Peoria, Gilbert, Sun City, Goodyear, Buckeye, and Apache Junction as well as many smaller cities and Indian communities. The model simulates groundwater flow conditions using the United States Geological Survey model MODFLOW. The Salt River Valley model is a three-layered model that simulates groundwater flow in the regional aquifer system. Results from an early application of the model are in the Department's report "Analysis of Future Water Use and Supply Conditions: Current Trends Alternative 1989-2025." Planned future modifications to the model include land subsidence prediction capabilities and refined geologic structure data.

Other groundwater information is compiled by federal, state, and local entities in addition to the Department. Water quality sampling is conducted by ADEQ and results are available in compiled databases at the agency. The United States Geological Survey has published multiple reports on water resources, including recent reports on the East SRV and West SRV Subbasins (Laney and Hahn, 1986); (Brown and Pool, 1989).

2.3.2 East Salt River Valley Subbasin

The East SRV Subbasin is one of the larger subbasins in the AMA, covering approximately 1,710 square miles. Located in the eastern half of the AMA, it is a broad, gently sloping alluvial plain bounded on the north and east by the New River, McDowell, Usery, Goldfield, and Superstition Mountains; on the south by the Santan and Sacaton Mountains; and on the west by the South Mountains, the Papago Buttes, the Phoenix Mountains, Union Hills, and the Deem Hills.

The Salt River channel crosses the central portion of the basin from east to west. The ephemeral Indian Bend Wash, much of which is a channelized greenbelt in the City of Scottsdale, flows south and drains the central portion of the subbasin until its confluence with the Salt River. Queen Creek, also ephemeral, drains the eastern portion of the subbasin until its confluence with the Gila River, which crosses the far southern portion of the subbasin and flows from east to west. Cave Creek, also ephemeral, drains the northern portion of the subbasin southwestward into the West SRV Subbasin.

Three hydrogeologic units are recognized within the basin-fill sediments in the East SRV Subbasin: an upper sand and gravel unit, a middle silt and clay unit, and a lower conglomerate unit (Laney and Hahn, 1986). The upper unit mainly consists of sand and gravel with some interbedded silt and clay. The upper unit ranges in thickness from less than 100 feet near the basin margins to over 350 feet in some parts of the basin. The middle unit consists mainly of silt and clay with some interbedded sand and gravel. Near the basin margins, the unit is coarser and typically cannot be distinguished from the upper and lower units. The middle unit ranges in thickness from less than 100 feet near the basin margins to over 1,800 feet southeast of Gilbert. The lower unit consists mainly of conglomerate near the basin margins. The unit ranges in thickness from less than 100 feet near the basin margins to over 9,000 feet southeast of Gilbert.

Prior to extensive development, groundwater underflow entered the East SRV Subbasin from the north, south, and southeast. Groundwater flowed generally east to west within the subbasin toward and along the

Salt and Gila Rivers. Minor underflow exited the subbasin into the West SRV Subbasin between the Papago Buttes and South Mountain. Water levels had ranged from greater than 1,500 feet above msl near the east and north basin margins to 1,150 feet above msl near Tempe Butte and south of South Mountain (Figure 2-3).

Since 1940 when extensive groundwater pumping to meet growing agricultural and municipal water demand began, water levels have declined significantly. Three large cones of depression in the Scottsdale, Mesa, and Santan Mountain areas have been created by agricultural pumping (Figure 2-4). In addition, water levels in the Scottsdale area declined 300 feet from 1900 to 1998 due to municipal use. Water levels declined by more than 400 feet near the Santan Mountains and 350 feet east of Mesa (Laney, Ross, and Litten, 1978).

In 1998 water level elevations ranged from approximately 900 feet above msl in the Scottsdale cone of depression to 1,500 feet above msl in the northern part of the subbasin (Figure 2-5). Depth to groundwater in 1998 ranged from less than 100 feet below land surface near the Salt and Gila Rivers to over 850 feet below land surface north of Paradise Valley and 550 feet below land surface near the Superstition Mountains (Figure 2-6). Today, most groundwater flows toward the three large cones of depression.

Assured Water Supply Rules (AWS Rules) require developers and water providers to demonstrate the availability of water for new subdivisions consistent with the management goal of the Phoenix AMA. Applicants must demonstrate the use of renewable supplies, rather than groundwater, to meet most demand for development for 100 years (see Chapter 5). Only groundwater physically available to a depth of 1,000 feet may be used as a part of an assured water supply. In the Apache Junction area of the East SRV Subbasin, current and committed demand has already accounted for all groundwater up to a depth of 1,000 feet and, thus, all groundwater allowed under the AWS Rules.

Although significant quantities of surface water are available to users in this subbasin (see section 2.4), groundwater pumping is still extensive in the Paradise Valley and the Sun Lakes areas by municipal and industrial users and in the Queen Creek vicinity by agricultural users.

2.3.3 West Salt River Valley Subbasin

Like the East SRV Subbasin, the West SRV Subbasin is one of the larger subbasins in the AMA (1,330 square miles) and is a broad, gently sloping alluvial plain. It is bounded on the north by the Hieroglyphic Mountains and Hedgpeth Hills; on the east by Union Hills, Phoenix Mountains, and Papago Buttes; on the south by the South Mountains, the Estrella Mountains, and Buckeye Hills; and on the west by the White Tank Mountains (Figure 2-1).

The Salt River channel meets the Gila River in the southern portion of the subbasin. When flowing, much of the subbasin drains from north to south into the Gila River via Skunk Creek, New River, the Agua Fria River, and Cave Creek. Skunk Creek drains into New River just east of Sun City, which subsequently flows into the Agua Fria River just south of Glendale Municipal Airport. The Agua Fria River joins the Gila River west of its confluence with the Salt River. Cave Creek flows from the East SRV Subbasin until it reaches the Arizona Canal Diversion Channel, which drains into Skunk Creek.

The West SRV Subbasin is hydrologically similar to the East SRV Subbasin. It also has three hydrogeologic units recognized within the basin-fill sequence, consisting of similar fill deposits. The upper unit ranges in thickness from less than 100 feet near the basin margins to over 500 feet in the Luke Air Force Base area. The middle unit ranges in thickness from less than 100 feet near the basin margins to over 1,300 feet southwest of Glendale. The lower unit ranges in thickness from less than 100 feet near the basin margins to over 10,000 feet southwest of Glendale. A large salt body, known as the Luke salt body, lies in the West SRV southeast of the Luke Air Force Base and occurs at a depth of 880 feet to over 6,000

feet. Geohydrologic data indicate that the upper part of the salt body has a local effect on groundwater salinity.

Historically, groundwater entered the West SRV Subbasin as underflow from the north, northwest, and southeast between the Sierra Estrellas and South Mountain. In addition, minor groundwater underflow entered the subbasin from the East SRV Subbasin between the Papago Buttes and South Mountain. Within the subbasin, groundwater flowed toward and along the Salt and Gila Rivers and finally exited the subbasin into the southern part of the Hassayampa Subbasin. Historic groundwater levels in the West SRV Subbasin ranged from 800 feet above msl along the western reaches of the Gila River to nearly 1,300 feet above msl in the north (Figure 2-3). Shallow groundwater conditions occurred in the Buckeye area.

Groundwater pumping for agriculture in the West SRV Subbasin began in the late 1800s from shallow irrigation wells along the Salt and Gila Rivers (Lee, 1905). Increases in well pumping capacity, expanding agriculture, and later, urban development have caused increased groundwater pumping. Groundwater levels have declined significantly, with two large cones of depression created by groundwater pumping near Luke Air Force Base and in Deer Valley near the Hedgpeth Hills. From 1923 to 1977, water levels declined by more than 300 feet in these areas (Ross, 1978).

In 1998, water levels ranged from 700 feet above msl in the Luke area cone of depression to 1,350 feet above msl in the northern area of the subbasin (Figure 2-5). Depth to groundwater during 1998 ranged from less than 50 feet below land surface near the Salt and Gila Rivers to over 550 feet below land surface near the Union Hills (Figure 2-6). Along the Gila River west of Goodyear, depth to groundwater may range from as shallow as 4 feet to as much as 20 feet below land surface. In the Buckeye area, shallow groundwater conditions have caused waterlogging problems with detrimental effects on crops (Montgomery & Associates, 1988). In spite of extensive groundwater pumping in the area, waterlogging problems persist because of the high volume of treated effluent discharged into the Salt River by the City of Phoenix's 91st Avenue Wastewater Treatment Plant (WWTP) and because of high volumes of water applied for agricultural irrigation to manage elevated salt levels (see section 2.3.10). Although some groundwater still flows westward from the West SRV Subbasin into the southern part of the Hassayampa Subbasin, much of the groundwater flows toward the two large cones of depression.

The West SRV Subbasin currently contains many water users who do not have access to many renewable supplies and rely heavily on groundwater, including municipal water providers such as Litchfield Park, Citizens Utilities - Sun City, Citizens Utilities - Sun City West, Citizens Utilities - Agua Fria, the City of El Mirage and Luke Air Force Base; agricultural users served by the Roosevelt Irrigation District; and numerous golf courses in the Sun City and Sun City West area that have their own grandfathered rights to pump groundwater.

2.3.4 Hassayampa Subbasin

In the far western portion of the AMA, the Hassayampa Subbasin covers 1,200 square miles and is a gently sloping alluvial plain bounded on the north by the Vulture Mountains and the Wickenburg Mountains; on the east by the White Tank Mountains; on the south by the Buckeye Hills and the Gila Bend Mountains; and on the west by the Big Horn Mountains, the Belmont Mountains, and the Palo Verde Hills (Figure 2-1). The area is drained by the Hassayampa River, which enters the subbasin in the northeast and joins the Gila River east of Arlington. The Gila River, which flows perennially with effluent from the west Phoenix metropolitan area, crosses the southeastern tip of the subbasin. Tributaries to the Hassayampa and Gila Rivers include Jackrabbit Wash and Centennial Wash, respectively.

The sequence of basin-fill sediments in the lower Hassayampa Subbasin consists of three hydrogeologic units designated as the upper, middle, and lower alluvium (Fugro, Inc., 1980). The upper unit is 30 to 60 feet thick and consists of sand and gravel. The middle unit, 230 to 300 feet thick, consists of clay and silt.

The lower unit, from 100 to more than 1,000 feet thick, consists of unconsolidated sand and moderately to well consolidated alluvial fan deposits.

Historically, groundwater entered the Hassayampa Plain from the northeast, most of which flowed south into the lower Hassayampa area. Groundwater also enters the southeastern part of the lower Hassayampa area as underflow from the southern part of the West SRV Subbasin. Groundwater levels historically ranged from 800 feet above msl in the southern area of the subbasin to more than 1,300 feet above msl in the extreme northern reaches of the subbasin (Figure 2-3). In the lower Hassayampa area, extensive groundwater pumping for agricultural development began in the early 1950s. Approximately 24,000 acres of land were under cultivation by 1960 and 22,500 acres were under cultivation in 1982 (Stulik, 1974). As a result of groundwater pumping, water levels have declined significantly in the agricultural areas of the subbasin. From the mid-1950s through 1998, water levels declined by as much as 70 feet in the Tonopah Desert and 90 feet in the Centennial Wash area, resulting in the creation of two large cones of depression in those areas. Data from 1998 shows groundwater levels ranging from 700 feet above msl in the southern area of the subbasin to 1,350 feet above msl in the northern section (Figure 2-5). Depth to groundwater in the Hassayampa Subbasin in 1998 ranged from less than 20 feet below land surface near the Gila River in Arlington Valley to over 700 feet below land surface near the Vulture Mountains.

After passing a bedrock constriction between the Belmont Mountains and the White Tank Mountains, groundwater currently flows from the northeast to southwest toward two cones of depression in the Tonopah Desert and Centennial Wash areas. Groundwater entering the southeastern part of the lower Hassayampa area from the southern part of the West SRV Subbasin is largely captured by the cone of depression in the Centennial Wash area.

2.3.5 Rainbow Valley Subbasin

The Rainbow Valley Subbasin is a gently sloping alluvial plain of approximately 420 square miles bounded on the north by the Buckeye Hills and the northern part of the Sierra Estrella, on the east by the Sierra Estrellas and the Palo Verde Mountains, on the south by the Haley Hills and the Booth Hills and the southern part of the Maricopa Mountains, and on the west by the Maricopa Mountains (Figure 2-1) (White, 1963). The area is drained by Waterman Wash, which joins the Gila River near Buckeye.

The basin-fill sequence which comprises the regional aquifer of the Rainbow Valley Subbasin consists of poorly sorted gravel, sand, silt, and clay (White, 1963). Due to a lack of geologic data, the regional aquifer is not well-defined. Wells are concentrated in the northern part of the subbasin; there are very few wells in other parts of the subbasin. Depth to bedrock in the Rainbow Valley Subbasin ranges from a few feet near the basin margins to a maximum verified depth of over 1,200 feet in the north-central part of the basin (White, 1963). More recent data suggest that the depth may exceed 9,600 feet in the central part of the basin (Oppenheimer, 1980).

Historically, groundwater may have entered the Rainbow Valley Subbasin from the Pinal AMA between the Palo Verde Mountains and the Haley Hills (White, 1963). Groundwater from the southern part of the Rainbow Valley Subbasin generally flowed toward the northwest. Water levels in the Rainbow Valley Subbasin were approximately 900 feet above msl (Figure 2-3). Water levels began declining in the early 1950s with the commencement of intensive agricultural development in the northern part of the subbasin. By 1982, water levels had declined by as much as 200 feet in the north and by about 12 feet further south near Mobile. Pumping in the north has created an extensive cone of depression there. Water levels in the subbasin in 1998 ranged from 750 feet above msl in the northwestern area to 950 feet above msl in the southeast area (Figure 2-5). Depth to groundwater in the Rainbow Valley Subbasin in 1998 ranged from 120 feet below land surface near the Buckeye Hills to over 400 feet near the cone of depression and further south in the Mobile Valley.

Available information suggests that the regional aquifer in the Rainbow Valley Subbasin is not currently connected to adjacent subbasins. Groundwater no longer flows into the subbasin from the Pinal AMA because of groundwater pumping in that AMA. Similarly, groundwater that historically flowed from the Rainbow Valley Subbasin into the West SRV Subbasin prior to development no longer does so because of groundwater pumping for agricultural irrigation in the northern part of the subbasin. In that area, groundwater flows toward the cone of depression.

2.3.6 Fountain Hills Subbasin

In the northeastern part of the AMA, the Fountain Hills Subbasin, covering approximately 360 square miles, is an extensively dissected alluvial plain bounded on the north and east by the Mazatzal Mountains and Stewart Mountain, on the south by the Usery Mountains and Sawik Mountain, and on the west by the McDowell Mountains (Figure 2-1). The subbasin is drained by the lower part of the Verde River, a perennial river regulated by Bartlett Dam near the northeastern boundary of the subbasin. The Verde River flows south along the axis of the basin, joining a regulated reach of the Salt River between Stewart Mountain Dam and Granite Reef Dam in the southern part of the subbasin. Tributaries to the Verde River include Camp Creek and Sycamore Creek.

Depth to bedrock in the Fountain Hills Subbasin ranges from a few feet near the basin margins to over 1,200 feet near the center of the basin (Ross, 1978); more recent data indicates the depth may exceed 4,800 feet (Oppenheimer, 1980). The regional aquifer consists of two distinct hydrogeologic units: an older basin-fill sequence and unconsolidated alluvium deposited by the Verde River. The unconsolidated alluvium underlies the modern floodplain of the Verde River.

The general direction of groundwater flow is from north to south, parallel to the axis of the subbasin and has likely remained unchanged since development has occurred in this subbasin. Available information suggests that the regional aquifer in the Fountain Hills Subbasin is not connected to adjacent subbasins. To date, groundwater pumping in the Fountain Hills Subbasin has been relatively minimal. In the 1920s, the City of Phoenix began diverting groundwater from the Verde River alluvium for municipal water supply. Currently, groundwater is pumped by Chaparral City Water Company, Fountain Hills Golf Course, the development of Rio Verde, and a number of domestic wells. Almost all groundwater pumping occurs in the southern part of the subbasin.

Long-term water level records are not available for the area; however, available information suggests that water levels have not been significantly affected by groundwater pumping in the subbasin. Depth to groundwater in 1998 ranged from 19 feet below land surface in the Verde River floodplain south of Bartlett Dam to over 500 feet below land surface near the McDowell Mountains.

2.3.7 Lake Pleasant Subbasin

In the northern part of the AMA, the Lake Pleasant Subbasin is a relatively small, gently sloping alluvial plain of 240 square miles bounded on the north by an unnamed ridge southeast of the Agua Fria River; on the east by the New River Mountains and an unnamed group of hills to the south; on the south by the Union, Deem and Hedgpeth hills; and on the west by the Hieroglyphic Mountains (Figure 2-1). The subbasin is drained by the lower part of the Agua Fria River, an ephemeral stream regulated by New Waddell Dam at the northern boundary of the subbasin; by New River, which heads in the New River Mountains to the northeast; and by Skunk Creek.

The basin-fill sediments comprising the regional aquifer of the Lake Pleasant Subbasin consist of unconsolidated to semi-consolidated silt, sand, and gravel, and locally may include interbedded basalt (Litten, 1979). Depth to bedrock in the Lake Pleasant Subbasin ranges from a few feet near the basin margins to over 800 feet near the center of the basin.

The general direction of groundwater flow, from north to south, has likely remained unchanged since little development has occurred in this subbasin. Groundwater flow directions suggest that the Lake Pleasant Subbasin is hydraulically connected with the West SRV and East SRV Subbasins. Groundwater enters the subbasin from the northeast and flows south along New River and into the West SRV Subbasin, both at the Agua Fria River east of the Hieroglyphic Mountains and at Skunk Creek between the Deem Hills and the Union Hills. Groundwater flows into the East SRV south of the town of New River and north of the Union Hills.

To date, the quantity of groundwater pumping in the Lake Pleasant Subbasin has been relatively minimal. Currently, groundwater is pumped by numerous domestic wells mainly near the town of New River, a few small, private water companies, and an outlet mall. Water levels for 1998 ranged from 1,550 feet above msl in the northern area of the subbasin to 1,300 feet above msl in the southern portion of the subbasin.

Long-term water level records are not available for the area; however, available information suggests that water levels have been significantly affected by groundwater pumping. Near the Town of New River, areas underlain by volcanic rock have experienced severe declines and many domestic wells have gone dry. Depth to groundwater in 1998 ranged from 11 feet below land surface in a local aquifer near the Town of New River to nearly 300 feet below land surface in the regional aquifer south of New River (Figure 2-6).

2.3.8 Carefree Subbasin

The Carefree Subbasin covers approximately 140 square miles. It is bordered on the east by the northernmost McDowell Mountains, on the north by a mountainous area southwest of New River Mesa, and to the south and west by a group of low-lying hills including Black Mountain (Figure 2-1). The groundwater-bearing portion of the subbasin is a small dissected alluvial plain located in the far northern portion of the AMA.

Compared to other subbasins in the AMA, the Carefree Subbasin is relatively shallow (approximately 2,000 feet) and is filled with older, partially consolidated to consolidated sedimentary rocks (Pewe and Dorn, 1989). The primary aquifer in the basin is the Carefree Formation, which consists of alluvial fan and playa deposits (1989). The Carefree Formation consists of five members, of which only the Grapevine member is a significant source of groundwater. The Carefree Formation is underlain by volcanic rocks.

Groundwater in the Carefree Subbasin generally moves west-southwest. The general direction of groundwater flow probably has not changed since groundwater pumping has commenced in the subbasin. Mountain-front recharge occurs along the northeast and eastern portions of the subbasin, and groundwater flow is generally from east to west in that area. Streambed recharge also occurs along the channel of Cave Creek in the northwestern portion of the subbasin. Other ephemeral washes draining upland areas also contribute to groundwater recharge. Groundwater leaves the basin and flows into the East SRV Subbasin.

Detailed water level data prior to development is unavailable for the Carefree Subbasin. However, groundwater pumping in the Carefree Subbasin has had a serious impact on groundwater levels. Water levels began declining in the early 1960s with the onset of pumping. In the center of the basin near the Carefree Airport, a cone of depression has formed as a result of heavy pumping associated with golf courses. Water-level declines in this area have exceeded 10 feet per year (Figure 2-4) (Bernier, 1992). However, since the early 1990s, many of the golf courses in the area have ceased pumping groundwater and have converted to CAP and commingled water because of concerns raised regarding the impacts on the aquifer and the supply for other users.

Water elevations in 1998 range from 2,000 feet above msl in the northwestern area of the subbasin to 2,450 feet above msl in northeastern area of the subbasin. Depth to groundwater in the Carefree Subbasin

in 1998 ranged from less than 30 feet below land surface near Cave Creek to over 390 feet below land surface in the eastern part of the basin.

The Carefree Subbasin aquifers are relatively shallow and unproductive. Under the AWS Rules, current and committed demand for groundwater in storage to a depth of 1,000 feet has already been completely accounted for in the northern part of the subbasin.

2.3.9 Land Subsidence

Land subsidence is the lowering of the earth's surface and may occur when groundwater pumping lowers the water level or hydraulic pressure in an aquifer to the extent necessary to cause compression of the alluvial sediments. This results in a drop in elevation and can result in cracks and fissures emerging at land surface. The drop in land surface elevation occurs as the fine-grained sediments in the dewatered zone of the aquifer become compressed as a result of the absence or reduction of the hydraulic pressure on the sediments and the increase in the intragranular stress. The compression of sediments signifies the reduced pore space and a reduction in aquifer storage capacity that can never be regained (Pewe, 1990). Land subsidence can also cause considerable damage to sewage systems, well casings, and building foundations.

If land subsides at the same rate over a large area, there is less impact to surface activities than if adjacent land subsides at different rates. Such "differential subsidence" can occur when subsurface conditions change over a short distance. This can occur near bedrock, around faults, and in areas where the composition of subsurface sediments changes abruptly.

Earth fissures are long, narrow, eroded tension cracks and are associated with land subsidence caused by groundwater withdrawals. They have primarily formed near the margins of mountains or outlying bedrock outcrops where groundwater declines have occurred. Some are very deep, perhaps extending to the water table. Fissures often open up very swiftly after storms and can increase in size due to erosion from surface runoff (Pewe, 1990). As a result, fissures can be conduits for contaminated water to enter the aquifer directly without the normal filtration and purification that occurs when these same waters infiltrate the ground and percolate through thick layers of sediment.

Several areas of subsidence and fissures exist in the Phoenix AMA. In the West SRV Subbasin, subsidence of up to 17 feet and the development of earth fissures has occurred in an area of approximately 140 square miles near Luke Air Force Base. The greatest hazard to the area as a result of the subsidence has been flooding; in 1992, extensive flooding caused approximately $3 million in damages. It became necessary to re-level the Dysart Drain at a cost of approximately $16 million and to re-level fields and repair irrigation ditches in this area (Schumann and O'Day, 1995 and Gelt, 1992). The total cost to repair and improve subsidence-related problems has been in excess of $22 million at Luke Air Force Base. Another structure, a major flood control dam owned by the Maricopa Flood Control District and located within the White Tank Mountains watershed, has been determined a "significant safety hazard" by the Dam Safety Section of the Department. Constructed in 1952, this dam has lost 4.5 feet in elevation due to subsidence. The total project cost for modifying the dam to meet current dam safety standards is estimated at $2.4 million.

In the East SRV Subbasin, land subsidence and the development of earth fissures has also occurred in the Queen Creek, east Mesa, Apache Junction, and Paradise Valley areas (Schumann and Genualdi, 1986). In the Queen Creek area, an area of approximately 230 square miles north of the Santan Mountains had subsided more than 3 feet by 1977. Over 5 feet of land subsidence occurred east of Mesa between 1948 and 1981. In the vicinity of Apache Junction, over 2 to 3 feet of subsidence has been documented since the early 1970s, and earth fissuring represents an ever-present concern. Both the Salt-Gila Aqueduct of the CAP and the Maricopa County-Vineyard Flood Control Dike run directly through the subsidence and earth

fissure zone (Raymond, undated). As much as 5 feet of land subsidence occurred in the Paradise Valley area between 1965 and 1982. In 1980, an earth fissure opened in Paradise Valley at a residential construction site. It was the first known occurrence of a fissure in a densely populated area (Pewe, 1990). The fissure cost approximately $500,000 in repair and planning expenses (Larson and Pewe, 1986). At least 0.5 feet of subsidence has been documented in the central Scottsdale area where water levels have declined by 200 to 300 feet since development has occurred (Schumann, 1974). Problems caused by subsidence in these areas resulted in a need to repair sewer lines that had undergone a change in gradient and caused an interruption in flow (Gelt, 1992). All of these areas are characterized by extensive historic groundwater withdrawals and water level declines.

2.3.10 Waterlogged Areas

In the West SRV, the area in the vicinity of the Buckeye Water Conservation and Drainage District, the St. Johns Irrigation District, and the Arlington Canal Company has an extremely shallow depth to groundwater. There are several possible causes for waterlogging in the area, including the natural drainage of the East SRV and West SRV toward the confluence of the Gila and Salt Rivers, crop irrigation and canal seepage, and treated wastewater discharged to the Salt River from the City of Phoenix's 23rd Avenue and 91st Avenue wastewater treatment plants. The combined wastewater discharges continue today at approximately 148,000 acre-feet per year.

In some areas, the current depth to water is less than 10 feet. For certain crops to be grown, the surrounding land must be drained and dewatered. In the aforementioned irrigation districts, systems of drainage channels are operated. These channels divert and discharge groundwater and surface runoff from the area to the Salt and Gila Rivers.

High salinity present in the waterlogged area has worsened over time as the salts delivered in irrigation water have accumulated. Deep percolation of water in an effort to leach salts from the root zone has further pushed salts into the groundwater, although this has been somewhat mitigated by the influx of treated wastewater from the plants in certain parts of the waterlogged area.

2.3.11 Groundwater Quality

Groundwater can be affected by the presence of elevated concentrations of inorganic and organic constituents that make the water unacceptable for potable use due to health concerns or due to negative aesthetic characteristics. The elevated concentrations of these constituents are both from historical practices and natural sources. In some cases, this water may be acceptable for non-potable uses in place of potable groundwater. Water quality conditions are briefly discussed below and in greater depth in Chapter 7.

In the AMA, large volumes of groundwater are unsuitable for use due to elevated concentrations of hazardous substances such as volatile organic compounds, petroleum hydrocarbons, and pesticides. Groundwater contaminated above Maximum Contaminant Levels cannot be delivered for drinking water use. Many municipal wells, particularly in the central Phoenix and west Phoenix areas, have been closed due to contamination from past disposal practices, leaking underground storage tanks, and the presence of pesticides. Naturally occurring substances such as radon and arsenic have also caused the closure of municipal supply wells.

Non-point source contamination, or contamination that has not originated from one single source, has also rendered large volumes of groundwater unsuitable for most uses. Contaminants such as nitrate, sulfate, and dissolved solids are present in elevated concentrations due to wastewater discharge, septic tanks, agriculture, urban stormwater, and other causes. Although many non-point source contaminants such as sulfate and total dissolved solids are not regulated for drinking water use, their presence in groundwater at

elevated concentrations can cause aesthetic problems in drinking water and can render groundwater unsuitable for other uses, such as agricultural irrigation.

2.4 SURFACE WATER

The Phoenix AMA is drained by the Gila River and four principal tributaries: the Salt, Verde, Agua Fria, and Hassayampa Rivers. Other tributaries include Queen Creek, New River, Skunk Creek, Cave Creek, Waterman Wash, and Centennial Wash. In the last 100 years, significant infrastructure has been built on major rivers in the AMA to capture and store as much surface water as possible for users in the AMA and elsewhere. Despite the regulatory control afforded by the dam and reservoir system, annual diversions of surface water for downstream users varies greatly with the amount of water that flows into the reservoirs from the watershed. The amount of water stored for use is especially dependent on the snowpack and resultant snowmelt of each winter storm season on the watershed. This can be highly variable from year to year, with extensive droughts not uncommon in recent history. When surface water supplies are insufficient to meet demand, supplies are often supplemented by groundwater pumping to make up the shortfall. In years of excessive snowmelt, water may need to be spilled from storage reservoirs. Although some spillwater can augment supplies in the AMA, much of it flows through the AMA without being used. Environmental concerns, cost, and a shortage of suitable sites make it highly unlikely that any additional large-scale regulatory projects will be created to further develop surface water storage capacity in the AMA.

Other than Colorado River water delivered to the AMA through the CAP aqueduct (discussed separately in section 2.5), the Salt and Verde Rivers are the principal sources of surface water in the AMA. Most of the surface water from the Salt and Verde Rivers is appropriated to downstream users in irrigation districts and is limited for use to lands within the Salt River Project, the Roosevelt Water Conservation District, and the Buckeye Water Conservation and Drainage District. The Gila and Agua Fria Rivers also provide surface water. Water from the Gila River is used mainly for agricultural uses in the San Carlos Irrigation District on the Gila River Indian Community (partially within the AMA) and in the Buckeye Water Conservation and Drainage District. Water from the Agua Fria River is used by Maricopa Water District in the West SRV Subbasin. Small, localized surface water appropriations have been made to users from Cave Creek, Queen Creek, and Centennial Wash. Many municipal, industrial, and agricultural users are outside of the aforementioned district boundaries and are ineligible to receive surface water supplies.

Surface water flow recharges the Phoenix AMA aquifer by infiltrating through stream channel sediments into the aquifer. Stream channel recharge is a component of net natural recharge and is incorporated into water budget estimates of Phoenix AMA water supply (see Chapter 11).

2.4.1 Salt and Verde Rivers

The Salt River originates in eastern Arizona and drains approximately 6,000 square miles of the Mogollon Rim area in the east-central part of the state. The Salt River channel enters the AMA north of the Goldfield Mountains; crosses toward the southwest through the East SRV and West SRV Subbasins and the cities of Mesa, Tempe, and Phoenix; and finally joins the Gila River near Laveen. Downstream from the Granite Reef Diversion Dam, the Salt River is ephemeral, flowing in response to flooding or reservoir releases. The Salt River is perennial further downstream due to effluent discharges from the 23rd Avenue and 91st Avenue wastewater treatment plants.

The Verde River originates in the Chino Valley north of Prescott. It is a perennial river that drains approximately 7,000 square miles of central Arizona. The Verde River channel enters the AMA in the north Fountain Hills Subbasin and moves southward where it joins the Salt River between Stewart Mountain Dam and Granite Reef Diversion Dam. The Verde River is regulated by Horseshoe Dam outside the AMA and Bartlett Dam within the AMA, both of which are part of the Salt River Project.

The Salt River flowed perennially before the late 1800s (Lee, 1905). The diversion dams, canals, and laterals constructed in the late 1880's along the Salt River were inadequate to regulate the effects of drought and flood and to produce a reliable and safe water supply for agricultural irrigation uses in the Salt River Valley. In response, the Salt River Valley Water Users Association was formed in 1903 for the purpose of furnishing water, power, and drainage for participating landowners in the Valley. A series of four regulatory storage reservoirs and five dams were constructed on the Salt River to accomplish this goal. On the Verde River, the United States Bureau of Reclamation (USBR) constructed Bartlett Dam in the 1930's and the Phelps-Dodge Corporation constructed Horseshoe Dam in the 1940s. Collectively, these projects make up the Salt River Project. Table 2-1 shows the dams and reservoir capacity of the Salt River Project. Total water storage capacity of the Salt River Project is nearly 3.6 million acre-feet, although a large portion of this space is usually left vacant for flood storage. At Granite Reef Diversion Dam, which is southwest of the confluence of the Salt and Verde Rivers and within the AMA, water is diverted to users through the Arizona Canal and the South Canal.

TABLE 2-1
SALT AND VERDE RIVERS - WATER STORAGE AND DIVERSION PROJECTS
PHOENIX ACTIVE MANAGEMENT AREA

River	Dam	Reservoir	Storage Capacity (acre-feet)
Salt	Roosevelt	Roosevelt	2,910,200
	Horse Mesa	Apache	245,100
	Mormon Flat	Canyon	57,900
	Stewart Mountain	Saguaro	69,800
	Granite Reef	(N/A - diversion dam)	N/A
Verde	Bartlett	Bartlett	178,200
	Horseshoe	Horseshoe	152,900

Because of concern over detrimental environmental impacts, two additional dams to increase storage capacity on the Salt and Verde Rivers (Orme Dam on the Salt River and Cliff Dam on the Verde River) were never built. An alternative to the construction of Orme Dam (known as Plan 6) raised Roosevelt Dam 76 feet in 1996 and made important flood-handling modifications to Stewart Mountain Dam. The effect of raising Roosevelt Dam was an increased capacity of approximately 1.5 million acre-feet, of which 255,100 acre-feet will be used for regulatory storage and the remainder left vacant to provide flood storage. From 1913 to 1997, diversions have ranged from 506,000 to 1,360,000 acre-feet per year. The median diversion has been approximately 808,000 acre-feet. Most Salt and Verde River water is appropriated to shareholders of the Salt River Valley Water Users Association (Salt River Project) for use on lands within the Project. The Salt River Project encompasses portions of the East SRV and West SRV Subbasins in the AMA, including portions of Glendale, Peoria, Phoenix, Scottsdale, Tempe, Chandler, Gilbert, and Mesa. (See Figure 4-2 in Chapter 4.) Although Salt River Project still provides water for significant agricultural use, much of the lands within the project boundaries are highly urbanized, including mature development in central Phoenix, south Scottsdale, Tempe, and Mesa. Most new urban development of the Phoenix urban area is occurring outside the Project's boundaries and is not eligible to directly receive water from the Project. Salt River Project water may be delivered outside of the Project's boundaries only if it is exchanged for another source.

Some Salt and Verde River system water has also been adjudicated to or agreed to be delivered to several other irrigation districts, including the Buckeye Water Conservation and Drainage District, Roosevelt Water Conservation District, St. Johns Irrigation District, and Peninsula Ditch Water Company. Salt and Verde River water partially meets water demand within these district boundaries but must be supplemented with other sources, including groundwater. Water rights settlements have allocated Salt and Verde waters to the Fort McDowell Indian Community and Salt River Pima-Maricopa Indian Community, which will be used to meet urban and agricultural demand within these communities. In 1946, the City of Phoenix increased the capacity of Horseshoe Dam by constructing spillway gates; as compensation, it is eligible to receive a portion of Verde River water. Water stored behind additional storage capacity on Roosevelt Dam created by Plan 6 is divided by Salt River Project and the cities of Phoenix, Mesa, Chandler, Scottsdale, Tempe, and Glendale. Plan 6 water is not restricted for use within Salt River boundaries.

2.4.2 Gila River

The Gila River channel enters the AMA between the San Tan and Sacaton Mountains near Sacaton. It crosses northwest and west near the Sierra Estrella Mountains and the Buckeye Hills, and exits the AMA at Gillespie Dam. Prior to 1890, the river flowed perennially through the AMA (Lee, 1904). The river is currently regulated by the Ashurst-Hayden Dam east of Florence outside the AMA. Most natural surface water flows are diverted to the San Carlos Irrigation District at the Ashurst-Hayden Dam. The district encompasses a portion of the Gila River Indian Community in the AMA and the community uses the water for agricultural purposes. The river flows downstream from the dam when floods exceed the dam's diversion capacity and is perennial for a couple miles above the confluence with the Salt River. Below the confluence with the Salt River, the Gila River is perennial due to effluent discharge in the Salt River from the City of Phoenix's 23rd Avenue and 91st Avenue wastewater treatment plants. Much of this water is diverted for agricultural irrigation by the Buckeye Water Conservation and Drainage District and the Arlington Canal Company.

2.4.3 Agua Fria River

The Agua Fria River is an intermittent to ephemeral stream that begins northeast of Prescott and drains part of central Arizona between Prescott and Phoenix. The Agua Fria River enters the AMA approximately 20 miles north of Peoria, flows south along the western edge of the Phoenix metropolitan area and joins the Gila River south of Avondale. The drainage area of the Agua Fria River and its tributaries is approximately 2,000 square miles.

The Agua Fria River is regulated at the northern boundary of the AMA by New Waddell Dam, which forms Lake Pleasant. At Lake Pleasant, which functions as regulatory storage for both the Agua Fria River and Colorado River water brought into the AMA by the CAP, water is diverted by the Maricopa Water District to the Beardsley Canal, a 30-mile long canal that cuts southward across the West SRV Subbasin east of the White Tank Mountains. Maricopa Water District delivers a combination of Agua Fria River water, groundwater, and CAP water to users in the district. Downstream from the dam, the Agua Fria River is ephemeral.

2.4.4 Other Tributaries

Other tributaries exist in the AMA that are not significant sources of surface water supply, including the Hassayampa River, Cave Creek, Queen Creek, New River, Skunk Creek, Waterman Wash, and Centennial Wash. All of these tributaries are ephemeral with the exception of the Hassayampa River, which is intermittent to ephemeral.

2.5 CENTRAL ARIZONA PROJECT

The CAP was constructed to annually deliver 1.5 million acre-feet of Arizona's allocation of Colorado River water to central and southern Arizona through a series of aqueducts and pumping stations. The project is over 300 miles long and lifts Colorado River water 2,400 feet to its final destination in Tucson. A significant portion of CAP water is stored in Lake Pleasant behind New Waddell Dam at the northern edge of the AMA. The dam was constructed as a part of the Plan 6 alternative to the construction of Orme Dam and Cliff Dam on the Salt River and Verde River, respectively. Turnouts from the CAP aqueduct connect it to municipal water treatment plants and irrigation district canals for distribution.

CAP water is not freely available to all municipal, industrial, and agricultural users in the AMA. CAP water was originally allocated in 1983 to parties among Indian users, non-Indian municipal and industrial (M&I) users, and agricultural users who requested an allocation. Allocations for Indian and M&I users are fixed; allocations for agricultural users are calculated as a percentage of remaining CAP water. Contracts for the allocations are made with the Central Arizona Water Conservation District (CAWCD), which is also responsible for operating and maintaining CAP infrastructure and managing the repayment of the costs to build CAP to the federal government. As of 1995, a total of 375,845 acre-feet of CAP water have been allocated to M&I and agricultural users in the Phoenix AMA.

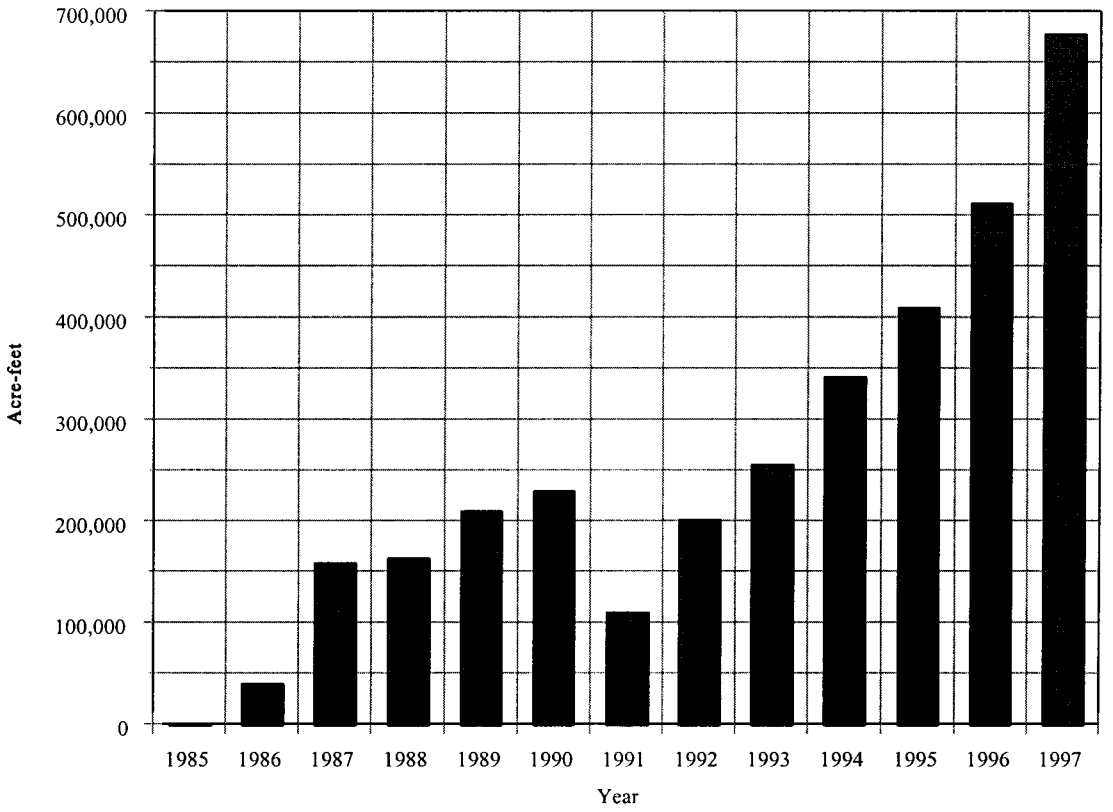
CAP water was first delivered and used in the AMA in 1985 and its use has grown steadily since (see Figure 2-7). However, the relatively high cost of the water compared to pumping groundwater has caused several irrigation districts to turn back their original allocations. Unused agricultural water has been "pooled" and offered by CAWCD to irrigation districts at a substantial discount to entice use and generate revenue to pay for the capital costs of the canal. Many M&I users (both inside and outside the AMA) are distant from the CAP canal; lack of physical infrastructure needed to convey CAP water has hindered its use. CAWCD has offered short-term contracts for unused allocated M&I water (known as "excess" CAP water) to users in the AMA. In the future, M&I allocations may change as allocated entities buy or sell unused allocations. CAP water may also be used to settle Indian water rights claims in the future.

A total of over 677,000 acre-feet of CAP water, including both CAP water delivered to allocated entities and excess CAP water, was used for non-Indian purposes in the AMA in 1997. This total includes both direct use of the water and direct and indirect recharge of CAP water. Direct recharge can occur in basins, streambeds, or injection wells. A total of nearly 56,000 acre-feet of CAP water was directly recharged in this manner in 1995. Indirect recharge, known as water stored at "groundwater savings facilities," allows existing groundwater to remain underground by replacing groundwater pumping with CAP use, typically by irrigation districts for agricultural users. A total of approximately 56,500 acre-feet of CAP water was delivered to irrigation districts as groundwater savings facilities in 1995. Recharge projects are administered statewide by the Department under the 1994 Underground Water Storage, Savings, and Replenishment Program (see Chapter 8). Direct and indirect recharge projects that have received permits in the Phoenix AMA are discussed and tabulated in Appendix 8A.

2.6 EFFLUENT

Effluent production is tied to population size. Based on the assumption that effluent is produced at wastewater treatment plants at a rate of 100 gallons per person per day, an estimated 286,000 acre-feet of effluent were produced within the Phoenix AMA in 1995. For much of Glendale, Mesa, Phoenix, Scottsdale, Sun City, and Tempe, wastewater is piped and treated at the 91st Avenue WWTP. This facility accounts for most of the effluent produced in the AMA, averaging approximately 159,000 acre-feet of effluent per year since 1989. From this facility, up to 60,000 acre-feet per year of effluent have been piped from the plant to the Palo Verde Nuclear Generating Station, which has a contract to receive the effluent through the year 2027; a total of 48,899 acre-feet were delivered to the plant in 1995. Another 30,000

FIGURE 2-7
CENTRAL ARIZONA PROJECT WATER USE: 1985-1997
PHOENIX ACTIVE MANAGEMENT AREA



acre-feet are contracted to the Buckeye Water Conservation and Drainage District through the year 2030 to irrigate crops. The remaining effluent from this plant, approximately 53,000 acre-feet per year, flows out of the AMA in the Salt and Gila River channels. Much of the effluent from Phoenix's 23rd Avenue WWTP is used to irrigate crops in the Roosevelt Irrigation District. Significant quantities of effluent from Chandler's Lone Butte WWTP is used to irrigate crops within the Gila River Indian Community. Much of the remaining direct use from other wastewater treatment plants across the AMA consists primarily of landscape watering by industrial users and municipally served facilities. The City of Scottsdale is currently developing an extensive reclaimed water distribution system to deliver effluent to a number of north Scottsdale golf courses.

Small quantities of effluent were used for artificial recharge in 1995. A total of approximately 6,500 acre-feet of effluent were directly recharged in basins, streambeds, or injection wells in 1995. Approximately 460 acre-feet of effluent were delivered to irrigation districts acting as groundwater savings facilities in 1995. Recharge projects are administered statewide by the Department under the 1994 Underground Water Storage, Savings, and Replenishment Program. Direct and indirect recharge projects that have received permits in the Phoenix AMA are discussed and tabulated in Appendix 8A.

REFERENCES

Arizona Meteorological Network. (1998). Data derived from 1988 to 1998 Phoenix Greenway, Phoenix Encanto, and Litchfield weather stations, world wide web site http:\\ag.arizona.edu\azmet\.

Bernier, J.C. and Associates. (1992). *Report on the 1992 Static Water Level Measurement in the Carefree - Cave Creek Basin: Prepared for the City of Scottsdale and the Towns of Carefree and Cave Creek.*

Brown, J.G. and Pool, D.R. (1989). *Hydrogeology of the Western Part of the Salt River Valley Area, Maricopa County, Arizona.* United States Geological Survey Water-Resources Investigations Report 88-4202.

CH2M Hill. (1995). *Study and Evaluation of Irrigation Water Duties Established Under the Second Management Plan.* Arizona Department of Water Resources Task P-2.

Fugro, Inc. (1980). *Operational Groundwater Monitoring Program - Palo Verde Nuclear Generating Station: unpublished report.*

Gelt, J. (1992). *Land Subsidence, Earth Fissures Change Arizona's Landscape.* Arroyo, v. 6, no. 2.

Laney, R.L., Ross, P.P., and Litten, G.R. (1978). *Maps Showing Ground-water Conditions in the Eastern Part of the Salt River Valley Area, Maricopa and Pinal Counties - 1976.* United States Geological Survey Water-Resources Investigations 78-61.

Laney, R.L. and Hahn, M.E. (1986). *Hydrogeology of the Eastern Part of the Salt River Valley Area. Maricopa and Pinal Counties, Arizona.* United States Geological Survey Water-Resources Investigations Report 86-4147.

Larson, M.K. and Pewe, T.L. (1986). *Origin of Land Subsidence and Earth Fissuring, Northeast Phoenix Arizona.* Bulletin of the Association of Engineering Geologists Volume XXIII, No.2, 1986, pp. 139-165.

Lee, W.T. (1904). *The Underground Waters of Gila Valley, Arizona.* United States Geological Survey Water-Supply and Irrigation Paper 104.

Lee, W.T. (1905). *Underground Waters of the Salt River Valley.* United States Geological Survey Water Supply Paper 136.

Litten, G.R. (1979). *Maps Showing Groundwater Conditions in the New River-Cave Creek Area, Maricopa and Yavapai Counties, Arizona - 1977.* United States Geological Survey Water-Resources Investigations Open-File Report 79-1068.

McDonald, H.R. and Padgett, H.D. Jr. (1945). *Geology and Groundwater Resources of the Verde River Valley Near Fort McDowell, Arizona.* United States Geological Survey open file report.

Montgomery, E.L. and Associates, Inc. (1988). *Study of Waterlogging Problems in the West Salt River and Hassayampa Sub-basins of the Phoenix Active Management Area - Modified Overall Study Evaluation: Prepared for the Phoenix Active Management Area, Arizona Department of Water Resources.*

Oppenheimer, J. (1980). *Gravity Modeling of the Alluvial Basins, Southern Arizona*: unpublished masters thesis. University of Arizona, Tucson, Arizona.

Pewe, T.L. and Dorn, P.L. (1989). *Geologic and Gravimetric Investigations of the Carefree Basin, Maricopa County, Arizona: Report Prepared for the Foothills Community Foundation.*

Pewe, T.L. (1990). *Subsidence and Earth Fissure Formation Caused by Groundwater Withdrawal in Arizona.* A review, in Higgins, C.G. and Coates, D.R., eds., Groundwater Geomorphology: The Role of Subsurface Water in Earth-surface Processes and Landforms. Boulder, Colorado, Geological Society of America Special Paper 252, pp. 219-233.

Raymond, R.H., undated. *Land Subsidence and Potential Earth Fissures, Salt-Gila Aqueduct, Central Arizona Project.*

Ross, P.P. (1978). *Maps Showing Groundwater Conditions in the Western Part of the Salt River Valley Area, Maricopa County, Arizona - 1977.* United States Geological Survey Water-Resources Investigations 78-40.

Salt River Project. (1994). *Strategic Water Resource Plan, Phase I: Assessment and Potential Strategies, January 1994.*

Schumann, H.H. (1974). *Land Subsidence and Earth Fissures in Alluvial Deposits in the Phoenix Area, Arizona.* United States Geological Survey Miscellaneous Investigations Series-MAP I-845-H.

Schumann, H.H. and Genualdi, R.B. (1986). *Land Subsidence, Earth Fissures, and Water-Level Change in Southern Arizona.* Arizona Bureau of Geology and Mineral Technology - Geological Survey Branch- Map 23.

Schumann, H.H. and O'Day, C.M. (1995). *U.S. Department of the Interior-U.S. Geological Survey-Investigation of Hydrogeology, Land Subsidence, and Earth Fissures, Luke Air Force Base, Arizona - Administrative Report.* Tucson, Arizona.

Stulik, R.S. (1974). *Ground-water Conditions in the Lower Hassayampa Area, Maricopa County, Arizona.* Arizona Water Commission Bulletin 8.

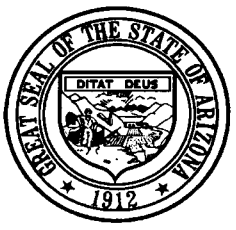
United States Bureau of Reclamation. (1997). Data from www.usbr.gov\cdams\dams, April, 1997.

White, N.D. (1963). *Groundwater Conditions in the Rainbow Valley and Waterman Wash areas, Maricopa and Pinal Counties, Arizona.* United States Geological Survey Water Supply Paper 1669-F.

CHAPTER

3

Water Use Characteristics



3.1 INTRODUCTION

As discussed in Chapter 2, the Phoenix Active Management Area (AMA) has a combination of groundwater and surface water supplies available which have been an asset to the water management of the area. However, limitations exist which restrict accessibility to renewable supplies. Institutional constraints, physical distribution, and reliability can limit a supply over an area as large as the Phoenix AMA. Surface water projects have been developed throughout Arizona's history and are protected by a series of water rights. The use of the majority of Salt and Verde River water is limited to those lands that have obtained the right to use this supply, and cannot be removed, used, or sold separately from those lands. Also, many water users are located in areas that do not have direct access to renewable supplies either due to large distances from distribution systems or the lack of financial capability to construct physical transmission and distribution systems. Renewable supply reliability is almost exclusively dependent on weather patterns in the watershed which can limit the amount and timing of available supplies. Other factors can also limit the use of a supply such as water quality constraints, public perceptions, and demand requirements. The Department of Water Resources (Department) has developed many water management alternatives that have been effective in mitigating some of these constraints. These alternatives will be discussed in detail in subsequent chapters.

Although there are significant limitations in the distribution of renewable supplies, water users in the Phoenix AMA have been successful in increasing the utilization of these supplies while decreasing dependency on groundwater. The switch to renewable supplies has decreased the overdraft in the Phoenix AMA since the management plans went into effect. Additional renewable supply utilization combined with comprehensive conservation programs are the water management objectives that the Department will use to move the AMA closer to its goal of safe-yield. However, in order to develop an effective water management program designed to achieve the management goal of the region, the water use characteristics of the end users must first be evaluated.

This chapter describes historic and current water use patterns in the Phoenix AMA within three water demand sectors: agricultural, municipal, and industrial. Sources of water supply that have been used over time and trends in their use are discussed, as well as expected supply source utilization in the future. Finally, a water budget of current demand and supply conditions within each sector is presented, which illustrates the need for continued conservation and augmentation efforts during the third management period to realize progress toward achieving the AMA goal of safe-yield by 2025.

Each water demand sector has unique water use characteristics which affect the AMA's ability to achieve safe-yield. Agricultural use includes water used for irrigation of crops for animal or human consumption by all farming operations within the AMA who are required to report their water use to the Department (all irrigation grandfathered rights of two or more acres). Municipal uses include water supplied by cities, towns, private water companies, and irrigation districts for non-irrigation uses (including domestic, industrial, and commercial purposes). Industrial use includes groundwater withdrawn pursuant to a non-irrigation grandfathered groundwater right (Type 1 and Type 2 non-irrigation) or withdrawal permits for industrial purposes, such as irrigation of school grounds, parks, or golf courses, and for sand and gravel operations, dairy and feedlot operations, and electrical power generation.

In addition to these demand sectors, three Indian communities are located within the boundaries of the Phoenix AMA: the Salt River Pima-Maricopa Indian Community, the Fort McDowell Indian Community, and the northern portion of the Gila River Indian Community (also extending into the Pinal AMA). The water use by these communities is exempt from regulation by the state. However, it is important to include these uses in an assessment of water use for the AMA as the demand characteristics of these communities have a hydrologic impact on the safe-yield goal. These communities are dominated by agricultural uses, with a small portion of domestic uses and some commercial and industrial uses such as shopping centers and gaming facilities. It is expected that agricultural uses within the Indian communities may increase due

to the urbanization outside of these areas, relocation of farms from non-Indian agricultural areas, and increased commercial opportunities within the communities. Historical Indian water use has been collected and divided into agricultural and municipal uses. This information is incorporated into the discussions for each water demand sector.

Table 3-1 illustrates water demand within each demand sector within the Phoenix AMA for the years 1985, 1990, and 1995. As shown in the table, in 1995 agricultural use comprised 58 percent of the total use in the AMA, municipal use accounted for 38 percent of the reported water use, the industrial sector accounted for 4 percent of the total water use. A comparison of the 1985 and 1995 Phoenix AMA total demand results in an approximate decrease of 4 percent. However, as will be discussed in the subsequent sections of this chapter, demand characteristics in the Phoenix AMA are affected by a number of factors, each having a unique impact within each of the demand sectors. For instance, the table shows that the agricultural sector still accounts for the majority of the total water use in the AMA. However, as a proportion of total water use, agricultural use has declined with the municipal proportion subsequently increasing. Factors such as urbanization of agricultural lands may be one reason for this decline. As described later, other factors such as a depreciation in the farm economy or the impact of federal assistance programs may temporarily result in a reduced agricultural demand.

TABLE 3-1
1985, 1990, AND 1995
WATER DEMAND BY SECTOR
PHOENIX ACTIVE MANAGEMENT AREA

	1985		1990		1995	
Sector	**Total Use (acre-feet)**	**% of AMA**	**Total Use (acre-feet)**	**% of AMA**	**Total Use (acre-feet)**	**% of AMA**
Agricultural [1]	1,622,039	69	1,260,186	60	1,333,885	58
Municipal [2]	657,191	28	782,474	37	869,962	38
Industrial	73,485	3	73,767	3	83,088	4
TOTAL	**2,352,715**		**2,116,427**		**2,286,935**	

[1] Includes Indian Agriculture use
[2] Includes Indian Municipal & Industrial use, deliveries to Palo Verde Nuclear Generating Facility, and exempt wells

Water users within the Phoenix AMA have historically utilized both surface water and groundwater supplies. Beginning with the post-World War II period, a cotton boom occurred and additional agricultural lands were brought into production. Additionally, people and industry moved to the area and a period of rapid growth occurred. These factors resulted in steadily increasing demands on the groundwater supply and have led to the need for augmentation of renewable supplies and groundwater use limitations. After the Groundwater Code (Code) went into effect in 1980, supply composition began to slowly change. Although approved by Congress in 1968, water from the Central Arizona Project (CAP) first became available to the Phoenix AMA in 1985. The use of this supply has increased annually, especially with the flexibility provided by artificial recharge to store excess CAP water. Prior to this, surface water from the Salt and Verde Rivers was the largest source of renewable supplies to this region. With the aid of the Salt River Project (SRP), its series of reservoirs and large distribution system, water from the Salt and Verde Rivers is heavily utilized in all water demand sectors. Additionally, although the reuse of effluent is not a new concept to this area, widespread utilization has historically been limited by institutional constraints, the location of wastewater treatment facilities, and public perceptions. Technological and institutional progress is continuously being made in the area of effluent reuse, either through direct use or artificial

recharge and recovery facilities. Effluent reuse is becoming an increasingly larger proportion of the water use in the Phoenix AMA.

As stated earlier, the utilization of renewable water supplies has increased in the Phoenix AMA. This is especially true of the municipal sector. Even as water use increases in this sector, due to population increases, many municipal providers have taken advantage of the availability of renewable supplies and thus have become less reliant upon groundwater sources throughout the first and second management periods. Total water use in the agricultural sector has also declined from historic levels, however, this may be misleading since the utilization rate of agricultural lands is relatively low. If the agricultural land utilization rate increases, the minor declines in use over this period may vanish. As urbanization continues in agricultural areas that currently receive renewable supplies, the remaining agricultural demand will be dependent upon groundwater supplies unless access to renewable supplies is extended. Though only a small proportion of the total AMA water use, industrial use has increased approximately 13 percent from 1985 to 1995, with less than 1 percent of the increase being supplied by non-groundwater supplies. Table 3-2 illustrates total groundwater, effluent, and surface water use by each water demand sector for the years 1985, 1990, and 1995.

While a decline in total water use of 3 percent has occurred between 1985 and 1995, groundwater use has decreased approximately 19 percent in that same period. Many factors have contributed to the water demand and supply changes in this period. The following sections describe more fully water use in each of the demand sectors: agricultural, municipal, and industrial. Indian water use has been incorporated into the agricultural and municipal demand information, as appropriate.

TABLE 3-2
1985, 1990, AND 1995
WATER USE BY SOURCE (ACRE-FEET)
PHOENIX ACTIVE MANAGEMENT AREA

Year	Agricultural	Municipal	Industrial	Total Use
1985 TOTAL	**1,622,039**	**657,191**	**73,485**	**2,352,715**
Groundwater	772,632	276,541	62,558	1,111,731
Effluent	32,325	10,654	571	43,550
CAP	0	0	0	0
Surface Water	817,082	369,996	10,356	1,197,434
1990 TOTAL	**1,260,186**	**782,474**	**73,767**	**2,116,427**
Groundwater	816,047	292,047	67,649	1,175,743
Effluent	35,554	52,514	4,014	92,082
CAP	72,480	150,827	395	223,702
Surface Water	365,433	287,086	1,709	624,900
1995 TOTAL	**1,333,885**	**869,962**	**83,088**	**2,286,935**
Groundwater	573,183	253,585	71,285	898,053
Effluent	36,353	70,355	3,023	109,731
CAP	121,238	151,791	1,530	274,559
Surface Water	603,111	394,231	7,250	1,004,592

3.2 AGRICULTURAL WATER USE CHARACTERISTICS

Agricultural water use includes water supplied for irrigation of crops grown for human or animal consumption. Water users within this sector use a combination of surface water, effluent, and groundwater to meet annual demands. The availability of non-groundwater supplies is primarily dependent upon the location of the farm within an irrigation district that has existing surface water rights and a system capable of distributing the supply.

3.2.1 Agricultural Demand

The Department regulates all Irrigation Grandfathered Rights (IGFRs) within AMAs. Indian agriculture is not regulated. In 1994, IGFRs that were 10 acres or less, and not part of an integrated farming operation, were deregulated as a result of the Small Water Rights Bill. Laws 1986, Ch 107, §§ 2 and 3. Pursuant to this Bill, IGFRs in this "small farm" category were no longer required to report annual water use and comply with water duty limitations. Historically, these small farms made up about half of the IGFRs in the Phoenix AMA, but only accounted for 4 percent of the total use. Historic water demand figures described in this discussion include the small exempted rights.

Demand in the agricultural sector is influenced primarily by three factors: the number of acres irrigated, the crops grown, and the efficiency of water application. Agricultural users are assigned an irrigation efficiency requirement under the management plans (see Chapter 4, Agricultural Conservation Program). Additionally, pursuant to the Code, no new agricultural acres can be put into production, significantly limiting the potential for increases in agricultural demand in the future. Due to a combination of these factors and the urbanization of the Phoenix AMA, total water use in the agricultural sector has declined since the Code went into effect. Indian agricultural water use will be discussed separately from non-Indian agriculture due to the impact of water availability and regulations outside of the Indian communities. Table 3-3 shows annual historical agricultural water use from 1985 through 1995 and the sector's groundwater use characteristics.

In 1985 the agricultural sector used 1,622,039 acre-feet of water, comprising 69 percent of the total AMA water demand, and 70 percent (772,632 acre-feet) of the total groundwater used in the AMA. Water use in 1995 totaled 1,333,885 acre-feet, or 58 percent of the total AMA water use. Of the total 1995 water use in this sector, groundwater in the amount of 573,183 acre-feet was used in this sector which made up 64 percent of the total AMA groundwater use.

3.2.1.1 Non-Indian Agricultural Demand

Non-Indian agriculture accounts for approximately 83 percent of the total agricultural water use in the Phoenix AMA. Unlike Indian agriculture, it was expected that water use in this sector would decline as a result of urbanization. In 1985, the non-Indian agricultural sector used 1,363,530 acre-feet of water and 663,738 acre-feet of groundwater. Water use declined approximately 19 percent by 1995 when water use by non-Indian agriculture totaled 1,109,105 acre-feet. Of the total water use in 1995, groundwater in the amount of 482,151 acre-feet was used in this sector, which made up 43 percent of the non-Indian agricultural water use. A total of 3,575 IGFRs were being monitored in 1995 in the Phoenix AMA covering approximately 308,681 acres (not including exempt right holders who are not required to report annual water use). Most of these right holders are located within the boundaries of one of 20 irrigation districts located in the Phoenix AMA, with 80 percent of the total use located in the seven largest irrigation districts: SRP, Roosevelt Irrigation District, Roosevelt Water Conservation District, Buckeye Water Conservation and Drainage District, New Magma Irrigation and Drainage District, Maricopa Water District, and Queen Creek Irrigation District.

TABLE 3-3
1985-1995
AGRICULTURAL WATER DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Year	Non-Indian Demand [1] (acre-feet)	Indian Demand (acre-feet)	Total Demand (acre-feet)	Total Groundwater Demand (acre-feet)	Groundwater % of Total Agricultural Demand
1985	1,363,530	258,509	1,622,039	772,632	48
1986	1,003,036	258,509	1,261,545	734,453	58
1987	1,246,076	258,509	1,504,585	642,702	43
1988	1,222,109	252,790	1,474,899	664,111	45
1989	1,217,557	251,365	1,468,922	758,513	52
1990	1,023,970	236,216	1,260,186	816,047	65
1991	974,652	234,803	1,204,455	596,784	49
1992	909,098	223,822	1,132,920	513,560	45
1993	962,066	221,651	1,183,717	563,810	48
1994	1,067,352	223,467	1,290,819	627,630	49
1995	1,109,105	224,780	1,333,885	573,183	43

[1] Includes small exempt water use

When comparing demand in the non-Indian agricultural sector between 1985 and 1995, water use has declined. However, in recent years, due possibly to a combination of dry weather conditions and a recovery in the agricultural economy, an increase in water demand has been exhibited in this sector. Overall, water use in the agricultural sector has fluctuated throughout the period. Additional factors that can affect demand in this sector are discussed below.

3.2.1.1.1 Crop Water Requirements

The consumptive use of a particular crop will impact the water use on a farm. Although the conservation requirements developed for agricultural water users are based on the crops grown between 1975 and 1979, producers are given the flexibility to grow any crop as long as they can achieve their conservation requirements. Because of the relatively moderate climatic conditions in the Phoenix AMA, producers also have the flexibility to double-crop their acreage with summer and winter crop varieties. To maximize land productivity, rotation of several crops over a period of years is also practiced.

The crops predominantly grown in the Phoenix AMA include cotton, alfalfa, wheat, and barley. Other crops grown throughout the area include vegetables, citrus, potatoes, and melons. Although the total number of cropped acres has declined, there has not been a significant change in the historic crop mixes within the Phoenix AMA since 1980. Consumptive use values for the crops grown in the Phoenix AMA are listed in Appendix 4. Table 3-4 shows the percent of the top four crops grown in proportion to the total crops grown in the Phoenix AMA from 1975 through 1979 compared to the period 1992 through 1996.

Cotton remains the principal crop grown in the Phoenix AMA, accounting for almost half of the total crop production. On average, no significant change in the principal crops can be seen between these two periods. Wheat production in the period 1992 through 1996 has begun to increase but cotton and alfalfa production, with a consumptive use of 3.43 acre-feet per acre and 4.69 acre-feet per acre respectively, remain the largest proportion of crops in the Phoenix AMA.

TABLE 3-4
PROPORTION OF TOTAL CROPS GROWN (%)
COMPARISON: 1975-1979 TO 1992-1996
PHOENIX ACTIVE MANAGEMENT AREA

	1975	1976	1977	1978	1979	Average
Cotton	25.1	31.9	46.6	50.8	58.2	42.5
Alfalfa	20.5	19.1	17.8	18.2	13.2	17.8
Wheat	19.2	25.5	9.0	8.8	7.8	14.1
Barley	10.8	5.8	5.2	3.0	3.7	5.7
TOTAL	75.6	82.3	78.6	80.7	82.9	80.0
	1992	**1993**	**1994**	**1995**	**1996**	**Average**
Cotton	55.3	49.9	47.0	49.3	40.2	48.3
Alfalfa	16.7	16.3	18.3	18.5	18.3	17.6
Wheat	7.2	10.6	12.7	11.3	16.8	11.7
Barley	3.1	5.0	4.7	3.1	6.2	4.4
TOTAL	82.3	81.8	82.7	82.2	81.5	82.0

NOTES:
1. From the Arizona Agricultural Statistics, various years.
2. The tables exclude acreage outside of Maricopa County that is within the Phoenix AMA (such as NMIDD) and include acreage outside of the AMA but inside Maricopa County (such as the Gila Bend and Harquahala Valley areas).
3. Cotton combines Upland and American Pima.
4. Wheat combines Winter and Durum.
5. Data from 1996 are preliminary.

3.2.1.1.2 Cropping Patterns

Cropping patterns (i.e., crop mixes, acres in production, and crop rotations) have a significant impact on water demand in this sector. It was expected that urbanization of agricultural lands within the Phoenix AMA would lead to a proportionate decline in cropped acres throughout the management periods. Urbanization has occurred in the Phoenix AMA at phenomenal rates. However, not all urbanization has occurred on agricultural lands, and agricultural water use has fluctuated. An analysis of trends in agricultural demand is also complicated by the difficulty associated with obtaining information required by the Department, such as crops grown, acres in production, and other farming practices. It is not known for certain how many acres are in production on an annual basis. Lack of information on farming practices such as double-cropping, crop rotation, and land fallowing also make it difficult to assess annual water demand.

The decision to grow a particular crop and how much land to put into production in any year is based on a number of factors including economic conditions, water prices, weather, and local planting conditions. One of the leading factors that may have affected cropping patterns over the past 20 years has been federal commodity incentive programs, including acreage reduction programs (land fallowing). Government-set

target prices for wheat, feed grains, rice, and cotton exceed market prices. Therefore, acreage reduction programs were implemented to limit federal budget disbursements and to prevent the build up of surplus commodities held by the government. Participation in acreage reduction programs was voluntary, however, producers had to participate to be eligible for program benefits, such as price and income supports, crop insurance, farm loans, and deficiency payments. Through the 1996 Farm Bill, acreage reduction restrictions were lifted, allowing participating producers to plant 100 percent of their total contract acreage, plus any additional acreage, with any crop (with limitations on fruits and vegetables) with no loss in benefits.

Although it was expected that urbanization of agricultural lands in the Phoenix AMA would lead to a decline in cropped acres, the change in the incentives for acreage reductions and any boost in agricultural economic conditions may increase the land utilization rate. Since 1984 when the Phoenix AMA certified approximately 389,000 irrigation acres, approximately 60,000 acres have gone out of production due to conversion of those acres to non-irrigation uses, a reduction of approximately 17 percent. Alternatively, some acres available for production have not been cultivated continuously due to unfavorable economic conditions or programs that provide incentives for fallowing (acreage reduction). The Department estimates that approximately 161,797 acres were cropped in 1995, out of a potential 326,695 acres (including exempt and non-exempt rights). This represents a 49 percent land utilization rate. Between 1984 and 1995, a 17 percent decline in potential cropped acreage was experienced and total water use declined approximately 13 percent. However, comparing annual acreage reduction and water use between 1984 and 1995 has not shown any consistent trend. Table 3-5 shows that irrigation acres within the Phoenix AMA have been consistently declining. However, total agricultural water use has been inconsistent with the acreage reductions, fluctuating throughout the period.

3.2.1.1.3 Application Rates

Application rates for the AMA or for individual areas could provide information important to the agricultural conservation program. The application rate can be determined by comparing the amount of water applied each year to the acreage actually in production. This analysis would make it possible to determine the demand for specific crops for different years. However, the Department does not require producers to report the number of acres in production in each year. Based on the information in section 3.2.1.1.2, comparing water use and irrigation acres (see Table 3-5), overall agricultural water use has not been consistent. Increases in total water use of up to 24 percent have been exhibited as well as a decrease of 26 percent. These fluctuations in total water use could be a result of extreme weather conditions, such as higher consumptive use and evaporation in warmer/drier years, changes in agricultural economic conditions, or changes in water conservation practices. Nonetheless, water use trends do not exhibit the same trends as irrigable acreage (which may or may not bear any correlation to cropped acreage). Additional data regarding application rates could assist the Department in its AMA-wide water use analyses.

3.2.1.2 Indian Agricultural Demand

Annual water use by Indian communities is not required to be reported to the Department. Thus, for the purposes of this chapter, agricultural water use on Indian lands is estimated using information obtained from SRP annual water reports and water right settlement information. Irrigable farmland for all three Indian communities in the Phoenix AMA in 1986 was estimated to be 59,271 acres, with 29,423 acres actually in production (50 percent land utilization). In 1995, the farmland in production was estimated to be 36,925 acres, an increase in land utilization of approximately 12 percent from 1986. Agricultural water use in 1987 was estimated at 258,509 acre-feet (108,894 acre-feet of groundwater and 149,615 acre-feet of surface water). Water use decreased to 224,780 acre-feet in 1995. Because water users in these areas are not subject to the conservation requirements or acreage restrictions, it is projected that agricultural water use will increase in the future. Projections for future Indian agriculture are discussed in more detail in

Chapter 11 of this plan. Table 3-6 shows the estimated water use for 1990 through 1995 for Indian agriculture located in the Phoenix AMA.

TABLE 3-5
1984-1995
NON-INDIAN AGRICULTURE
COMPARISON: TOTAL WATER USE/IRRIGATION ACREAGE
PHOENIX ACTIVE MANAGEMENT AREA

Year	Total Water Use (acre-feet)	Certified Irrigation Acres	Annual % Change in Water Use	Annual % Change in Acreage
1984	1,244,466	389,000		
1985	1,363,530	365,501	+ 10	- 6.0
1986	1,003,036	355,467	- 26	- 2.7
1987	1,246,076	347,297	+ 24	- 2.3
1988	1,222,109	343,826	- 2	- 0.9
1989	1,217,557	339,368	- 1	- 1.0
1990	1,023,970	338,588	- 16	- 0.2
1991	974,652	336,804	- 5	- 0.5
1992	909,098	334,709	- 7	- 0.6
1993	962,066	331,454	+ 6	- 0.9
1994	1,067,352	328,788	+ 11	- 0.8
1995	1,109,105	326,695	3	- 0.6

TABLE 3-6
1990-1995
INDIAN AGRICULTURAL DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Year	Total Demand (acre-feet)	Groundwater % of Total Use
1990	236,216	67
1991	234,803	47
1992	223,822	48
1993	221,651	44
1994	223,467	37
1995	224,780	41

3.2.2 Agricultural Supplies

Groundwater use accounted for approximately 43 percent of the total agricultural supplies utilized in 1995. This is a reduction from 1985 when groundwater accounted for about 48 percent of the agricultural supply. However, as shown previously in Table 3-3 (section 3.2.1), the utilization of groundwater in the agricultural sector has fluctuated between 1985 and 1995, ranging between a low of 43 percent of the total agricultural use in 1987 and 1995 and a high of 65 percent in 1990. The use of surface water in this sector is highly dependent upon the location of the IGFR within an irrigation district that has access to renewable supplies, weather conditions on the watershed, and the cost of the surface water compared to groundwater pumping. Table 3-7 shows the 1995 utilization of supplies by irrigation district, right holders outside of irrigation districts, and the Indian communities.

Agricultural water users outside of irrigation districts are almost entirely dependant upon groundwater sources to meet demand. The majority of the surface water use is located within a few irrigation districts: SRP, Roosevelt Water Conservation District, Buckeye Water Conservation and Drainage District, New Magma Irrigation and Drainage District, Maricopa Water District, and Queen Creek Irrigation District. Effluent is also utilized in the Phoenix AMA by agricultural water users. Effluent reuse has been facilitated through agreements for effluent discharge from the 91st Avenue Wastewater Treatment Plant (WWTP). The Buckeye Water Conservation and Drainage District has contracted with the Multi-City Sub-Regional Operating Group (participants in the 91st Avenue WWTP), made up of the cities of Phoenix, Mesa, Scottsdale, Tempe, and Glendale to receive 30,000 acre-feet of effluent per year. Through a water exchange agreement with the City of Phoenix, the Roosevelt Irrigation District is entitled to utilize up to 30,000 acre-feet of effluent per year, although Phoenix actually gets credited with the effluent use in their accounting (see Water Exchanges, A.R.S. § 45-1001, *et seq.*). Additionally, the Gila River Indian Community uses effluent generated at the Chandler Lone Butte WWTP.

Agricultural water users began utilizing CAP water when it became available in the Phoenix AMA in 1986. Many irrigation districts entered into subcontracts for CAP water with the Central Arizona Water Conservation District (CAWCD), the agency responsible for CAP repayments to the federal government. However, many agricultural water users were unable to pay the charges required under the CAP sub-contracts. Thus, in 1994, in exchange for waiving their rights to receive delivery of CAP water under long-term contracts, defaulting irrigation districts were entitled to receive excess CAP water (subject to the availability of the water in each year) on a short-term basis at low rates set by CAWCD. This price incentive CAP water is referred to as "Pool water." Pool 1 water was made available to each district that executed a CAP subcontract prior to October 1, 1993. Pool 2 water was made available to non-Indian irrigation subcontractors who relinquished all or a portion of the original entitlement between October 7, 1993 and January 1, 1994. A volume of approximately 98,000 acre-feet was made available through Pool 1 and Pool 2 to Phoenix AMA agricultural users.

In addition to the pricing incentive described above, some irrigation districts in the Phoenix AMA agreed to implement groundwater savings (in-lieu recharge) projects with municipal CAP subcontractors, CAWCD, and the Arizona Water Banking Authority (otherwise known as water storers) in exchange for CAP water at rates comparable to groundwater pumping. These agreements allowed the water storers to offer CAP water at a low cost to irrigation districts and irrigation right holders who then agreed to reduce their groundwater pumping in an equal proportion to the amount of CAP water used. As a result, the water storers received credits for the recovery of CAP water within their service areas for every acre-foot of groundwater that was not pumped. Although the legal characteristic of the in-lieu water used by the agricultural sector is considered groundwater (see Chapter 8 for a detailed description of groundwater savings facilities), this option has lead to significant "banking" of excess CAP water for use by municipalities or other users in times of need.

TABLE 3-7
1995 AGRICULTURAL WATER USE BY SOURCE (ACRE-FEET)
PHOENIX ACTIVE MANAGEMENT AREA

	Ground-water Pumped	In-Lieu Water [1]	CAP Water	Direct Use Effluent	Surface Water	Tailwater	Total Water Use
SRP	29,628	0	0	4,028	265,947	1,500	301,103
RID	150,226	0	0	0	4,635	2,630	157,491
RWCD	38,188	19,119	15,120	0	45,287	138	117,852
BWCDD	4,508	0	0	30,000	67,683	769	102,960
NMIDD	7,446	26,516	57,943	0	0	0	91,905
MWD	26,164	0	0	0	53,759	510	80,433
QCID	13,886	8,656	34,375	0	0	0	56,917
All Other Districts	29,485	2,177	13,800	0	26,576	792	72,830
Outside Districts	126,152	0	0	0	0	1,462	127,614
Indian Communities	91,032	0	0	2,325	131,423	0	224,780
TOTAL	**516,715**	**56,468**	**121,238**	**36,353**	**595,310**	**7,801**	**1,333,885**

Salt River Project (SRP), Roosevelt Irrigation District (RID), Roosevelt Water Conservation District (RWCD), Buckeye Water Conservation and Drainage District (BWCDD), New Magma Irrigation and Drainage District (NMIDD), Maricopa Water District (MWD), and Queen Creek Irrigation District (QCID).

[1] Counted as groundwater in water use accounting.

Table 3-8 shows the historic use of in-lieu CAP water in the agricultural sector, since the program began in 1992, and CAP water directly used in the agricultural sector between 1990 and 1995. It is important to note that the in-lieu water is accounted for as groundwater pursuant to the groundwater savings facility requirements and thus is not reflected as CAP or surface water use in the agricultural sector except in this table. Because of the incentive pricing and the in-lieu recharge program, CAP use by the agricultural sector has increased significantly from 1991 through 1995, as shown in Table 3-8.

3.2.3 Summary

The agricultural sector still accounts for the majority of the total water use in the Phoenix AMA and the largest use of groundwater. However, due to rapid urbanization and the Code prohibition on new agricultural acreage, the agricultural sector in the Phoenix AMA is expected to be surpassed by the municipal sector during the third or fourth management periods as the largest water demand sector. However, decreased reliance on groundwater is not expected in the agricultural sector, since the majority of acres to be urbanized will be from within irrigation districts that use primarily renewable water sources. The impact of the 1996 Farm Bill could increase the acreage put into production on an annual basis. However, urbanization will reduce the acreage available for irrigation. Additionally, it is expected that as

some of the lands outside of the Indian communities urbanize, farming will increase on Indian lands. Thus, agricultural acreage may decline, but not to the levels originally anticipated. It is assumed that the principal crops grown in the Phoenix AMA, for the most part, will remain the same. Most of the acreage that is anticipated to be urbanized is located within irrigation districts that have access to renewable supplies: SRP, Roosevelt Water Conservation District, and Maricopa Water District. Irrigation districts relying wholly or primarily on groundwater and IGFRs located outside of districts are not anticipated to urbanize at the same rates. Thus, the agricultural sector may become more dependent on groundwater in the future even though total water demand will decrease. Without any requirements to switch to renewable supplies, the agricultural sector will be contributing little to achievement of the Phoenix AMA management goal.

TABLE 3-8
1990-1995
NON-INDIAN AGRICULTURAL CAP WATER USE
PHOENIX ACTIVE MANAGEMENT AREA

	1990	1991	1992	1993	1994	1995
In-Lieu CAP Water (acre-feet)	0	0	81,560	125,710	10,917	56,468
Direct Use CAP Water (acre-feet)	39,569	26,967	10,102	5,480	142,124	121,238
% of Total Non-Indian Agricultural Use	4	3	10	14	14	17

3.3 MUNICIPAL WATER USE CHARACTERISTICS

Municipal water providers (cities, towns, private water companies, or irrigation districts) deliver water pursuant to service area rights administered under the Code. Municipal water use includes water delivered to residential customers for indoor and outdoor watering; water delivered to non-residential users such as industrial facilities, commercial properties, construction users, and individual users. Individual users include turf-related facilities, landscaped public rights-of-way, and new large cooling users served by a municipal system having been identified as having high water use rates, significant conservation potential, or high visibility within the service area. Municipal water use also includes untreated water delivered to residential customers for urban flood irrigation. Depending on supply availability, proximity to renewable supplies, and the ability to finance infrastructure, municipal water users are delivered a combination of groundwater, surface water, and effluent.

3.3.1 Municipal Demand

Water demand in the municipal sector is closely tied to population growth, and thus, has increased steadily as growth has occurred in the Phoenix AMA. Municipal providers are required to meet certain efficiency requirements for water use within their service areas, which are described in detail in Chapter 5 of this plan. Water use in the municipal sector is expected to continue to increase as population growth continues through the third management period. However, in addition to water use efficiency requirements, municipal demand in new residential development is required to be met with renewable supplies, under the Assured Water Supply Rules (also described in Chapter 5). Thus, the use of groundwater in this sector is not expected to increase.

Table 3-9 shows municipal water demand for each year from 1985 through 1995 in the Phoenix AMA and the percent of groundwater that supplies this demand. Spillwater and effluent, which are not calculated in

the gallons per capita per day compliance determination for municipal providers, are included in the total water use figure in order to illustrate actual water use patterns in the municipal sector. Water use in the municipal sector has increased in relative proportion to population growth. However, as shown below, although overall water use has increased, the proportion of groundwater use has declined from 1985 to 1995, as a result of increased utilization of renewable supplies.

TABLE 3-9
1985-1995
MUNICIPAL WATER DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Year	Non-Indian Municipal Demand [1] (acre-feet)	Indian Municipal Demand (acre-feet)	Total Municipal Demand (acre-feet)	Total Groundwater Use (acre-feet)	Groundwater % of Total Municipal Demand
1985	654,000	3,191	657,191	276,541	42
1986	699,285	3,191	702,476	304,207	43
1987	746,283	3,191	749,474	281,092	38
1988	785,506	3,587	789,093	253,386	32
1989	781,409	4,042	785,451	250,704	32
1990	778,090	4,384	782,474	292,047	37
1991	750,956	4,727	755,683	232,224	31
1992	761,699	5,125	766,824	197,871	26
1993	786,000	5,476	791,476	226,840	29
1994	823,473	7,131	830,604	271,351	33
1995	862,987	6,975	869,962	253,585	29

[1] Includes exempt wells and water demand at Palo Verde Nuclear Generating Facility

In 1985, municipal water use accounted for 28 percent of the total water use in the Phoenix AMA. By 1995, the municipal sector accounted for 37 percent of the total AMA water use. As stated previously, population growth has a significant impact on municipal demand, thus, as this growth has continued, total water use in this sector has also increased, although not proportionately. Total water use has not increased at the same rate as growth, suggesting that water use by new residential customers may be more efficient. Table 3-10 shows the total water use, population, and gallons per capita per day (GPCD) use rate for non-Indian municipal water providers for the years 1985, 1990, and 1995. As shown in the table, total per capita use for non-Indian municipal providers has declined since 1985.

3.3.1.1 Non-Indian Municipal Demand

Non-Indian municipal water use accounts for 99 percent of the total municipal use in the Phoenix AMA. In 1985, non-Indian municipal water use totaled 654,000 acre-feet. By 1995, water use increased approximately 32 percent, totaling 862,987 acre-feet (including water delivered to the Palo Verde Nuclear Generating Facility and water pumped from exempt wells).

TABLE 3-10
1985, 1990, AND 1995
NON-INDIAN MUNICIPAL GALLONS PER CAPITA PER DAY TRENDS [1]
PHOENIX ACTIVE MANAGEMENT AREA

	1985	1990	1995
Large Municipal Providers			
Total Use	492,748	570,403	656,146
Population	1,808,409	2,089,025	2,494,041
GPCD	243	244	235
Small Municipal Providers			
Total Use	9,007	13,775	9,868
Population	21,674	39,621	39,441
GPCD	371	310	223
Large Untreated Water Providers			
Total Use	128,889	132,756	135,218
Total Non-Indian Municipal Use			
Total Use	630,644	716,934	801,232
Population	1,830,083	2,128,646	2,533,482
GPCD	308	301	282

[1] Table does not include effluent deliveries to Palo Verde Nuclear Generating Facility or groundwater pumped from small exempt wells

In the Phoenix AMA, a total of 147 water providers are regulated under the Municipal Conservation Program. There are three primary categories of water providers in the municipal sector: large municipal providers, large untreated water providers, and small municipal providers. Thirty-two large municipal water providers supply the majority of potable water for use within the Phoenix AMA. In 1995, these 32 large providers supplied 656,146 acre-feet of water or 75 percent of the total municipal water demand. Large untreated providers supplied 135,218 acre-feet of untreated water for urban irrigation in 1995. Small municipal providers supplied 9,868 acre-feet in 1995. An additional 48,899 acre-feet of effluent is supplied to the Palo Verde Nuclear Generating Facility from the 91st Avenue WWTP and an estimated 12,856 acre-feet of groundwater is pumped by individual well owners not supplied by a water provider.

Table 3-11 compares water demand between the large municipal providers, large untreated providers, and the small municipal providers for the years 1985, 1990, and 1995 and their proportion of the total municipal demand supplied by a municipal provider. The following sections describe the water use patterns of each category of provider in the Phoenix AMA.

TABLE 3-11
1985, 1990, AND 1995
NON-INDIAN MUNICIPAL WATER DEMAND BY PROVIDER TYPE [1]
PHOENIX ACTIVE MANAGEMENT AREA

Year	Large Municipal Providers (acre-feet)	% of Total Municipal Use	Untreated Water Providers (acre-feet)	% of Total Municipal Use	Small Municipal Providers (acre-feet)	% of Total Municipal Use
1985	492,748	78	128,889	20	9,007	2
1990	570,403	80	132,756	19	13,775	1
1995	656,146	82	135,218	17	9,868	1

[1] Table does not include deliveries to Palo Verde Nuclear Generating Facility or groundwater withdrawn from exempt wells

3.3.1.1.1 Large Municipal Providers

Large municipal providers are water providers that serve more than 250 acre-feet of water annually and are regulated for compliance with specific conservation requirements, usually a total GPCD requirement, designed to achieve efficient water use within the service area (see Chapter 5). Large municipal providers account for the largest proportion of water use in the municipal sector. These providers include the largest cities and private utilities. In 1985 large municipal providers served approximately 98 percent of the AMA's population and provided 78 percent of the total water used for residential, industrial, construction, and commercial uses. By 1995, these large providers still accounted for 98 percent of the population but increased to 82 percent of the total water use in this sector. Large population increases, a limitation on the expansion of untreated water providers, as described in Chapter 5, and the acquisition of small provider service areas may be the cause of the increase in the proportion of large municipal provider water use.

Water use characteristics of large municipal providers are commonly analyzed by the Department based on the political subdivision (public or private ownership) of the provider. Due to the different abilities of each provider to adopt ordinances or finance water projects, dividing providers into municipalities and private water companies provides a better analysis of the characteristics of water use in this category. Other water providers in this sector include two military installations, one of which has been closed and is in the process of being sold. Municipalities include incorporated towns or cities who have the ability to set rates, pass ordinances, and finance bonds through public ballots or the governing body, usually through the town or city council. A private water company is an individually owned or corporately owned entity which distributes or sells water. Private water companies have no ability to pass ordinances and must obtain permission from the Arizona Corporation Commission (ACC) to incur debt. Additionally, the rates for water charged by the private water company are also regulated by the ACC. Table 3-12 is a comparison of water use characteristics of municipalities and private water companies in 1995.

In the Phoenix AMA, 13 municipalities (cities or towns) are regulated under the municipal program, 12 of which are large municipal providers. In 1995, municipalities accounted for 93 percent of the population and 91 percent of the water use by large municipal providers. Of the total water use by municipalities, 80 percent was supplied by surface water or other non-groundwater sources. Municipalities in the Phoenix AMA have access to multiple sources of water for distribution: groundwater, Salt and Verde River water from SRP and other diversions, treated and untreated CAP water, and effluent. The City of Phoenix with a 1995 water service area population of 1,149,486 is the largest municipal water provider in the Phoenix AMA. In 1995, the City of Phoenix comprised 45 percent of the AMA population and supplied 33 percent of the total municipal water supply (93 percent of the city's total use was from renewable supplies).

TABLE 3-12
1995 LARGE MUNICIPAL PROVIDERS
COMPARISON: MUNICIPALITIES AND PRIVATE WATER COMPANIES
PHOENIX ACTIVE MANAGEMENT AREA

	Population	% of Total Population	Total Use [1] (acre-feet)	Total Groundwater Use (acre-feet)	% of Total Municipal Use	GPCD Rate
Municipalities	2,332,199	93	599,671	121,653	91	230
Private Water Companies	161,842	7	56,475	50,316	9	312

[1] Does not include deliveries to Palo Verde Nuclear Generating Facility

Approximately 66 (20 large and 46 small) privately owned and operated water companies are regulated in the Phoenix AMA. They serve a wide range of development from relatively small, built-out communities to rapidly growing regions on the exterior boundaries of the metropolitan area. Development in these areas typically consists of either single family subdivisions or retirement communities associated with golf courses. Twenty of the 32 large municipal providers are private water companies. Private water companies regulated as large municipal providers supply approximately 7 percent of the population and account for 9 percent of the large provider municipal water use. The remaining "small" private water companies supply less than one percent of the total municipal water use in the Phoenix AMA. Most private water companies in the Phoenix AMA serve only groundwater, with the exception of Chaparral City Water Company in Fountain Hills, Cave Creek Water Company, Carefree Water Company, and Arizona Water Company - Apache Junction, who have developed the ability to directly serve renewable supplies. Other private utilities pump groundwater, but through water exchanges or other permits they can account for some of this water as non-groundwater supplies. In 1995, approximately 11 percent of the total water used by private water companies came from renewable supplies, a significant increase from 1985 when less than one percent of the total use consisted of renewable supplies.

3.3.1.1.2 Large Untreated Water Providers

Twenty-one large untreated water providers have been identified in the Phoenix AMA. These are providers who deliver untreated water (non-potable) to more than 500 persons or deliver 100 acre-feet or more of untreated water through a system separate and distinct from their potable system, or through an irrigation water distribution system. Sources of untreated water include groundwater, CAP water, and Salt and Verde River water and are commonly used for urban flood irrigation of residential pasture and turf landscaping. In 1985, water use in this category totaled 128,889 acre-feet, increasing to 135,218 acre-feet in 1995. Large untreated water providers are not regulated on a per capita basis but instead are assigned a rate of use requirement of 4 acre-feet per acre per year. Additionally, no new untreated water provider service areas can be established in the Phoenix AMA, however, expansion can occur within the current service areas of the untreated water provider. Future untreated water service outside the existing boundaries will be regulated in the same manner as the provider's potable water service area.

There are two general types of untreated providers in the Phoenix AMA: Municipal Untreated Water Providers (including private water companies, cooperatives, institutional facilities, and home owner associations) and Agricultural Untreated Water Providers (irrigation districts serving non-irrigation urban

uses). Large untreated water providers account for approximately 17 percent of the total municipal sector water use in the Phoenix AMA. The SRP is the largest provider in this category, accounting for approximately 85 percent of the total untreated deliveries. Appendix 5-B contains a complete list of the Phoenix AMA large untreated providers and their 1995 total water use. Untreated water deliveries have increased 5 percent since 1985. However, untreated water deliveries are not expected to increase at significant levels in the future, as most residential deliveries are expected to be met with potable supplies or are in areas that are not eligible to be designated as untreated water provider service areas.

3.3.1.1.3 Small Municipal Providers

Small municipal providers are defined as municipal providers that deliver 250 acre-feet of water or less for non-irrigation uses annually. Small providers are required to use water efficiently, but are not assigned volumetric conservation requirements. Currently, 82 active small municipal providers exist in the Phoenix AMA. Sixteen of those are former large municipal providers that were legislatively deregulated in 1994 under the Small Rights Bill (Sunrise Water Company and Desert Hills Water Company have since been transitioned back to large municipal providers as their use exceeded 250 acre-feet). Water use in this category has not changed significantly in the past 11 years and accounts for approximately one percent of the total municipal sector water demand. The average per capita use rate among small municipal providers is estimated to be 223 GPCD.

There are six general categories of small municipal providers: well cooperatives, mobile home parks, private water companies regulated by the Arizona Corporation Commission, institutional facilities, irrigation districts, and miscellaneous water providers. The most numerous of the small municipal providers are the 46 private water companies with a total water use of 4,365 acre-feet in 1995, or 45 percent of the total small provider water use. The remaining small providers include ten miscellaneous providers, nine mobile home parks, 12 well cooperatives in which several property owners share a well, one irrigation district, and four institutions.

3.3.2 Indian Municipal Demand

Municipal uses of water in the Indian communities include water used for domestic, commercial, and industrial facilities, gaming operations, and sand and gravel mining. Water use information other than agricultural uses were not historically collected for the Indian communities. Estimated water use information was based on estimated uses included in the Ft. McDowell Indian Community and Salt River Pima-Maricopa Indian Community water rights settlements and the Draft Gila River Indian Community Hydrologic Survey Report. Water supplied for this sector typically comes from pumped water which may not always be considered groundwater due to the proximity of wells to surface water systems and water rights settlement provisions. In 1987, municipal water use by Indian communities was estimated to be 3,191 acre-feet. By 1995, due primarily to the opening of gaming operations and limited commercial development, the water use increased to approximately 6,975 acre-feet. It is assumed that population estimates for the Indian communities have remained relatively stable over the past decade, however, this may change as opportunities for employment and other benefits increase with proposed economic development projects.

3.3.3 Municipal Supplies

Municipal providers in the Phoenix AMA originally developed groundwater supplies to provide a potable water source for residents and industries. Renewable supplies were developed for potable water distribution first by the largest cities to replace groundwater dependancy. In 1985, groundwater use in the municipal sector totaled 276,541 acre-feet, which accounted for 42 percent of the total municipal use. By 1995 groundwater use by municipal providers decreased to 253,585 acre-feet and was only 29 percent of

the total municipal water use. Table 3-13 shows the water sources used within the municipal sector for 1985, 1990 and 1995.

TABLE 3-13
1985, 1990, AND 1995
MUNICIPAL WATER USE BY SOURCE (ACRE-FEET)[1]
PHOENIX ACTIVE MANAGEMENT AREA

	Groundwater	CAP Water	Surface Water	Effluent	Palo Verde Effluent	Total Use
1985	276,541	0	369,998	154	10,500	657,191
1990	292,047	150,827	287,086	4,214	48,300	782,474
1995	253,585	151,791	394,231	21,456	48,899	869,962

[1] Includes Indian water use

The use of renewable supplies for municipal purposes first began in 1922 when the City of Phoenix built a pipeline from the Verde River and was able to provide the first non-groundwater potable supplies. In 1947, the Verde Water Treatment Plant was built to treat the city's entitlement to Verde River water. By 1952 the city began treating and serving its SRP entitlement. Since that time, many other large communities in the valley have begun to utilize their SRP surface water supplies.

Salt and Verde River water from SRP, with 331,215 acre-feet being directly used for municipal purposes in 1995, continues to be the primary surface water supply in the Phoenix AMA. Water from the SRP is the least expensive and in wet years the availability of free water, or spillwater, may increase the use of Salt and Verde River water. The construction of the CAP canal initiated the supply of Colorado River water to the Phoenix area in 1986. The cities of Phoenix, Chandler, Glendale, Scottsdale, Mesa, and Peoria, the Town of Gilbert, and Chaparral City Water Company have constructed water treatment plants or have plants under construction to treat CAP surface water supplies. Other providers such as the City of Chandler and Arizona Water Company - Apache Junction have agreements with the City of Mesa to treat CAP water for them. Other providers even use untreated CAP water for non-potable purposes such as golf course irrigation or storage underground for future use. Additionally, many Phoenix AMA cities have been actively pursuing the acquisition of CAP subcontracts from other providers that are not able to utilize this supply. Municipal subcontractors in the Phoenix AMA are entitled to 308,817 acre-feet of CAP water. In 1995, 151,791 acre-feet (49 percent) of the total Phoenix AMA municipal CAP entitlement was directly utilized by municipal providers. An additional 112,375 acre-feet was stored underground (not included in the demand figures because it is stored for future demand) for recharge credits, resulting in a total utilization of 85 percent of the Phoenix AMA municipal and industrial CAP allocation.

Effluent use has increased significantly since 1980. Most providers historically discharged their treated wastewater into streams, rivers, or disposal ponds. Improvements in treatment technologies, changing attitudes, and increasing costs associated with discharging into public waters (which requires water quality permits) have facilitated efforts to utilize effluent as a water supply. Although more than half of the available effluent is still being discharged, many municipal providers have contracted with end users to deliver treated effluent for direct use and/or have developed recharge facilities to store and recover effluent. For example, the Sub Regional Operating Group cities have contracted with Palo Verde Nuclear Generating Facility to deliver up to 140,000 acre-feet per year of effluent from the 91st Avenue WWTP for cooling reactors at the nuclear facility. Annual demand by Palo Verde has not exceeded 60,000 acre-feet to date, due in part to a reduced cooling capacity at the facility. Additional uses of effluent are being developed by many municipalities which will result in an increase in the use of this supply into the future.

Constraints on the utilization of renewable supplies include the location and lack of infrastructure relative to the CAP canal or other surface waterways. Regional solutions to these constraints are being explored by water providers in the Phoenix AMA. Other mechanisms of receiving renewable water supplies have been obtained through lease agreements with local Indian communities for CAP water, additional surface water supplies developed on the Salt and Verde Rivers through the increase of storage capacity at Roosevelt Dam, and the added flexibility of indirect use through recharge and recovery programs.

3.3.4 Summary

By the end of the third management period, municipal water use will surpass that of agriculture. Municipal water demand is closely tied to population increases. Although per capita water use fluctuates within a service area over time depending on a number of factors (see Chapter 5), added population almost always results in an increase in total water demand. The population in the Phoenix AMA has increased approximately 38 percent from approximately 1.8 million in 1985 to approximately 2.5 million in 1995 (including population within the three Indian communities). Eleven large providers have seen population increases of more than 50 percent in that same period. These population increases are occurring evenly in both municipalities and private water companies across the AMA. During the second management period, annual population increases for the AMA ranged between 2 and 7 percent per year.

The switch to renewable supplies by the largest water users in this sector has led to a reduction in groundwater use. Although CAP water replaced groundwater use for some of the larger providers, the availability of spillwater, which is not counted in compliance by the Department, had the largest impact on decreases in groundwater pumping in 1992, 1993, and 1995. Recharge and recovery of CAP, effluent, and SRP water has significantly increased the availability of renewable supply utilization in this sector. Finally, the Department's requirements for demonstrating an assured water supply will be essential in ensuring that the municipal sector will continue the development and utilization of renewable supplies.

3.4 INDUSTRIAL WATER USE CHARACTERISTICS

Industrial water users withdraw groundwater in accordance with non-irrigation grandfathered groundwater rights (Type 1 or Type 2 non-irrigation rights) or groundwater withdrawal permits. It is important to note that water supplied by municipal providers for industrial or commercial uses within their service areas is not included in this section as industrial water use; instead, it is identified and discussed in section 3.3 as non-residential municipal water use. Because of the definition of industrial users, this sector is primarily dependent upon groundwater, although a portion of the water use in this sector does come from surface water supplied by irrigation districts. Industrial users are also subject to annual conservation requirements, described in Chapter 6. The following industrial user groups have been assigned specific conservation requirements by the Department:

- Turf-Related Facilities
- Sand and Gravel Facilities
- Large-Scale Power Plants
- Large-Scale Cooling Facilities
- Dairy Operations
- Cattle Feedlot Operations
- New Large Landscape Users
- New Large Industrial Users
- Other Industrial Users

Industrial demand in the Phoenix AMA has increased since the Code went into effect. Because industrial uses are closely tied to population growth, it is anticipated that industrial demand will continue to increase.

3.4.1 Industrial Demand

As a proportion of overall AMA demand, industrial use has not increased significantly in the past ten years. In 1985 industrial use accounted for approximately 3 percent of the AMA use and has remained approximately 3 to 4 percent of the total AMA demand since that time. However, because industrial users are primarily dependent upon groundwater, the proportion of groundwater use in the industrial sector has increased as the municipal users have switched to renewable supplies. Table 3-14 illustrates industrial water demand for the years 1985, 1990, and 1995, in addition to the proportion of groundwater use in each year.

TABLE 3-14
1985, 1990, AND 1995
INDUSTRIAL WATER DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Year	Total Use (acre-feet)	Groundwater % of Total Industrial Use
1985	73,485	85
1990	73,767	91
1995	83,088	86

Total water use by industrial users has increased since 1985, however, the industrial proportion of overall AMA demand has remained fairly stable over the period. Industrial users with groundwater rights or permits accounted for approximately 4 percent of the AMA's total water use in 1995. Although only a small proportion of the total AMA water use, 86 percent of the water used in this sector is from groundwater supplies. The remaining 14 percent comes from deliveries by irrigation districts and effluent supplied by municipal providers. Industrial use in the Phoenix AMA is dominated by turf-related facilities which include schools, parks, cemeteries, golf courses, and other facilities with a water-intensive landscaped area of 10 or more acres. These facilities are characterized by turf-grass irrigation, and thus have water demand characteristics highly dependent on weather conditions.

Table 3-15 identifies the number of industrial facilities, associated groundwater rights and permits, and the volume of water used in 1995 for facilities subject to each of the industrial conservation requirements in the Second Management Plan (except for Large-Scale Cooling Facilities, which have not been identified). Turf-related facilities that are classified by the Department as "individual users" are not included in this table. These individual users are identical in character to the industrial turf-related facility water users, however, they receive their water from a municipal provider instead of from a Type 1 or Type 2 non-irrigation right or a general industrial use permit. It is important to note that water use by individual users is not discussed in the industrial sector, because the water is supplied by a municipal provider and is included in the water use for that sector.

Since industrial users are groundwater right or withdrawal permit holders, it is not surprising that the majority of water use by industrial users, or 86 percent, is groundwater. Only some turf-related facilities that are industrial users use sources other than groundwater; these sources are mostly surface water delivered by irrigation districts to the facilities. Characteristics within each industrial category are discussed briefly below and water use by each category is illustrated in Table 3-16.

TABLE 3-15
1995 INDUSTRIAL GROUNDWATER RIGHTS AND WITHDRAWAL SUMMARY
PHOENIX ACTIVE MANAGEMENT AREA

User Category	Right or Permit	Number of Facilities	Right or Permit Volume (acre-feet)	Groundwater Use (acre-feet)	Total Water Use (acre-feet)
Large-Scale Power Plants	Type 1 & Type 2-electrical generation	4	12,062	3,832	3,832
Dairies	Type 1 & Type 2; industrial use permits	86	15,676	8,423	8,423
Feedlots	Type 1 & Type 2; industrial use permits	10	2,214	809	809
Sand and Gravel Facilities	Type 1, Type 2, Type 2-mineral extraction; mineral extraction permits	22	26,196	8,278	8,278
Turf-Related Facilities	Type 1 & Type 2; industrial use permits	110	69,755	37,424	49,227
Other Industrial Users [1]	Type 1 & Type 2; industrial use permit	304	70,994	12,519	12,519
Total			**196,897**	**71,285**	**83,088**

[1] Includes water used by Large Cooling Users, New Large Landscape Users, New Large Industrial Users, and Other Industrial Users

TABLE 3-16
1985, 1990, AND 1995
INDUSTRIAL WATER DEMAND BY CATEGORY (ACRE-FEET)
PHOENIX ACTIVE MANAGEMENT AREA

	1985	1990	1995
Turf-Related Facilities	48,327	43,930	49,227
Sand and Gravel Operations	6,895	7,681	8,278
Dairies	5,457	6,708	8,423
Large-Scale Power Plants	2,092	3,128	3,832
Feedlots	951	903	809
Other	9,763	11,417	12,519
Total	**73,485**	**73,767**	**83,088**

Large-Scale Power Plants

Between 1984 and 1986, electric power plants withdrew an average of approximately 2,100 acre-feet of groundwater per year. Although water users in this category hold rights to withdraw over 12,000 acre-feet of groundwater per year, in 1995 electrical power plants only used approximately 3,832 acre-feet of groundwater.

Dairy Operations

Eighty-six dairies have been identified in the Phoenix AMA. Water use in this category has been steadily increasing, with groundwater as the primary source. In 1985, dairy operations used approximately 5,457 acre-feet of water, and by 1995 these users pumped over 8,400 acre-feet.

Cattle Feedlot Operations

In 1995, cattle feedlots used approximately 809 acre-feet of water, a decrease from 951 acre-feet in 1985. Additional reductions in use are expected throughout the third management period as urbanization occurs in rural areas of the AMA where feedlots are located.

Sand and Gravel Facilities

Sand and gravel facilities mine unconsolidated stream deposits to produce construction materials and are primarily dependent on groundwater supplies to meet their water demand. Annual water use in this sector has fluctuated from approximately 6,900 acre-feet to approximately 13,600 acre-feet, due to the association with construction.

Turf-Related Facilities

This sector of industrial users include golf courses, schools, parks, cemeteries, and common areas of sub-divisions. Landscape watering by turf-related facilities dominates industrial water use in the Phoenix AMA. Turf-related facility water use has increased from approximately 87,700 acre-feet in 1987 to 97,151 acre-feet in 1995. Of this amount, 51 percent, or 49,227 acre-feet, was used by industrial groundwater right or permit holders while 49 percent, or 47,924 acre-feet, was used by facilities that are individual users receiving water from a municipal provider. During this period, some turf-related facilities have begun to take water from a municipal provider rather than exercising their industrial rights. Additionally, most new turf-related facilities are being developed on municipal supplies. Municipally served turf-related facilities are supplied greater percentages of surface water, including CAP and effluent.

Large-Scale Cooling Facilities

Water use in this category has not been historically identified due to the lack of record-keeping and possibly due to the fact that most of these uses are supplied by municipal providers instead of groundwater withdrawal authorities.

New Large Landscape Users

No new large landscape users were identified during the second management period. Most of this use may be provided by municipal providers. However, potential exists for the use of groundwater under withdrawal authorities for new large landscape users.

New Large Industrial Users

Water use in this category has increased since it was established in 1992 due to the addition of six new large industrial users. In 1995 water use in this category totaled 3,100 acre-feet. Although the trend for new large industrial users to be served water by a municipal provider is most likely going to continue, it is expected that additional large industrial users will use non-irrigation rights in the third management period.

Other Industrial Users

The second largest use category is "other" industrial users. This category of water users is comprised of miscellaneous industrial users that did not have specific conservation requirements in the Second Management Plan, although the unreported cooling tower water use is most likely included in this volume. In 1995, other industrial users used over 12,000 acre-feet; an increase from the 9,763 acre-feet used in 1985.

3.4.2 Industrial Supplies

Industrial water use in the Phoenix AMA has increased approximately 13 percent since 1985. The proportion of groundwater and surface water use has remained fairly constant throughout this period. Industrial users currently use considerably less groundwater than they are entitled to use pursuant to their grandfathered groundwater right or permit allotments. When aggregated, industrial users were entitled to an allotment of 196,897 acre-feet per year in 1995, not including dewatering, hydrologic testing, and poor quality permits. Actual groundwater use by industrial users totaled only 71,285 acre-feet in 1995, or 36 percent of the aggregated allotment. The difference between the allotment volume and actual use is partially explained by the process used to establish non-irrigation grandfathered groundwater rights. The allotment for Type 2 non-irrigation rights was set at the highest annual pumping from 1975 through 1979. Industrial production levels and associated water use can fluctuate widely in response to varying economic conditions and in some cases were high during the historic period in comparison to current use conditions.

Although the definition of industrial users appears to limit this sector to groundwater use, renewable supplies (especially effluent), can be utilized. Turf-related facilities account for the largest proportion of the demand in this sector – approximately 59 percent of the total industrial use. The water quality requirements for turf irrigation do not require a high quality, potable, water supply. Thus, the utilization of effluent could reduce the impact of groundwater use on these facilities. However, the availability of the infrastructure necessary to deliver effluent to these users, in addition to concerns about public health, increased cost, and increased maintenance, may be limiting the actual use of this resource. With 60 percent of the effluent that is produced in the Phoenix AMA not being utilized, it appears that significant increases in effluent use could occur if the financial resources (cost of the supply and cost of the necessary infrastructure) were made available to transport the water to the actual users. It is expected that new turf-related facilities will be using increasing amounts of the available effluent produced in the future. Table 3-17 shows industrial water use by source for 1985, 1990, and 1995.

3.4.3 Summary

Because the definition of an industrial user is limited to non-irrigation withdrawal authorities, this sector is primarily dependent upon groundwater withdrawals to meet demand. This sector is expected to increase to meet the needs associated with additional population, although water demand for most new turf-related facilities will be met by municipal providers. As water use in the industrial sector increases, groundwater use will also increase.

TABLE 3-17
1985, 1990, AND 1995
INDUSTRIAL WATER USE BY SOURCE (ACRE-FEET)
PHOENIX ACTIVE MANAGEMENT AREA

	Groundwater	Surface Water	CAP Water	Effluent	Total Industrial Use
1985	62,558	10,356	0	571	73,485
1990	67,649	1,709	395	4,014	73,767
1995	71,285	7,250	1,530	3,023	83,088

3.5 PHOENIX ACTIVE MANAGEMENT AREA WATER BALANCE

Table 3-18 contains information on water supply and demand within each demand sector for the years 1990 through 1995. This water balance is reflective of actual conditions during this time period. Sector demands were obtained from a combination of annual groundwater withdrawal and use reports and annual water storage and recovery reports. Natural system demand components were derived from information provided in Chapter 2 along with the Department's Hydrology Division. Supply components were also retrieved from these same information sources.

The table displays a variable trend in water supply utilization when compared against the cumulative water demands of the Phoenix AMA. Each water demand sector demonstrates a contribution to the overdraft in the Phoenix AMA. Although the overdraft varies from year to year, a consistent level of demand exceeds renewable supplies throughout the time period displayed. This table represents only a brief period of time, however, serious questions are being raised about the likelihood of achieving safe-yield. Although a large portion of the future municipal demand will be required to develop with a reliance on renewable supplies rather than groundwater, agricultural, industrial, and some municipal users do not have any obligation to eliminate groundwater mining through the management periods. The volume of this residual groundwater mining is substantial – approximately 365,000 acre-feet in 1995. This illustration is essential for supporting the development of conservation requirements contained in this management plan and the proposals to develop additional mechanisms necessary to attain the management goal of the Phoenix AMA, described in Chapter 12.

3.6 CONCLUSIONS

As described in the previous sections, each water demand sector has unique characteristics which have effected past and current water use patterns. The municipal sector has exhibited the greatest amount of growth since 1980 while agricultural use has declined somewhat. Industrial use has displayed moderate growth.

Table 3-18 illustrates the current contribution to overdraft by each sector. The water demand characteristics described above, including sources of supply utilized, when projected to continue through-out the third management period and beyond (see Chapter 11), illustrate that additional water conservation and augmentation programs are necessary in order to achieve the AMA goal by 2025.

TABLE 3-18
1990-1995 HISTORICAL WATER BUDGET
PHOENIX ACTIVE MANAGEMENT AREA

Sector	1990	1991	1992	1993	1994	1995
Agricultural						
Demand						
Indian	236,216	234,803	223,822	221,651	223,467	224,780
Non-Indian	1,023,970	974,652	909,098	962,066	1,067,352	1,109,105
Supply						
Renewable	444,139	612,671	619,360	619,907	663,189	760,702
Groundwater	816,047	596,784	513,560	563,810	627,630	573,183
Incidental Recharge	337,304	323,953	303,562	316,830	344,984	356,322
Overdraft	**474,743**	**272,831**	**209,998**	**246,980**	**282,646**	**216,861**
Municipal						
Demand						
Indian	4,384	4,727	5,125	5,476	7,131	6,975
Non-Indian	778,090	750,956	761,699	786,000	823,473	862,987
Supply						
Renewable	490,427	523,459	568,953	564,636	559,254	616,377
Groundwater	292,047	232,224	197,871	226,840	271,351	253,585
Incidental Recharge	57,895	56,932	57,465	58,521	60,142	61,887
Overdraft	**234,152**	**175,292**	**140,406**	**168,319**	**211,209**	**191,698**
Industrial						
Demand	73,767	73,007	70,167	76,173	77,911	83,088
Supply						
Renewable	6,118	9,212	11,302	10,150	9,671	11,803
Groundwater	67,649	63,796	58,865	66,023	68,239	71,285
Incidental Recharge	6,683	6,614	6,356	6,901	7,058	7,527
Overdraft	**60,966**	**57,182**	**52,509**	**59,122**	**61,181**	**63,758**
Riparian						
Demand	48,000	48,000	48,000	48,000	48,000	48,000
Supply						
Renewable	0	0	0	0	0	0
Groundwater	48,000	48,000	48,000	48,000	48,000	48,000
Incidental Recharge	0	0	0	0	0	0
Overdraft	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**	**48,000**
Other						
Demand						
Total Natural Outflows	*28,600*	*28,600*	*28,600*	*28,600*	*28,600*	*28,600*
Supply						
Total Natural Inflows	*(137,700)*	*(137,700)*	*(137,700)*	*(137,700)*	*(137,700)*	*(137,700)*
Unused 91st Ave WWTP	*(46,000)*	*(46,000)*	*(46,000)*	*(46,000)*	*(46,000)*	*(46,000)*
Cut-to-the-Aquifer	*(28)*	*(2)*	*(7,861)*	*(12,022)*	*(2,106)*	*(5,197)*
Overdraft	*(155,128)*	*(155,102)*	*(162,961)*	*(167,122)*	*(157,206)*	*(160,297)*
Total Net Overdraft	**666,734**	**398,203**	**287,952**	**355,300**	**445,830**	**360,019**
Cumulative Overdraft	**666,734**	**1,064,937**	**1,352,889**	**1,708,189**	**2,154,019**	**2,514,039**

SECTION

II

Regulatory Programs

Chapter 4 Agricultural Conservation Program

Chapter 5 Municipal Conservation Program

Chapter 6 Industrial Conservation Program

Chapter 7 Groundwater Quality Management Program

Chapter 8 Augmentation and Recharge Program

Chapter 9 Water Management Assistance Program

Chapter 10 Plan Implementation

Preface

Section I provided an overview of the Arizona Department of Water Resources' (Department) statutory authority and management objectives, and described the physical, climatic, demographic, and water use characteristics of the Phoenix Active Management Area (AMA). Long-term water level declines, land subsidence, and water quality problems, coupled with current and projected groundwater over-drafting estimates, provide compelling justification for the development of progressive and responsible water management programs.

This section of the Third Management Plan, Section II, is entitled "Regulatory Programs" because the programs described are required of groundwater users or are preconditions to obtaining certain permits or financial assistance. The regulatory chapters that follow describe specific requirements for groundwater users within the AMA. Programs contained in this section include mandatory conservation requirements, a criterion for demonstrating consistency with the management plan by applicants for Certificates of Assured Water Supply, additional programs designed to encourage the use of renewable water sources, recharge program eligibility and operational criteria, criteria for obtaining financial assistance for water management assistance programs, and plan implementation activities, including the Department's compliance and enforcement program.

Chapters 4, 5, and 6 contain the agricultural, municipal, and industrial conservation programs, respectively. Chapter 7 discusses the Department's groundwater quality management program and provides an assessment of water quality within the AMA. Chapter 8 describes the Department's augmentation and recharge program, and Chapter 9 discusses the Department's water management assistance program. Finally, Chapter 10 outlines the Department's policies and procedures for implementation of the Plan.

The regulatory programs are based on a philosophy developed by the Department over the course of the last two management periods. In the first management period, the Department focused on the conservation of groundwater as its primary management goal. In the second management period, the Department continued to enhance the conservation programs, but also implemented a program for the augmentation of water supplies, which included incentives for the increased use of renewable supplies. In the third management period, the Department's focus is on both conservation of groundwater and augmentation of water supplies. The Department's regulatory philosophy is based on its overall water management goals for the management plans: the conservation of groundwater through the efficient use of all water sources and the augmentation of water supplies to ensure a long-term, secure water supply.

The safe-yield goal and the overall mission statement of the Department are guiding concepts in the agency's activities. An understanding of the basic framework of the regulatory programs requires knowledge of the components of the safe-yield goal and the Department's compliance approach. The framework is described below.

- **The AMA Management Goal: Safe-yield**

  "Safe-yield" by January 1, 2025 is the management goal of the Phoenix AMA. "Safe-yield" is defined by statute to mean:

  > [A] groundwater management goal which attempts to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial recharge in the active management area. A.R.S. § 45-561 (12).

The statute specifies that safe-yield is "a long-term balance." Thus, the hydrologic conditions in the AMA cannot simply be viewed in the short-term, but rather must be viewed over a longer period of time. Further, establishing a "balance" is more complicated than comparing the total amount of groundwater withdrawals for the AMA to the amount of recharge occurring in the area in a given year.

In analyzing whether an AMA is at a safe-yield condition, the Department considers the following factors which impact groundwater levels and water in storage:

1. Net natural recharge: Net natural recharge in a given year is the volume of water that naturally recharges the groundwater supply minus the natural depletions to the groundwater supply over the course of that year. The components of net natural recharge that increase the groundwater supply are stream channel infiltration, mountain front recharge, and groundwater inflow into the AMA. The components that naturally deplete the groundwater supply are groundwater outflow out of the AMA and water loss due to evapotranspiration. Infiltration of treated effluent discharged to surface water channels is not a component of net natural recharge.

2. Incidental recharge: Incidental recharge originates as groundwater or surface water which percolates down to the water table during and after its use for human activity. In the Phoenix AMA, the volume of incidental recharge is largely dependent on the quantity of municipal effluent discharged into stream channels, and the volume and efficiency of agricultural and mining water use. It should be noted that incidental recharge that occurs during the use of the water may not be permitted as an underground storage activity under the state's Underground Water Storage (UWS) Program. Water that is treated after its use for municipal purposes, becomes effluent, and is released into a natural streambed, however, is specifically recognized by the UWS Program as eligible to become a managed underground storage activity. *See A.R.S. §§ 45-801.01 et seq.* As is more fully explained below, storage credits that are accrued through an effluent discharge that has been permitted as a managed storage facility cannot be counted as a contribution to safe-yield.

3. Artificial recharge: Under the state's UWS Program, A.R.S. §§ 45-801.01 *et seq.,* persons may undertake recharge projects to purposely add water to an aquifer without the right to withdraw it in the future. However, artificial recharge is commonly used as a storage mechanism to accrue credits with the expectation of future recovery. Stored water for which credits have been issued cannot be counted as a contribution to safe-yield, because it is already allocated to the water storer. Therefore, this type of water has no impact on the safe-yield volume; however, it does result in a temporary increase in groundwater in storage.

   Not all water stored under the UWS Program can be recovered. The volume of recharge which is allocated permanently to the aquifer, or the "cut to the aquifer" that results from generation of certain types of recharge credits does benefit the aquifer and is a component of the safe-yield groundwater supply. In addition, any non-recoverable storage that is conducted under the UWS Program in a given year can be included in the safe-yield volume for that year. Recharge credits that are generated and then subsequently extinguished prior to use are also a component of the safe-yield supply.

4. Groundwater pumping: Annual pumpage volumes from the AMA's aquifers are considered in the safe-yield calculation. Withdrawals in association with irrigation grandfathered rights, non-irrigation grandfathered rights, groundwater withdrawal permits, and undesignated municipal providers are calculated as debits to the groundwater system.

Also considered in the safe-yield calculation as a debit to the system is the volume of groundwater allowed through the Assured Water Supply Program for each Designation and Certificate of Assured Water Supply issued prior to 2025. The Department concluded in the development of the Assured Water Supply Rules that a limited quantity of the groundwater in storage could be allocated as a portion of the allowable water supply for each applicant. This groundwater can be used at any time in the 100 year period; however, it is expected that this allowance will be used in the early years while other supplies are being developed, or to offset groundwater pumpage during shortage years in CAP supplies.

5. Committed demand: Committed demand is an important component in the calculation of safe-yield. In the context of an application for a Designation of Assured Water Supply, the applicant must demonstrate the physical availability of a water supply for a 100 year period which includes sufficient water to serve current, committed, and projected demand. Committed demand is associated with platted, undeveloped lots which will be served in the future. In the assured water supply demonstration process, all demands, including the committed demand, must be determined to be physically available, or "allocated." This demand is reflected in the safe-yield calculation. Outside of the designation process, committed demand is associated with unbuilt subdivisions for which a Certificate of Assured Water Supply already exists. These subdivisions can be developed without the requirement to replenish groundwater use with a renewable water supply, as a result of being approved prior to the 1995 Assured Water Supply Rules, which, for the first time, required a renewable water supply. In addition, lots that otherwise fall outside of the Assured Water Supply Program requirements represent a potential future demand. This committed groundwater demand must be counted as already having been "allocated" when examining safe-yield. To do otherwise would allow groundwater to be allocated multiple times to multiple developments, resulting in an underestimation of the long-term demands on the AMA's aquifers.

The volume of groundwater that can be withdrawn while maintaining a safe-yield condition in the AMA is not a fixed amount; it will change due to annual variations in incidental, natural, and artificial recharge, as well as other factors listed above. The groundwater system is in a state of "overdraft" as long as groundwater withdrawals exceed the sum of the naturally and incidentally recharged volumes plus the portion of the artificially recharged volume that will not be withdrawn later as storage credits.

Because water level changes are direct indicators of changes in groundwater storage, they are the measured data which support the other factors of the safe-yield analysis. However, changes in water levels are expected to continue even after achievement of safe-yield, as stored credits are recovered and entities with assured water supply designations utilize their groundwater allotments. An AMA that is at safe-yield should not experience broad-ranging, significant, and continuing declines in average water levels after adjustments are made for the factors just described. Therefore, water levels are considered in making the safe-yield determination.

- **Total Water Use Conservation Requirements and "Stacking"**

With the wide array of water resources available in Arizona as an alternative to groundwater, including surface water, effluent, CAP water, and poor quality remediation water, the Department attempts to provide incentives that will promote use of these alternative supplies whenever and wherever possible. At the same time, we recognize that groundwater is often a very accessible and inexpensive source of supply, whereas the alternative sources can be expensive and difficult to access. The Department also recognizes that groundwater is our state's "emergency" supply, and

it must be available for use whenever the other alternatives run short. Groundwater is particularly valuable as a long-term drought supply, to buffer the effect of changes in surface water availability. In order to maximize the supply of groundwater, and ensure sufficient supplies of water, all sources must be utilized efficiently.

For these reasons, the Department believes that it is both impractical and unwise to consider groundwater use as the only measure of regulatory compliance. The level of groundwater use that is reasonable is relative to the amount of water used from other sources. To ensure that groundwater users make reasonable use of groundwater, and to encourage efficiency and flexibility in the use of alternative supplies, the regulatory strategy includes evaluation of the total water use of each water user and provider, and setting conservation requirements based upon that total water use. In keeping with the Department's statutory obligations and limitations, however, the conservation requirements of the management plan only apply if groundwater is used.

The Department's regulatory program is, therefore, structured around the concept of "stacking" different types of water, by type, in a compliance hierarchy, with groundwater on top. If a total water use conservation requirement is exceeded by a user of groundwater, the amount of the violation of that requirement will be measured by the amount of groundwater used in excess of the regulatory requirements. This strategy will ensure that if groundwater is being used, it is being used as wisely and efficiently as economically possible. This system also provides the flexibility needed by most users of commingled supplies, allowing groundwater to be used as needed to supplement alternative sources

- **Flexibility in the Components of the Regulatory Plan**

The Department recognizes that water use varies by year and locality. Therefore, the Department has provided maximum flexibility when administering the regulatory provisions of the management plan. For example, most regulatory provisions include a basic program, with one or more alternative programs designed to meet special circumstances. The basic program is generally designed to place simple numerical limits on water use, leaving the means of achieving those limits wholly up to the water user or provider. The alternative programs tend to remove numerical limits in favor of specific conservation measures more suitable to the water user.

Another component of regulatory flexibility is the establishment of "flexibility accounts" for most allotment-based requirements. These accounts generally allow water users to borrow or bank water from one year to the next in order to overcome the variation in use caused by weather or other unforseen circumstances. Flexibility accounts are mandated by statute for agricultural users, and the Department has used this example to incorporate flexibility accounting into municipal and industrial programs as well.

- **Administrative Review and Variance of Conservation Requirements**

Even with the general flexibility of the regulatory programs, the Groundwater Code (Code) recognizes that certain individual conservation requirements may pose hardship in certain circumstances. To allow relief in these situations, the Code provides for an administrative review and variance process. The emphasis in this process is on the impact of a particular conservation requirement as it is applied to an individual water user. Administrative review and variance are fact-intensive inquiries which may result in some regulatory relief and are considered on a case-by-case basis.

- **Accounting for Water Use**

Many water providers deliver a mix of water types. In order to determine compliance with conservation requirements, the Department must adopt a set of policies for commingled systems. The Department is continuing to develop policies for "volumetric" accounting.

Generally, a water provider delivering different types of water through a commingled system cannot determine which type of water a customer actually received. Therefore, the provider is generally asked to account for all deliveries to its customers on a volumetric as opposed to molecular basis. This allows the provider to compute the percentage of each type of water delivered in a given year, and apply that same percentage to the water delivered to each customer, regardless of the type of water actually received by the customer. This volumetric accounting policy works well for most providers, because of its simplicity and certainty. Individual circumstances may warrant individual consideration, however, and the Department is constantly reviewing its policies on volumetric accounting to recognize necessary exceptions. Generally speaking, however, the Department does not recognize accounting which shows a concentration of deliveries of certain types of water to certain users if the delivery system is physically commingled.

- **Enforcement**

  An effective conservation plan requires effective enforcement. The Department is given wide ranging enforcement authority in the statutes to ensure that all water users are contributing their share to the overall goal of groundwater conservation and augmentation of water supplies. While the statutes allow the imposition of substantial monetary penalties for violating either water use limitations or conservation requirements, the Department is also given considerable discretion in how that enforcement program will be managed. Overall, the Department's philosophy has been that the ability to correct management deficiencies and save groundwater is more important than collecting monetary penalties. Therefore, most of the Department's regulatory efforts to date have involved voluntary "consent orders" where the water user in violation agrees to adopt conservation measures, guarantee future compliance, or otherwise mitigate the impact of the violation on the state's groundwater resources in exchange for a waiver or reduction of the civil penalties. This approach has worked well in the past, and has been particularly useful in making the transition from a state where groundwater use was essentially unregulated to a state where water regulation has become a fact of everyday life.

  In the third management period, the Department will continue its policy of reviewing each suspected violation on an individual basis. The Department will also continue its policy of working with any water user in violation of the groundwater laws to make certain that all the surrounding circumstances are understood and to explore alternative means by which the problem might be solved. In some cases, however, violations are not matters of inadvertence or misunderstanding, but are repeat offenses or voluntary decisions based on economic considerations, lack of planning, or careless disregard for the resource. During the third management period, the Department will strive to identify these latter types of violations and pursue stringent civil penalties. By so doing, the Department intends to bring greater equity and fairness to the common goal of saving our groundwater supply. Alternative mechanisms to achieve compliance while encouraging achievement of local water management goals will also be explored.

The foregoing synopsis of the Department's regulatory approach is intended to assist the reader in understanding the reasons behind the mandatory conservation requirements in the following regulatory chapters. In addition, we have included a Plan Implementation Chapter which gives more definitive explanation to many of the administrative policies and procedures introduced here. Finally, it has always been the Department's policy to offer assistance to anyone seeking to better understand or comply with the conservation requirements imposed by the management plans, or the requirements of the Groundwater Code. The AMA offices, or the central office in Phoenix, can provide valuable support on most water management issues.

CHAPTER

4

Agricultural Conservation Program

4.1 INTRODUCTION

The Agricultural Conservation Program for the Third Management Plan has been developed to contribute to the achievement of the water management goal of the Phoenix Active Management Area (AMA), which is to attain safe-yield by the year 2025. The agricultural sector's contribution to meet the Phoenix AMA's safe-yield goal is projected to come from a combination of improved on-farm water management practices, the utilization of renewable supplies, and the reduction of irrigated acreage due to urban development.

As discussed in Chapter 3, agriculture was responsible for approximately 59 percent of the total water use in the Phoenix AMA in 1995. In that year, approximately 425,683 acre-feet of groundwater, 463,887 acre-feet of surface water, 121,238 acre-feet of Central Arizona Project (CAP), 56,468 acre-feet of in-lieu, 34,028 acre-feet of effluent, and 7,801 acre-feet of tailwater were reported used by Irrigation Grandfathered Rights (IGFRs) in the Phoenix AMA for a combined total use of water of approximately 1,109,105 acre-feet. Indian water uses for agriculture are estimated at approximately 224,780 acre-feet. Given these water sources and amounts, agriculture contributed 46 percent of the total overdraft in the Phoenix AMA in the year 1995 (see Chapter 11).

Under the Groundwater Code (Code), land associated with a Certificate of Irrigation Grandfathered Right can be legally irrigated with groundwater within an AMA. A.R.S. § 45-465. These certificates were issued by the Arizona Department of Water Resources (Department) based on acreage planted from the years 1975 through 1979. Land not irrigated during this time period may not be irrigated with any water unless one of the exceptions stated in the Code applies. A.R.S. § 45-452. For each IGFR, the Department establishes a maximum annual groundwater allotment based on certain statutory criteria. Figure 4-1 depicts the land associated with IGFRs within the Phoenix AMA as well as the acres irrigated within Indian reservations. Figure 4-2 depicts the major irrigation districts in the Phoenix AMA.

At this time, the Department is deferring adoption of a Base Program under A.R.S. § 45-566(A)(1) as part of the Agricultural Conservation Program. This delay is based on concerns which have been raised by the agricultural community regarding the proposed adoption of an agricultural conservation program that includes water duties based upon an 85 percent irrigation efficiency.

Presently, the Department is adopting the Historic Cropping Program that was authorized by A.R.S. § 45-566.02, and conservation requirements for irrigation distribution systems. Participation in the Historic Cropping Program is voluntary, and those who do not participate will be subject to the agricultural conservation requirements established by the Second Management Plan until the Department adopts a Base Program for the Third Management Plan. Descriptions of the Historic Cropping Program and the irrigation distribution system conservation program are detailed in this chapter.

In addition to these regulatory conservation programs, the Department will continue to encourage the use of renewable water supplies by the agricultural sector through other water resource management methods. During the third management period, indirect recharge, effluent reuse, and programs supported by water management assistance funds will be options available to encourage this use.

This chapter discusses the following topics in the order listed:

- Statutory Provisions (section 4.2)
- Irrigation Water Duties and Maximum Annual Groundwater Allotments (section 4.3)
- Agricultural Conservation Program Components (section 4.4)
- Non-regulatory Water Resource Management Strategies (section 4.5)
- Future Directions (section 4.6)
- Agricultural Conservation Requirements and Monitoring and Reporting Requirements (section 4.7)

4.2 STATUTORY PROVISIONS

The Code manages the use of groundwater for irrigation purposes in AMAs in several ways. These statutory provisions are described below.

4.2.1 Third Management Plan

A.R.S. § 45-566 requires the director to follow established guidelines in developing management plans for the third management period (years 2000 to 2010). For the agricultural sector, in the plan for each AMA, the director:

- Shall establish an irrigation water duty for each farm unit to be reached by the end of the third management period. A.R.S. § 45-566(A)(1).

- May establish one or more intermediate water duties to be reached at specified intervals during the third management period. A.R.S. § 45-566(A)(1).

- Shall calculate the irrigation water duty or intermediate water duties as the quantity of water reasonably required to irrigate the crops historically grown in the farm unit and shall assume the maximum conservation consistent with prudent long-term farm management practices within areas of similar farming conditions, considering the time to amortize conservation investments and financing costs. A.R.S. § 45-566(A)(1).

- After computing the irrigation water duties or intermediate water duties, may adjust the highest 25 percent of the water duties within an area of similar farming conditions by reducing each water duty in an amount up to 10 percent, except that in making the adjustment, no water duty may be reduced to an amount less than the highest water duty within the lowest 75 percent of the water duties computed within an area of similar farming conditions. A.R.S. § 45-566(A)(1).

- Shall grant an exemption from the irrigation water duties at any time during the third management period if an applicant can demonstrate to the director's satisfaction that the applicant's farm unit meets specific hydrologic conditions regarding waterlogging or basin outflow. A.R.S. § 45-566(D).

- Shall establish additional economically reasonable conservation requirements for the distribution of groundwater by irrigation districts within their service areas. A.R.S. § 45-566(A)(5).

4.2.2 Prohibition on New Irrigated Acres

Under A.R.S. § 45-452, only acres of land which were legally irrigated at any time from January 1, 1975 through January 1, 1980, which are capable of being irrigated, and which have not been retired from irrigation or conveyed for a non-irrigation use, may be irrigated with any water unless one of the following exceptions apply:

- Surface water may be used pursuant to decreed or appropriative rights established before June 12, 1980. A.R.S. § 45-452(A).

- Existing acreage irrigated with surface water may be replaced with new acreage if the surface water right is severed and transferred to the new acreage. A.R.S. § 45-172.

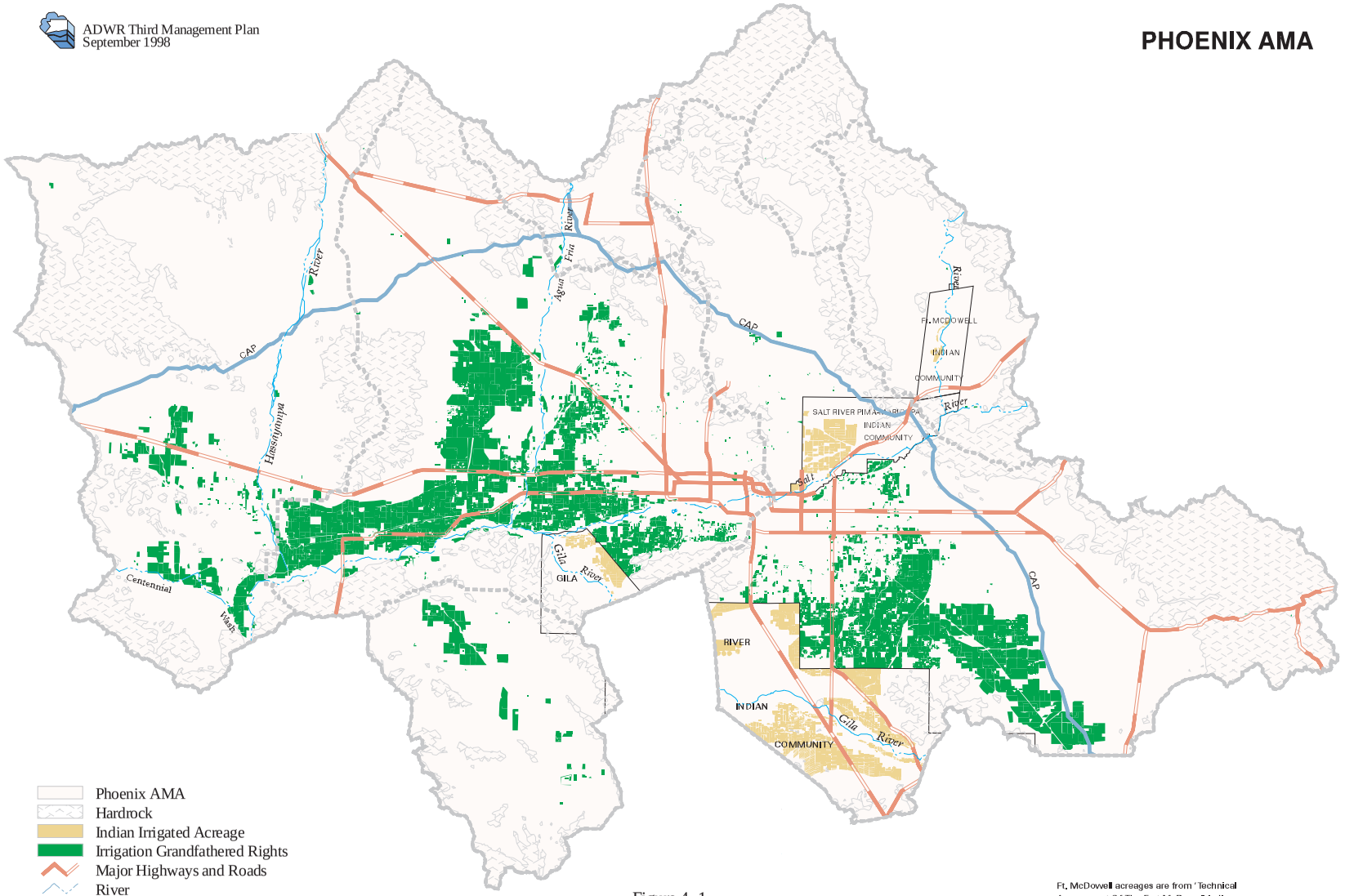


Figure 4- 1

Irrigation Grandfathered Rights and Indian Community Irrigated Acreage

Ft. McDowell acreages are from 'Technical Assessment Of The Fort McDowell Indian Community Water Righs Settlement' ADWR, May 13, 1993

GRIR acreages are from 'Hydographic Survey Report For The Gila River Indian Reservation ADWR, December, 1996

SRPMIC acreages are from 1971 orthophoto quads and 1997 landsat.

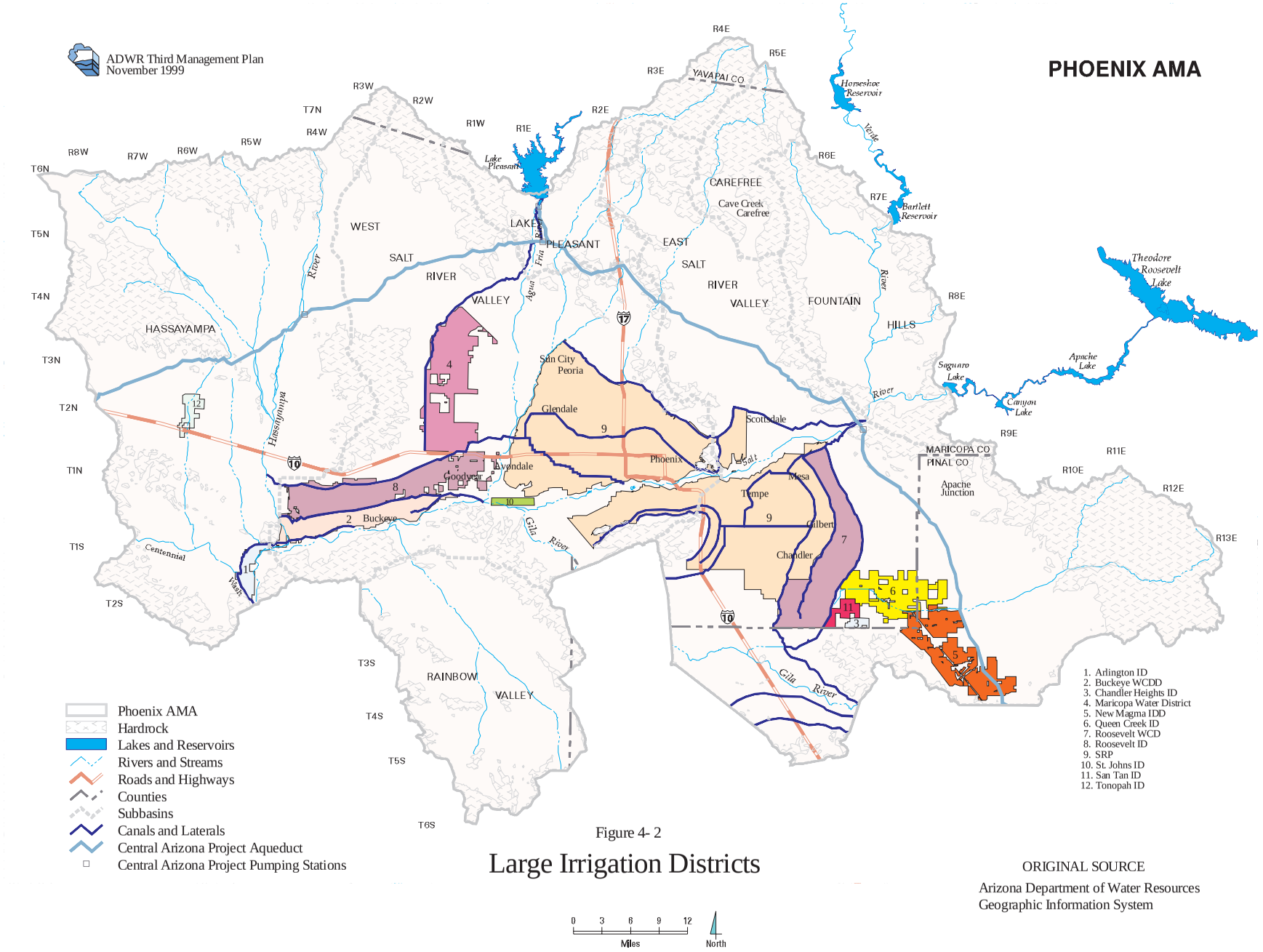


Figure 4- 2

Large Irrigation Districts

ORIGINAL SOURCE

Arizona Department of Water Resources
Geographic Information System

- State universities may irrigate new acreage not to exceed a total of 320 acres of land with not more than five acre-feet of groundwater per acre per year. A.R.S. § 45-452(I).

- Correctional facilities under the jurisdiction of the Arizona Department of Corrections may irrigate new acreage not to exceed a total of 10 acres of land with not more than four and one-half acre-feet of water per acre per year for the purpose of producing plants for consumption by inmates as part of a prisoner work program. A.R.S. § 45-452(J).

- Existing acreage damaged by floodwaters may be replaced with new acreage. A.R.S. § 45-465.01.

- Existing acreage that has a condition that limits irrigation efficiency may be replaced with new acreage. A.R.S. § 45-465.02.

4.2.3 Maximum Annual Groundwater Allotments

Under A.R.S. § 45-465, the maximum annual groundwater allotment for each IGFR is determined by multiplying the irrigation water duty by the water duty acres. Water duty acres are the highest number of acres in a farm, taking land rotation into account, that were legally irrigated during any one year from 1975 through 1979. The maximum annual groundwater allotment may be used to irrigate any or all of the irrigation acres in the farm unit. Irrigation acres are the acres in the farm which were legally irrigated at any time from 1975 to 1980.

4.2.4 Flexibility Account Provisions

To provide farmers with sufficient flexibility to address varying climatic conditions and to take advantage of changing agricultural market conditions, the Code requires the director to establish a flexibility account for each farm that receives a maximum annual groundwater allotment. A.R.S. § 45-467. In 1987, the Department began implementing these provisions in the Phoenix AMA.

Under the flexibility account statute, a right holder may accumulate both flexibility account credits and debits. If a right holder uses water during a year in excess of the farm's maximum annual groundwater allotment, the flexibility account is debited. A negative balance that exceeds 50 percent of the annual allotment results in a violation of the conservation requirement. If a right holder uses less water during a year than the farm's maximum annual groundwater allotment, the flexibility account is credited. Accrued flexibility account credits are not limited, can be used at any time in future years, and may be used to offset a debit. In addition, under certain conditions right holders may transfer flexibility account credits accumulated during the preceding calendar year from one IGFR to another. A.R.S. § 45-467(O).

4.2.5 Historic Cropping Program

In 1998, the legislature adopted A.R.S. § 45-566.02 that directs the Department to include in the Third Management Plan an agricultural conservation program entitled the Historic Cropping Program. Laws 1998, Ch. 274, § 1. Under this program, the director must calculate the maximum annual groundwater allotment as provided in A.R.S. § 45-465, and must calculate the irrigation water duty using an irrigation efficiency of 75 percent. In areas deemed by the director to have limiting soils, the statute authorizes the director to use an irrigation efficiency as low as 70 percent. In addition, the director may not register credits to the flexibility account established under A.R.S. § 45-467 which cause the credit balance to exceed 75 percent of the maximum annual groundwater allotment established under the Historic Cropping Program. This program is described in more detail in section 4.4.1.

4.2.6 Small Irrigation Grandfathered Rights

In 1994, legislation was passed that deregulated small IGFRs. A small IGFR is defined as an IGFR appurtenant to a farm with ten or fewer irrigation acres, and that is not part of an integrated farming operation of more than ten acres. Under A.R.S. §§ 45-563.02 and 632(D), small IGFRs are not required to report annual water use or to comply with water duty limitations. Small IGFRs make up about one half of the IGFRs in the Phoenix AMA, but accounted for less than 4 percent of the total water use in 1992.

4.2.7 The Buckeye Waterlogged Area

Legislation was passed in 1985 authorizing a study to identify major causes of the waterlogging problems in the West Salt River and Hassayampa Subbasins. Laws 1985, Ch. 319, § 1. Upon completion of the study and subsequent review by the Department and the public, House Bill 2353 was passed. Laws 1988, Ch. 97, § 1. This legislation exempted the Arlington Canal Company (Arlington), the Buckeye Water Conservation and Drainage District (Buckeye), and the St. Johns Irrigation District (St. Johns) during the first, second, and third management periods from the conservation requirements for the distribution of groundwater. In addition, this legislation exempted persons using groundwater pursuant to an IGFR on certain waterlogged farm areas located in or near Buckeye, Arlington, and St. Johns from irrigation water duties and the payment of withdrawal fees. These exemptions became effective on January 1, 1989 and extend until the end of the third management period, December 31, 2009. A.R.S. § 45-411.01(A). However, either the entity delivering water to the exempted areas or the persons owning irrigation acres within the exempted areas must pay a water duty exemption fee, except for holders of small IGFRs (see section 4.2.6). Laws 1995, Ch. 258, § 2. Prior to December 15, 2005, the Department will review the hydrologic conditions influencing the designated waterlogged areas, consult with representatives of Buckeye, Arlington, and St. Johns, and submit a recommendation to the Governor and legislative leadership regarding an extension of the exemptions. A.R.S. § 45-411.01(F).

4.3 IRRIGATION WATER DUTIES AND MAXIMUM ANNUAL GROUNDWATER ALLOTMENTS

The irrigation water duty is the primary component of the Historic Cropping Program and is used to determine the maximum annual groundwater allotment for each IGFR. The following sections describe how the Department determines water duties and maximum annual groundwater allotments.

4.3.1 Calculation of Irrigation Water Duties

The irrigation water duty is the quantity of water reasonably required per acre to annually irrigate the crops historically grown in a farm unit from 1975 to 1980. The crops historically grown in each farm unit were verified and established during the first management period. The Department calculates the irrigation water duty for each IGFR using the following formula:

$$\textit{Irrigation Water Duty} = \frac{\textit{Total Irrigation Requirement Per Acre}}{\textit{Assigned Irrigation Efficiency}}$$

In this formula, the irrigation water duty is calculated by dividing the total water requirements to produce the crops historically grown by an assigned irrigation efficiency. Each component of the formula is discussed below.

4.3.1.1 Assigned Irrigation Efficiency

Irrigation efficiency is a measure of the overall effectiveness of water application during a crop season. The effectiveness is a function of many variables including evaporation loss, soil intake rate, water application rate, irrigation system type, crop type, and irrigation water management practices.

The assigned irrigation efficiency establishes a benchmark value which is determined for each management period in accordance with statutory provisions. For the Historic Cropping Program, the assigned irrigation efficiency for farms with non-limiting soils is 75 percent as prescribed by A.R.S. § 45-566.02.

4.3.1.2 Total Irrigation Requirement

The total irrigation requirement for each farm unit equals the amount of water needed annually to satisfy the sum of the irrigation requirements for all of the crops historically grown. For each crop, the irrigation requirement (IR) consists of the amount of water needed to meet: the consumptive use (CU) requirement of the crop, plus any other needs (ON) that the crop may have, plus any needed leaching allowance (LA), less the amount of any effective precipitation (EP). The total irrigation requirement is calculated by the following equation:

$$IR = CU + ON + LA - EP$$

For purposes of determining the irrigation water duty in the Phoenix AMA, effective precipitation is not subtracted from the total irrigation requirement. The components of the total irrigation requirement equation are discussed below.

4.3.1.2.1 Consumptive Use

The consumptive use requirement of a crop is the amount of water used in transpiration and building of plant tissue together with the amount of water evaporated from adjacent soil during the growing season. Crop consumptive use values are based on accepted scientific methods and commonly used values for the Phoenix AMA. Appendix 4 lists the consumptive use requirement for each crop historically grown in the Phoenix AMA during the years 1975 through 1979 based on the data currently available.

4.3.1.2.2 Other Needs

Water required by certain crops for purposes other than consumptive use is referred to as "other needs" water. For example, some vegetable crops such as lettuce need additional water for germination, cooling, and quality control. The Department makes adjustments for those crops that have "other needs." Appendix 4 lists the "other needs" requirements for crops historically grown in the Phoenix AMA.

4.3.1.2.3 Leaching Allowance

In some situations, a crop may require additional water for leaching or deep percolation. A leaching allowance may be necessary to prevent salts from accumulating in the crop root zone when high levels of total dissolved solids (TDS) are present in the irrigation water. If the accumulated salts in the soil profile are not leached below the root zone, soil salinity will increase and eventually inhibit plant growth and yields.

The procedure used to calculate the leaching allowance for a crop is shown by the following equation:

$$LA = \frac{AE}{0.85}\left[CU\left[\frac{1}{1 - \frac{EC_w}{5EC_e - EC_w}} - 1 \right] \right]$$

In this equation, LA = leaching allowance for the crop; AE = assigned irrigation efficiency for the farm unit; CU = consumptive use requirement of the crop; EC_w = electrical conductivity of the irrigation water (expressed in millimhos per centimeter); and EC_e = tolerance of the crop to soil salinity in electrical conductivity of the soil saturation extract (expressed in millimhos per centimeter).

Most irrigation water in the Phoenix AMA is of adequate quality for irrigation purposes. Consequently, the Department did not include any leaching allowances in the calculation of irrigation requirements for crops grown in the Phoenix AMA. If, however, a particular irrigation water supply has an EC_w value greater than 1.5 millimhos per centimeter (a concentration of approximately 1,000 milligrams per liter of TDS), the right holder may apply to the Department for an administrative review as discussed in Chapter 10.

4.3.1.2.4 Effective Precipitation

Effective precipitation is defined as the amount of precipitation occurring before and during the growing season that is available for plant growth. Because precipitation is minimal and varies considerably by year and location in the Phoenix AMA, effective precipitation is difficult to quantify and is not subtracted from the total irrigation requirements for the crops historically grown. However, managing the use of precipitation to offset use of other water supplies could be an irrigation water management tool available to IGFR holders.

4.3.2 Calculation of Maximum Annual Groundwater Allotments

The maximum annual groundwater allotment for each IGFR is determined by multiplying the irrigation water duty by the water duty acres. These calculations are governed by A.R.S. § 45-465 (see section 4.2.3 above).

4.4 AGRICULTURAL CONSERVATION PROGRAM COMPONENTS

The following section describes the Agricultural Conservation Program for the Third Management Plan that is being adopted at this time. This program consists of two main parts: the Historic Cropping Program, and the irrigation distribution system conservation requirements program. Each of these programs is described below.

4.4.1 Historic Cropping Program

The Historic Cropping Program was developed by the Department pursuant to A.R.S. § 45-566.02. As required by statute, for the Historic Cropping Program, the Department will calculate the water duty and maximum annual groundwater allotment by dividing the total irrigation requirement per acre by an assigned irrigation efficiency of 75 percent. In areas determined by the director to have limiting soils, the director may use an assigned irrigation efficiency as low as 70 percent for the water duty calculation. As further required by A.R.S. § 45-566.02, the use of flexibility account provisions will be limited.

To qualify for the Historic Cropping Program, the IGFR owner must satisfy the following requirements: (1) file an application with the Department, (2) reduce any debit balance in the existing flexibility account

to an amount that does not exceed 25 percent of the existing maximum annual groundwater allotment, (3) reduce any flexibility account credits in the existing flexibility account balance to an amount that does not exceed 75 percent of the existing maximum annual groundwater allotment, and (4) provide documentation showing that an actual irrigation efficiency of 75 percent has been, or will be, achieved on the farm on a seasonal basis. Once an IGFR owner has been accepted into the Historic Cropping Program, the right holder must remain in the historic Cropping Program during the entire third management period, unless there has been a change in IGFR ownership.

Participants in the Historic Cropping Program will be subject to limitations on their ability to accumulate flexibility account credits and debits. Participants will only be allowed to accrue flexibility account credits up to 75 percent, and flexibility account debits up to 25 percent, of their maximum annual groundwater allotment calculated for the Historic Cropping Program. Any IGFR owner, or any person entitled to use groundwater pursuant to that IGFR, who uses groundwater in an amount that causes the farm's flexibility account to be in arrears in excess of 25 percent of the maximum annual groundwater allotment, will be considered in violation of the conservation requirements. In addition, IGFR owners participating in the Historic Cropping Program will not be allowed to sell or purchase flexibility account credits.

In addition to these flexibility account credit provisions, participants will also be required to comply with certain reporting requirements. Participants must provide information regarding irrigation water management practices, irrigation system type, and the acreage and type of crops grown to assist the Department in determining program effectiveness.

The Historic Cropping Program requires a high level of farm management. Specific entrance and performance criteria must be satisfied, and only owners of IGFRs may apply (see section 4.7). IGFR owners interested in participating in the Historic Cropping Program may file an application beginning January 1, 2000 on forms provided by the Department

4.4.2 Irrigation Distribution System Conservation Program

For the third management period, the director is required to establish "additional economically reasonable conservation requirements for the distribution of groundwater by cities, towns, private water companies and irrigation districts within their service areas." A.R.S. § 45-566(A)(5). The same conservation requirements were part of the Second Management Plan. A.R.S. § 45-565(A)(5). These requirements do not apply to entities distributing groundwater to waterlogged areas (see section 4.2.7).

In the Second Management Plan, private water companies and irrigation districts that distributed 20 percent or more of their total water deliveries for irrigation use by January 1, 1990 were required to reduce their irrigation distribution system lost and unaccounted for water either by lining all their canals, or by operating their delivery systems so that the total quantity of lost and unaccounted for water is 10 percent or less of the total quantity of water withdrawn, diverted, or received during a year. These requirements become effective upon the commencement of operation or by January 1, 2000, whichever is later. A Department review of the conservation practices of the largest irrigation districts has shown that the Second Management Plan distribution system conservation requirements are being achieved by most districts.

For the Third Management Plan, the irrigation distribution system conservation requirements established by the Second Management Plan will continue to apply to irrigation districts and private water companies which, as of January 1, 2000, distribute 20 percent or more of their total water deliveries for irrigation use. These irrigation districts and private water companies will be required to reduce their irrigation distribution system lost and unaccounted for water either by lining all their canals, or by operating their delivery systems so that the total quantity of lost and unaccounted for water is 10 percent or less of the total quantity of water withdrawn, diverted, or received during a year. These requirements become effective upon the

commencement of operation or by January 1, 2002, whichever is later. Until this time, the Second Management Plan irrigation distribution system conservation requirements will apply.

If a private water company or irrigation district has economic circumstances that prevent timely compliance with the irrigation distribution system conservation requirements, a variance of up to five years may be requested as provided by A.R.S. § 45-574. Information submitted in support of the variance request must include a complete water loss reduction plan prepared by a registered civil engineer, which contains:

- A complete construction design document that shows specifications for repairing or modifying the irrigation distribution system. The document must include material specifications, proposed design specifications, installation and construction specifications, and any other engineering information or specifications necessary to complete the proposed rehabilitation of the distribution system.

- A detailed list of engineering costs and the proposed investment options designed to pay for the system improvements.

- The final completion date for the rehabilitation.

- If applicable, a system operating guide for use by the district to reduce lost and unaccounted for water to a minimum. This guide may be modified as the rehabilitation progresses.

The procedures for obtaining a variance are described in Chapter 10, section 10.3.1.

4.4.3 Program Summary

The Department is adopting an Agricultural Conservation Program for the Third Management Plan that consists of two parts: the Historical Cropping Program and the irrigation distribution system conservation program. The Historic Cropping Program is a new program which the legislature authorized in 1998 through the enactment of A.R.S. § 45-566.02. Pursuant to this legislation, the irrigation efficiency used to calculate the maximum annual groundwater allotment for non-limiting soils is set at 75 percent, and the flexibility account provisions of A.R.S. § 45-467 are restricted. The irrigation distribution system conservation requirements are essentially a continuation of requirements that were established for the Second Management Plan. These requirements are designed to assure that the amount of lost and unaccounted for water from water distribution systems is kept to a minimum. Both the Historic Cropping Program and the irrigation distribution system conservation program provide important tools for achieving the water management goal for the Phoenix AMA. To further the attainment of this water management goal, the Department will also adopt a Base Program pursuant to A.R.S. § 45-566(A)(1) in the future.

4.5 NON-REGULATORY WATER RESOURCE MANAGEMENT STRATEGIES

In addition to the Agricultural Conservation Programs, other water resource management strategies are available to achieve the water management goal for the Phoenix AMA. These strategies focus on the use of renewable sources of water and are described below.

4.5.1 Effluent Use

In 1991, the Legislature amended A.R.S. § 45-467 to exclude effluent from consideration in determining the amount of any debit to be registered to a farm's flexibility account. Laws 1991, Ch. 112, § 3. Under this amendment, a person using groundwater on a farm pursuant to an IGFR may use an unlimited amount

of effluent on the farm without any debit being registered to the farm's flexibility account as a result of effluent use. This amendment created an incentive for the use of effluent.

During the Third Management Plan, the Department will study alternatives to increase the utilization of effluent. In the past, effluent utilization for agricultural irrigation has been limited mostly by the lack of necessary infrastructure. Other requirements, such as the wastewater reuse rules adopted by the Arizona Department of Environmental Quality, have limited the types of crops that can be irrigated solely with effluent. As effluent treatment techniques improve and more effluent becomes accessible to the agricultural sector, the Department expects that effluent use for agricultural purposes will increase.

4.5.2 Groundwater Savings Program (Indirect Recharge)

A reduction in agricultural groundwater use has occurred in the Phoenix AMA as a result of indirect recharge opportunities, which were first authorized by the Legislature in 1990 and later reauthorized in 1994 as the groundwater savings program. Laws 1994, Ch. 291, § 32; Laws 1990, Ch. 176, § 14. In the early 1990s, the agricultural sector began to utilize CAP water to a greater extent through the incentives provided by the indirect recharge program. (Effluent may also be utilized in the groundwater savings program.) This increased use of renewable water supplies has decreased groundwater use by the agricultural sector in the Phoenix AMA. However, while this program has increased the current use of renewable water supplies by the agricultural sector, it should also be noted that there is a legacy of credits that are associated with in-lieu water use that may be recovered to meet future non-agricultural demand. (See section 8.7.2.1.1.)

4.5.3 Water Management Assistance Program

Non-regulatory efforts such as the Department's Water Management Assistance Program have contributed to the reduction of agricultural water use in the Phoenix AMA during the second management period. The Water Conservation Management Program (WCMP) is a program which has been funded by the Department through the Water Management Assistance Program for a total of six years on the west side of the AMA and for four years on the east side. The west side and east side programs combined into one program, the Central Arizona WCMP, in November 1996. This cooperative program with the Agua Fria-New River, Buckeye, and East Maricopa Natural Resources Conservation Districts, the Natural Resources Conservation Service, the United States Bureau of Reclamation, and the Department provides computer-based and field-measured irrigation scheduling and application rate information to cooperating farmers in the Phoenix AMA. The efforts of the WCMP have resulted in the conservation of an estimated average of 1,300 acre-feet per year. In 1998, the WCMP was approved for funding for an additional year.

Other Conservation Assistance Program grants awarded include funding to the United States Water Conservation Lab to develop software for the design of sloping border irrigation systems; a grant to the University of Arizona Cooperative Extension to study the consumptive use requirements of medium maturity determinate upland cotton, and a grant to Duncan's Sunfresh Farms to develop and add a water conservation education component to their farm tours that would include educational materials given out to school children and their teachers.

The use of Water Management Assistance Program monies to fund programs designed to assist the agricultural sector in the conservation of groundwater resources is expected to extend into the third management period. The Department will continue to encourage programs that promote efficient agricultural water use. (See Chapter 9 for more information regarding the Water Management Assistance Program.)

4.6 FUTURE DIRECTIONS

During the third management period, the Department will continue to provide the agricultural sector with technical and financial assistance to increase its efficiency and reduce its reliance on groundwater supplies. The Department will investigate incentives for, and encourage the increased use of, effluent and groundwater savings facilities. In addition, the waterlogged area and those IGFRs deregulated pursuant to the small rights exemption will continue to be monitored by the Department. The Department will submit a report to the Legislature prior to December 15, 2005, with recommendations for whether the waterlogged area exemptions should be continued.

The Department will continue to work cooperatively with the agricultural community to determine appropriate conservation requirements un A.R.S. § 45-566(A)(1) and to develop additional alternative agricultural conservation programs in the Phoenix AMA for the third management period.

The Department will also monitor crop and water use patterns during the third management period to evaluate the impacts of Department programs on farming operations. More research on the consumptive use of newer varieties of crops grown in the AMA may occur. Urbanization impacts on agricultural water use, as well as water use trends due to agricultural market conditions, will be evaluated for future planning needs.

The Agricultural Conservation Program for the Third Management Plan is a step toward achieving the safe-yield goal for the Phoenix AMA. During the third management period, this program will continue to be evaluated for its effectiveness in achieving this goal.

4.7 AGRICULTURAL CONSERVATION REQUIREMENTS AND MONITORING AND REPORTING REQUIREMENTS

4-101. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, the following words and phrases used in sections 4-101 through 4-105 of this chapter shall have the meanings set forth below, unless the context otherwise requires:

1. *"Assigned Irrigation Efficiency" is defined as the maximum economically feasible levels of conservation within areas of similar farming conditions which each right holder is expected to achieve.*

2. *"Canal" is defined as a waterway constructed for the purpose of transporting water to a point of delivery, including main canals and lateral canals.*

3. *"Farm" is defined under A.R.S. § 45-402.*

4. *"Farm Unit" is defined under A.R.S. § 45-402.*

5. *"Flexibility Account" is an account maintained under A.R.S. § 45-467.*

6. *"Irrigation Acre" is defined under A.R.S. § 45-402.*

7. *"Irrigation Distribution System" is defined as a system of canals, flumes, pipes, or other works which are owned or operated by an irrigation district or private water company and used to deliver water for irrigation use.*

8. *"Irrigation Water Duty" is defined under A.R.S. § 45-566 which, for the Third Management Plan, is the total irrigation requirement to produce the crops historically grown divided by the assigned irrigation efficiency.*

9. *"Lost Water" is defined as water from any source, including effluent, which enters an irrigation distribution system and is lost from the system during transportation or distribution due to seepage, evaporation, leaks, breaks, phreatophyte use, or other causes.*

10. *"Maximum Annual Groundwater Allotment" is defined as the maximum amount of groundwater which may be used per year for the irrigation of each irrigation acre in the farm which is calculated pursuant to A.R.S. § 45-465.*

11. *"On-farm Seasonal Irrigation Efficiency" is defined as the total water requirements to produce a crop divided by the total quantity of water actually applied to that crop during one growing season.*

12. *"Total Quantity of Lost and Unaccounted for Water" is defined as the total quantity of water from any source, including effluent, withdrawn, diverted, or received by an irrigation district or private water company during a calendar year less the total deliveries of water from any source, including effluent, made by the irrigation district or private water company during the calendar year that are measured or estimated based on a generally accepted method of estimating water use.*

13. *"Water Duty Acres" is defined under A.R.S. § 45-461.*

4-102. Base Agricultural Conservation Program Requirements

Unless the owner of a Certificate of Irrigation Grandfathered Right (IGFR) is regulated under the Historic Cropping Program described in section 4-103, the IGFR owner and any person who is entitled to use groundwater pursuant to that IGFR shall continue to comply with the agricultural conservation requirements established by the Second Management Plan until the director adopts a Base Program for the Third Management Plan.

4-103. Historic Cropping Program

A. Application for Regulation under the Historic Cropping Program

Only an owner of an IGFR may apply to be regulated under the Historic Cropping Program. Beginning January 1, 2000, an application may be filed by an IGFR owner at any time prior to the first compliance date for the agricultural conservation requirements established in the Fourth Management Plan. An application for regulation under the Historic Cropping Program shall be on a form prescribed by the director and shall include the following information:

1. *The name, address, and phone number of the IGFR owner.*

2. *The number of the Certificate of Irrigation Grandfathered Right.*

3. *The name, address, and phone number of any person entitled to use groundwater under the IGFR.*

4. *For each of the three previous years, the number of acres and types of crops planted and the amount of water used to irrigate the planted acres.*

5. *For each of the three previous years, the type of irrigation system which has been used, including percent of slope, length of runs, and method of field application.*

6. *For each of the three previous years, a description of all water conservation practices used on the farm, including the name of any conservation program or irrigation water management service used on the farm.*

B. Criteria for Approval of Application

The director shall approve a complete and correct application for regulation under the Historic Cropping Program if the following requirements are satisfied:

1. *Any negative flexibility account balance in the farm's flexibility account does not exceed 25 percent of the maximum annual groundwater allotment in effect at the time that the application is made.*

2. *Any positive flexibility account balance in the farm's flexibility account does not exceed 75 percent of the maximum annual groundwater allotment in effect at the time that the application is made. In order to satisfy this requirement, the IGFR owner may sell or convey any excess credits as provided by A.R.S. § 45-467 or the IGFR owner may relinquish any excess credits.*

3. *The IGFR owner demonstrates that the average on-farm seasonal irrigation efficiency achieved on the farm's irrigation acres during the previous three years was 75 percent or greater. If the IGFR owner cannot demonstrate that an average on-farm seasonal irrigation efficiency of at least 75 percent has been achieved during the previous three years, the IGFR owner shall agree in writing to develop and implement at least one of the following:*

   a. *Enroll in a Department-sponsored or private irrigation management services program throughout the entire third management period or until the IGFR owner can demonstrate to the Department that an average on-farm seasonal irrigation efficiency of at least 75 percent has been achieved during the previous three years.*

   b. *Install a conservation system improvement, approved by the Department, designed to enable the IGFR owner to achieve an on-farm seasonal irrigation efficiency of at least 75 percent.*

C. *Historic Cropping Program Requirements*

An IGFR owner who has been approved for regulation under the Historic Cropping Program and any person using groundwater pursuant to that IGFR shall comply with the provisions of this section.

1. *The IGFR owner and any person entitled to use groundwater under that IGFR shall comply with the irrigation water duty and maximum annual groundwater allotment established by the director under this section, beginning with the calendar year in which the IGFR owner is accepted into the Historic Cropping Program, and continuing thereafter until the first compliance date for any substitute conservation requirement established in the Fourth Management Plan. The director shall establish the irrigation water duty and maximum annual groundwater allotment in the same manner that the director established the irrigation water duty and maximum annual groundwater allotment assigned to the IGFR in the Second Management Plan, except that the director shall use an assigned irrigation efficiency of 75 percent. In areas deemed by the director to have limiting soils, the director may use an assigned irrigation efficiency as low as 70 percent.*

2. *The IGFR owner, and any person entitled to use groundwater under that IGFR, may use the maximum annual groundwater allotment assigned to the IGFR to irrigate only the irrigation acres to which the IGFR is appurtenant.*

3. *The IGFR owner and any person entitled to use groundwater under that IGFR shall not use water for irrigation purposes during a calendar year in an amount which exceeds the maximum annual groundwater allotment assigned to the right, except as provided in the flexibility account provisions of A.R.S. § 45-467, as modified in subsection D of this section, and any rules adopted by the director.*

D. *Flexibility Account Provisions*

Under the Historic Cropping Program, the flexibility account provisions of A.R.S. § 45-467 shall apply to the IGFR owner and any person entitled to use groundwater under that IGFR with the following modifications:

1. *If the amount of water used to irrigate the farm in any year is less than the maximum annual groundwater allotment established for the farm pursuant to subsection C, paragraph 1 of this section, the amount of any credit registered to the farm's flexibility account pursuant to A.R.S. § 45-467 shall not exceed the difference between the existing balance in the account and a positive account balance of 75 percent of the maximum annual groundwater allotment. The director shall not register a credit to the farm's flexibility account in any year in which the account has an existing positive account balance equal to or greater than 75 percent of the maximum annual groundwater allotment.*

2. *The IGFR owner and any person entitled to use groundwater under that IGFR who are regulated under the Historic Cropping Program shall not:*

    a. *Purchase or sell flexibility account credits to another IGFR owner or any other person entitled to use groundwater under another IGFR regardless of whether they are regulated under the Historic Cropping Program.*

    b. *Transfer credits from the flexibility account of one farm to another farm even if the farms are owned by the same IGFR owner.*

3. *The maximum excess amount of groundwater that may be used pursuant to A.R.S. § 45-467 shall not exceed 25 percent of the maximum annual groundwater allotment established for the farm pursuant to subsection C, paragraph 1 of this section. The IGFR owner and any person entitled to use groundwater under that IGFR violate this section if the flexibility account maintained for the IGFR is in arrears at any time in excess of this amount.*

E. Reporting Requirements

In addition to the information required to be submitted in the annual report required by A.R.S. § 45-632, the IGFR owner and any person entitled to use groundwater pursuant to that IGFR shall submit the following information in the report:

1. *The name, address, and phone number of any person entitled to use groundwater under the IGFR.*

2. *The number of acres and types of crops planted and the amount of water used to irrigate the planted acres.*

3. *The type of irrigation system which has been used, including percent of slope, length of runs, and method of field application.*

4. *A description of all water conservation practices used on the farm, including the name of any conservation program or irrigation water management service used on the farm.*

F. Duration of Regulation under Historic Cropping Program

1. *Except as provided in paragraph 2 of this subsection, after the director approves an application for regulation under the Historic Cropping Program, the IGFR owner and any person entitled to use groundwater pursuant to that right shall be regulated under the Historic Cropping Program until the first compliance date for any substitute agricultural conservation requirement established in the Fourth Management Plan.*

2. *After the director approves an application for regulation under the Historic Cropping Program, the IGFR owner must remain in the Historic Cropping Program during the entire third management period, except that a subsequent owner of the IGFR file a written request to leave the Historic Cropping Program with the director within 90 days after acquiring an ownership interest in the IGFR. The director shall grant the request unless the director determines that the request is being made for the purpose of circumventing the provisions of paragraph 1 of this subsection, in which case the request will be denied. In the event that an IGFR is owned by more than one person, this paragraph does not apply unless all owners have conveyed their interests in the IGFR and all subsequent owners join in filing a written request with the director to leave the Historic Cropping Program.*

4-104. Conservation Requirements for Irrigation Distribution Systems

A. Applicability

The irrigation distribution system conservation requirements set forth in subsection B below apply to irrigation districts and private water companies which, as of January 1, 2000, distribute 20 percent or more of their total water deliveries for irrigation use.

B. Conservation Requirements

By January 1, 2002 or upon commencement of operation, whichever is later, and continuing thereafter until the first compliance date of any substitute requirement in the Fourth Management Plan, each irrigation district and private water company owning or operating an irrigation distribution system shall either:

1. *Line all canals used to deliver water for irrigation use with a material that allows no more lost water than a well-maintained concrete lining, or*

2. *Operate and maintain its distribution system so that the total quantity of lost and unaccounted for water is 10 percent or less of the total quantity of water from any source, including effluent, withdrawn, diverted, or received by the irrigation district or private water company on either a calendar year basis or a three-year average basis based on that calendar year and the two preceding calendar years.*

4-105. Monitoring and Reporting Requirements for Irrigation Districts and Private Water Companies

A. Applicability

The monitoring and reporting requirements set forth in subsection B below apply to irrigation districts and private water companies which, as of January 1, 2000, distribute 20 percent or more of their total water deliveries for irrigation use.

B. Monitoring and Reporting Requirements

For calendar year 2002 and for each calendar year thereafter until the compliance date for any substitute requirement in the Fourth Management Plan, each irrigation district and private water company owning or operating an irrigation distribution system shall submit in its annual report required by A.R.S. § 45-632, the following information as it applies to the irrigation district or private water company:

1. *A map showing the irrigation distribution system, including those portions which have lined canals and those portions which have unlined canals, unless a current map is on file with the Department.*

2. *The number of miles of lined canals and the number of miles of unlined canals in the irrigation distribution system.*

3. *The total quantity of water from any source, including effluent, which was withdrawn, diverted, or received by the irrigation district or private water company during the calendar year.*

4. *The total quantity of water from any source, including effluent, delivered by the irrigation district or private water company to all water users during the calendar year.*

5. *An estimate of the irrigation district's or private water company's total quantity of lost and unaccounted for water for the calendar year. This quantity shall be determined by a generally accepted engineering method.*

APPENDIX 4
CONSUMPTIVE USE AND OTHER NEEDS BY CROPS[1]
PHOENIX ACTIVE MANAGEMENT AREA

Crop	Consumptive Use (acre-feet per acre)	Other Needs (acre-feet per acre)	IRRIGATION REQUIREMENT (acre-feet per acre)
Grain Crops			
Barley	2.08	0.00	2.08
Maize (Sorghum)	2.12	0.00	2.12
Millet	2.58	0.00	2.58
Oats	1.83	0.00	1.83
Rye	1.83	0.00	1.83
Sorghum Grain (Single Crop)	2.12	0.00	2.12
Sorghum Grain (Double Crop)	4.28	0.00	4.28
Wheat	2.15	0.00	2.15
Corn, Grains	2.12	0.00	2.12
Forage Crops			
Alfalfa	4.69	0.00	4.69
Alfalfa High Yield[2]	6.19	0.00	6.19
Bermuda Grass	3.63	0.00	3.63
Blue Panic Grass	4.36	0.00	4.36
Clover[3]	4.33	0.00	4.33
Ensilage (All Single Crop)	2.08	0.00	2.08
Ensilage, Sorghum (Double Crop)	4.52	0.00	4.52
Permanent Pasture Mix	5.67	0.00	5.67
Sudan Sudex Grass	2.58	0.00	2.58

APPENDIX 4 *(continued)*
CONSUMPTIVE USE AND OTHER NEEDS BY CROPS[1]
PHOENIX ACTIVE MANAGEMENT AREA

Crop	Consumptive Use (acre-feet per acre)	Other Needs (acre-feet per acre)	IRRIGATION REQUIREMENT (acre-feet per acre)
Field Crops			
Castor Beans	3.70	0.00	3.70
Cotton	3.43	0.00	3.43
Cotton (Dry Plant)[4]	3.43	0.33	3.76
Flax	2.60	0.00	2.60
Pinto Beans	1.25	0.00	1.25
Safflower	3.78	0.00	3.78
Soybeans	1.85	0.00	1.85
Sugar Beets	3.56	0.00	3.56
Plantago	1.25	0.00	1.25
Guar (for seed production)	1.93	0.00	1.93
Vegetable Crops			
Beets, Table	2.00	0.50	2.50
Broccoli	1.64	1.00	2.64
Cabbage, Early	1.43	1.00	2.43
Cabbage, Late	2.04	1.25	3.29
Carrots	1.38	0.75	2.13
Cauliflower	1.55	1.00	2.55
Chili Peppers	2.50	0.50	3.00
Corn, Sweet	1.63	0.87	2.50
Cucumbers, All	1.50	0.50	2.00
Lettuce	0.71	2.44	3.15
Okra	2.50	0.50	3.00
Onions, Dry	1.94	0.75	2.69
Onions, Green	1.46	0.75	2.21
Parsnips	2.00	0.50	2.50

APPENDIX 4 *(continued)*
CONSUMPTIVE USE AND OTHER NEEDS BY CROPS[1]
PHOENIX ACTIVE MANAGEMENT AREA

Crop	Consumptive Use (acre-feet per acre)	Other Needs (acre-feet per acre)	IRRIGATION REQUIREMENT (acre-feet per acre)
Potatoes	2.03	0.75	2.78
Radishes	0.75	0.50	1.25
Rappini	2.75	0.50	3.25
Turnips and Rutabagas	1.50	0.50	2.00
Tomatoes, All	2.00	0.50	2.50
Miscellaneous Vegetables	2.00	0.50	2.50
Mixed Vegetables	2.00	0.50	2.50
Summer Squash and Zucchini	1.75	0.50	2.25
Green Manure Crops			
Guar	1.93	0.00	1.93
Papago Peas	1.63	0.00	1.63
Sesbania	1.09	0.00	1.09
Small Grain for Green Manure	1.00	0.00	1.00
Vine Crops			
Cantaloupe, Early	1.71	0.50	2.21
Cantaloupe, Late	1.40	0.50	1.90
Honeydew Melons	2.00	0.50	2.50
Watermelons	1.75	0.50	2.25

APPENDIX 4 *(continued)*
CONSUMPTIVE USE AND OTHER NEEDS BY CROPS[1]
PHOENIX ACTIVE MANAGEMENT AREA

Crop	Consumptive Use (acre-feet per acre)	Other Needs (acre-feet per acre)	IRRIGATION REQUIREMENT (acre-feet per acre)
Citrus			
Grapefruit	3.99	0.00	3.99
Lemons/Limes	3.99	0.00	3.99
Oranges, All	3.26	0.00	3.26
Tangerines	3.26	0.00	3.26
Fruits			
Dates	4.92	0.00	4.92
Grapes	3.00	0.50	3.50
Apricots	4.17	0.00	4.17
Nectarines	4.17	0.00	4.17
Peaches	4.17	0.00	4.17
Plums	4.17	0.00	4.17
Olives	2.58	0.00	2.58
Nuts			
Pecans with Ground Cover	5.83	0.00	5.83
Pecans Without Ground Cover	4.50	0.00	4.50
Pistachios	4.33	0.00	4.33
Miscellaneous Crops			
Aloe Vera	1.50	0.00	1.50
Guayule	3.00	0.00	3.00
Jojoba	3.00	0.00	3.00
Christmas Trees	2.50	0.00	2.50
Flowers, Cut	3.33	0.00	3.33
Double Cropped Vegetables	3.33	0.00	3.33

APPENDIX 4 *(continued)*
CONSUMPTIVE USE AND OTHER NEEDS BY CROPS[1]
PHOENIX ACTIVE MANAGEMENT AREA

Crop	Consumptive Use (acre-feet per acre)	Other Needs (acre-feet per acre)	IRRIGATION REQUIREMENT (acre-feet per acre)
Roses	2.50	0.00	2.50
Nursery Stock	3.00	0.00	3.00
Salt Bush	1.50	0.00	1.50
Cactus (In Nursery)	1.25	0.00	1.25

[1] Based on crops that were reported from 1975 to 1980 history.
[2] The Department assigned an irrigation requirement of 6.19 acre-feet per acre to farms with demonstrated historic yields above the average.
[3] Data are not available for the consumptive use of clover. Until FAO calculations can be made, the Department has estimated that value at 4.33 acre-feet per acre.
[4] The Department assigned an irrigation requirement of 3.76 acre-feet per acre for Areas of Similar Farming Conditions #3 (Roosevelt Irrigation District) and #4 (Buckeye) due to historic dry plant practices.

Sources: Consumptive Use of Water by Major Crops in the Southwestern United States, Conservation Research Report #29, United States Department of Agriculture, Agricultural Research Service. (Provides consumptive use values for major crops in southwestern United States.)

FAO Irrigation and Drainage Paper #24, Food and Agriculture Organization of the United Nations (revised 1977). (Describes Blaney-Criddle method for computing consumptive use values.)

APPENDIX 4 *(continued)*
ASSIGNED CONSUMPTIVE USE (CU) VALUES FOR CROPS ASSOCIATED WITH FARM UNITS LESS THAN TEN ACRES
PHOENIX ACTIVE MANAGEMENT AREA

HIGH CONSUMPTIVE USE CROPS

Crops with a CU value of 4.50 acre-feet per acre or more are assigned a CU value of 5.00 acre-feet per acre.

Alfalfa	Pecans (with and without ground
Dates	Permanent Pasture Mix

MEDIUM CONSUMPTIVE USE CROPS

Crops with a CU value of 3.00 to 4.49 acre-feet per acre are assigned a CU value of 3.50 acre-feet per acre.

Apricots	Grapefruit	Oranges, all
Bermuda Grass	Grapes	Peaches
Blue Panic Grass	Guayule	Plums
Castor Beans	Jojoba	Safflower
Cotton	Lemons/Limes	Sorghum, Grain,
Double Crop Vegetables	Nectarines	Double Cropped
Flowers, Cut	Nursery Stock	Sugar Beets

LOW CONSUMPTIVE USE CROPS

Crops with a CU value less than 2.99 acre-feet per acre are assigned a CU value of 2.50 acre-feet per acre.

Aloe Vera	Guar (for Seed Production)	Rappini
Barley	Honeydew Melons	Roses
Beet, Table	Lettuce	Rye
Broccoli	Maize (Sorghum)	Salt Bush
Cabbage, all	Millet	Sesbania
Cactus (Nursery)	Misc. Vegetables	Small Grain for Green
cantaloupe, all	Oats	Sorghum, Grain, Single and
Carrots	Okra	Double Cropped
Cauliflower	Onions, all	Soybeans
Chili Peppers	Papago Peas	Sudan/Sudex Grass
Christmas Trees	Parsnips	Summer Squash and
Corn, Sweet	Pinto Beans	Tomatoes, all
Cucumbers	Planatago	Turnips and Rutabagas
Ensilage, (all Single Crop)	Potatoes	Watermelons
Flax	Radishes	Wheat

CHAPTER

5

Municipal Conservation Program

5.1 INTRODUCTION

The primary goal of the Municipal Conservation Program is to assist the Phoenix Active Management Area (AMA) in moving toward safe-yield by: (1) gradually reducing per capita water consumption, (2) encouraging the use of the best available water conservation practices, and (3) maximizing the efficient use of all water supplies including the direct use of effluent (reclaimed water). For the third management period, the Arizona Department of Water Resources (Department) is also increasing its attention on renewable supply sources, particularly the substitution of groundwater use with renewable supplies and the use of artificial recharge. The Municipal Conservation Program in the Third Management Plan encourages the equitable distribution of water in an environmentally and economically sound manner through long-range planning, cooperative regional efforts, technical assistance, and regulatory programs. The efficient use of all sources of water and replacement of groundwater sources by renewable supplies will ensure that the groundwater supply will be available when needed to replace drought-reduced surface water supplies.

Municipal water providers include cities, towns, private water companies, and irrigation districts that deliver water for non-irrigation uses (such as residential, commercial, governmental, industrial, and construction). Municipal water providers can also include well cooperatives, mobile home parks, or improvement districts. Appendix 5-A contains a complete listing of all municipal water providers located in the Phoenix AMA. The Department regulates those water providers serving more than 250 acre-feet of water for non-irrigation use annually as large municipal providers. (Figure 5-1 displays the 1998 service area boundaries of all large municipal providers). Those providers serving 250 acre-feet or less annually are regulated as small municipal providers. Municipal providers that as of January 1, 1990 were serving untreated water to at least 500 persons or supplying at least 100 acre-feet of untreated water during a year are regulated as large untreated providers.

The municipal sector in the Phoenix AMA accounts for about 38 percent of the total AMA water use. While some municipal providers are still dependent on mined groundwater, some providers in the Phoenix AMA have been successful in using a mix of groundwater, surface water from the Salt River Project, Central Arizona Project (CAP) water, and effluent. Groundwater use accounts for approximately 29 percent of the total municipal water use in the Phoenix AMA. Municipal providers in the Phoenix AMA have substantially increased direct use of CAP water from 13,036 acre-feet in 1986 to 151,791 acre-feet in 1995. Additionally, the use of other surface water supplies and effluent reuse reached 464,586 acre-feet in 1995. Some municipal providers are also using underground storage and recovery as an indirect means of utilizing renewable supplies.

Between 1985 and 1995, annual population increases of approximately 3 percent a year have been experienced in the Phoenix AMA. Significant population growth is expected during the third management period as new residents continue to move to the area. The Assured Water Supply Rules (AWS Rules), adopted by the Department in 1995, require new housing subdivisions to demonstrate that their water use will be consistent with the achievement of safe-yield in the Phoenix AMA. A.A.C. R12-15-705. This is accomplished by demonstrating that the use of renewable supplies will satisfy a majority of the current and future water demand.

Conservation programs have been implemented by municipal water providers in response to regulatory requirements of the First and Second Management Plans. While these programs have generally been successful, a firm commitment to the continued implementation of conservation measures, and implementation of additional measures, will result in further reductions in per capita use rates and increased water use efficiency in the municipal sector. Increased conservation efforts combined with region-wide distribution of renewable water supplies are needed in order to achieve the safe-yield goal of the AMA by the year 2025.

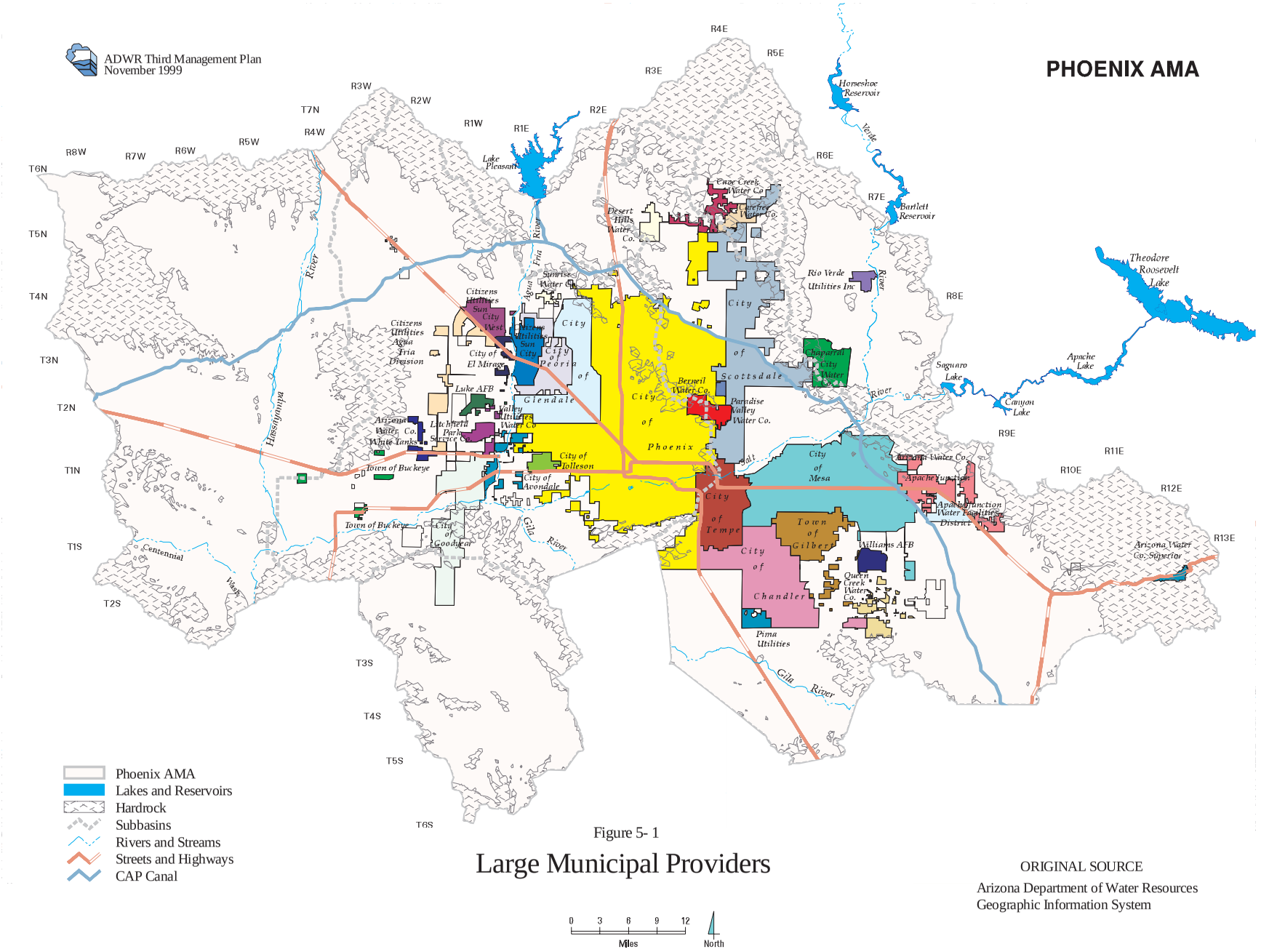


Figure 5- 1

Large Municipal Providers

ORIGINAL SOURCE

Arizona Department of Water Resources
Geographic Information System

5.2 STATUTORY PROVISIONS

5.2.1 Per Capita Requirements for Large Municipal Providers

The Groundwater Code (Code) requires that the management plans for each AMA include a conservation program for municipal uses. For the First, Second and Third Management Plans, the Code expressly mandates that the programs require reasonable reductions in per capita use. A.R.S. §§ 45-564(A)(2), 45-565(A)(2), and 45-566(A)(2). To comply with this mandate the Department developed the Total Gallons Per Capita Per Day Program (Total GPCD Program). As originally enacted, the Code did not exempt any municipal providers from the requirement to achieve reductions in per capita use. Consequently, the Municipal Conservation Program in the First Management Plan established maximum gallons per capita per day (GPCD) requirements for all municipal providers, regardless of size.

In 1986, the Legislature amended the statutes governing the Second and Third management plans to exempt "small municipal providers" from the requirement to achieve reasonable reductions in per capita use. Laws 1986, Ch. 107, §§ 2 and 3. Instead of requiring small municipal providers to achieve reductions in per capita use, the statutes require the director to establish "reasonable conservation requirements for small municipal providers." A.R.S. §§ 45-565(A)(4) and 45-566(A)(4). Until 1994, "small municipal provider" was defined in the Code as "a city, town, private water company or irrigation district that supplies water for non-irrigation use, serves less than five hundred people and supplies less than one hundred acre-feet of water for non-irrigation use during a calendar year." Laws 1986, Ch. 107, § 1. In 1994, the Legislature changed the definition of small municipal provider to "a municipal provider that supplies two hundred fifty acre-feet or less of water for non-irrigation use during a calendar year." A.R.S. § 45-561(13).

Two other statutory amendments have created exceptions to the requirement that municipal providers achieve reasonable reductions in per capita use. In 1991, the Legislature exempted large untreated water providers from the requirement to achieve reductions in per capita use. Laws 1991, Ch. 211, §§ 16, 17, and 18. In 1992, the Legislature enacted legislation requiring the director to include in each management plan a Non-Per Capita Conservation Program for large municipal providers as an optional, alternative program to the program requiring reductions in per capita use. Laws 1992, Ch. 183 §§ 5, 7, and 9. Those amendments are described in greater detail in the following two sections.

5.2.2 Conservation Requirements for Large Untreated Providers

As a result of legislation enacted in 1991, large untreated water providers are exempt from the requirement to achieve reasonable reductions in per capita use. Instead of requiring reductions in per capita use by large untreated water providers, the director is required to establish "conservation or rate of use requirements for deliveries of untreated water by large untreated water providers based on the use of the latest commercially available conservation technology consistent with reasonable economic return." A.R.S. § 45-566(A)(3).

"Large untreated water provider" is defined in the Code as "a municipal provider that as of January 1, 1990 was serving untreated water to at least five hundred persons or supplying at least one hundred acre-feet of untreated water during a calendar year." A.R.S. § 45-561(7). "Untreated water" is defined as "water that is not treated to improve its quality and that is supplied by a municipal provider through a distribution system other than a potable water distribution system.". A.R.S. § 45-561(14). A complete listing of the large untreated water providers is contained in Appendix 5-B.

5.2.3 Non-Per Capita Conservation Requirements for Large Municipal Providers

In 1992, the Legislature enacted legislation requiring the Department to include in the management plans a Non-Per Capita Conservation Program (NPCCP) as an optional, alternative program to the Total GPCD Program requiring reasonable reductions in per capita use. Each provider regulated under the NPCCP is required to implement specific residential and non-residential conservation programs for interior and exterior water use, a public education program relating to water conservation, and a program to meter most service area connections. Additionally, providers who are regulated under the NPCCP are required to either reduce their groundwater pumping consistent with the AWS Rules (A.A.C. R12-15-701, *et seq.*) or eliminate their use of mined groundwater by the year 2010. The NPCCP is a performance-based program with compliance determined by the effective implementation of stipulated conservation measures and the required groundwater reduction. For the Third Management Plan, the statutory requirements for the NPCCP are found in A.R.S. § 45-566.01.

5.2.4 Conservation Requirements for Individual Users

In addition to requiring the director to establish conservation requirements for municipal providers, the Code requires the director to establish in the Third Management Plan "such other conservation measures as may be appropriate for individual users." A.R.S. § 45-566(A)(2). An "individual user" is a person or entity who receives water from a municipal provider for a non-irrigation use. In the Third Management Plan, the director has established conservation requirements for the following individual users: turf-related facilities, large-scale cooling facilities, and publicly owned rights-of-way.

A municipal provider that receives notice of an individual user conservation requirement is responsible for complying with the requirement with respect to all individual users to which it serves water and to which the requirement applies, with two exceptions. First, the municipal provider is not responsible for complying with the requirement with respect to an individual user that has received notice of the requirement directly from the director. In that case, the individual user is responsible for complying with the requirement. Second, if the requirement is substantially identical to an industrial conservation requirement, the municipal provider is not responsible for complying with the requirement with respect to an individual user that it has identified in writing to the Department by a specified date. If the individual user was in existence when the management plan was adopted, the municipal provider must have identified the individual user to the Department at least 90 days before the management plan was adopted. A.R.S. § 45-566(B). If the individual user came into existence after the management plan was adopted, the municipal provider must identify the individual user to the Department within 90 days after it begins serving water to the individual user. If the municipal provider identifies a new individual user to the Department more than 90 days after it begins serving water to the individual user, the municipal provider will be responsible for complying with the individual user requirement until the end of the year in which it first identifies the user to the Department. See section 5-112 of the municipal conservation requirements.

5.2.5 Distribution System Requirements

The director is required to include in the Third Management Plan "additional economically reasonable conservation requirements for the distribution of groundwater by cities, towns, private water companies, and irrigation districts within their service areas." A.R.S. § 45-566(A)(5). Distribution system requirements for municipal providers consist of a requirement to limit lost and unaccounted for water and a requirement to meter deliveries. See section 5-113 of the municipal conservation requirements.

5.3 RELATIONSHIP OF SECTOR TO ACHIEVEMENT OF MANAGEMENT GOAL

Since 1985, groundwater use by municipal providers has decreased approximately 8 percent in the Phoenix AMA while total municipal water use has increased with population growth. As a percent of total

municipal water use, groundwater is becoming a smaller component, decreasing from 42 percent of total municipal use in 1985 to 29 percent of total municipal use in 1995. Municipal providers in the Phoenix AMA have expended enormous capital to acquire and build infrastructure to utilize renewable resources. Cooperative planning by the large municipalities has aided in the development of a regional recharge facility, the Granite Reef Underground Storage and Recovery Project, and the establishment of intergovernmental agreements to provide for the transportation, treatment, and use of renewable supplies. Table 5-1 illustrates the municipal sector's contribution to overdraft in the Phoenix AMA for the years 1985, 1990, and 1995.

TABLE 5-1
MUNICIPAL SECTOR OVERDRAFT ESTIMATES
1985, 1990, AND 1995
PHOENIX ACTIVE MANAGEMENT AREA
(Acre-Feet)

	1985	1990	1995
Total Water Use	657,191	782,474	869,962
Groundwater Use	276,541	292,047	253,585
Incidental Recharge	52,866	57,895	61,887
Overdraft	***223,675***	***234,152***	***191,698***

Table includes untreated water providers, small municipal providers, large municipal providers, estimated exempt wells, and estimated Indian Municipal & Industrial water use.

By 2025, the municipal sector is expected to surpass the agricultural sector and become the largest water use sector in the Phoenix AMA primarily because of continued urban growth and development. With the adoption of the AWS Rules, the municipal sector has been given a greater responsibility in the achievement of safe-yield. It is assumed that most of the large municipalities will be designated as having an assured water supply by the end of the second management period, accounting for the majority of the water use in this sector (approximately 69 percent). These large municipalities are currently the principal users of renewable supplies. Although these providers will have the ability to phase in new growth on an allocation of groundwater (limited to 7.5 multiplied by the 1994 total water use), most large municipal providers currently utilizing renewable resources have indicated that they will reserve this allowable groundwater for times when surface water availability is limited (due to factors such as canal dry up, peak daily demands, treatment facility shut downs, and drought).

Although the AWS Rules require the use of renewable supplies for new growth, they do not address residual overdraft (groundwater mining allowed under the Code) associated with existing municipal uses or new municipal uses on unsubdivided lands. Unless changes are made to the Code or the AWS Rules, these uses can be addressed only through implementation of water conservation measures, including renewable supply incentives. In the Phoenix AMA, the groundwater demand associated with existing municipal users is approximately 250,000 acre-feet per year. Of this annual demand, approximately 139,000 acre-feet is associated with municipal users that have not applied for a Designation of Assured Water Supply (Designation of AWS). It will not be possible to reach safe-yield if this demand continues to be met entirely with mined groundwater.

Primarily because of institutional and geographic constraints, some providers, particularly private utilities, have not applied to be designated as having an assured water supply. A new subdivision may be served by an undesignated provider only if it obtains a Certificate of Assured Water Supply (Certificate of AWS) and

demonstrates the use of renewable supplies for the new development. A new subdivision may demonstrate the use of renewable supplies by becoming a member of the Central Arizona Groundwater Replenishment District (CAGRD), which replenishes groundwater used by a member in excess of the amount allowed under the AWS Rules. The availability of the CAGRD as a mechanism to demonstrate the use of renewable supplies allows small cities and private water companies to grow and establish sufficient demand and tax base to develop renewable supply infrastructure.

The overall impact of the municipal sector on overdraft should decrease over time with the implementation of the AWS Rules. However, because of the size and diversity of the Phoenix AMA, the Department needs to focus its water management efforts on a more localized basis in addition to striving to achieve safe-yield on an AMA-wide basis. Different areas of the AMA are utilizing groundwater or renewable supplies at various levels. While some areas of the AMA may be experiencing increases in groundwater levels, other areas have severe declines. Subbasin or subarea management is an alternative that the Department will analyze throughout the third management period.

5.4 ASSURED WATER SUPPLY PROGRAM

The Code requires persons proposing to offer subdivided lands for sale or lease within an AMA to demonstrate that the proposed subdivision has an assured water supply. A.R.S. § 45-576. If a subdivider fails to demonstrate that a proposed subdivision has an assured water supply, the plat for the subdivision may not be approved by a city, town, or county, and the State Real Estate Commissioner may not issue a public report authorizing the sale or lease of the subdivided lands. A.R.S. § 45-576 (B) and (C).

There are two mechanisms for demonstrating that a proposed subdivision has an assured water supply. First, the subdivider may apply for and obtain a Certificate of AWS from the director. Second, the subdivider may obtain a written commitment of water service for the subdivision from a city, town, or private water company that the director has designated as having an assured water supply. A.R.S. § 45-576(A). For both of these purposes, "assured water supply" means that sufficient water of adequate quality will be continuously available to meet the water needs of the proposed use for at least 100 years; that the projected use is consistent with the management plan and achievement of the management goal for the AMA; and that the financial capability has been demonstrated to construct the water facilities necessary to make the supply of water available for the proposed use, including a delivery system and any storage facilities or treatment works. A.R.S. § 45-576(I).

In 1995, the Department adopted rules to carry out the purposes of the assured water supply statute. A.A.C. R12-15-701, *et seq*. The AWS Rules specify in detail what an applicant for a Certificate of AWS or a Designation of AWS must demonstrate. Of particular relevance to the Municipal Conservation Program are the requirements for demonstrating that a proposed use is consistent with the management plan and achievement of the management goal for the AMA.

5.4.1 Consistency With Management Goal

In order to demonstrate that a proposed use is consistent with the management goal for the Phoenix AMA, the AWS Rules require applicants to demonstrate that renewable supplies, including groundwater replenished by the CAGRD, will be used to satisfy most of the water demand of the development or water service area for 100 years. A.A.C. R12-15-705. For a municipal provider applying for a Designation of AWS, this means that most of the water demand for both existing and new customers must be met with water supplies other than mined groundwater.

5.4.2 Consistency With Management Plan

In order to demonstrate consistency with the AMA's management plan, the AWS Rules generally require that an applicant be in compliance with its management plan requirements. For municipal providers, the applicable management plan requirements are the municipal provider conservation requirements set forth in section 5.12 of this chapter. Thus, if a municipal provider applying for a Designation of AWS is regulated under the Total GPCD Program, the provider must either be in compliance with its total GPCD requirement, or with the terms of a stipulation and consent order entered into to remedy non-compliance with the GPCD requirement, in order to demonstrate consistency with the management plan.

An applicant for a Certificate of AWS is not subject to the municipal provider conservation requirements set forth in the management plan because the applicant is not a municipal provider as defined in A.R.S. § 45-561. However, certain uses that may be associated with a certificate application, such as turf-related facilities, large-scale cooling facilities and landscaping or water features in publicly owned rights-of-way, are subject to the individual user requirements in section 5-112(A) of the municipal conservation requirements if groundwater will be used. For all individual users, whether served by a designated or undesignated provider, either the entity delivering water or the individual user (e.g., homeowner's association, turf-related facility owner, etc.) will be responsible for compliance with the individual user requirements.

The water use of a new subdivision will also affect a large municipal provider's ability to meet its GPCD requirement. While individual users or the entity delivering water to them are responsible for meeting the individual user requirements, new subdivisions should be developed in a manner consistent with the municipal provider's conservation requirements in the management plan. This could be accomplished by some relatively simple and voluntary efforts by the certificate applicant or homebuilder. A few examples are:

- Establish Conditions, Covenants and Restrictions or other conditions that will limit water-intensive landscaping within the subdivision
- Provide lot buyers with written water conservation information, including irrigation management of automatic irrigation timers
- Landscape model homes in accordance with Xeriscape™ principles
- Feature water conservation fixtures and appliances in model homes
- Limit water-intensive vegetation in common areas to those areas that provide significant recreational benefits
- Provide low water use landscaping packages to home buyers
- Locate hot water heaters to minimize long hot water pipe runs or install looped systems

An application for a Certificate of AWS requires submittal of general information to allow the Department to estimate the water demand of the subdivision. These include submittal of any Conditions, Covenants and Restrictions or other conditions that will limit exterior water demand and any proposed conservation practices, policies, devices, etc. that may be utilized.

5.4.2.1 Consistency With Management Plan Criteria for Applicants for Certificates of Assured Water Supply

Some subdivisions include a golf courses and other non-residential water uses. Demands associated with non-residential use are considered to be part of the subdivision offering if they will be part of the common promotional plan and they are covered by the official definition of a subdivision (A.R.S. § 32-2101). Because of the large volume of water associated with the needs of a golf course, a person applying for Certificate of AWS must demonstrate the following:

That any new golf courses to be included within the development plan will be designed to comply with any applicable turf-related facility conservation requirements contained in Chapter 6 of this management plan. To make this demonstration, the applicant shall describe in its application the design and landscaping plans for any golf courses that will be included within the development.

When the AWS Rules are revised, more specific Consistency with Management Plan requirements for Certificates of AWS may be included.

5.4.3 Assured Water Supply Role in the Municipal Conservation Program

The AWS Rules are expected to result in reductions in mined groundwater use and greater reliance on renewable water supplies compared to pre-rule water use. This will be a great benefit to the Phoenix AMA as groundwater supplies are preserved for future uses. However, as the utilization of renewable supplies increase as a result of the AWS Rules, the Municipal Conservation Program will continue to focus on the efficient use of all water supplies. As growth in the Phoenix AMA continues, the stress on renewable supplies will also increase. The programs developed for the Third Management Plan are aimed at increasing the efficiency of water use in the municipal sector. It is the goal of the Department to use the AWS Rules along with the Municipal Conservation Program and incentives for the use of renewable supplies to bring the AMA closer to the achievement of safe-yield.

5.5 FIRST AND SECOND MANAGEMENT PLANS

For the First and Second Management Plans, the Department was required by statute to focus on per capita reductions as a mechanism to move the municipal sector toward safe-yield. Reductions in GPCD rates result in conservation of the groundwater supply that can be preserved for times of drought or reserved for future growth. To achieve reductions in per capita water use, the Total GPCD Program was established as the base program for all large municipal providers.

In developing the Total GPCD Program, the Department began with a very basic approach in the First Management Plan and moved to addressing unique water use characteristics in the Second Management Plan. Through each management period, the Department has addressed water management concerns by including incentives for the use of renewable supplies, providing technical and financial assistance, and revising programs by updating data and assumptions using new information on current technologies and programs. In addition to the Total GPCD Program, voluntary alternative programs that are not based solely on per capita reductions were developed in the Second Management Plan for providers able to limit or reduce reliance on groundwater supplies. The intent of these programs is to allow demand flexibility if groundwater use is limited to a historic amount or reduced over time.

5.5.1 First Management Plan Approach

The approach to municipal conservation in the First Management Plan was a reduction from the base year GPCD rate for all water providers. The higher the base year GPCD rate, the greater the required reduction in per capita use. The 1980 census population and total water use were used to calculate each provider's base year GPCD use rate. A First Management Plan total GPCD requirement was then calculated, which, for providers with high per capita use (greater than 350 gallons per capita per day) in the base year, was 11 percent lower than their base year GPCD rate. Providers with moderate per capita use (between 140 and 350 gallons per capita per day) were assigned a GPCD requirement that was 6 percent lower than their base year GPCD rate. Providers at or under 140 GPCD in 1980 were not required to conserve further during the first management period, but were not permitted to use more than 140 GPCD per year. Additional requirements for distribution systems, individual users, and monitoring and reporting were also components of the Municipal Conservation Program during the first management period.

Providers were given the opportunity to request a modification of their First Management Plan total GPCD requirement based on unique circumstances within their service area. Adjustments were granted for factors such as acquisition of all or a portion of another provider's service area, increasing non-residential uses within the service area not in existence when the requirements were adopted, and technical or factual errors made in calculating the requirements.

Both small and large providers were regulated in the same manner in the first management period. Additionally, a special provider category was established for service areas that were dominated by non-residential/institutional uses (e.g., hospitals, schools, correctional facilities, or military installations) whose water use patterns and conservation potential could not be adequately characterized by per capita rates. The special provider program established a residential GPCD requirement along with non-residential measures commensurate to the uses within the service area.

5.5.2 Second Management Plan Approach

During the development of the Second Management Plan, the Department recognized that the unique characteristics and growth patterns within each service area have a great influence on the provider's ability to reduce per capita use and help achieve the goal of safe-yield. It was recognized that new users should be more efficient than existing water users due to the installation of high-efficiency plumbing fixtures in new residences that comply with federal, state, and local ordinances.

The approach to setting GPCD requirements for large municipal providers in the Second Management Plan was based on an analysis of conservation potential for each service area, using 1985 as the base year. Conservation potential for existing residential uses was estimated based on the comparison of existing water use patterns to assumed levels of savings associated with changing attitudes and implementation of selected conservation programs. Providers with relatively high GPCD rates were assumed to have greater conservation potential while those whose residential GPCD fell under a certain level were assumed to have minimal or no conservation potential. Estimated savings assumptions, based on documented conservation programs successfully applied in Arizona, California, and other regions in the United States, were then applied to the existing residential GPCD rate for each large municipal provider to develop a GPCD requirement for existing residential uses. New residential water users were assumed to come in at model use rates established by the Department for new residential housing based on the latest commercially available technology such as low-flow plumbing fixtures and low water use landscaping practices. Non-residential uses were held constant from base year non-residential water use levels with an additional 7 percent reduction to be achieved by 2000. Lost and unaccounted for water was also held constant at base year levels, but not to exceed a maximum of 10 percent.

Finally, a single total GPCD requirement was established for each large municipal provider combining the assumptions for existing residential, new residential, non-residential, and lost and unaccounted for water. Intermediate GPCD requirements were established for 1992 and 1995 to encourage providers to make progress in conservation efforts throughout the management period, with achievement of the final GPCD requirement in 2000.

Because non-residential uses continue to increase, and in most instances are not subject to assured water supply requirements limiting groundwater use, modifications to the total GPCD requirement for disproportionate increases in non-residential growth were not allowed in the Second Management Plan. Instead, the Department established the Alternative Conservation Program (ACP) that regulates providers based on a residential per capita requirement and the implementation of specific non-residential conservation measures. In order to participate in this more flexible program, providers were required to limit their groundwater withdrawals to a historic level, which required them to utilize renewable resources or retire groundwater rights to serve new demand. Additionally, providers that served predominantly non-

residential/institutional uses were allowed to apply for the Institutional Provider Program (IPP), which replaced the special provider category established in the First Management Plan.

In the Second Management Plan, small municipal providers were not assigned a total GPCD requirement. Instead, because of their limited conservation potential and small proportion of overall municipal demand, small municipal providers were required to comply with the following requirements: minimize waste, maximize efficiency of outdoor watering, encourage reuse, and reduce the GPCD usage in their service areas.

5.5.3 Overview of Changes During the Second Management Period

Since 1990, the Second Management Plan has been modified twice. In general, changes were made to the Municipal Conservation Program to provide incentives for the use of non-groundwater sources, to provide technical assistance to the regulated community, and to add a Non-Per Capita Conservation Program. Additionally, a legislative change created an incentive for municipal providers to use groundwater withdrawn pursuant to approved remedial action projects.

5.5.3.1 Management Plan Modifications

5.5.3.1.1 First Modification (1991):

An exclusion for the use of untreated CAP water was included in the first modification. Providers who were willing to make a commitment to ultimately serve effluent to a non-residential customer, but did not yet have access to or the ability to distribute effluent immediately, were allowed to serve untreated CAP water to the customer without having that water counted in the total GPCD rate for up to ten years. This incentive was adopted to encourage construction of the necessary non-potable distribution lines before the effluent is available, to expedite the future use of effluent within the AMA.

The Conservation Assistance Grants Program was adopted for the Second Management Plan to provide financial, planning, technical, and other support and services to all regulated sectors. Each year grants are awarded to support education, projects, and research that promote water conservation. The funds to support the grants program come from a portion of the groundwater withdrawal fees paid by all persons in the AMA that pump groundwater.

5.5.3.1.2 Second Modification (1995):

Legislation passed in 1994, and incorporated into the second modification, redefined small municipal providers as those water providers serving 250 acre-feet of water or less annually. Previously, a small municipal provider was defined as a water provider serving 100 acre-feet of water or less annually or a water provider that served a population of 500 people or less. The intent of this legislation was to allow the Department to focus its conservation efforts on providers with significant water use and greater conservation potential. In the Phoenix AMA, passage of this legislation reduced the number of large providers from 48 to 32. However, since that time, two providers have increased their water service and have transitioned back into the large municipal provider category.

The NPCCP, adopted by the Legislature in 1992, exempts qualified large municipal providers from per capita conservation requirements by substituting reasonable conservation measures (RCMs) targeting both residential and non-residential users, for per capita requirements. ARS § 45-565.01(A). Providers who elect to enter this program are required to gradually eliminate the use of mined groundwater in their service areas consistent with the program requirements.

The second modification also included an incentive for the use of renewable supplies that allowed large municipal providers whose annual groundwater use was 30 percent or less of their total annual water use to remain at their Second Management Plan First Intermediate GPCD requirement. This incentive could be used in each year that a provider achieved the groundwater limitation standard of 30 percent or less, through the year 1999.

5.5.3.2 Legislative Change

In 1997, legislation was enacted providing an incentive for municipal providers to use groundwater withdrawn pursuant to an Environmental Protection Agency (EPA) or Arizona Department of Environmental Quality (ADEQ) "approved remedial action project." Prior to the passage of this bill, the withdrawal and use of groundwater, regardless of its quality, was counted as groundwater use in the determination of compliance with the management plan conservation requirements (see Chapter 10). This legislation requires the Department to account for remediated groundwater withdrawn pursuant to an approved remedial action project in the same manner as surface water for determining compliance with the management plan conservation requirements adopted for the Third, Fourth, and Fifth Management Plans. Thus, this groundwater is counted as surface water in the compliance determination. Laws 1997, Ch. 287, § 51(B). Although the 1997 legislation did not expressly apply to conservation requirements adopted in the Second Management Plan, an amendment passed in 1999 applies these accounting principles to the Second Management Plan. Laws 1999, Ch. 295, § 49. The Department has indicated through a substantive policy statement how it will apply the incentive to Second Management Plan conservation requirements beginning in 1998. Section 5.8 contains a discussion of this incentive as it applies to the Third Management Plan.

5.6 MUNICIPAL PROGRAM ISSUES

Throughout the preparation of the Third Management Plan, extensive input from the water-using community was obtained to identify the issues to be addressed in the development of the Third Management Plan. This section provides an overview of the issues raised by the Department and the AMA water providers.

5.6.1 Private Water Company Issues

Some municipal water providers regulated under the Municipal Conservation Program are privately owned companies separate from the city, town, or county in which they are located. While local plumbing and landscape ordinances may apply within the private water company service area, the water company itself lacks the authority to enact ordinances regulating water use by its customers. In addition to being regulated by the Department, private water companies are regulated by the Arizona Corporation Commission (ACC), an elected body whose mission includes exercising exclusive state regulatory authority over public service corporations (public utilities) in the public interest. The ACC monitors the operations of approximately 350 private water utility companies throughout Arizona, reviewing company financial records and recommending revenue requirements and rates and charges to be collected. The regulatory responsibilities of the ACC are fully defined in Article XV of the Arizona Constitution and §§ 40-201, *et seq.*, Arizona Revised Statutes (including A.R.S. § 40-250 requiring that all public service corporations obtain ACC approval before establishing or changing any rate).

Private water companies have raised several issues regarding the relationship of the Department's requirements and the ACC's review of rate recovery associated with the requirements. The most significant issues identified include: (1) the perception of uncertainty in the ability to recover the holding costs of CAP subcontracts and financing the construction of facilities for receipt and use of renewable supplies and (2) the impact of the ACC's position in rate cases that implementation of conservation

programs is discretionary because the Department does not identify specific conservation programs or measures needed to be carried out by the provider.

These issues have been extensively reviewed and discussed by the Department staff, private water company representatives, and ACC staff. The ACC has indicated that "although they cannot guarantee recovery of costs prior to their incurrence" they would consider cost recovery for the use of renewable supplies and the implementation of conservation measures, applying the principles of "used and useful" and "least-cost alternative." In the past, these principles have meant that a provider would have to be actively providing a resource in order to recover costs, and any conservation measure implemented would have to be the most cost-effective option before the recovery of costs would be allowed. Private water companies argue that these principles do not guarantee cost recovery, as they are considered by the ACC on a case-by-case basis.

During the development of the Third Management Plan, the Department explored the possibility of establishing a municipal conservation program designed exclusively for private water companies. In order to meet the goals of the Department and obtain the support of the ACC, the Department considered a program that would mandate specific conservation measures and reduce reliance on groundwater supplies. Upon further examination, it was determined that additional statutory authority would be needed to implement such a program. It was decided by the Department not to pursue this action at this time. However, Department staff, with the cooperation of the regulated community, will continue to explore options. Some of these options include continued dialogue between the two agencies aimed at establishing a united strategy in achieving the most economically efficient reduction in reliance on mined groundwater by private water companies, including providing more certainty of cost recovery for providers.

5.6.2 Renewable Water Supply Use

In the first and second management periods, the management plans focused primarily on increasing water use efficiency through conservation regulations. The AWS Rules have increased the emphasis on renewable supply requirements for municipal growth. Renewable supplies available to Phoenix AMA water providers include CAP water, Salt and Verde River water, Agua Fria River water, and effluent. Water use efficiency through conservation, increased direct use of renewable water (including effluent), restrictions on inappropriate uses water, and artificial recharge are each critical to ensuring a secure and sustainable water supply. A number of providers argue that these goals conflict or that insufficient resources are available to pursue both conservation and renewable supply acquisition and development simultaneously.

Municipal providers have also expressed the concern that the incentives for utilization of renewable water supplies in the management plans are inadequate. Although the AWS Rules have increased the emphasis on the use of renewable supplies, there is a perceived need to provide additional encouragement to utilize renewable supplies. Some have recommended that the use of renewable resources should be facilitated by exempting such deliveries from conservation requirements or discounting their use in any compliance calculation. However, long-term demand and supply projections indicate that Phoenix AMA providers will need to fully utilize their CAP water, and that lower GPCD rates will be necessary to attain and maintain safe-yield. The Department recognizes the importance of encouraging the use of renewable supplies while continuing to stress that all available water supplies must be used efficiently through effective conservation programs.

A number of incentive programs for the use of renewable supplies were included in the Second Management Plan, including the effluent use incentive, the CAP exclusion, and the alternative programs (see Table 8-6 in Chapter 8 for a detailed list of all incentives). Several additional incentive options were considered for inclusion in the Third Management Plan. However, with the creation of the Arizona Water Banking Authority, which is expected to store unutilized CAP water, additional incentives for CAP

utilization are not included in this plan. Although direct effluent use by municipal providers is completely exempt from conservation requirements, a large portion of the effluent available in the Phoenix AMA is not utilized (approximately 60 percent). A task force may be established to review the issues associated with ways to maximize the likelihood of achieving safe-yield, the tools needed to manage water on a more localized basis, and the appropriateness of developing additional regulatory incentives. It may be necessary to develop both legislation and modifications to the management plan to adopt a comprehensive strategy that addresses these various concerns.

5.6.3 Total Gallons Per Capita Per Day Program Issues

Municipal providers bear the responsibility of ensuring efficient water use by the persons to whom they deliver water (residential and non-residential water customers). For providers regulated under the Total GPCD Program, compliance is determined by comparing the provider's actual GPCD usage rate in a year with the provider's total GPCD requirement for the year. When the Second Management Plan total GPCD requirements were assigned in 1990, the Department received numerous requests for administrative review. Adjustments were requested for a number of reasons, including inaccurate population projections, disproportionate seasonal population increases, disproportionate increases in non-residential growth, and inaccurate assumptions for new residential growth (i.e., lot size and exterior landscape patterns).

Population projections for 1990, 1995, and 2000 were used in the Second Management Plan to calculate total GPCD requirements for each large municipal provider. Several issues arise when using population projections, including: (1) the economic forecast at the time the projections are made can affect the projections, (2) the ratio of single family to multifamily projections can influence the achievement of the new residential component of the per capita requirements, and (3) the way a provider's service area population actually grows in relation to the projections can make it easy or difficult for the provider to achieve its requirements.

To address these uncertainties, the Department did not use population projections to calculate GPCD requirements for the Third Management Plan. Instead, an annual GPCD requirement will be calculated using a "component" approach based on the actual new single family and multifamily populations. This approach is discussed in greater detail in section 5.7 of this chapter.

Seasonal visitors are people who reside in Arizona during part of the year but who do not claim residency in Arizona. Variations from year-to-year in seasonal population can skew GPCD rates to make it appear that water use is becoming more or less efficient. Providers who can demonstrate a disproportionate increase in seasonal population can request an administrative review of the annual population estimate.

In most cases, providers have a wide range of lot sizes that average approximately 7,500 square feet. For that reason, the models for new development are based on an average single family lot size of 7,500 square feet. Some service areas are dominated by larger lots due to development preferences and the availability of inexpensive urban irrigation. Large lots with considerable landscapable areas tend to increase the residential GPCD rate because more water use is divided among fewer people than if development were of a higher density. Providers who can demonstrate a disproportionate amount of large lots can apply for administrative review.

For the municipal sector, the ratio of residential to non-residential demand can impact the GPCD rate of a water provider. Adding a new large non-residential customer can drastically increase the overall demand within a service area and can negatively impact a provider's ability to achieve compliance with the total GPCD requirement. The First Management Plan contained a provision that allowed a provider experiencing a disproportionate increase in non-residential use to apply for a modification to its total GPCD requirement to accommodate the increased non-residential use. The Second Management Plan did not contain such a provision because it contained several other provisions that would allow a provider to

serve disproportionately increasing non-residential uses while remaining in compliance with its conservation requirements. For instance, deliveries of effluent, other than effluent recovered outside the area of impact of an underground storage project, were excluded when determining a provider's compliance with its total GPCD requirements. Thus, a provider could serve an unlimited amount of effluent to a new non-residential customer without the service having an impact on the GPCD usage rate. Additionally, providers who used renewable supplies could apply for one of the alternative programs that did not impose GPCD requirements on non-residential uses, but which did limit the amount of groundwater that could be used during the year.

Some providers have pointed out that the Department's current position on this issue must be addressed in the future in light of the AWS Rules. Providers who obtain a Designation of AWS are required to reduce their groundwater use for all water users, existing and new, and the concern of a disproportionately increasing non-residential GPCD rates on groundwater is becoming a limited argument. In the Third Management Plan, the Department will continue to maintain its position to not grant an increase in the GPCD requirements for disproportionate non-residential growth. This is due to the availability of the alternative programs that allow providers who have committed to the use of renewable supplies the flexibility to address this situation.

5.7 THIRD MANAGEMENT PLAN MUNICIPAL CONSERVATION PROGRAM

Conservation requirements have been established pursuant to the statutory provisions of the Code for large municipal providers, small municipal providers, and large untreated water providers. This section will detail the requirements that have been developed for the Third Management Plan.

5.7.1 Conservation Requirements for Large Municipal Providers

In order to establish conservation requirements for large municipal providers in the Second Management Plan, the Department identified existing water use patterns and service area characteristics that influence a provider's water conservation potential. Assumptions about future service area population growth, water supply, and demand were also included in the analysis. This assessment was referred to as the "municipal provider profile." Targets for each water use sector or component (existing residential, new residential, non-residential and lost and unaccounted for water) were combined to establish a preassigned total GPCD requirement based on projected population growth for the years 1992, 1995, and 2000. The two intermediate dates, 1992 and 1995, were established to allow a phase-in to achieve the final Second Management Plan requirement in 2000.

For the Third Management Plan, the Department used a similar approach to identify service area water use characteristics. Information gathered through annual reports, annual population estimates supplied by the Maricopa Association of Governments (MAG), and individual interviews conducted to determine existing water conservation programs were used to determine water conservation potential for each large municipal provider.

The Code requires additional reasonable reductions in per capita use by large municipal providers in the Third Management Plan. Pursuant to this statutory requirement, the Department will calculate a total GPCD requirement for each large municipal provider. However, the Department will not initially combine the water use components into a preassigned total GPCD requirement. Instead, in order to eliminate the uncertainty of population projections, each component is assigned a separate water use rate with a total GPCD requirement calculated each year based on actual population growth within the service area. As in the Second Management Plan, there will be two intermediates and a final GPCD requirement for all large municipal providers. Each large municipal provider will be noticed of its GPCD components for its service area and the method for calculating a total GPCD requirement. Providers may apply for a variance from or an administrative review of the conservation requirements within 90 days after the notice is given.

Alternatively, a large municipal provider may apply for one of the alternative programs: the Non-Per Capita Conservation Program (NPCCP), the Alternative Conservation Program (ACP), or the Institutional Provider Program (IPP). Large municipal providers who do not apply for an alternative program will be regulated under the Total GPCD Program.

5.7.1.1 Total Gallons Per Capita Per Day Program

As in previous management periods, the base municipal program for the Third Management Plan will be the Total GPCD Program. Each large municipal providers regulated under this program must limit its annual gallons per capita per day water usage within its service area to the amount allowed under their total GPCD requirement.

5.7.1.1.1 Total Gallons Per Capita Per Day Program Development

For the third management period, an annual total GPCD requirement will be calculated using a "component method." The components of the total GPCD requirement are: existing residential use, new single family interior residential use, new single family exterior residential use, new multifamily interior residential use, new multifamily exterior residential use, non-residential use, and lost and unaccounted for water. Each component has an assigned "per capita per day" or "per housing unit per day" target use rate based on factors including: an assessment of the conservation potential of existing residential users, model use demands in new housing units based in part on plumbing code requirements and efficient exterior water use practices, a constant non-residential GPCD rate, identical to the rate assigned in the provider's total GPCD requirement in the Second Management Plan and system losses and unmetered uses in each year up to a limit of 10 percent. The component calculation is described and illustrated in more detail in Appendices 5-C.1 and 5-C.2. The sum of the component volumes will be multiplied by the annual estimated population or housing units in the service area each year (supplied by MAG). The resulting allowable volume will be compared to the actual amount of water withdrawn, diverted, or received in the calendar year to determine compliance.

5.7.1.1.1.1 Analysis of Existing Residential Conservation Potential

Conservation potential, based on existing water use, is an estimate of the amount of a reduction in water use that can be achieved from implementing reasonable conservation measures or programs for each water provider. To determine the residential conservation potential of each large provider in the Second Management Plan, the Department established a base year to determine water use rates for existing water users, then analyzed residential water use patterns and then selected appropriate conservation measures (based on an analysis of existing conservation measures). This analysis resulted in a GPCD reduction for existing users that was factored into the Total GPCD requirement for each provider.

In the development of the Third Management Plan, staff conducted a detailed analysis of all assumptions used to estimate the conservation potential of existing residential users in the Second Management Plan. This included an extensive inventory and analysis of available water conservation devices, measures, and programs. Adjustments were made to the assumptions for water savings, market penetration, and installation rates based on documented water savings from water conservation programs throughout the United States, including the Phoenix area and the Southwest. The Department also analyzed the existence of conservation programs within each service area and additional conservation measures that could be implemented during the third management period. Even with the existence of current conservation measures, the Department assumes some potential still exists for savings, even in service areas that have had programs in place. Water use for the years 1992 through 1996 for each provider was averaged and disaggregated into residential, non-residential, and lost and unaccounted for water use. The average water use for existing residential water users, both single family and multifamily, was then identified (see Appendix 5-D). Next, four categories were established to express existing single family and existing

multifamily conservation potential (the ability to achieve water savings through implementation of conservation programs): no potential, minimum potential, moderate potential, or maximum potential.

Table 5-2 illustrates the interior single family and interior multifamily GPCD and the exterior single family gallons per housing unit per day (GPHUD) used to establish the conservation potential categories. Each provider's existing residential average water use for the year's 1992 through 1996 was compared to the numbers in Table 5-2 to determine the conservation potential for each service area. After the provider's conservation potential was determined (see Appendix 5-E), a flat reduction of 0, 3, 5, or 7 percent was applied to each conservation potential category, respectively. Note: a flat rate of 77 GPHUD was allotted for the multifamily exterior sector. No conservation potential was assumed from this rate. The reduction assigned to each provider assumes the potential water savings for implementation of conservation measures commensurate with the provider's conservation potential. Finally, the water savings subtracted from the existing residential GPCD for each provider resulted in the existing residential component (see Appendix 5-F).

TABLE 5-2
THIRD MANAGEMENT PLAN
EXISTING RESIDENTIAL CONSERVATION POTENTIAL
PHOENIX ACTIVE MANAGEMENT AREA

	INTERIOR Single Family/Multifamily GPCD	EXTERIOR Single Family GPHUD
No Potential	0 - 57	0 - 117
Minimum Potential	58 - 74	118 - 178
Moderate Potential	75 - 87	179 - 256
Maximum Potential	>87	>256

GPCD = Gallons Per Capita Per Day
GPHUD = Gallons Per Housing Unit Per Day

5.7.1.1.1.2 Models for New Residential Users

For new residential water users (those residential users who begin to receive water from a municipal provider after 2000) the Department utilized a model-based approach similar to the one used in the Second Management Plan. Staff conducted an analysis of all assumptions used to generate the models for new residential interior and exterior water use. Current water fixture flow rates, existing technology, and behavioral patterns were evaluated and incorporated into the updated models for interior and exterior water use. These two models are described below.

INTERIOR RESIDENTIAL WATER USE MODEL The interior water use model for new residential development was updated from the Second Management Plan to reflect performance specifications for toilets, showerheads, and faucet aerators in current local, state, and federal plumbing codes; use of water-efficient clothes washers and dishwashers; and to show documented behavioral patterns. It should be noted that low-flow toilet requirements are limited to 1.6 gallons per flush. However, to compensate for occasional double-flushing, the model rate for toilets was adjusted to 1.7 gallons per flush. A miscellaneous water use component, which was not included in the Second Management Plan, was added to allow for reasonable water consumption associated with fixtures, appliances, and behavior not specifically addressed as a model component. Behavioral patterns affecting the duration and frequency of water use were reevaluated and adjusted based on data obtained from residential flow trace analyses

conducted in the Phoenix area and other areas of the United States sponsored by the American Water Works Association Research Foundation. As a result, an interior residential model use rate of 57 GPCD, which is an increase from the model use rate of 51.4 GPCD assumed in the Second Management Plan final total GPCD requirement, will be used as the interior residential component for all new residential water users through the third management period (see Table 5-3). This increase is based on the current data and adjustments for local climate.

EXTERIOR RESIDENTIAL WATER USE MODEL Models developed in the second management period for exterior water use in new single family developments were based on average swimming pool demand, evaporative cooling demand, and efficient landscaping needs. The same approach, using up-to-date information, will be used in the Third Management Plan.

TABLE 5-3
THIRD MANAGEMENT PLAN
SINGLE FAMILY AND MULTIFAMILY
INTERIOR WATER USE MODEL NEW RESIDENTIAL DEVELOPMENT
PHOENIX ACTIVE MANAGEMENT AREA

Device	Model Assumptions	Model Use Rate
Toilet	5 flushes/person/day x 1.7 gallon/flush	9 GPCD
Shower	7.9 minutes/shower x 2.50 gpm x 0.9 shower/person/day	18 GPCD
Bath	32.5 gallons/bath x 0.10 bath/person/day	3 GPCD
Faucets	Kitchen & Bathroom 2.5 gpm x 4.0 minutes/person/day	10 GPCD
Dishwasher	9.81 gallons/load x 0.20 loads/person/day	2 GPCD
Clothes Washer	30.3 gallons/load x 0.30 loads/person/day	9 GPCD
Miscellaneous		6 GPCD
TOTAL		**57 GPCD**

Numbers may not calculate due to rounding

Because exterior water use is not dependent on the number of persons in the household, the exterior model is expressed in GPHUD. Unlike the Second Management Plan, which used three landscaping water use models (see Second Management Plan, Chapter 5, p.127), the approach for the Third Management Plan assumes that the same potential exists for all new housing units to implement appropriate landscaping patterns for the local climate and utilize efficient water use practices. Thus, instead of three separate models, the Phoenix AMA used a single model for all new residential housing units.

Water use and landscaping assumptions are based on the potential for the provider to promote the use of, provide incentives for, and educate new residents on the benefits of using low water use plants and utilizing efficient irrigation practices (including the use of drip irrigation and proper management of irrigation timers). The single family exterior water use model is based on the average lot size for the Phoenix AMA of 7,500 square feet. Demand for evaporative cooling, swimming pools, and landscaping were developed from the Phoenix AMA evaporative cooler study, a telephone survey of swimming pool and spa contractors on average pool water use and installation rates, and landscaping consumptive use values obtained from average evapotranspiration (ETo) rates and rainfall for the Phoenix AMA and the University of Arizona Pima County Cooperative Extension Service. Although it is recognized that not all homeowners conform to model use rates, it was assumed that new homes have the potential to implement appropriate landscaping practices and that providers have a stronger ability to influence new homeowners'

decisions than homeowners in established neighborhoods. The exterior water use model for new single family residential development is 178 GPHUD. The exterior water use model for new multifamily residential development will remain constant from the Second Management Plan at 77 GPHUD. Table 5-4 summarizes the assumptions used to develop the single family exterior water use model for the Third Management Plan. Details on the assumptions used in developing the exterior water use model are contained in Appendices 5-G.1, 5-G.2, and 5-G.3.

TABLE 5-4
THIRD MANAGEMENT PLAN
EXTERIOR WATER USE MODEL - NEW SINGLE FAMILY DEVELOPMENT
PHOENIX ACTIVE MANAGEMENT AREA

Exterior Use	Model Use Rate
Evaporative Cooling	5 GPHUD
Swimming Pool	29 GPHUD
Landscape Watering	144 GPHUD
TOTAL	**178 GPHUD**

5.7.1.1.1.3 Analysis of Non-Residential Water Use

In the Second Management Plan, the proportion of non-residential water use to residential water use was held constant from base year levels for each provider. Additionally, the Department assumed that non-residential water use in the Phoenix AMA could become more efficient through the management period and assumed a 4 percent reduction to be achieved by 1995 and an additional 3 percent reduction to be achieved by the year 2000. It was assumed, in order to achieve these reductions, that providers would have the ability to utilize effluent for new non-residential uses such as turf-related facilities and landscaping within industrial and commercial facilities, and that the influence of compliance with the turf-related facility requirements would result in more efficient new non-residential users. Specifically, the direct use of effluent to serve these needs would have no impact on a provider's ability to comply with its total GPCD requirement because the direct use of effluent is not counted when determining compliance with the gallon per capita per day requirements.

A significant potential for effluent reuse still exists within the municipal sector for existing non-potable uses. The exclusion of effluent, either delivered directly or stored underground and recovered from within the area of impact, from the total GPCD requirement will continue through the third management period. Also, providers have the option of applying for the ACP or the NPCCP, neither of which imposes per capita requirements on the non-residential sector. Because providers with disproportionate increases in non-residential water use have the option to enter one of the alternative programs, each provider's non-residential GPCD component in the Third Management Plan will remain the same as the non-residential GPCD assumed for the provider in the final GPCD requirement for the Second Management Plan (see Appendix 5-H).

5.7.1.1.1.4 Lost and Unaccounted for Water

In the Third Management Plan, large municipal providers must limit the amount of lost and unaccounted for water in their distribution systems during a year to no more than 10 percent of the total water withdrawn, diverted, or received in the year. (See section 5.7.6.2, Distribution System Requirements.) In the Second Management Plan, requirements were set assuming lost and unaccounted for water use rates held constant from the base year throughout the management period up to the limit of 10 percent. By

doing so, providers with less than 10 percent lost and unaccounted for water in the base year were held to a figure below the standard throughout the second management period. For the third management period, providers will be allowed to include their actual lost and unaccounted for water, up to the 10 percent limit, each year when calculating the annual total GPCD requirement and will not be held to the lower historic rates.

5.7.1.1.2 Total Gallons Per Capita Per Day Compliance

5.7.1.1.2.1 Compliance Calculation

Compliance with the Total GPCD Program will be determined annually by comparing the large municipal provider's total annual use (in gallons) of all water (except spill water, CAP exclusion water, direct use effluent, and effluent recovered within the area of impact) withdrawn, received, and diverted for non-irrigation use to the amount of water the provider could legally withdraw, divert, and receive during the year for non-irrigation use. The amount of water that a provider can legally withdraw, divert, or receive during a year for non-irrigation use is calculated by multiplying the provider's total GPCD requirement for the year, as calculated using the component methodology, by the provider's service area population as of July 1 of the year, and then multiplying the product by the number of days in the year. The difference between the provider's actual use volume and the component volumes will thus be used to determine compliance. Any credits or debits in the provider's flexibility account will be taken into account when determining compliance as discussed below.

5.7.1.1.2.2 Flexibility Account

To account for variations in weather, the Department established a flexibility account in the Second Management Plan to determine compliance with the total GPCD requirements. This same approach will be used for determining compliance with the total GPCD requirement during the third management period. Under this approach, if the provider uses less water in a year than is allowed by its total GPCD requirement, a credit is registered to the provider's account in the amount of the difference. Alternatively, if a provider uses more water during a year than is allowed by its total GPCD requirement, a debit is registered to the provider's flexibility account in the amount of the difference. The flexibility account allows providers to accumulate 60 GPCD of credit or up to 20 GPCD of debit. A provider is out of compliance with its total GPCD requirement for the year if a debit causes the flexibility account to exceed the maximum negative account balance of 20 GPCD.

5.7.1.1.2.3 Annual Population Estimates

In order to determine annual service area populations, the Department will request, on an annual basis, an updated service area boundary from each large municipal provider delineating the areas within the service area that contain distribution lines, treatment facilities, and wells. These boundaries are updated and compared to the census tracts or enumeration districts determined by the United States Census Bureau. Annual service area population is based on the latest Census, which is broken down or disaggregated by unit type (single family homes, apartments, town homes, mobile homes, and other) to determine the base housing unit counts for each service area. Each year, county and municipal entities report the number of housing completions and deletions that occur within the city or town limits to the Maricopa Association of Governments. The reported new units are added to the number of existing total housing units within the service area boundary pursuant to the latest Census to derive the new total housing unit figure for the service area each year. Occupancy rates and persons per occupied housing unit rates are then calculated and used to determine the estimated service area population for each provider.

For providers outside Maricopa County, population estimates will also be based on the latest Census data. However, annual housing unit additions will be taken from the annual water use report and verified through the Pinal County Planning Department and other local entities.

5.7.1.2 Non-Per Capita Conservation Program

The NPCCP was added to the Second Management Plan in 1995 after being developed in cooperation with representatives of the water using community. This program requires a provider to implement specific conservation measures within its service area instead of requiring compliance with per-capita conservation requirements. A provider in this program must implement reasonable conservation measures, or RCMs, for interior and exterior residential water uses and interior and exterior non-residential uses, as well as an education program. The RCMs must be designed to result in water use efficiency within the provider's service area equivalent to the water use efficiency assumed in the provider's total GPCD requirement.

The Department has established a list of standard RCMs that are designed to achieve an efficiency equivalent to the assumptions used in the Total GPCD Program. However, if the standard RCMs do not fit the service area characteristics of a provider, the program allows the provider the flexibility to substitute measures that are designed to achieve the same savings yet fit the unique characteristics of the provider's service area. For the third management period, the Department will establish a steering committee to assist the Department in reviewing the existing RCMs outlined below, the substitute RCMs contained in Appendix 5-I.4, and development of monitoring and reporting requirements that would benefit the administration of the alternative programs. This steering committee will be made up primarily of Department staff and large municipal providers that are regulated under an alternative program. Other persons who the director considers to be beneficial may also be included.

5.7.1.2.1 Groundwater Use Reduction Requirement

The provider must meet one of the following requirements to be eligible to participate in the NPCCP: (1) the provider must be a member of a groundwater replenishment district, (2) the provider must be designated as having a 100-year assured water supply under the Department's AWS Rules, or (3) the provider must implement a plan to reduce mined groundwater withdrawals to zero by the year 2010 using a straight-line volumetric reduction.

5.7.1.2.2 Reasonable Conservation Measures

A set of standard Residential, Non-Residential, and Education RCMs were developed by the Department with the aid of an advisory group made up of conservation program experts from the regulated community. Each RCM prescribes actions that must be taken by the provider to achieve water use efficiencies in each sector. Providers who have already implemented these measures will be required to implement additional conservation measures, consistent with the conservation potential for their service area, to qualify for the program. An outline of the standard RCMs are listed below. For a more detailed description of each RCM, please refer to Appendices 5-I.1, 5-I.2, and 5-I.3. Additional substitute RCMs (Appendix 5-I.4) were developed to allow a provider to develop a conservation program that meets the characteristics of its service area. In order for a provider to use a substitute RCM in place of a Standard RCM, the provider must apply to the director and demonstrate that the substitute RCM will be designed to achieve a water use efficiency equivalent to the Standard RCM. The Standard RCMs are outlined below.

Standard RCMs

A. Residential Interior

1. Water Audit And Fixture Retrofit Program for Existing Residential Customers

2. Ordinance Or Condition of New Service Prohibiting Installation Or Replacement of Plumbing Fixtures in Residential Housing Units Unless Fixtures Meet Water Savings Standards

B. Residential Exterior

1. Audit Program for Existing Residential Customers
2. Landscape Watering Advice Program for Existing And New Residential Customers
3. Ordinance Or Condition of New Service for Model Homes in New Residential Developments
4. Prohibit the Creation of Covenants, Conditions, And Restrictions Which Require the Use of Water-Intensive Landscaping Or Which Prohibit the Use of Low Water Use Landscaping in New Residential Developments
5. *One additional landscape RCM from the three below* ***(Choice of one of the following)***
   a) Ordinance Or Condition of New Service Limiting Use of Turf And Other Water-Intensive Landscaping in New Multifamily Developments; **or**
   b) Ordinance Or Condition of New Service Limiting Use of Turf And Other Water-Intensive Landscaping in Common Areas of New Single Family And Multifamily Developments; **or**
   c) Rebate Program for New Residential Customers

C. Non-Residential Interior

1. Interior Audit Program for Existing Facilities
2. Ordinance Or Condition of New Service Prohibiting Installation Or Replacement of Plumbing Fixtures in Non-Residential Facilities Unless Fixtures Meet Water Saving Standards
3. Distribution of Conservation Information to All New Non-Residential Customers And Submittal of Water Use Plan by New Large Facilities

D. Non-Residential Exterior

1. Exterior Audit Program for Existing Non-Residential Customers
2. Landscape Ordinance Or Condition of New Service for New Facilities

E. Education

1. Public Information And Education Program

5.7.1.2.3 Compliance with the Non-Per Capita Conservation Program

A large municipal provider regulated under the NPCCP is in compliance with the program if it implements the agreed-to RCMs and limits its use of groundwater to the amount allowed under the AWS Rules or the amount allowed under the straight-line reduction, whichever is applicable. The Department will use the written agreement for the NPCCP to monitor progress with the program. Each year, along with the Annual Water Withdrawal and Use Report, the municipal provider will be required to submit a progress report describing the implementation of each RCM, the cost of implementing the program, estimated or actual water savings, and a description of any difficulties with the program. Providers regulated under the NPCCP will also be required to comply with individual user, distribution system, and monitoring and reporting requirements contained in this chapter.

5.7.1.3 Alternative Conservation Program

The ACP was developed for the Second Management Plan to give large municipal providers with disproportionately increasing non-residential water use an alternative to the Total GPCD Program. The ACP allows providers with disproportionately increasing non-residential water use the flexibility to serve

those non-residential uses while achieving water use efficiency levels comparable to those set by the Total GPCD Program. The ACP consists of the following requirements that must be met by the provider: (1) a groundwater use limitation, (2) a residential GPCD requirement, and (3) non-residential RCMs.

5.7.1.3.1 Groundwater Use Limitation Requirement

A provider regulated under the ACP must limit its annual groundwater use as follows: (1) If the provider is designated as having an assured water supply, it must limit its annual groundwater use to the amount it can use consistent with the AWS Rules; or (2) If the provider is not designated as having an assured water supply, it must limit its annual groundwater use to its largest legal groundwater use during any one year from 1980 through 1989 if it was serving water on or before January 1, 1990, or to 50 percent of the largest legal groundwater use during any one year from January 1, 1990 through 1999 if it began serving water after January 1, 1990 but before January 1, 2000. A provider can achieve compliance with the groundwater use limitation requirement by permanently extinguishing grandfathered rights within the AMA, or by serving groundwater that will be replenished by a replenishment district, remediated groundwater that is accounted for as surface water under section 5-115 of the municipal conservation requirements, groundwater withdrawn outside of an AMA, or renewable supplies.

5.7.1.3.2 Residential Gallons Per Capita Per Day Requirement

Each provider regulated under the ACP is required to comply with a residential GPCD requirement that is calculated using separate GPCD and GPHUD rates for existing residential, new single family, and new multifamily water users. These rates are derived using the same methodology as that used to calculate the residential portion of the total GPCD requirement. The residential GPCD requirement is recalculated annually based on growth within the service area using the same calculation used for the residential components of the Total GPCD Program (see Appendix 5-K).

5.7.1.3.3 Non-Residential Reasonable Conservation Measures

Providers regulated under the ACP must implement specific conservation measures for non-residential water users. Providers who have already implemented these measures will be required to implement additional conservation measures to qualify for the program. The non-residential requirements for the Third Management Plan have been modified from the Second Management Plan to be identical to the non-residential requirements for the NPCCP. These requirements are as follows:

Standard Non-Residential RCMs

A. Non-Residential Interior

1. Interior Audit Program for Existing Facilities
2. Ordinance Or Condition of New Service Prohibiting Installation Or Replacement of Plumbing Fixtures in Non-Residential Facilities Unless Fixtures Meet Water Saving Standards
3. Distribution of Conservation Information to All New Non-Residential Customers And Submittal of Water Use Plan by New Large Facilities

B. Non-Residential Exterior

1. Exterior Audit Program for Existing Non-Residential Customers
2. Landscape Ordinance Or Condition of New Service for New Facilities

Providers also have the added flexibility of requesting a substitute RCM for the non-residential requirements, which must be approved by the director.

5.7.1.3.4 Compliance with the Alternative Conservation Program

A provider regulated under the ACP is in compliance with the program if it does not exceed its residential GPCD requirement, implements the agreed to non-residential RCMs, and limits its use of groundwater to the amount allowed under the AWS Rules or the amount allowed under the historic use limitation, whichever is applicable. The Department will use the written agreement for the ACP to monitor progress with the program. Each year, along with the Annual Water Withdrawal and Use Report, the municipal provider will be required to submit a progress report describing the implementation of each non-residential RCM, the cost of implementing the program, estimated or actual water savings, and a description of any difficulties with the program. Providers regulated under the ACP will also be required to comply with individual user, distribution system, and monitoring and reporting requirements.

5.7.1.3.4.1 Groundwater Use Limitation

A provider regulated under the ACP is in compliance with the groundwater use limitation requirement of the ACP if no more groundwater is used in the calendar year than is allowed pursuant to the provisions of the program.

5.7.1.3.4.2 Residential Gallons Per Capita Per Day Requirement

Compliance with the residential GPCD requirement will be determined in a manner similar to the manner in which compliance with the total GPCD requirement is determined. A flexibility account will be established for the provider at the time the provider enters the ACP. The maximum positive balance allowed in the account at any time is 45 GPCD, and the maximum negative balance allowed in the account at any time is 15 GPCD.

Following each year in which the provider is regulated under the ACP, the total amount of water allocated to the provider for residential use during the year will be calculated by multiplying the provider's residential GPCD requirement for the year by the provider's service area population for the year, and then multiplying that product by the number of days in the year. That amount will then be compared to the total amount of water from any source, except spillwater and direct use effluent and effluent recovered within the area of impact, delivered by the provider for residential use during the year. If the allocated amount is greater than the amount delivered for residential use during the year, the difference is credited to provider's flexibility account, subject to the maximum positive account balance. If the allocated amount is less than the amount delivered for residential use during the year, the difference is debited to the provider's flexibility account. The provider is out of compliance with its residential GPCD requirement for the year if the debit causes the flexibility account to exceed the maximum negative account balance of 15 GPCD.

5.7.1.3.4.3 Non-Residential Reasonable Conservation Measures

A provider regulated under the ACP is in compliance with the standard non-residential RCMs, or any substitute non-residential RCMs approved by the director, if it implements the agreed-to non-residential RCMs.

5.7.1.4 Institutional Provider Program

The IPP in the Second Management Plan replaced the First Management Plan special provider category and will be continued in the Third Management Plan. The IPP allows those providers with primarily non-residential uses and who are unable to economically utilize non-groundwater sources to be regulated under a program that focuses on the specific institutional water use characteristics of their service area. The IPP is designed for large municipal providers who supply more than 90 percent of their total water deliveries to non-residential water users. Specifically, these non-residential uses may include prisons, hospitals, military

installations, airports, and schools. A large municipal provider may request entrance into this program by submitting an application in writing to the director at any time during the management period. If the request is approved, the provider will be assigned a maximum residential GPCD requirement and specific conservation measures for non-residential uses, and will also be required to comply with individual user, distribution system, and monitoring and reporting requirements. The Department will grant institutional provider designation only if the Total GPCD Program is not appropriate and the provider demonstrates that it cannot qualify for the ACP or NPCCP by limiting its groundwater use, retiring grandfathered groundwater rights, or using alternative sources of water.

5.7.2 Conservation Requirements for Large Untreated Water Providers

A large untreated water provider must limit its deliveries of untreated water during a year to an amount calculated by multiplying the number of gross acres of land to which it serves untreated water by an average annual application rate of 4 acre-feet per acre. A gross acre is the entire area, including associated structures, but not including any acres regulated as a turf-related facility. A large untreated water provider must also meet the individual user requirements, distribution system requirements, and the monitoring and reporting requirements.

5.7.3 Conservation Requirements for New Large Municipal Providers

A new large municipal provider is defined as a city, town, private water company, or irrigation district that begins serving more than 250 acre-feet of non-irrigation water per year after January 1, 2000. All new large municipal providers will initially be assigned to the Total GPCD Program. Their total GPCD requirement will be calculated consistent with the component methodology used for existing large municipal providers.

The Department will determine the base year for the new large municipal provider as the year, or years, preceding the year in which the provider began serving more than 250 acre-feet per year, unless the director determines that water usage during that period is not representative of historic water use. The Department will then collect residential and non-residential water use data for the base year and the total gallons of water withdrawn, diverted, or received by the provider in the service area. Using an analysis of conservation potential for existing residential users, the Department will calculate a GPCD requirement for existing residential users. New residential development will be assigned the interior residential model use rates of 57 GPCD for new single family and multifamily water users, the exterior water use model of 178 GPHUD for new single family, and 77 GPHUD for new multifamily exterior water use. The actual annual amount of non-residential water use will be included in the GPCD requirement, up to 18 GPCD. The annual amount of lost and unaccounted for water will also be included, up to 10 percent of the total water use in each year.

A new large provider may apply for an administrative review requesting a temporary adjustment to its total GPCD requirement in order to serve a turf-related facility. A temporary adjustment will be allowed if the provider demonstrates that direct use effluent or effluent recovered within the area of impact is committed to serve the turf-related facility beginning in four years, but a longer period is necessary for sufficient effluent to be produced to serve the entire facility. The adjustment will remain in effect only until sufficient direct use effluent or effluent recovered within the area of impact is available to serve the entire facility, not to exceed eight years, and may be adjusted as the volume of effluent use increases. The adjustment will be terminated if the infrastructure necessary to deliver the effluent is not in place at the beginning of the fourth year after the provider commences service to the facility. A permanent adjustment will not be granted to a new large municipal provider. If a new large municipal provider cannot serve a turf-related facility under its existing per capita requirement and direct use effluent or effluent recovered within the area of impact will not be physically available to serve the facility within a reasonable period of

time, the provider may enroll in the Non-Per Capita Conservation Program or the Alternative Conservation Program, if it wishes to serve the facility.

Each new large municipal provider will be notified of its total GPCD requirement and will be given two full years to comply with the requirement. A new large municipal provider may apply for the NPCCP or the ACP in accordance with the provisions of these programs and is subject to the individual user, distribution system, and monitoring and reporting requirements contained in this chapter.

5.7.4 Conservation Requirements for Consolidated Municipal Providers and Providers that Acquire or Convey a Portion of a Service Area

If two or more municipal providers consolidate their service areas or if a large municipal provider acquires a portion of another provider's service area, the consolidated provider, acquiring provider, or conveying provider will receive a recalculated or revised conservation requirement. A consolidated provider that qualifies as a large municipal provider will be assigned to the Total GPCD Program and its GPCD components will be calculated by prorating the respective per capita component targets, populations, and water use as appropriate. A consolidated provider may apply for the NPCCP or the ACP. If one of the consolidated providers was regulated under one of these programs prior to the consolidation, the consolidated provider's application for the program must include only the information that has changed since the provider originally filed the application for the program. Providers that acquire or convey a portion of a service area continue to be regulated under the conservation program they were under prior to the acquisition or conveyance. However, if they were regulated under either the NPCCP or the ACP, they must reapply for regulation under that program within 180 days after the acquisition or conveyance and must submit only the information that has changed since the original application was filed.

5.7.5 Conservation Requirements for Small Municipal Providers

During the third management period, small municipal providers will be required to minimize waste of all water supplies, maximize efficiency in outdoor watering, encourage reuse of water supplies, and reduce total gallons per capita per day usage.

5.7.6 Regulatory Requirements for All Municipal Providers

The following requirements have been established for all municipal providers: individual user requirements, distribution system requirements, and monitoring and reporting requirements. Each is described in this section.

5.7.6.1 Individual User Requirements

An individual user is a person who receives water from a municipal provider. For the Third Management Plan, the director is required to establish "such other conservation measures as may be appropriate for individual users." A.R.S. § 45-566 (A)(2). In the Second Management Plan, individual user requirements were established for turf-related facilities, publicly owned rights-of-way, and large cooling towers. These requirements have been retained for the Third Management Plan with some modifications.

Turf-related facilities are subject to an allotment-based conservation requirement. Landscaping planted after December 31, 1986 in publicly owned rights-of-way and watered with groundwater may be planted only with plants from the Low Water Use/Drought Tolerant Plant List (Appendix 5-L). The cooling tower requirements have been modified from the Second Management Plan requirements, which applied only to towers built after January 1, 1990 with a total capacity exceeding 250 tons. The Third Management Plan regulates both new and existing large-scale cooling facilities with a total capacity of 1000 tons or more.

In addition to these individual user requirements, the Third Management Plan contains an individual user requirement that was not included in the Second Management Plan. This additional requirement prohibits the use of groundwater to maintain a water feature installed in a publicly owned right-of-way after January 1, 2002.

Either the individual user or the municipal provider serving the individual user is responsible for complying with the individual user requirement. See section 5-112 for determining responsibility for compliance with the individual user requirements.

5.7.6.2 Distribution System Requirements

Lost and unaccounted for water is defined as the total water from any source, except direct use effluent, withdrawn, diverted, or received in a year minus the total amount of authorized deliveries made by the municipal provider in that year. Lost and unaccounted for water includes line leakage, meter under-registration, evaporation or leakage from storage ponds or tanks, system and hydrant leaks or breaks, and illegal connections.

All municipal providers are required to meet an efficient lost and unaccounted for water standard in their service areas. Lost and unaccounted for water will be determined for each municipal provider based on the total quantity of metered and unmetered water deliveries and the total water pumped, received, or diverted by the municipal provider for each calendar year, excluding direct use effluent. Small municipal providers must maintain lost and unaccounted for water at or below 15 percent. Large municipal providers are required to maintain their system not to exceed 10 percent lost and unaccounted for water. Large untreated water providers are required to either line all canals used to deliver untreated water to the provider's delivery points with a material that allows no more lost water than a well-maintained concrete lining, or operate and maintain its distribution system to limit lost and unaccounted for water at or below 10 percent.

For the third management period, the Department will allow providers to exclude water from the lost and unaccounted for water calculation that is either metered or estimated using approved estimating procedures and that is used pursuant to other regulatory requirements such as well purging and line flushing. Providers may also exclude estimated water uses such as construction (truck loads for dust control) or fire services, but all other uses of water within a distribution system must be metered. Appendix 5-M provides a complete list of uses that are considered in the lost and unaccounted for water calculation and those uses that can be estimated to determine the volume.

5.7.6.3 Monitoring and Reporting Requirements

All municipal providers are required to annually: (1) report to the Department information on the total quantity of water used within the service area and the total volume of water delivered for various municipal purposes, (2) calculate the volume of lost and unaccounted for water within the service area, and (3) report the total number of housing units, by unit type, added to the water service area from July 1 of the previous calendar year to July 1 of the reporting year.

Large municipal providers are required to separately measure and report the amount of water delivered each month for: irrigation uses; residential uses, separated by single family and multifamily; and non-residential uses, separated by water use categories, including turf-related facility use, commercial use, industrial use, government use, construction use, surface water treatment, and other uses.

All municipal providers are required to submit to the Department, on an annual basis, an updated service area and distribution system map delineating all potable and non-potable distribution lines greater than four inches, all potable treatment facilities, all well sites, and all non-potable treatment.

Large municipal providers regulated under the NPCCP or the ACP are required to submit a progress report that includes an evaluation of the reasonable conservation measures in accordance with their written stipulated agreement.

5.8 INCENTIVES FOR THE USE OF RENEWABLE SUPPLIES AND REMEDIATED GROUNDWATER

Incentives have been developed to increase the use of non-groundwater supplies. For instance, effluent (directly used or stored underground and recovered from within the area of impact) and spill water are not counted in the annual per capita use rate for municipal providers regulated under the Total GPCD Program or the ACP.

Providers who have committed to serve effluent, but have not yet fully developed the resource, can enter into an agreement with the Department to exclude from their total GPCD usage rate CAP deliveries to non-residential facilities that have committed to use effluent when it becomes available. In order to qualify for this exclusion, the facility must commit to fully utilize the effluent within a 10-year period.

In 1997, the Legislature enacted legislation significantly revising the Water Quality Assurance Revolving Fund (WQARF) program to provide incentives for the use of remediated groundwater to facilitate the treatment of contaminated groundwater. Among other things, the WQARF legislation provides that when determining compliance with management plan conservation requirements, the Department shall account for groundwater withdrawn pursuant to approved remedial action projects under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or Title 49, Arizona Revised Statutes, consistent with the accounting for surface water. Laws 1997, Ch. 287, § 51(B). See Chapter 7, section 7.4.4.6.3. Groundwater withdrawn pursuant to an approved remedial action project retains its legal character as groundwater for all other purposes under Title 45, Arizona Revised Statutes, including all other laws regulating groundwater withdrawal and use such as the assessment of withdrawal fees pursuant to A.R.S. § 45-611, *et seq.*, as well as laws regulating water exchanges as set forth in A.R.S. § 45-1001, *et seq.*, the transportation of groundwater as set forth in A.R.S. § 45-541, *et seq.*, withdrawals of groundwater for transportation to active management areas as set forth in A.R.S. § 45-551, *et seq.*, and underground water storage, savings, and replenishment as set forth in Title 45, Chapter 3.1, Arizona Revised Statutes.

For each approved remedial action project, the annual amount of groundwater that is eligible for the remediated groundwater accounting incentive is the maximum annual volume of groundwater that may be withdrawn pursuant to the project, as specified in the consent decree or other document approved by the EPA or ADEQ. However, if the project was approved prior to June 15, 1999 and the maximum annual volume of groundwater that may be withdrawn pursuant to the project is not specified in a consent decree or other document approved by the EPA or ADEQ, the annual amount of groundwater that is eligible for the remediated groundwater accounting incentive is the highest annual use of groundwater withdrawn pursuant to the project prior to January 1, 1999. The director may modify the annual amount of groundwater that is eligible for the accounting incentive if an increase in withdrawals is necessary to further the purpose of the project or if a change is made to the consent decree or other document approved by the EPA or ADEQ.

In order to qualify for the remediated groundwater accounting incentive, a person must notify the director in writing of the anticipated withdrawal of the groundwater prior to its withdrawal. The notification must include a copy of a document approved by ADEQ or the EPA such as the Remedial Action Plan (RAP), Record of Decision (ROD) or consent decree. Unless specified in the document, the notification must include the volume of groundwater that will be pumped annually pursuant to the project, the time period to which the document applies, and the annual authorized volume of groundwater that may be withdrawn pursuant to the project. The notification must also include the purpose for which the remediated groundwater will be used and the name and telephone number of a contact person. Additionally, at the

time the notice is given, the person must be using remediated groundwater pursuant to the approved remedial action or must have agreed to do so through a consent decree or other document approved by ADEQ or the EPA. Remediated groundwater that qualifies for the accounting must be metered and reported separately from groundwater that does not qualify for the accounting. (See section 5-115 of the Municipal Conservation Requirements).

5.9 NON-REGULATORY EFFORTS

In 1991, the Department initiated a grants program for conservation assistance in the AMAs. Individual AMA programs focus on the areas of highest water conservation potential in each water use sector (municipal, industrial, and agricultural) based on total water usage, current water usage practices, and potential for implementation of new conservation technologies. Funding for the grants program comes from an annual withdrawal fee levied and collected from all persons withdrawing groundwater in the AMAs. Since the grant program began, the Phoenix AMA has funded 33 municipally related conservation assistance grants for a total of $995,173.

For the Third Management Plan, funding efforts for the municipal sector may be focused on developing methodologies to more accurately analyze water savings associated with various conservation measures and determining the water use patterns of end users. Studies have been developed and are currently being conducted in these areas. Future funds may be used to further analyze these studies and evaluate the need for additional examination and analysis.

For the development of the Third Management Plan, the Phoenix AMA formed the Municipal Technical Advisory Committee to aid in evaluating the Second Management Plan requirements and to assist in the development of regulations for the third management period. During the third management period, the Phoenix AMA will continue to utilize this group, made up of representatives from the regulated and non-regulated community, on an ongoing basis. Actions may include evaluation of the Third Management Plan municipal programs, especially the NPCCP requirements, and to serve as a clearinghouse for new conservation technologies and data acquisition. This committee may consist of city, town, and private water company representatives, as well as other water management professionals who have the expertise to assist the AMA in implementing municipal conservation programs.

5.10 SUMMARY AND CONCLUSIONS

The Third Management Plan Municipal Program includes conservation requirements for large municipal providers, large untreated water providers, and small municipal providers. Large municipal providers are noticed of conservation requirement components for existing residential water use, new residential water use, non-residential water use, and lost and unaccounted for water use for the third management period. The components are used to calculate a total GPCD requirement for each calendar year based on growth within the large municipal provider's water service area. Large municipal providers may also apply for the ACP or the NPCCP. Both of these alternative programs require a limitation or reduction in the provider's use of groundwater in order to qualify. Large untreated providers will continue to be regulated under an acre-foot per gross acre basis. Small municipal providers are only required to reduce waste and improve water use efficiency within their water service areas during the third management period.

All municipal providers must comply with individual user, monitoring and reporting, and distribution system requirements. Information on water use, growth, and system losses, for example, must be reported to the Department on an annual basis.

5.11 FUTURE DIRECTIONS

The municipal sector in the Phoenix AMA, as a whole, has been on the forefront of reducing reliance on groundwater supplies since the Code went into effect in 1980. Achieving the Phoenix AMA goal of safe-yield will ensure that adequate water supplies exist for future water users. The utilization of renewable supplies in lieu of groundwater mining, combined with the implementation of effective conservation measures, is the management approach that will continue to be used by the Department to reach the safe-yield goal by 2025 or earlier. The Department recognizes the significant contribution the municipal sector has made to the achievement of the management goal for the Phoenix AMA. However, it is also recognized that, due to the significant growth potential in this sector through 2025 and beyond, this sector will ultimately be responsible for the majority of the demand and the ultimate benefactors of the conservation of groundwater supplies in the future. Thus, in order to ensure that adequate water supplies are available for this sector in the future, the Department will continue to rely heavily on this sector to achieve safe-yield. Through a combination of the AWS Rules and the Municipal Conservation Program, the municipal sector will be required to use all supplies efficiently through the programs developed in this and subsequent management plans to support the anticipated growth in this area.

The remaining issues that need to be addressed in the municipal sector during the third management period include providing a mechanism for private water companies and smaller municipalities to share the responsibility of developing the distribution and treatment facilities necessary to directly utilize renewable supplies. The Department will look at ways to encourage regional solutions and will provide technical assistance to accelerate the direct use of renewable supplies in these areas. Additionally, designing a conservation program approach for private water companies that meets with the standards exercised by the ACC yet also addresses the legislative requirement of the Department to achieve safe-yield is another very important issue that needs to be resolved in the third management period. Through discussions with the ACC, the Department will work closely to be involved in the development of ACC policies related to water conservation and supply acquisition. The Department will also work to develop an understanding with the ACC on the ability of private water companies to implement alternative programs and be given more assurance for the pass-through of costs associated with the required programs established by the Department.

Increasing the utilization of renewable supplies across the municipal sector, for both municipalities and private water companies, has been partially addressed through the implementation of the AWS Rules, resulting in a limitation of the amount of groundwater available for future growth. However, certain existing water users within the municipal sector have no requirements for the utilization of non-groundwater supplies. Comments have been made that the Department needs to develop additional incentives to encourage these users to accept and finance the more expensive renewable supplies. An analysis of the availability of renewable supplies for current and projected populations needs to be made to assess the likelihood of developing renewable supplies outside of the assured water supply requirements. Continued evaluations through groundwater modeling of the impact of continued pumping outside of areas that have been designated as having an assured water supply must also be conducted. A reevaluation of the "grandfathering in" and the responsibility of existing water users to remedy the continued overdraft has been identified as an area that needs new attention. The short-term and long-term impacts of additional incentives for renewable supplies should also be evaluated, especially with the tremendous growth potential and the need to identify efficient uses.

Addressing the relationship of the Assured Water Supply Program (AWS Program) and the management plan provisions is another area that the Department needs to accomplish. The inability to require new subdivisions outside the boundaries of a designated water service area to implement water conserving approaches and comply with the consistency with management plan criteria in the design and building of the subdivision needs to be addressed. Further, it is necessary to identify the role of conservation as a

water supply in the AWS Program to strengthen the Department's assertion of efficient use of all water supplies to ensure a viable water supply into the future.

The Department and the regulated community have both realized that information regarding the water savings and cost/benefit of existing conservation programs and practices is not as readily available or even easily identifiable to produce a comprehensive evaluation of the successes or deficiencies in water conservation in the Phoenix AMA. In cooperation with the regulated community, the Department will work throughout the third management period to improve data collection and analyses of conservation measures and practices. The Department will continue to collect information on the best available technologies for residential and non-residential water use. Based on this information, the Department will evaluate its current Municipal Conservation Program approach to determine if alternatives can or should be developed to effectively evaluate the impacts of the municipal program. Additionally, it is the intent of the Department to continue to quantify reasonable goals for future reductions in municipal water use.

Finally, the Department will focus on developing water management strategies to address localized water conditions affecting the ability of municipal water providers to develop and maintain adequate water supplies in the Phoenix AMA. The development of critical area management will be a major focus of the Department during the third management period. The strategy for critical area management could include promoting water withdrawals from areas that are benefiting from natural and artificial recharge rather than from areas experiencing severe water level declines. Additional management strategies could include the development of incentives for recharge and direct use of renewable water supplies in these areas or disincentives for excessive withdrawals.

5.12 MUNICIPAL CONSERVATION REQUIREMENTS AND MONITORING AND REPORTING REQUIREMENTS

5-101. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, unless the context otherwise requires, the following words and phrases used in this chapter shall have the following meanings:

1. *"Canal" means a waterway constructed for the purpose of transporting water to a point of delivery, including main canals and lateral canals.*

2. *"CAP water" means central Arizona project water.*

3. *"Common area" means a recreational or open space area or areas owned and operated as a single integrated facility and maintained for the benefit of the residents of a housing development.*

4. *"Construction use" means a use of water for construction purposes, including the use of water for dust control, compaction and preparation of building materials on construction sites.*

5. *"Direct use effluent" means effluent that is transported directly from a facility regulated pursuant to Title 49, Chapter 2, Arizona Revised Statutes, to an end user. Direct use effluent does not include effluent that has been stored pursuant to Title 45, Chapter 3.1, Arizona Revised Statutes.*

6. *"Effluent recovered within the area of impact" means effluent that has been stored pursuant to Title 45, Chapter 3.1, Arizona Revised Statutes, and recovered within the stored effluent's area of impact prior to use. For the purpose of this definition, "area of impact" has the same meaning as prescribed by A.R.S. § 45-802.01.*

7. *"Excluded CAP water" means CAP water that is excluded from a municipal provider's total GPCD requirement pursuant to section 5-103, subsection E.*

8. *"Existing individual user" means an individual user that was receiving water from a municipal provider as of the date the Third Management Plan was adopted.*

9. *"Existing large municipal provider" means a large municipal provider that was in operation and was serving water on or before January 1, 2000.*

10. *"Existing non-residential customer" means, with respect to a large municipal provider regulated under the Non-Per Capita Conservation Program described in section 5-104 or the Alternative Conservation Program described in section 5-105, a non-residential customer to whom the provider served water on the date the provider was accepted for regulation under the program.*

11. *"Existing residential customer" means, with respect to a large municipal provider regulated under the Non-Per Capita Conservation Program described in section 5-104, residential customer to whom the provider served water on the date the provider was accepted for regulation under the program.*

12. *"Existing residential housing units" means housing units that first began using water prior to July 1, 2000.*

13. *"Existing residential population" means the portion of the service area population of a municipal provider that resides in existing residential housing units.*

14. *"Exterior water use" means non-residential or residential uses of water for landscaping, pools, evaporative cooling systems, decorative fountains and other outdoor uses of water.*

15. *"Extinguish" means, for the Alternative Conservation Program's groundwater use limitation requirement, to cause a grandfathered groundwater right to cease to exist through a formal process established by the director.*

16. *"GPCD" means gallons of water per capita per day.*

17. *"GPHUD" means gallons of water per housing unit per day.*

18. *"Housing unit" means a group of rooms or a single room occupied as separate living quarters. Housing unit includes a single family home, a patio home, a townhouse, a condominium, an apartment, a permanently set-up mobile home or a unit in a multifamily complex. Housing unit does not include a mobile home in an overnight or limited-stay mobile home park or a unit in a campground, motel, hotel or other temporary lodging facility. A housing unit may be occupied by a family, a family and unrelated persons living together, two or more unrelated persons living together, or by one person.*

19. *"Incidental recharge" and "incidental recharge factor" have the definitions prescribed by A.R.S. § 45-561.*

20. *"Individual user" means a person receiving water from a municipal provider for non-irrigation uses to which specific conservation requirements apply, including turf-related facilities, large-scale cooling facilities, and publicly-owned rights-of-way.*

21. *"Interior water use" means non-residential or residential indoor uses of water, including toilet flushing, bathing, drinking, and washing.*

22. *"Landscapable area" means the entire area of a lot less any areas covered by structures, parking lots, roads and any other area not physically capable of being landscaped.*

23. *"Large municipal provider" means a municipal provider serving more than 250 acre-feet of water for non-irrigation use during a calendar year, not including untreated water served by a municipal provider that qualifies as a large untreated water provider.*

24. *"Large-scale cooling facility" means a facility that has control over cooling operations with a total combined cooling capacity greater than or equal to 1,000 tons. For the purposes of this definition, the minimum cooling tower size that shall be used to determine total facility cooling capacity is 250 tons. A large-scale cooling facility does not include a large-scale power plant that utilizes cooling towers to dissipate heat.*

25. *"Large untreated water provider" means a municipal provider that as of January 1, 1990 was serving untreated water to at least 500 persons or supplying at least 100 acre-feet of untreated water during the calendar year. In addition, a municipal provider that entered into a written agreement between December 15, 1989 and September 21, 1991 to serve*

untreated water to a user, and that provided a copy of that agreement to the director by June 22, 1992, is a large untreated water provider upon serving untreated water to at least 500 persons pursuant to the service agreement or upon supplying 100 acre-feet of untreated water during a calendar year pursuant to the agreement.

26. *"Lost and unaccounted for water" means:*

    a. *With respect to a distribution system other than an untreated water municipal distribution system, the total quantity of water from any source, except direct use effluent, withdrawn, diverted or received by a municipal provider during a calendar year for non-irrigation use less the total quantity of authorized deliveries of water from any source, except direct use effluent, made by the municipal provider during the calendar year for non-irrigation use that are metered deliveries or deliveries that the municipal provider accounts for by a method of estimating water use approved by the director.*

    b. *With respect to an untreated water municipal distribution system, the total quantity of untreated water from any source, withdrawn, diverted or received by a large untreated water provider during a calendar year for non-irrigation use less the total quantity of authorized deliveries of untreated water from any source made by the provider during the calendar year for non-irrigation use that are metered deliveries or deliveries that the provider accounts for by a method of estimating water use approved by the director.*

27. *"Lost water" means untreated water from any source that enters an untreated water distribution system and is lost from the system during transportation or distribution due to seepage, evaporation, leaks, breaks, phreatophyte use or other similar or dissimilar causes.*

28. *"Mined groundwater" has the definition prescribed by A.R.S. § 45-561(9).*

29. *"Multifamily housing unit" means a mobile home in a mobile home park and any permanent housing unit having one or more common walls with another housing unit located in a multifamily residential structure, and includes a unit in a duplex, triplex, fourplex, condominium development, town home development, or apartment complex.*

30. *"Municipal distribution system" means a system of pipes, canals or other works within a municipal provider's service area that are owned and operated by the provider to collect, store, treat or deliver water for non-irrigation use.*

31. *"Municipal provider" means a city, town, private water company or irrigation district that supplies water for non-irrigation use.*

32. *"New individual user" means an individual user that begins receiving water from a municipal provider after adoption of the Third Management Plan.*

33. *"New large municipal provider" means a municipal provider that begins serving more than 250 acre-feet of water for non-irrigation use during a calendar year after January 1, 2000, not including untreated water served by a municipal provider that qualifies as a large untreated water provider.*

34. *"New multifamily housing units" means multifamily housing units that first begin using water on or after July 1, 2000.*

35. *"New multifamily population" means the portion of the service area population of a municipal provider that resides in new multifamily housing units.*

36. *"New non-residential customer" means, with respect to a large municipal provider regulated under the Non-Per Capita Conservation Program described in section 5-104 or the Alternative Conservation Program described in section 5-105, a non-residential customer that begins receiving water from the provider after the provider is accepted for regulation under the program.*

37. *"New residential customer" means, with respect to a large municipal provider regulated under the Non-Per Capita Conservation Program described in section 5-104, a residential customer that begins receiving water from the provider after the provider is accepted for regulation under the program.*

38. *"New single family housing units" means single family housing units that first begin using water on or after July 1, 2000.*

39. *"New single family population" means the portion of the service area population of a municipal provider that resides in new single family housing units.*

40. *"Non-residential customer" means a person who is supplied water by a municipal provider for a non-irrigation use other than a residential use.*

41. *"Non-residential exterior water use" means, with respect to a large municipal provider regulated under the Non-Per Capita Conservation Program described in section 5-104 or the Alternative Conservation Program described in section 5-105, water supplied by the provider and used for exterior water use purposes by non-residential customers, other than individual users, within the provider's service area.*

42. *"Non-residential interior water use" means, with respect to a large municipal provider regulated under the Non-Per Capita Conservation Program described in section 5-104 or the Alternative Conservation Program described in section 5-105, water supplied by the provider and used for interior water use purposes by non-residential customers, other than individual users, within the provider's service area.*

43. *"Reasonable Conservation Measures" or "RCMs" means policies, practices, rules, regulations, ordinances, or the use of devices, equipment or facilities, that meet either of the following criteria:*

    a. *An established and generally accepted practice among water providers that results in efficient use or conservation of water, or*

    b. *A practice for which sufficient data are available from existing water conservation projects to indicate that significant water conservation or conservation related benefits can be achieved; that the practice is technically and economically reasonable and not environmentally or socially unacceptable; and that the practice is not otherwise unreasonable for most water providers to implement.*

44. *"Residential customer" means a person who is supplied water by a municipal provider for a residential use.*

45. *"Residential exterior water use" means, with respect to a large municipal provider regulated under the Non-Per Capita Conservation Program described in section 5-104, water supplied by the provider and used for exterior water use purposes by residential customers within the provider's service area.*

46. *"Residential interior water use" means, with respect to a large municipal provider regulated under the Non-Per Capita Conservation Program described in section 5-104, water supplied by the provider and used for interior water use purposes by residential customers within the provider's service area.*

47. *"Residential use" means a non-irrigation use of water related to the activities of a single family or multifamily housing unit or units, including exterior water use.*

48. *"Service area" has the definition prescribed by A.R.S. § 45-402.*

49. *"Service area population" means the number of people residing in housing units connected to distribution lines maintained by the municipal provider within its service area that are being served as of July 1 of the applicable year, as determined pursuant to section 5-103, subsection D.*

50. *"Service connection" means a coupling of a municipal provider's distribution system and its customer's water system.*

51. *"Single family housing unit" means a detached dwelling, including mobile homes not in mobile home parks.*

52. *"Small municipal provider" means a municipal provider that supplies 250 acre-feet or less of water for non-irrigation use during a calendar year, not including untreated water served by a municipal provider that qualifies as a large untreated water provider.*

53. *"Spillwater" means water, other than Colorado River water, released for beneficial use from storage, diversion, or distribution facilities to avoid spilling that would otherwise occur due to uncontrolled surface water inflows that exceed facility capacity.*

54. *"Turf-related facility" means any facility including 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 include those facilities listed in Appendix 6B.*

55. *"Untreated water" means water that is not treated to improve its quality and that is supplied by a municipal provider through a distribution system other than a potable water distribution system.*

56. *"Untreated water municipal distribution system" means a municipal distribution system operated by a large untreated water provider for the purpose of delivering untreated water for non-irrigation use.*

57. *"Water-intensive landscaped area" means, for a calendar year, an area of land that is watered with a permanent water application system and planted primarily with plants not*

listed in Appendix 5-L, (Low Water Use/Drought Tolerant Plant List or modifications to the list) and the total surface area of all bodies of water filled or refilled with water from any source, including effluent, that are an integral part of the landscaped area. Bodies of water used primarily for swimming purposes are not an integral part of a landscaped area.

5-102. Large Municipal Providers - Conservation Programs

A. *Beginning with the calendar year determined under section 5-103, subsection A, paragraph 2, and continuing until the first compliance date for any substitute requirement in the Fourth Management Plan, a large municipal provider shall be regulated under the Total Gallons Per Capita Per Day (GPCD) Program described in section 5-103, unless the provider has applied for and been accepted for regulation under the Non-Per Capita Conservation Program described in section 5-104 or the Alternative Conservation Program described in section 5-105, or is designated as an institutional provider under section 5-108.*

If a large municipal provider is accepted into the Non-Per Capita Conservation Program, the Alternative Conservation Program, or is designated as an institutional provider, the provider shall continue to comply with its total GPCD requirement until the first compliance date assigned by the director for the provider under the Alternative Conservation Program, the Non-Per Capita Conservation Program, or the Institutional Provider Program.

A large municipal provider that was regulated under the Non-Per Capita Conservation Program, the Alternative Conservation Program or the Institutional Provider Program under the Second Management Plan and that applies to be regulated under the same program in the Third Management Plan 180 days following adoption of the plan shall continue to be regulated under the Non-Per Capita Conservation Program, the Alternative Conservation Program or the Institutional Provider Program under the Second Management Plan, whichever applies, until January 1, 2002 or until the director approves or denies the provider's application under the Third Management Plan, whichever is later.

B. *A large municipal provider may apply for the Non-Per Capita Conservation Program as described in section 5-104. If the director approves the application, the provider shall comply with the requirements of the Non-Per Capita Conservation Program beginning on a date determined by the director but not later than January 1 of the year following the year in which the application is approved.*

C. *A large municipal provider may apply for the Alternative Conservation Program as described in section 5-105. If the director approves the application, the provider shall comply with the requirements of the Alternative Conservation Program beginning on a date determined by the director but not later than January 1 of the year following the year in which the application is approved.*

D. *A large municipal provider may apply for designation as an institutional provider pursuant to section 5-108. If the director approves the application, the provider shall comply with the institutional provider requirements assigned by the director beginning on a date determined by the director but not later than January 1 of the year following the year in which the application is approved.*

E. *A large untreated water provider shall comply with the requirements of section 5-107.*

F. All municipal providers shall comply with individual user requirements, distribution system requirements, and applicable monitoring and reporting requirements as prescribed in sections 5-112, 5-113, and 5-114.

5-103. Large Municipal Provider Total Gallons Per Capita Per Day Program

A. Total GPCD Requirement

1. Beginning with the calendar year determined under paragraph 2 of this subsection, and for each calendar year thereafter until the first compliance date for any substitute municipal conservation requirement in the Fourth Management Plan, a large municipal provider regulated under the total GPCD program shall not withdraw, divert or receive water from any source, except spillwater, direct use effluent, effluent recovered within the area of impact, and excluded CAP water, for non-irrigation use during a year in a total amount that exceeds its total GPCD requirement for the year as calculated in subsection B of this section, except as provided in the flexibility account provisions in section 5-106.

2. A large municipal provider regulated under the Total GPCD Program shall begin complying with its total GPCD requirements as calculated under subsection B of this section beginning with calendar year 2000, except that if the provider's total GPCD requirement for the year 2000 as calculated under subsection B of this section is lower than the provider's final total GPCD requirement under the Second Management Plan, the provider shall begin complying with its total GPCD requirements as calculated under subsection B of this section beginning with calendar year 2002.

B. Calculation of the Annual Total GPCD Requirement

A large municipal provider's total GPCD requirement for a year shall be calculated as follows:

1. For calendar years 2000 through 2004, multiply the provider's existing residential population for the year, as calculated pursuant to subsection D of this section, by the first intermediate GPCD component for existing residential population as assigned to the provider in Table 5-103.A.

For calendar years 2005 through 2009, multiply the provider's existing residential population for the year, as calculated pursuant to subsection D of this section, by the second intermediate GPCD component for existing residential population as assigned to the provider in Table 5-103.A.

For the calendar year 2010, and for each calendar year thereafter until the first compliance date for any substitute total GPCD requirement in the Fourth Management Plan, multiply the provider's existing residential population for the year, as calculated pursuant to subsection D of this section, by the final GPCD component for existing residential population as assigned to the provider in Table 5-103.A.

2. Multiply the provider's new single family population for the year, as calculated pursuant to subsection D of this section, by 57 GPCD.

3. Multiply the number of new single family housing units within the provider's service area as of July 1 of the calendar year in question by 178 GPHUD.

4. *Multiply the provider's new multifamily population for the year, as calculated pursuant to subsection D of this section, by 57 GPCD.*

5. *Multiply the number of new multifamily housing units within the provider's service area as of July 1 of the calendar year in question by 77 GPHUD.*

6. *Multiply the provider's total service area population for the year, as calculated pursuant to subsection D of this section, by the GPCD component for non-residential use as assigned to the provider in Table 5-103.A.*

7. *Divide the provider's allowable lost and unaccounted for water by the number of days in the calendar year. The provider's allowable lost and unaccounted for water is the lesser of the following:*

   a. *the provider's actual lost and unaccounted for water for the year, in gallons.*

   b. *an amount calculated by multiplying the total gallons of water from any source, except direct use effluent, withdrawn, diverted or received by the provider during the year by 10 percent.*

8. *Add the results from paragraphs 1 through 7 of this subsection, and then divide the sum by the provider's annual service area population as of July 1 of that year. The quotient is the provider's total GPCD requirement for the calendar year.*

C. Compliance with Total GPCD Requirement

The director shall determine if a large municipal provider is in compliance with its total GPCD requirement for a calendar year pursuant to the flexibility account provisions in section 5-106, using the provider's service area population as calculated in subsection D of this section.

D. Calculation of Large Municipal Provider's Service Area Population

The director shall calculate a large municipal provider's service area population for a calendar year as follows, unless the director has approved an alternative methodology for calculating the provider's service area population prior to the calendar year in question:

1. *Determine the number of existing single family housing units and existing multifamily housing units served by the provider's distribution system as of July 1, 2000, less any existing single family housing units and any existing multifamily housing units removed from the provider's distribution system between July 1, 2000 and June 30 of the calendar year in question.*

2. *Adjust these totals by the respective average annual vacancy rate for single family housing units and multifamily housing units as calculated from the most recent census or other approved source of information.*

3. *Multiply the adjusted number of existing single family housing units calculated in paragraph 2 of this paragraph by the average number of persons per occupied single family housing unit as calculated in accordance with the most recent census or other approved source of information.*

TABLE 5-103.A
GPCD COMPONENT REQUIREMENTS
FOR EXISTING RESIDENTIAL AND NON-RESIDENTIAL
PHOENIX ACTIVE MANAGEMENT AREA

Provider	Existing Residential			Non-Residential
	TMP 1	TMP 2	TMP Final	
Adaman Mutual Water Company	108	107	105	30
AJ Water Facilities District	100	100	100	62
City of Avondale	118	109	100	36
AWC - Apache Junction	100	100	100	34
AWC - Superior	100	100	100	18
AWC - White Tanks	136	123	111	18
Berneil Water Company	421	407	392	18
Town of Buckeye	100	100	100	47
Carefree Water Company	205	198	191	341
Cave Creek Water Company	111	109	107	45
City of Chandler	127	123	119	66
Chaparral City Water Company	140	136	133	119
Citizens Utilities - Agua Fria	105	103	100	19
Citizens Utilities - Sun City	192	184	176	50
Citizens Utilities - Sun City West	160	157	155	26
Desert Hills Water Company	102	101	100	18
City of El Mirage	113	107	100	39
Town of Gilbert	138	135	131	53
City of Glendale	124	121	118	52
City of Goodyear	136	118	100	117
H2O Water Company	100	100	100	18
Litchfield Park Service Company	178	172	165	124
Luke Air Force Base	100	100	100	184
City of Mesa	130	116	103	51
Paradise Valley Water Company	436	421	406	240
City of Peoria	130	116	102	45

TABLE 5-103.A
GPCD COMPONENT REQUIREMENTS
FOR EXISTING RESIDENTIAL AND NON-RESIDENTIAL
PHOENIX ACTIVE MANAGEMENT AREA

Provider	Existing Residential			Non-Residential
	TMP 1	TMP 2	TMP Final	
City of Phoenix	135	129	123	66
Pima Utilities	133	127	122	287
Queen Creek Water Company	194	175	156	30
Rio Verde Utilities	141	139	137	855
Rose Valley Water Company	172	166	160	18
City of Scottsdale	171	166	162	71
Sunrise Water Company	133	129	124	18
City of Tempe	128	124	121	113
City of Tolleson	123	120	117	35
Valley Utilities	116	108	100	18
Williams Air Park	101	101	100	308

4. *Multiply the adjusted number of existing multifamily housing units calculated in paragraph 2 of this subsection by the average number of persons per occupied multi-family housing unit as calculated in accordance with the most recent census or other approved source of information.*

5. *Add the products from paragraphs 3 and 4 of this subsection. The sum is the provider's existing residential population.*

6. *Determine the number of new single family housing units and new multifamily housing units added to the provider's distribution system between July 1 of the previous calendar year and July 1 of the calendar year in question, less any new single family and new multifamily housing units removed from the system during that period.*

7. *Adjust these totals by the respective average annual vacancy rate for single family housing units and multifamily housing units as calculated from the most recent census or other approved source of information.*

8. *Multiply the adjusted number of new single family housing units calculated in paragraph 7 of this subsection by the average number of persons per occupied single family housing unit as calculated in accordance with the most recent census or other approved source of information.*

9. *Multiply the adjusted number of new multifamily housing units calculated in paragraph 7 of this subsection by the average number of persons per occupied multifamily housing*

unit as calculated in accordance with the most recent census or other approved source of information.

10. *Add the product from paragraph 8 of this subsection to the provider's new single family population as of July 1 of the previous year and add the product from paragraph 9 of this subsection to the provider's new multifamily population as of July 1 of the previous year. The sums are the provider's new single family population and new multifamily population.*

11. *Add the results from paragraphs 5 and 10 of this subsection. The sum is the provider's service area population for the calendar year.*

E. Exclusion of Deliveries of Central Arizona Project Water from Total GPCD Requirement

1. *Exclusion*

A large municipal provider may apply to the director to have CAP water delivered by the provider to a non-residential customer excluded from the provider's total water use when determining the provider's compliance with its total GPCD requirement as established pursuant to subsection B of this section. The director shall grant a one time exclusion for a period not to exceed ten years if the director finds that all of the following apply:

a. *The provider will ultimately serve direct use effluent to the non-residential customer from a wastewater treatment plant that is either in existence or planned for construction; the provider will begin replacing the deliveries of CAP water with direct use effluent as soon as direct use effluent becomes available for delivery to the non-residential customer from the treatment facility; and the provider will completely replace the deliveries of CAP water with direct use effluent within a reasonable period of time, not to exceed ten years.*

b. *The CAP water that the provider will deliver to the non-residential customer cannot be delivered through the provider's potable water distribution system to any of its customers located outside the boundaries of a water users association, as defined in A.R.S. § 10-140, because of treatment facility or distribution system limitations, and the provider's CAP water treatment facilities and potable water distribution system have a reasonable level of capacity.*

c. *Granting the exclusion will result in the non-residential customer receiving effluent sooner than it would if the exclusion is not granted, and the effluent that the non-residential customer will receive as a result of the exclusion would not otherwise be put to a direct beneficial use by the provider.*

d. *Neither the Non-Per Capita Conservation Program described in section 5-104 of this chapter nor the Alternative Conservation Program described in section 5-105 of this chapter are currently an appropriate conservation program for the provider.*

e. *If the non-residential customer is a turf-related facility, a large-scale cooling facility, or a publicly owned right-of-way, the customer will be required to comply with conservation requirements during the duration of the exclusion identical to the conservation requirements that would apply to the customer under section 5-112 of this chapter if the customer was using groundwater.*

f. If the CAP water that the provider will deliver to the non-residential customer is to be recovered by the provider pursuant to a recovery well permit issued under Title 45, Chapter 3.1, Arizona Revised Statutes, the provider is unable to deliver CAP water to the customer except from a recovery well.

2. Duration of Exclusion

The duration of any exclusion granted pursuant to paragraph 1 of this subsection shall be determined by the director at the time the exclusion is granted and shall not exceed ten years. After the exclusion has become effective, the director may at any time rescind the exclusion, or reduce the amount of the exclusion as determined pursuant to paragraph 3 of this subsection, if the director determines that one of the following applies:

a. The large municipal provider is not delivering all available effluent to the non-residential customer.

b. The large municipal provider will not entirely replace the deliveries of CAP water with effluent by the date determined by the director to be reasonable at the time the exclusion was granted.

c. The large municipal provider's CAP water treatment facilities or potable water distribution system no longer have a reasonable level of capacity.

3. Amount of Exclusion

During the duration of any exclusion granted pursuant to paragraph 1 of this subsection, the amount of CAP water that shall be excluded from the large municipal provider's total water usage in any calendar year shall be calculated as follows:

a. Determine the amount of CAP water delivered by the provider to the non-residential customer during the calendar year and then subtract from that amount any amount of water used by the non-residential customer during the year in excess of the conservation requirements applicable to such use as set forth in section 5-112 of this chapter.

b. The amount of CAP water that shall be excluded from the provider's total water use during the calendar year shall be the volume from subparagraph a above, but not to exceed the lesser of the following:

1) The amount of effluent that will be available for direct delivery by the provider to the non-residential customer during the last year of the exclusion, as determined by the director at the time the exclusion is granted.

2) The amount of groundwater that would have been used by the non-residential customer during the year if the provider had not served CAP water to the customer, as determined by the director.

4. Agreement by Non-Residential Customer Not to Use Groundwater; Exception

An exclusion granted pursuant to paragraph 1 of this subsection shall not become effective until the non-residential customer agrees in writing that it will not use groundwater from a source other than the large municipal provider during the duration

of the exclusion, except during any temporary period in which the provider is unable to deliver a sufficient quantity of water to the customer because of distribution system failure or other emergency, and provided that the customer applies to the director in writing for permission to use the groundwater within seven days after commencement of the provider's distribution system failure or other emergency and the director approves the application in writing.

5. *Deliveries of Groundwater by Large Municipal Provider to Non-Residential Customer Included in GPCD Requirement; Exception*

   During the duration of any exclusion granted pursuant to paragraph 1 of this subsection, any groundwater delivered by the large municipal provider to the non-residential customer shall be included in determining the provider's compliance with its GPCD requirement, except for groundwater delivered by the provider to the non-residential customer during any temporary period, not to exceed 30 days, in which the provider is unable to deliver a sufficient quantity of CAP water or effluent to the customer because of distribution system failure or other emergency, and provided that the provider applies to the director in writing for an exclusion of such groundwater from its GPCD requirement within seven days after commencement of the distribution system failure or other emergency and the director approves the application in writing for a specified period of time.

5-104. Non-Per Capita Conservation Program

A. Eligibility for the Non-Per Capita Conservation Program

A large municipal provider may apply for the Non-Per Capita Conservation Program if any of the following applies:

1. *The provider is a member of a groundwater replenishment district established under Title 48, Chapter 27, Arizona Revised Statutes.*

2. *The service area of the provider has qualified as a member service area under Title 48, Chapter 22, Arizona Revised Statutes, or as a water district member under Title 48, Chapter 28, Arizona Revised Statutes, and the conditions established under A.R.S. § 45-576.01(B)(2) and (3) are met by the conservation district or the water district, as applicable, for the AMA in which the service area is located.*

3. *The provider has developed a plan to both:*

   a) *Reduce the proportion of mined groundwater supplied by it for use within its service area such that the result computed by dividing the volume of mined groundwater supplied by the provider for use within its service area in a year by the volume of all water supplied by the provider for use within its service area in that year does not exceed:*

      1) *Two-thirds for 2000.*
      2) *Three-fifths for 2001.*
      3) *Eight-fifteenths for 2002.*
      4) *Seven-fifteenths for 2003.*
      5) *Two-fifths for 2004.*
      6) *One-third for 2005.*

7) *Four-fifteenths for 2006.*
8) *One-fifth for 2007.*
9) *Two-fifteenths for 2008.*
10) *One-fifteenth for 2009.*

b) *Deliver no mined groundwater for use within its service area after January 1, 2010.*

4. *The provider is designated as having an assured water supply under rules adopted by the director pursuant to A.R.S. § 45-576.*

B. *Application for Non-Per Capita Conservation Program*

A large municipal provider's application for the Non-Per Capita Conservation Program must be approved by the provider's governing body, and must include the following:

1. *A description and evaluation, including implementation dates, of the provider's existing conservation programs.*

2. *A description of conservation programs the provider intends to implement if approved for the Non-Per Capita Conservation Program, including a time schedule for implementing the programs.*

3. *If the provider is applying for the Non-Per Capita Conservation Program under subsection A, paragraph 3, a water supply plan demonstrating that the provider will reduce the proportion of mined groundwater supplied by it within its service area to the proportions described in that subparagraph, and that it will deliver no mined groundwater after January 1, 2010.*

4. *If the provider intends to comply with subsection D of this section by implementing one or more substitute RCMs in lieu of a standard RCM, or if the provider requests the director to modify a level of conservation potential for the provider's service area pursuant to subsection D, paragraph 1, subparagraph a of this section, an analysis of water use within the provider's service area that includes all of the following:*

   a. *If the provider intends to implement one or more substitute RCMs, information demonstrating that the substitute RCM or RCMs will be designed to achieve a water use efficiency within the provider's service area equivalent to the efficiency that would result from implementation of the standard RCM or RCMs.*

   b. *The amount of water used each month during the past three years by each of the following water use sectors, as applicable: (1) residential (disaggregated by single family and multifamily), (2) commercial, (3) industrial, (4) turf-related facilities, (5) government, (6) construction, (7) distribution system losses, and (8) any other uses. The provider is not required to include this information if it has already been reported to the Department.*

   c. *An identification and evaluation of the water use sectors described in item b of this subparagraph that have the highest water conservation potential.*

5. *If the provider is requesting an individual incidental recharge factor under subsection C, paragraph 2 of this section:*

a. *A copy of a hydrological study that demonstrates the amount of water withdrawn, diverted or received for delivery by the provider for use within its service area during each of the preceding five years and the amount of incidental recharge that was attributable to the provider during those years. The study shall be prepared consistent with the methodology contained in Appendix 5-J.*

b. *A copy of a hydrological study projecting the average annual amount of water that will be withdrawn, diverted or received for delivery by the provider for use within its service area during the management period and the average annual amount of incidental recharge that will be attributable to the provider during the management period.*

6. *Any other information required by the director.*

C. *Incidental Recharge Factor*

1. *Standard Incidental Recharge Factor*

The standard incidental recharge factor for the Phoenix AMA for the third management period is 4 percent. The standard incidental recharge factor shall be used to calculate the amount of mined groundwater supplied during a year by a large municipal provider that applied for the Non-Per Capita Conservation Program under subsection A, paragraph 3 of this section, unless the provider applies for and is granted an individual incidental recharge factor pursuant to paragraph 2 of this subsection.

2. *Individual Incidental Recharge Factor*

A large municipal provider that applies for the Non-Per Capita Conservation Program under subsection A, paragraph 3 of this section may request an incidental recharge factor that is different than the standard incidental recharge factor set forth in paragraph 1 of this subsection by submitting the information described in subsection B, paragraph 5 of this section with its application. The director shall establish a different incidental recharge factor for the provider, as described in Appendix 5-J, if the information submitted by the provider demonstrates that the ratio of the average annual amount of incidental recharge expected to occur within the provider's service area during the third management period to the average annual amount of water expected to be supplied by the provider for use within its service area during the third management period is different than the standard incidental recharge factor. If the director establishes an individual incidental recharge factor for the provider under this paragraph, the individual incidental recharge factor shall be used to calculate the amount of mined groundwater supplied by the provider during a year.

D. *Criteria for Approval of Application*

A large municipal provider that applies for the Non-Per Capita Conservation Program shall be approved for the program only if all of the following conditions are satisfied, as applicable:

1. *The provider agrees in writing to implement RCMs that the director determines will, if properly implemented, result in the achievement of a water use efficiency within the provider's service area equivalent to the water use efficiency assumed in the provider's total GPCD requirements for the third management period. To comply with this*

requirement, the provider must agree in writing to implement the following RCMs for the following water use categories and programs beginning on a date agreed upon by the director and the provider:

a. Residential Water Use

1) Residential interior water use category - The provider shall agree in writing to implement the residential interior standard RCMs described in Appendix 5-I.1. In lieu of implementing one or both of the standard RCMs, the provider may agree to implement one or more of the residential interior substitute RCMs or system-related substitute RCMs listed in the substitute RCM list described in Appendix 5-I.4 if the director determines that the substitute RCM or RCMs will be designed to achieve a water use efficiency within the provider's service area equivalent to the efficiency that would result from implementation of the standard RCM.

2) Residential exterior water use category - The provider shall agree in writing to implement the residential exterior standard RCMs described in Appendix 5-I.1. In lieu of implementing one or more of the standard RCMs, the provider may agree to implement one or more of the residential exterior substitute RCMs or system-related substitute RCMs listed in the substitute RCM list described in Appendix 5-I.4 if the director determines that the substitute RCM or RCMs will be designed to achieve a water use efficiency within the provider's service area equivalent to the efficiency that would result from implementation of the standard RCM.

3) Implementation level - The provider shall agree to implement residential interior or exterior RCMs for existing residential customers at the implementation level (minimum, moderate, or maximum) that corresponds to the level of conservation potential that the director determined existed for water use by existing residential users within the provider's service area when the director established the provider's total GPCD requirements for the third management period, as shown in Appendix 5-E.

The director may modify a level of conservation potential shown for a provider in Appendix 5-E if the provider requests a modification in an application for administrative review pursuant to A.R.S. § 45-575(A) or in the provider's application for regulation under the Non-Per Capita Conservation Program, and the provider demonstrates that the level of conservation potential shown in Appendix 5-E is not accurate for the provider's service area. A provider requesting a modification of a level of conservation potential shall submit to the director a water use analysis containing the information described in subsection B, paragraph 4, of this section. If the level of conservation potential for water use by existing residential users as shown in Appendix 5-E, or as modified by the director, is "no reduction," the provider is not required to implement any RCMs for existing residential customers in that water use category.

b. Non-Residential Water Use

1) Non-residential interior water use category - The provider shall agree in writing to implement the non-residential interior standard RCMs described in Appendix 5-I.2. In lieu of implementing one or more of the standard RCMs, the provider

may agree to implement one or more of the non-residential interior substitute RCMs or system-related RCMs listed in the substitute RCM list described in Appendix 5-I.4 if the director determines that the substitute RCM or RCMs will be designed to achieve a water use efficiency within the provider's service area equivalent to the efficiency that would result from implementation of the standard RCM.

2) *Non-residential exterior water use category - The provider shall agree in writing to implement the non-residential exterior standard RCMs described in Appendix 5-I.2. In lieu of implementing one or both of the standard RCMs, the provider may agree to implement one or more of the non-residential exterior substitute RCMs or system-related RCMs listed in the substitute RCM list described in Appendix 5-I.4 if the director determines that the substitute RCM or RCMs will be designed to achieve a water use efficiency within the provider's service area equivalent to the efficiency that would result from implementation of the standard RCM.*

c. *Public Education Program*

The provider shall agree in writing to implement the education standard RCM described in Appendix 5-I.3. In lieu of implementing the standard RCM, the provider may agree to implement one or more of the education substitute RCMs listed in the substitute RCM list described in Appendix 5-I.4. The substituted RCM or RCMs must not duplicate other RCMs that the provider will implement as part of the Non-Per Capita Conservation Program.

2. *If the provider is applying for the Non-Per Capita Conservation Program under subsection A, paragraph 1 of this section, the provider will be accepted into the program only if the conditions established in A.R.S. § 45-576.01(A)(2) and (3) are met by the groundwater replenishment district of which the provider is a member.*

3. *If the provider is applying for the Non-Per Capita Conservation Program under subsection A, paragraph 2 of this section, the provider will be accepted into the program only if the conditions established in A.R.S. § 45-576.01(B)(2) and (3) are met for the AMA by the multi-county water conservation district or AMA water district of which the provider is a member.*

4. *If the provider is applying for the Non-Per Capita Conservation Program under subsection A, paragraph 3 of this section, the provider will be accepted into the program only if the director has determined that the provider will reduce the proportion of mined groundwater supplied within its service area to the proportions described in that subparagraph.*

5. *If the provider is applying for the Non-Per Capita Conservation Program under subsection A, paragraph 4 of this section, the provider will be accepted into the program only if the director determines that the provider is designated as having an assured water supply under the rules adopted by the director under A.R.S. § 45-576.*

E. Non-Per Capita Conservation Program Requirements

A large municipal provider regulated under the Non-Per Capita Conservation Program shall comply with the following requirements, as applicable, until the effective date of any substitute conservation requirements established in the Fourth Management Plan:

1. *The provider shall implement the RCMs agreed to in writing under subsection D, paragraph 1 of this section beginning on a date agreed upon by the director and the provider.*

2. *If the provider applied for the Non-Per Capita Conservation Program under subsection A, paragraph 3 of this section, the provider shall reduce the proportion of mined groundwater supplied within its service area to the proportions described in that paragraph. A provider's failure to comply with this requirement during any year will be excused if the provider demonstrates to the director's satisfaction that the failure was due to drought conditions or the failure of a surface water distribution system.*

3. *If the provider applied for the Non-Per Capita Conservation Program under subsection A, paragraph 4 of this section, the provider shall not supply groundwater for use within its service area in an amount that exceeds the amount of groundwater that the provider may supply for use within its service area consistent with the rules adopted by the director pursuant to A.R.S. § 45-576. If the provider's designation of assured water supply is revoked or otherwise terminates after the provider is accepted into the program, the amount of groundwater the provider may supply for use within its service area consistent with the rules shall be determined by the director as the amount of groundwater the provider would have been allowed to supply under the rules if the provider's designation of assured water supply had not been revoked or terminated.*

5-105. Alternative Conservation Program

A. Eligibility for the Alternative Conservation Program

A large municipal provider is eligible to apply for the Alternative Conservation Program if one of the following applies:

1. *The provider is designated as having an assured water supply under rules adopted by the director pursuant to A.R.S. § 45-576.*

2. *The provider agrees to limit its annual use of groundwater withdrawn from within the AMA as provided in subsection C, paragraph 1, subparagraph a, item 2 of this section.*

B. Application for Alternative Conservation Program

A large municipal provider's application for the Alternative Conservation Program must be approved by the provider's governing body, and must include the following:

1. *A plan to limit the provider's overall groundwater withdrawals as required by subsection C, paragraph 1 of this section.*

2. *A description and evaluation, including implementation dates, of the provider's existing conservation programs.*

3. *A description of the proposed conservation strategies for all existing and new non-residential customers to be implemented by the provider under this program and the provider's schedule for implementation of all proposed conservation measures.*

4. *If the provider intends to comply with subsection C, paragraph 3 of this section by implementing one or more substitute non-residential RCMs in lieu of a standard non-residential RCM, an analysis of water use within the provider's service area that includes all of the following:*

   a. *A demonstration that the substituted RCM or RCMs will be designed to achieve a water use efficiency within the provider's service area equivalent to the efficiency that would result from implementation of the standard RCM.*

   b. *The amount of water used each month during the past three years by each of the following water use sectors, as applicable: (1) residential (disaggregated by single family and multifamily), (2) commercial, (3) industrial, (4) turf-related facilities, (5) government, (6) construction, (7) distribution system losses, and (8) any other uses. The provider is not required to include this information if it has already been reported to the Department.*

   c. *An identification and evaluation of the water use sectors described in subparagraph b of this paragraph that have the highest water conservation potential.*

C. Alternative Conservation Program Requirements

1. *Groundwater Use Limitation Requirement*

   a. *Beginning with a calendar year agreed upon by the director and a large municipal provider regulated under the Alternative Conservation Program, and for each calendar year thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan, the provider shall limit its annual use of groundwater withdrawn from within the AMA to the following, as applicable:*

      1) If the provider is designated as having an assured water supply under the rules adopted by the director pursuant to A.R.S. § 45-576, the amount of groundwater that the provider may use consistent with the rules, including any amount of groundwater that will be replenished by a conservation district pursuant to Title 48, Chapter 22, Arizona Revised Statutes.

      2) If the provider is not designated as having an assured water supply under the rules adopted by the director pursuant to A.R.S. § 45-576, one of the following, as applicable:

         a) If the provider was serving water as a large municipal provider on or before January 1, 1990, the provider's largest legal groundwater use during any one calendar year from calendar year 1980 through calendar year 1989.

         b) If the provider began serving water as a large municipal provider after January 1, 1990 but before January 1, 2000, 50 percent of the provider's largest legal groundwater use during any one calendar year from January 1, 1990 through calendar year 1999.

b. The large municipal provider may achieve compliance with the groundwater use limitation requirement described in subparagraph a, item 2 of this paragraph by permanently extinguishing or causing to be permanently extinguished grandfathered rights to groundwater as described in subparagraph c of this paragraph, by serving groundwater that will be replenished by a conservation district pursuant to Title 48, Chapter 22, Arizona Revised Statutes, by using remediated groundwater that is consistent with the accounting for surface water as provided in section 5-115, or by substituting non-groundwater supplies or groundwater withdrawn from outside the AMA for groundwater withdrawn from within the AMA, or by a combination of these methods.

c. Extinguishment of Groundwater Uses Associated with Grandfathered Rights

1) Applicability

Only irrigation grandfathered rights, Type 1 non-irrigation grandfathered rights and Type 2 non-irrigation grandfathered rights, as described in A.R.S. §§ 45-462 through 45-465, may be extinguished to meet the groundwater use limitation requirement. The large municipal provider shall not receive credit toward the achievement of the groundwater use limitation requirement for the extinguishment of either a Type 2 non-irrigation grandfathered right used for electrical energy generation or mineral extraction or processing purposes, or a Type 1 or Type 2 non-irrigation grandfathered right owned or previously owned by a municipal provider and used or previously used to serve the municipal provider's service area.

2) Annual Credits

The director shall determine the amount of annual credit a large municipal provider obtains for extinguishment of grandfathered rights to groundwater as follows:

a) For each irrigation grandfathered right extinguished or caused to be extinguished by the provider, the annual credit shall be the amount calculated by multiplying 1.5 acre-feet per acre by the number of water duty acres associated with the extinguishment, less any debits, in acre-feet, in the farm's operating flexibility account at the time the right is extinguished.

b) For each Type 1 non-irrigation grandfathered right or portion of such right extinguished or caused to be extinguished by the provider, the annual credit shall be the amount calculated by multiplying 1.5 acre-feet per acre by the number of acres to which the Type 1 non-irrigation grandfathered right is appurtenant, or a proportional amount thereof if only a portion of the right is extinguished.

c) For each Type 2 non-irrigation grandfathered right extinguished or caused to be extinguished by the provider, the annual credit shall be the full amount, in acre-feet, of the certificated Type 2 non-irrigation grandfathered right.

3) *Proof of Extinguishment*

In order for a large municipal provider to obtain an annual credit for extinguishing or causing to be extinguished a grandfathered right to groundwater, the holder of the grandfathered right must deliver the Certificate of Grandfathered Right to the director before the calendar year in which the credit will be used, request that the grandfathered right be extinguished, and direct that the provider receive the annual credit. Only one provider may receive annual credit for any one portion of a grandfathered right that has been extinguished.

d. *Compliance*

The director shall determine whether a large municipal provider is in compliance with its groundwater use limitation requirement, as described in subparagraph a, item 2) of this paragraph in a calendar year as follows:

1) *Add together the amount of annual credits received by the provider for extinguishing grandfathered rights to groundwater after January 1, 1990 pursuant to subparagraph c of this paragraph and pursuant to the Alternative Conservation Program in the second management plan.*

2) *Calculate the total volume of groundwater, in acre-feet, which the provider withdrew, diverted or received during the calendar year for use within the provider's service area. In making this calculation, the director shall not include any groundwater that a conservation district replenished or is obligated to replenish under Title 48, Chapter 22, Arizona Revised Statutes or any remediated groundwater qualifying under section 5-115.*

3) *Subtract the amount calculated in item 1) above from the volume calculated in item 2) above.*

4) *A provider is in compliance with its groundwater use limitation requirement if the amount calculated in item 3) of this subparagraph is equal to or less than the following, as applicable:*

a) *If the provider was serving water as a large municipal provider on or before January 1, 1990, the provider's largest legal groundwater use during any one calendar year from calendar year 1980 through calendar year 1989.*

b) *If the provider began serving water as a large municipal provider after January 1, 1990 but before January 1, 2000, 50 percent of the provider's largest legal groundwater use during any one calendar year from January 1, 1989 through calendar year 1999.*

Annual credits that are not needed by the provider to comply with its groundwater use limitation requirement in one calendar year shall not carry forward to any following calendar year.

2. *Residential GPCD Requirement*

a. *Beginning with a calendar year agreed upon by the director and a large municipal provider regulated under the Alternative Conservation Program, and for each calendar*

year thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan, the provider shall not serve water from any source, except spillwater, direct use effluent, and effluent recovered from within the area of impact, for residential use during a calendar year in a total amount that exceeds its residential GPCD requirement for the year, except as provided in the flexibility account provisions in section 5-106. Each year, the annual residential GPCD requirement for a provider regulated under the Alternative Conservation Program shall be calculated as follows:

1) *For each calendar year through 2004, multiply the provider's existing residential population for the year, as calculated pursuant to section 5-103, subsection D, by the first intermediate GPCD component for existing residential population as assigned to the provider in Table 5-103.A.*

   For calendar years 2005 through 2009, multiply the provider's existing residential population for the year, as calculated pursuant to section 5-103, subsection D, by the second intermediate GPCD component for existing residential population as assigned to the provider in Table 5-103.A.

   For the calendar year 2010, and for each calendar year thereafter until the first compliance date for any substitute GPCD requirement in the Fourth Management Plan, multiply the provider's existing residential population for the year, as calculated pursuant to section 5-103, subsection D, by the final GPCD component for existing residential population as assigned to the provider in Table 5-103.A.

2) *Multiply the provider's new single family population for the year, as calculated pursuant to section 5-103, subsection D, by 57 GPCD.*

3) *Multiply the number of new single family housing units within the provider's service area as of July 1 of the calendar year in question by 178 GPHUD.*

4) *Multiply the provider's new multifamily population for the year, as calculated pursuant to section 5-103, subsection D, by 57 GPCD.*

5) *Multiply the number of new multifamily housing units within the provider's service area as of July 1 of the calendar year in question by 77 GPHUD.*

6) *Add the products from items 1) through 5) of this subparagraph, and then divide the sum by the provider's service area population as of July 1 of the calendar year. The quotient is the provider's residential GPCD requirement for the calendar year.*

b. *Compliance with Residential GPCD Requirement*

   The director shall determine if a large municipal provider regulated under the Alternative Conservation Program is in compliance with its residential GPCD requirement pursuant to the flexibility account provisions in section 5-106.

3. *Non-Residential Requirement*

   a. *A large municipal provider regulated under the Alternative Conservation Program shall agree in writing to implement the following non-residential RCMs beginning on a date agreed upon by the director and the provider:*

1) *Non-Residential Interior Requirements - The provider shall agree in writing to implement the non-residential interior standard RCMs described in Appendix 5-I.2. In lieu of implementing one or more of the standard RCMs, the provider may agree to implement one or more of the non-residential interior substitute RCMs or system-related RCMs listed in the substitute RCM list described in Appendix 5-I.4 if the director determines that the substitute RCM or RCMs will be designed to achieve a water use efficiency within the provider's service area equivalent to the efficiency that would result from implementation of the standard RCM.*

2) *Non-Residential Exterior Requirements - The provider shall agree in writing to implement the non-residential exterior standard RCMs described in Appendix 5-I.2. In lieu of implementing one or both of the standard RCMs, the provider may agree to implement one or more of the non-residential exterior substitute RCMs or system-related RCMs listed in the substitute RCM list described in Appendix 5-I.4 if the director determines that the substitute RCM or RCMs will be designed to achieve a water use efficiency within the provider's service area equivalent to the efficiency that would result from implementation of the standard RCM.*

5-106. Compliance with Total GPCD Requirement and Residential GPCD Requirement - Flexibility Account

A. Total GPCD Program Flexibility Account

The director shall determine if a large municipal provider regulated under the Total Gallons Per Capita Per Day Program is in compliance with its annual total GPCD requirement through the maintenance of a flexibility account for the provider that shall operate as follows:

1. *Each provider regulated under the Total Gallons Per Capita Per Day Program shall be assigned a flexibility account. The beginning balance in the flexibility account of a provider that was regulated under the Total Gallons Per Capita Per Day Program in the Second Management Plan shall be the ending balance in the flexibility account maintained for the provider under section 5-105 of the Second Management Plan. The beginning balance in the flexibility account of all other large municipal providers shall be zero.*

2. *Following each calendar year in which the provider withdraws, diverts or receives groundwater for non-irrigation use, beginning with the calendar year determined under section 5-103, subsection A, paragraph 2, or the calendar year in which the provider first becomes a large municipal provider, whichever is later, the director shall adjust the provider's flexibility account as follows:*

   a. *Determine the total gallons of water from any source, except direct use effluent, effluent recovered from within the area of impact, spillwater, and excluded CAP water, withdrawn, diverted or received by the provider during the calendar year for non-irrigation use, and then subtract that amount from the amount of water the provider could legally withdraw, divert or receive during the calendar year for non-irrigation use, as calculated in subparagraph d of this paragraph.*

   b. *If the result in subparagraph a above is negative, debit the flexibility account by this volume.*

c. *If the result in subparagraph a above is positive, credit the flexibility account by this volume.*

d. *The amount of water that a provider regulated under the Total Gallons Per Capita Per Day Program can legally withdraw, divert or receive for non-irrigation use during a calendar year is calculated by multiplying the provider's total GPCD requirement for the calendar year, as calculated pursuant to section 5-103, subsection B, by the provider's service area population as of July 1 of the year, as calculated pursuant to section 5-103 subsection D, and then multiplying the product by the number of days in the calendar year.*

3. *The account balance existing in a provider's flexibility account after the adjustment provided for in paragraph 2 of this subsection is made shall carry forward subject to the following limitations:*

a. *The maximum positive account balance allowed in the flexibility account of a provider regulated under the Total Gallons Per Capita Per Day Program shall be calculated by multiplying the provider's service area population as of July 1 of the calendar year by a GPCD rate of 60, and then multiplying that product by the number of days in the calendar year. If the account balance exceeds the maximum positive account balance after any credits are registered, the balance carried forward shall equal the maximum positive account balance allowed in the provider's flexibility account for that year.*

b. *The maximum negative account balance allowed in the flexibility account of a provider regulated under the Total Gallons Per Capita Per Day Program shall be calculated by multiplying the provider's service area population as of July 1 of the calendar by a GPCD rate of -20, and then multiplying that product by the number of days in the calendar year. If the account balance exceeds the maximum negative account balance after any debits are registered, the balance carried forward shall equal the maximum negative account balance allowed in the provider's flexibility account for that year.*

B. Alternative Conservation Program Flexibility Account

The director shall determine if a large municipal provider regulated under the Alternative Conservation Program is in compliance with its annual residential GPCD requirement through the maintenance of a flexibility account for the provider that shall operate as follows:

1. *Each provider regulated under the Alternative Conservation Program shall be assigned a flexibility account with a beginning balance to be calculated by the director based on the ending balance in the provider's flexibility account while the provider was regulated under the Total Gallons Per Capita Per Day Program or under the Alternative Conservation Program of the Second Management Plan, whichever applies.*

2. *Following each calendar year in which the provider delivers groundwater for residential use, beginning with the calendar year agreed upon by the director and the provider, the director shall adjust the provider's flexibility account balance as follows:*

a. *Determine the total gallons of water from any source, except spillwater, direct use effluent, and effluent recovered from within the area of impact, served by the provider during the calendar year for residential use, and then subtract that amount from the*

amount of water the provider could legally serve during the calendar year for residential use, as calculated in subparagraph d of this paragraph.

b. If the result in paragraph a above is negative, debit the flexibility account by this volume.

c. If the result in paragraph a above is positive, credit the flexibility account by this volume.

d. The amount of water that a provider regulated under the Alternative Conservation Program can legally serve for residential use during a calendar year is calculated by multiplying the provider's residential GPCD requirement for the calendar year, as calculated pursuant to section 5-105, subsection C, paragraph 2, by the provider's service area population as of July 1 of the year as calculated pursuant to section 5-103, subsection D, and then multiplying the product by the number of days in the calendar year.

3. The account balance existing in a provider's flexibility account after the adjustment provided for in paragraph 2 of this subsection is made shall carry forward subject to the following limitations:

a. The maximum positive account balance allowed in the flexibility account of a provider regulated under the Alternative Conservation Program shall be calculated by multiplying the provider's service area population as of July 1 of the calendar by a GPCD rate of 45, and then multiplying that product by the number of days in the calendar year. If the account balance exceeds the maximum positive account balance after any credits are registered, the balance carried forward shall equal the maximum positive account balance allowed in the provider's flexibility account for that year.

b. The maximum negative account balance allowed in the flexibility account of a provider regulated under the Alternative Conservation Program shall be calculated by multiplying the provider's service area population as of July 1 of the calendar year by a GPCD rate of -15, and then multiplying that product by the number of days in the calendar year. If the account balance exceeds the maximum negative account balance after any debits are registered, the balance carried forward shall equal the maximum negative account balance allowed in the provider's flexibility account for that year.

C. Compliance Status

If the adjustment to a large municipal provider's flexibility account following a calendar year as provided for in subsection A or B of this section causes the account to have a negative account balance that exceeds the maximum negative account balance allowed in the provider's flexibility account for the year as calculated in subsection A, paragraph 3 or subsection B, paragraph 3, the provider is out of compliance for that calendar year.

5-107. Conservation Requirements for Large Untreated Water Providers

A. Rate of Use Requirement

Beginning on January 1, 2002, and continuing thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan, a large untreated water provider

shall not serve an amount of untreated water during a calendar year that exceeds an amount calculated as follows:

1. *Determine the number of gross acres of land to which the provider delivers untreated water during the calendar year. Gross acres do not include those acres regulated as a turf-related facility under section 5-112, subsection A, paragraph 1.*

2. *Multiply the number of gross acres determined in paragraph 1 of this subsection above by an average annual application rate of 4.0 acre-feet of untreated water per gross acre.*

B. Compliance

A large untreated water provider is in compliance with its rate of use requirement as set forth in subsection A of this section for a calendar year if one of the following applies:

1. *The amount of untreated water served by the provider during the calendar year does not exceed the amount of water calculated in subsection A of this section; or*

2. *The aggregate amount of untreated water served by the provider during that calendar year and the preceding two calendar years divided by three does not exceed the sum of the amount of untreated water calculated in subsection A of this section for those three years divided by three.*

5-108. Conservation Requirements for Institutional Providers

A. *If a large municipal provider operates primarily for the purpose of serving water to institutions, including prisons, hospitals, military installations, airparks and schools, and supplies or expects to supply more than 90 percent of its total non-irrigation deliveries to one or more of these institutions, the provider may apply to the director for designation as an institutional provider. The director may deem a facility other than one of those listed above as an institution if its water use characteristics are similar to the types of institutions listed above.*

B. *A large municipal provider regulated as an institutional provider in the Second Management Plan may reapply to the director to be designated as an institutional provider under the Third Management Plan any time after it has been noticed of its total GPCD requirements for the Third Management Plan.*

C. *A large municipal provider applying for designation as an institutional provider shall apply on a form prescribed and furnished by the director. The provider shall supply information in sufficient detail to allow the director to evaluate the provider's conservation potential and to establish appropriate conservation requirements for the provider.*

D. *The director shall approve a large municipal provider's application for designation as an institutional provider if the provider meets the criteria in subsection A of this section, and demonstrates that it does not qualify for the Non-Per Capita Conservation Program or the Alternative Conservation Program.*

E. *Each large municipal provider designated as an institutional provider shall be assigned mandatory conservation requirements and monitoring and reporting requirements, including a maximum residential GPCD requirement and appropriate conservation measures for non-residential uses. The institutional provider shall comply with the assigned conservation*

requirements by the date specified by the director, but not later than January 1 of the year following the year in which the provider's application is approved, and shall remain in compliance with those requirements until the first compliance date for any substitute requirements in the Fourth Management Plan.

5-109. Consolidation of Municipal Provider Service Areas; Acquisition of a Portion of Another Municipal Provider's Service Area

A. Notification

1. *If two or more municipal providers consolidate their service areas into one service area, the consolidated provider shall notify the Department of the consolidation within 30 days after the consolidation becomes effective.*

2. *If a municipal provider acquires a portion of another municipal provider's existing service area, both the acquiring provider and the conveying provider shall notify the Department of the acquisition within 30 days after the acquisition becomes effective.*

B. Regulation of Consolidated Provider

1. *Upon consolidation, a consolidated provider that qualifies as a large municipal provider shall be regulated under the Total GPCD Program described in section 5-103, unless the consolidated provider applies for and is accepted for regulation under the Non-Per Capita Conservation Program described in section 5-104 or the Alternative Conservation Program described in section 5-105.*

2. *If the consolidated provider is regulated under the Total GPCD Program, the director shall establish a total GPCD requirement for the consolidated provider consistent with the methodology used by the director to establish the consolidating providers' total GPCD requirements as set forth in Appendix 5-C.1. The director shall also establish and maintain a flexibility account for the consolidated provider in accordance with section 5-106, subsection A, with a beginning balance to be established by the director based on the ending balances in the flexibility accounts of the consolidating providers.*

3. *If the consolidated provider is accepted for regulation under the Alternative Conservation Program, the director shall establish a residential GPCD requirement for the consolidated provider consistent with the methodology used by the director to establish the consolidating providers' residential GPCD requirements as set forth in Appendix 5-K. The director shall also establish and maintain a flexibility account for the consolidated provider in accordance with section 5-106, subsection B, with a beginning balance to be established by the director based on the ending balances in the flexibility accounts of the consolidating providers.*

4. *If the consolidated provider applies for regulation under the Non-Per Capita Conservation Program or the Alternative Conservation Program and one of the consolidating providers was regulated under that program immediately prior to consolidation, the consolidated provider's application for regulation under the program shall include only the information required by section 5-104 or section 5-105 that has changed since the consolidating provider filed its application for the program.*

*C. **Regulation of Acquiring Provider***

1. Except as provided in paragraph 2 of this subsection, a large municipal provider that acquires a portion of another provider's existing service area shall continue to be regulated under the conservation program that the acquiring provider was regulated under immediately prior to the acquisition.

2. If the acquiring provider was regulated under either the Non-Per Capita Conservation Program described in section 5-104 or the Alternative Conservation Program described in section 5-105 immediately prior to the acquisition, the acquiring provider shall be regulated under the Total GPCD Program beginning on January 1 of the first calendar year after the acquisition unless the acquiring provider reapplies to be regulated under the Non-Per Capita Conservation Program or the Alternative Conservation Program, whichever is applicable, within 180 days after the acquisition. If the acquiring provider reapplies to be regulated under the Non-Per Capita Conservation Program or the Alternative Conservation Program within 180 days after the acquisition, both of the following shall apply:

a. The provider shall continue to be regulated under the Non-Per Capita Conservation Program or the Alternative Conservation Program, whichever is applicable, until the director makes a final decision on the acquiring provider's application.

b. The acquiring provider's application shall include only the information required by section 5-104 or section 5-105 that has changed since the acquiring provider filed its original application for the program.

3. If the acquiring provider is regulated under the Total GPCD Program after the acquisition, the director shall establish a new total GPCD requirement for the acquiring provider consistent with the methodology used to establish the provider's total GPCD requirements in Appendix 5-C.1, taking into account the addition to the provider's service area. The director may also adjust the balance in the acquiring provider's flexibility account maintained under section 5-106, subsection A, to take into account the balance in the conveying provider's flexibility account at the time of the conveyance.

4. If the acquiring provider is regulated under the Alternative Conservation Program after the acquisition, the director shall establish a new residential GPCD requirement for the provider consistent with the methodology used to establish the residential GPCD requirements in Appendix 5-K, taking into account the addition to the provider's service area. The director may also adjust the balance in the acquiring provider's flexibility account maintained under section 5-106, subsection A, to take into account the balance in the conveying provider's flexibility account at the time of the conveyance.

*D. **Regulation of Conveying Provider***

1. Except as provided in paragraph 2 of this subsection, a large municipal provider that conveys a portion of its service area to another provider and that qualifies as a large municipal provider after the conveyance shall continue to be regulated under the conservation program that the provider was regulated under immediately prior to the conveyance.

2. If the conveying provider was regulated under either the Non-Per Capita Conservation Program described in section 5-104 or the Alternative Conservation Program described

in section 5-105 immediately prior to the acquisition and if the conveying provider qualifies as a large municipal provider after the conveyance, the conveying provider shall be regulated under the Total GPCD Program beginning on January 1 of the first calendar year after the acquisition unless the provider reapplies to be regulated under the Non-Per Capita Conservation Program or the Alternative Conservation Program, whichever is applicable, within 180 days after the conveyance. If the conveying provider reapplies to be regulated under the Non-Per Capita Conservation Program or the Alternative Conservation Program within 180 days after the conveyance, both of the following shall apply:

a. *The provider shall continue to be regulated under the Non-Per Capita Conservation Program or the Alternative Conservation Program, whichever is applicable, until the director makes a final decision on the provider's application.*

b. *The provider's application shall include only the information required by section 5-104 or section 5-105 that has changed since the provider filed its original application for the program.*

3. *If the conveying provider is regulated under the Total GPCD Program after the conveyance, the director shall establish a new total GPCD requirement for the provider consistent with the methodology used to establish the total GPCD requirements in Appendix 5-C.1, taking into account the reduction in the provider's service area. The director may also adjust the balance in the conveying provider's flexibility account maintained under section 5-106 to take into account the reduction in the provider's service area.*

4. *If the conveying provider is regulated under the Alternative Conservation Program after the conveyance, the director shall establish a new residential GPCD requirement for the provider consistent with the methodology used to establish the residential GPCD requirements in Appendix 5-K, taking into account the reduction in the provider's service area. The director may also adjust the balance in the conveying provider's flexibility account maintained under section 5-106 to take into account the reduction in the provider's service area.*

5-110. Conservation Requirements for New Large Municipal Providers

A. Total GPCD Program

1. *A new large municipal provider shall be assigned to the Total GPCD Program described in section 5-103 and shall comply with its annual total GPCD requirement no later than the second full calendar year after the provider is given written notice of the requirement by the director, and for each calendar year thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan.*

2. *A new large municipal provider's total GPCD requirement for a year shall be calculated as follows:*

a. *For calendar years 2002 through 2004, multiply the provider's existing residential population for the year, as calculated pursuant to section 5-103, by the provider's first intermediate GPCD component for existing residential population as determined by the director after the provider qualifies as a new large provider. In determining the provider's first intermediate GPCD component for existing residential population,*

the director shall calculate the existing residential component consistent with the methodology used to calculate the existing residential component for existing large municipal providers, taking into consideration already existing conservation measures.

For calendar years 2005 through 2009, multiply the provider's existing residential population for the year, as calculated pursuant to section 5-103, by the provider's second intermediate GPCD component for existing residential population as determined by the director after the provider qualifies as a new large provider. In determining the provider's second intermediate GPCD component for existing residential population, the director shall calculate the existing residential component consistent with the methodology used to calculate the existing residential component for existing large municipal providers, taking into consideration already existing conservation measures.

For the calendar year 2010, and for each calendar year thereafter until the first compliance date for any substitute total GPCD requirement in the Fourth Management Plan, multiply the provider's existing residential population for the year, as calculated pursuant to section 5-103, by the provider's final GPCD component for existing residential population as determined by the director after the provider qualifies as a new large provider. In determining the provider's final GPCD component for existing residential population, the director shall calculate the existing residential component consistent with the methodology used to calculate the existing residential component for existing large municipal providers, taking into consideration already existing conservation measures.

b. *Multiply the provider's new single family population for the year, as calculated pursuant section 5-103, subsection D, by 57 GPCD.*

c. *Multiply the number of new single family housing units within the provider's service area as of July 1 of the calendar year in question by 178 GPHUD.*

d. *Multiply the provider's new multifamily population for the year, as calculated pursuant to section 5-103, subsection D, by 57 GPCD.*

e. *Multiply the number of new multifamily housing units within the provider's service area as of July 1 of the calendar year in question by 77 GPHUD.*

f. *Determine the provider's non-residential GPCD by dividing the total non-residential water delivered, in gallons, during the calendar year by the service area population for the calendar year, as calculated pursuant to section 5-103, subsection D, and dividing by the number of days in the calendar year. The non-residential GPCD component equals the non-residential GPCD rate for the calendar year up to 18 GPCD. If the non-residential GPCD rate for the calendar year is greater than 18 GPCD, the non-residential component shall be 18 GPCD.*

g. *Divide the provider's allowable lost and unaccounted for water by the number of days in the calendar year. The provider's allowable lost and unaccounted for water is the lesser of the following:*

   1) the provider's actual lost and unaccounted for water for the year, in gallons.

2) *an amount calculated by multiplying the total gallons of water from any source, except direct use effluent, withdrawn, diverted or received by the provider during the year for non-irrigation uses by 10 percent.*

h. *Add the results from paragraphs a through g of this section, and then divide the sum by the provider's annual service area population as of July 1 of that year, as determined pursuant to section 5-103, subsection D. The quotient is the provider's total GPCD requirement for the calendar year.*

3. *The director shall determine if a new large municipal provider is in compliance with its annual total GPCD requirement pursuant to the flexibility account provisions in section 5-106.*

B. Non-Per Capita Conservation Program

A new large municipal provider may apply for regulation under the Non-Per Capita Conservation Program in accordance with section 5-104.

C. Alternative Conservation Program

1. *Application*

A new large municipal provider may apply for regulation under the Alternative Conservation Program in accordance with section 5-105.

2. *Substitute Groundwater Use Limitation Requirement*

A new large municipal provider accepted into the Alternative Conservation Program is exempt from complying with the groundwater use limitation requirement as described in section 5-105, subsection C, paragraph 1, subparagraph a, but shall limit its annual groundwater use to the following amount as applicable:

a. *If the provider is designated as having an assured water supply under the rules adopted by the director pursuant to A.R.S. § 45-576, the amount the provider is allowed to use under those rules.*

b. *If the provider is not designated as having an assured water supply under the rules adopted by the director pursuant to A.R.S. § 45-576, the amount that it would be allowed to use if it was designated as having an assured water supply under those rules, as determined by the director.*

3. *Annual Residential GPCD Requirement*

a. *Requirement*

A new large municipal provider regulated under the Alternative Conservation Program shall comply with its annual residential GPCD requirement for each calendar year as described in section 5-105, subsection C, paragraph 2, subparagraph a.

b. Calculation of Annual Residential GPCD Requirement

Each year the annual residential GPCD requirement for a new large municipal provider regulated under the Alternative Conservation Program shall be calculated as follows:

1) Multiply the provider's existing residential population for the year, as calculated pursuant to section 5-103, subsection D, by the GPCD component for existing residential population as determined by the director. The GPCD components shall assume the implementation of conservation measures appropriate for the characteristics of the provider's service area, taking into consideration already existing conservation measures.

2) Multiply the provider's new single family population for the year, as calculated pursuant to section 5-103, subsection D, by 57 GPCD.

3) Multiply the number of new single family housing units within the provider's service area as of July 1 of the calendar year in question by 178 GPHUD.

4) Multiply the provider's new multifamily population for the year, as calculated pursuant to section 5-103, subsection D, by 57 GPCD.

5) Multiply the number of new multifamily housing units within the provider's service area as of July 1 of the calendar year in question by 77 GPHUD.

6) Add the products from items 1) through 5) of this subparagraph, and then divide the sum by the provider's service area population as of July 1 of the calendar year. The quotient is the provider's residential GPCD requirement for the calendar year.

c. Compliance with Annual Residential GPCD Requirement

The director shall determine if a new large municipal provider regulated under the Alternative Conservation Program is in compliance with its annual residential GPCD requirement pursuant to the flexibility account provisions in section 5-106.

4. Non-Residential Conservation Programs

A new large municipal provider regulated under the Alternative Conservation Program shall implement conservation programs for its non-residential customers in accordance with section 5-105, subsection C, paragraph 3.

5-111. Conservation Requirements for Small Municipal Providers

A. By January 1, 2002, or upon commencement of service of water, whichever is later, and until the first compliance date for any substitute requirements in the Fourth Management Plan, a small municipal provider shall adopt and implement a program to achieve the following goals:

1. Minimize waste of all water supplies.

2. Maximize efficiency in outdoor watering.

3. *Encourage reuse of water supplies.*

4. *Reduce its total GPCD usage.*

5-112. Individual User Requirements for Municipal Providers and Individual Users

A. Individual User Requirements

Beginning January 1, 2002, or upon commencement of service of water, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan, the municipal provider or individual user responsible for compliance with the individual user requirements under subsection B of this section shall comply with the following, as applicable:

1. *The municipal provider or individual user shall serve water to, or use water within, a turf-related facility only in accordance with sections 6-302 through 6-309 of the Industrial Chapter of the Third Management Plan, and shall comply with the monitoring and reporting requirements set forth in section 6-310 of the Industrial Chapter, as though the individual user were an industrial user. The person responsible for compliance shall also comply with the conservation requirements contained in section 6-202 of the Industrial Chapter, if applicable, as though the individual user were an industrial user.*

2. *The municipal provider or individual user shall serve water to, or use water within, a large-scale cooling facility only if the person using water at the facility complies with all applicable conservation requirements contained in sections 6-602 and 6-603 of the Industrial Chapter of the Third Management Plan as though the person was an industrial user. The person responsible for compliance shall also comply with the applicable monitoring and reporting requirements contained in section 6-203 and the conservation requirements contained in section 6-202 of the Industrial Chapter, if applicable, as though the individual user were an industrial user.*

3. *The municipal provider or individual user shall serve or use groundwater for the purpose of watering landscaping plants planted on or after January 1, 1987 within any publicly owned right-of-way of a highway, street, road, sidewalk, curb or shoulder that is used for travel in any ordinary mode, including pedestrian travel, only if the plants are listed in Appendix 5-L. The director may waive this requirement upon request from the municipal provider or individual user if a waiver of this requirement is in the public interest. This requirement does not apply to any portion of a residential lot that extends into a publicly owned right-of-way.*

4. *The municipal provider or individual user shall not serve or use groundwater for the purpose of maintaining a water feature, including fountains, waterfalls, ponds, water courses, and other artificial water structures installed after January 1, 2002 within any publicly owned right-of-way of a highway, street, road, sidewalk, curb or shoulder that is used for travel in any ordinary mode, including pedestrian travel. The director may waive this requirement upon request from the municipal provider or individual user if a waiver of this requirement is in the public interest. This requirement does not apply to any portion of a residential lot that extends into a publicly owned right-of-way.*

B. Responsibility for Compliance with Individual User Requirements

1. A municipal provider shall be responsible for complying with an individual user requirement set forth in subsection A of this section for an existing individual user unless one of the following applies:

a. The provider identified the existing individual user to the director on a form provided by the Department and received by the director no later than 90 days before the adoption of the Third Management Plan.

b. The director gave written notice of the individual user requirement to the individual user within 30 days after the adoption of the Third Management Plan.

2. An existing individual user that has been given written notice of an individual user requirement by the director shall be responsible for complying with the individual user requirement beginning on the date specified in the notice.

3. A municipal provider shall be responsible for complying with an individual user requirement set forth in subsection A of this section for a new individual user unless one of the following applies:

a. The municipal provider identifies the new individual user to the director on a form provided by the Department. If the provider identifies the new individual user to the director within 90 days after the provider begins serving water to the new individual user, the municipal provider shall not be responsible for complying with the individual user requirement at any time. If the provider identifies the new individual user to the director more than 90 days after the provider begins serving water to the new individual user, the provider shall be responsible for complying with the individual user requirement beginning on the date the new individual user first receives water from the provider until the end of the calendar year in which the provider identifies the individual user to the director.

b. The director has given written notice of the individual user requirement to the individual user and the individual user is responsible for complying with the requirement.

4. A new individual user that has been given written notice of an individual user requirement by the director shall be responsible for complying with the individual user requirement beginning on the date specified in the notice.

C. Notification of New Individual User by Municipal Provider

Beginning January 1, 2002, and continuing thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan, a municipal provider shall notify a new individual user in writing of its individual user requirements as set forth in subsection A of this section before commencement of service of water to the individual user.

5-113. Conservation Requirements for Municipal Distribution Systems

For the calendar year 2002, or the calendar year in which the provider commences service of water, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan:

1. *A large municipal provider shall not operate a municipal distribution system, other than an untreated water municipal distribution system, in a manner such that lost and unaccounted for water exceeds 10 percent of the total quantity of water from any source, except direct use effluent, withdrawn, diverted or received by the large municipal provider for non-irrigation uses on an annual or three-year average basis.*
2. *A small municipal provider shall not operate its municipal distribution system, other than an untreated water municipal distribution system, in a manner such that lost and unaccounted for water exceeds 15 percent of the total quantity of water from any source, except direct use effluent, withdrawn, diverted or received by the small municipal provider for non-irrigation uses on an annual or three-year average basis.*

3. *A large untreated water provider that operates an untreated water municipal distribution system shall either:*

   a) *Line all canals within its service area that are used to deliver untreated water to its delivery points with a material that allows no more lost water than a well-maintained concrete lining, and maintain such lining to minimize its lost and unaccounted for water; or*

   b) *Operate and maintain its untreated water municipal distribution system in a manner such that lost and unaccounted for water does not exceed 10 percent of the total quantity of untreated water from any source withdrawn, diverted or received by the provider for non-irrigation uses on an annual or three-year average basis.*

5-114. Monitoring and Reporting Requirements for Municipal Providers and Individual Users

For the calendar year 2002, or for the calendar year in which the municipal provider commences service of water, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan:

1. *A large municipal provider shall separately measure and report in its annual reports required by A.R.S. §§ 45-468 and 45-632, the total quantity of water from any source, including effluent, delivered each month for: a) irrigation uses; b) residential uses by category, including single family and multifamily; and c) non-residential uses by category, including turf-related facility uses, commercial uses, industrial uses, government uses, construction uses and other uses.*

2. *A municipal provider shall report the following in its annual report required by A.R.S. § 45-632:*

   a. *The total quantity of water from any source, disaggregated by each source, withdrawn, diverted or received by the provider for non-irrigation use during the reporting year, as separately measured with a measuring device in accordance with paragraph 7 of this subsection.*

   b. *The total quantity of water from any source, including effluent, withdrawn, diverted or received by the provider for irrigation use during the reporting year.*

   c. *The total quantity of effluent, disaggregated by direct use effluent, effluent recovered from within the area of impact, and effluent recovered outside the area of impact, served by the provider during the reporting year for non-irrigation use.*

d. *The number of single family housing units added to the provider's service area from July 1 of the previous calendar year to July 1 of the reporting year.*

e. *The number of multifamily housing units added to the provider's service area from July 1 of the previous calendar year to July 1 of the reporting year.*

f. *The total number of single family housing units and multifamily housing units served by the provider as of July 1, 2000.*

g. *The number of single family housing units and the number of multifamily housing units added to the provider's service area between July 1, 2000 and July 1 of the reporting year.*

h. *The provider's total quantity of lost and unaccounted for water during the calendar year.*

i. *The percentage of the total quantity of water from any source, except direct use effluent, withdrawn, diverted or received by the provider during the calendar year that is lost and unaccounted for water.*

3. *In addition to the information required by paragraphs 1 and 2 of this section, a large municipal provider regulated under the Non-Per Capita Conservation Program described in section 5-104 shall include the following in its annual report required by A.R.S. § 45-632:*

   a. *The information listed in the monitoring and reporting requirement sections of those RCMs set forth in Appendix 5-I that the provider agrees in writing to implement pursuant to section 5-104, subsection E, paragraph 1.*

   b. *If the provider applied for the Non-Per Capita Conservation Program under section 5-104, subsection A, paragraph 4, the information required to be submitted by the provider under the Assured Water Supply Rules adopted by the director pursuant to A.R.S. § 45-576.*

   c. *Any other information required by the director in order to determine the provider's compliance with the Non-Per Capita Conservation Program.*

4. *In addition to the information required by paragraphs 1 and 2 of this section, a large municipal provider regulated under the Alternative Conservation Program described in section 5-105 shall include in its annual report required by A.R.S. § 45-632:*

   a. *a status report describing progress in implementing the provider's programs proposed in its application, specifically including the provider's proposed conservation plan.*

   b. *The information listed in the monitoring and reporting requirement sections of those RCMs set forth in Appendix 5-I.2 and 5-1.4 that the provider agrees in writing to implement pursuant to section 5-105, subsection C, paragraph 3.*

5. *In addition to the information required by paragraphs 1 and 2 of this section, a large untreated water provider shall report in its annual report required by A.R.S. § 45-632:*

a. *The total quantity of untreated water by source, withdrawn, diverted or received by the provider during the reporting year, as separately measured with a measuring device in accordance with paragraph 7 of this section.*

b. *The number of gross acres to which the provider delivered water during the year, not including those acres regulated as a turf-related facility.*

c. *A map of the provider's service area shall be submitted with the annual report disaggregating the gross acres and the distribution system.*

d. *The provider's total quantity of lost and unaccounted for water during the calendar year.*

e. *The percentage of the total quantity of untreated water withdrawn, diverted or received by the provider during the calendar year that is lost and unaccounted for water.*

6. *A large municipal provider shall meter water deliveries to all service connections on its municipal distribution system, except connections to fire services, dwelling units in individual multifamily units, mobile homes in a mobile home park with a master meter, and construction users.*

7. *A municipal provider shall make all water use measurements using measuring devices in accordance with the Department's measuring device rules, R12-15-901, et seq., Arizona Administrative Code.*

8. *An individual user shall meet the monitoring and reporting requirements prescribed in the Industrial Chapter, if applicable, as though the individual user were an industrial user.*

5-115. Remediated Groundwater Accounting for Conservation Requirements

A. Accounting

Groundwater withdrawn pursuant to an approved remedial action project under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or Title 49, Arizona Revised Statutes, and used by a person subject to a conservation requirement established under this chapter, shall be accounted for consistent with the accounting for surface water for purposes of determining the person's compliance with the conservation requirement, subject to the provisions of subsections B through D of this section.

B. Amount of Groundwater Eligible for Accounting

For each approved remedial action project, the annual amount of groundwater that is eligible for the remediated groundwater accounting provided in subsection A of this section is the project's annual authorized volume. The annual authorized volume for a remedial action project approved on or after June 15, 1999 is the maximum annual volume of groundwater that may be withdrawn pursuant to the project, as specified in a consent decree or other document approved by the United States Environmental Protection Agency (EPA) or the Arizona Department of Environmental Quality (ADEQ). The annual authorized volume for a project approved prior to June 15, 1999 is the highest annual use of groundwater withdrawn pursuant to the project prior to January 1, 1999, except that if a consent decree or other document approved by the EPA or ADEQ specifies the maximum annual volume of

groundwater that may be withdrawn pursuant to the project, the project's annual authorized volume is the maximum annual volume of groundwater specified in that document. The director may modify the annual authorized volume for a remedial action project as follows:

1. *For an approved remedial action project associated with a treatment plant that was in operation prior to June 15, 1999, a person may request an increase in the annual authorized volume at the same time the notice is submitted pursuant to subsection C of this section. The director shall increase the annual authorized volume up to the maximum treatment capacity of the treatment plant if adequate documentation is submitted to the director demonstrating that an increase is necessary to further the purpose of the remedial action project and the increase is not in violation of the consent decree or other document approved by the EPA or ADEQ.*

2. *A person may request an increase in the annual authorized volume of an approved remedial action project at any time if it is necessary to withdraw groundwater in excess of the annual authorized volume to further the purpose of the project. The director shall increase the annual authorized volume up to the maximum volume needed to further the purpose of the project if adequate documentation justifying the increase is submitted to the director and the increase is not in violation of the consent decree or other document approved by the EPA or ADEQ.*

3. *The director shall modify the annual authorized volume of an approved remedial action project to conform to any change in the consent decree or other document approved by the EPA or ADEQ if the person desiring the modification gives the director written notice of the change within thirty days after the change. The notice shall include a copy of the legally binding agreement changing the consent decree or other document approved by the EPA or ADEQ.*

C. Notification

To qualify for the remediated groundwater accounting provided in subsection A of this section, the person desiring the accounting must notify the director in writing of the anticipated withdrawal of groundwater pursuant to an approved remedial action project under CERCLA or Title 49, Arizona Revised Statutes, prior to the withdrawal. A municipal provider may submit notice on behalf of an individual user. At the time the notice is given, the person desiring the accounting must be using remediated groundwater pursuant to the approved remedial action project or must have agreed to do so through a consent decree or other document approved by the EPA or ADEQ. The notice required by this subsection shall include all of the following:

1. *A copy of a document approved by ADEQ or the EPA, such as the Remedial Action Plan (RAP), Record of Decision (ROD) or consent decree, authorizing the remediated groundwater project. Unless expressly specified in the document, the person shall include in the notice the volume of groundwater that will be pumped annually pursuant to the project, the time period to which the document applies, and the annual authorized volume of groundwater that may be withdrawn pursuant to the project.*

2. *The purpose for which the remediated groundwater will be used.*

3. *The name and telephone number of a contact person.*

4. *Any other information required by the director*

D. Monitoring and Reporting Requirements

To qualify for the remediated groundwater accounting for conservation requirements as provided in subsection A of this section, groundwater withdrawn pursuant to the approved remedial action project must be metered separately from groundwater withdrawn in association with another groundwater withdrawal authority for the same or other end use. A person desiring the remediated groundwater accounting for conservation requirements shall indicate in its annual report under A.R.S. § 45-632 the volume of water withdrawn and used during the previous calendar year that qualifies for the accounting.

APPENDIX 5-A
MUNICIPAL PROVIDERS
PHOENIX ACTIVE MANAGEMENT AREA

Provider	Number	Large Provider	Large Unt. Provider	Small Provider	Status
Adaman Mutual Water Company	56-2150	X			Private Water Company
Adobe Mountain Juvenile Facility	56-2225			X	Institutional Facility
Alma Ranchettes	56-2153			X	Well Co-op
Apache Junction Water Facilities Dist.	56-2025	X			Municipality
Arcadia Vista Imp	56-2154		X	X	Private Water Company
Arcadia Water Company	57-2501		X		Irrigation District
Arctic Ice & Water	56-2156			X	Miscellaneous
Arizona Boys Ranch	56-2227			X	Institutional Facility
Arlington Farms	56-2158			X	Private Water Company
Arizona Water Co - Apache Jct.	56-2000	X			Private Water Company
Arizona Water Co - Superior	56-2001	X			Private Water Company
Arizona Water Co - White Tanks	56-2002	X			Private Water Company
City of Avondale	56-2003	X			Municipality
Beardsley Water Company	56-2159			X	Private Water Company
Berneil Water Company	56-2004	X			Private Water Company
Black Canyon Retreat Water Co	56-2287			X	Private Water Company
Brophy College Preparatory	56-2160			X	Institutional Facility
Town of Buckeye	56-2006	X			Municipality
Calle de Arcos Water Company	56-2299			X	Private Water Company
Carefree Water Company	56-2007	X			Municipality
Cave Creek Water Company	56-2008	X			Private Water Company
City of Chandler	56-2009	X			Municipality
Chandler Heights Citrus ID	56-2010		X	X	Irrigation District
Chaparral Water Company	56-2283			X	Private Water Company
Chaparral City Water Company	56-2011	X			Private Water Company
Citizens Utilities - Agua Fria	56-2012	X			Private Water Company
Citizens Utilities - Sun City	56-2038	X			Private Water Company
Citizens Utilities - Sun City West	56-2039	X			Private Water Company
Citrus Gardens Irrigation District	56-2345			X	Private Water Company
Clearwater Farms	57-2753		X		Irrigation District
Clearwater Utilities	56-2165			X	Private Water Company

APPENDIX 5-A
MUNICIPAL PROVIDERS
PHOENIX ACTIVE MANAGEMENT AREA

Provider	Number	Large Provider	Large Unt. Provider	Small Provider	Status
Consolidated Water Utility	56-2166			X	Private Water Company
Country Home Mobile Village Park	56-2314			X	Mobile Home Park
Crandall Water Users Association	56-2167			X	Well Co-op
Desert Hills Water Company	56-2169	X			Private Water Company
City of El Mirage	56-2016	X			Municipality
Friendly Village Mobile Home Park	56-2174			X	Mobile Home Park
Town of Gilbert	56-2017	X			Municipality
Gila Buttes Water Users Association	56-2297		X	X	Well Co-op
City of Glendale	56-2018	X			Municipality
City of Goodyear	56-2019	X			Municipality
Grandview Water Company	56-2175			X	Private Water Company
Greenfield Ranchettes	56-2241			X	Well Co-op
H2O Water Company	56-2020	X			Private Water Company
Harold Yingling	56-2224			X	Private Water Company
Hassayampa Water Co-op	56-2254			X	Well Co-op
Heartland Dairy	56-2298			X	Miscellaneous
J&M/B&K Land Investments	56-2178			X	Private Water Company
Leister Mobile Home Park	56-2182			X	Mobile Home Park
Liberty National	56-2248			X	Private Water Company
Litchfield Park Service Company	56-2021	X			Private Water Company
Luke Air Force Base	56-2022	X			Institutional Provider
MCMWD #1	57-2508		X		Irrigation District
Mar West Landowners Association	56-2184			X	Well Co-op
McCormick Ranch POA	56-2188		X	X	Well Co-op
McDowell Water Company	56-2250		X	X	Private Water Company
City of Mesa	56-2023	X			Municipality
Mobile Gardens	56-2278			X	Private Water Company
Mobile Water Company	56-2189			X	Private Water Company
Morristown Water Company	56-2324			X	Private Water Company
Nalbandian Farms	56-2191			X	Miscellaneous
New River Utility Company	56-2254			X	Private Water Company

APPENDIX 5-A
MUNICIPAL PROVIDERS
PHOENIX ACTIVE MANAGEMENT AREA

Provider	Number	Large Provider	Large Unt. Provider	Small Provider	Status
Olive Avenue HOA	56-2194			X	Miscellaneous
Orangewood Farms	57-2758		X		Irrigation District
Osborn Investment/Michigan MHP	56-2196			X	Mobile Home Park
Paloma Corporation	56-2197			X	Private Water Company
Paradise Valley Water Company	56-2027	X			Private Water Company
Park Shadows Country Homes	56-2028			X	Well Co-op
Pecan Tree MHP	56-2193			X	Mobile Home Park
Pecos Ranchos Association	56-2199			X	Well Co-op
Peek-A-Boo Water Coop	56-2200			X	Well Co-op
Peninsula Ditch Company	57-2514		X		Irrigation District
City of Peoria	56-2029	X			Municipality
City of Phoenix	56-2030	X			Municipality
Pima Utilities	56-2031	X			Private Water Company
Quail Hallow Water Company	56-2258			X	Private Water Company
Quail Run Irrigation Association	56-2275			X	Private Water Company
Quass Family Ranch	56-2204			X	Miscellaneous
Queen Creek Water Company	56-2032	X	X		Private Water Company
Queen Valley Domestic Improv Dist.	56-2221			X	Private Water Company
Rancho Jardines Irrigation District	57-2760		X		Irrigation District
Rigby Water Company	56-2034			X	Private Water Company
Rio Verde Utilities	56-2035	X			Private Water Company
Roosevelt Irrigation District	57-2517		X		Irrigation District
Roosevelt Water Conservation District	57-2518		X		Irrigation District
Rose Valley Water Company	56-2263	X			Private Water Company
Sabrosa Water Company	56-2209			X	Private Water Company
Saddle Mountain RV Park	56-2026			X	Mobile Home Park
Saguaro Acres Association	56-2210			X	Well Co-op
Saguaro View Management, Inc.	56-2282			X	Private Water Company
Salt River Project	57-2520		X		Irrigation District
City of Scottsdale	56-2037	X			Municipality
Shangri-La Resort	56-2319			X	Miscellaneous

APPENDIX 5-A
MUNICIPAL PROVIDERS
PHOENIX ACTIVE MANAGEMENT AREA

Provider	Number	Large Provider	Large Unt. Provider	Small Provider	Status
Singing Spur MHP	56-2212			X	Mobile Home Park
South Rainbow Valley Coop	56-2269			X	Well Co-op
Steve McAdams Water Company	56-2251			X	Private Water Company
Sunburst Farms East	56-2214		X	X	Private Water Company
Sunburst Farms Irrigation District	57-2523		X		Irrigation District
Sunburst Farms West	56-2215		X	X	Private Water Company
Sunrise Water Company	56-2041	X			Private Water Company
Superstition Village Limited Ptnshp.	56-2216			X	Private Water Company
Sylvia Waters	56-2228			X	Private Water Company
City of Tempe	56-2043	X			Municipality
Thunderbird Adventist Academy	56-2284		X	X	Institutional Facility
Tierra Buena Water Company	56-2339			X	Private Water Company
City of Tolleson	56-2044	X			Municipality
Tonopah Joe's Truck Stop	56-2161			X	Miscellaneous
Tonto Hills Utility Company	56-2271			X	Private Water Company
Turner Ranches Water Sewer Co.	56-2045		X	X	Private Water Company
Union Hills Auto Spa	56-2296			X	Miscellaneous
Valencia Water Company	56-2046			X	Private Water Company
Valley Utilities	56-2047	X			Private Water Company
Valley View Water Company	56-2289			X	Private Water Company
Virgil King Water Company	56-2180			X	Well Co-op
Water Utility of Greater Buckeye	56-2288			X	Private Water Company
Water Utility of Greater Tonopah	56-2276			X	Private Water Company
West End Water Company	56-2048			X	Private Water Company
Western Meadows Irrigation District	57-2525		X		Irrigation District
Wilhoit Water Company	56-2222			X	Private Water Company
Williams Gateway Airpark	56-2049	X			Miscellaneous
You and I Trailer Park	56-2280			X	Mobile Home Park

APPENDIX 5-B
LARGE UNTREATED WATER PROVIDERS
PHOENIX ACTIVE MANAGEMENT AREA

Large Untreated Water Provider	Provider Number	1995 Total Use (acre-feet)
Arcadia Water Co	57-2501	4,168
Arcadia Vista Improvement District	56-2154	281
Chandler Heights ID	57-2504	388
Clearwater Farms	57-2753	735
Gila Buttes Water Users	56-2297	217
McCormick Ranch POA	56-2188	490
McDowell Water Co.	56-2250	180
MCMWD#1	57-2508	229
Orangewood Farms	57-2758	193
Peninsula Ditch Co.	57-2514	1,560
Queen Creek Water Company	56-2032	67
Ranchos Jardines ID	57-2760	685
Roosevelt ID	57-2517	2,190
Roosevelt Water Conservation District	57-2518	5,147
Salt River Project	57-2520	112,913
Sunburst Farms ID	57-2523	1,404
Sunburst Farms East	56-2214	610
Sunburst Farms West	56-2215	616
Thunderbird Adventist	56-2284	244
Turner Ranches WSC	56-2045	2,563
Western Meadows ID	57-2525	338
TOTAL		**135,218**

APPENDIX 5-C.1
COMPONENT GALLONS PER CAPITA PER DAY CALCULATION - DESCRIPTION
PHOENIX ACTIVE MANAGEMENT AREA

A. Residential:

1. Existing Residential Allotment
   a. Determine Base Year 2000 Single Family Population
      Determine Base Year 2000 Multifamily Population
      Sum of Base Year 2000 Single Family and Multifamily Population
   b. Multiply Base Year 2000 Residential Population by the Existing Residential GPCD Component Requirement (Appendix 5F), multiply by 365 days and divide the product by 325,851.
   c. Result is a volumetric allotment, in acre-feet, for the Existing Residential Allotment with expected GPCD reductions included in the annual requirement calculation.
2. New Single Family and Multifamily Allotment:
   a. In Each Calendar Year Determine the following:
      New Single Family Housing Units added since June 30, 2000
      New Single Family Population (post - 2000) for the calendar year
      New Multifamily Housing Units added since June 30, 2000
      New Multifamily Population (post - 2000) for the calendar year
   b. Multiply New Single Family Housing Units and New Multifamily Housing Units by Exterior model GPHUD Rates for New Development:

Single Family	=	178 GPHUD
Multifamily	=	77 GPHUD

      Multiply the sum of the results by 365 days and divide the product by 325,851.
   c. Multiply the sum of the New Single Family Population and the New Multifamily Population by the Interior model GPCD rate of 57 for new residential development. Multiply the result by 365 days and divide the product by 325,851.
   d. The sum of the results in paragraphs b. and c. is the annual volumetric allotment in acre-feet for the New Residential Allotment.
3. Add together the Existing Residential Allotment to the New Residential Allotment to calculate the **Residential Allotment**, in acre feet for the calendar year.

B. Non-Residential:

1. Multiply the Total Population for the calendar year by the Non-Residential GPCD Requirement from Appendix 5H, multiply the result by 365 days and divide the product by 325,851.
2. The result is the volumetric **Non-Residential Allotment**, in acre-feet, for non-residential uses each calendar year.

C. Lost and Unaccounted For Water:

1. Subtract the calendar year total residential, non-residential, and system-related deliveries from the calendar year total non-irrigation water use to obtain the lost and unaccounted for water volume, in acre-feet.
2. Divide the lost and unaccounted for water volume by the total non-irrigation water use for the calendar year and multiply the result by 100.
3. If the product from D.1. is *less than* ten percent, the result is the volumetric allotment, in acre-feet, for lost and unaccounted for water for the calendar year; **or** if the product from D.1. is *greater than* ten percent, multiply the total water use for the calendar year by ten percent. The result is the volumetric **Lost and Unaccounted For Water Allotment**, in acre-feet, for the calendar year.

D. TOTAL GPCD PROGRAM COMPONENT REQUIREMENT

Sum the **Residential Allotment**, the **Non-Residential Allotment**, and the **Lost and Unaccounted For Water Allotment**, the result is the **TOTAL GPCD PROGRAM COMPONENT REQUIREMENT**, in acre-feet for the calendar year.

APPENDIX 5-C.2
COMPONENT GALLONS PER CAPITA PER DAY CALCULATION EXAMPLE
PHOENIX ACTIVE MANAGEMENT AREA

Example: The existing population is comprised of the residents served in calendar year 2000. The new population is comprised of those residents added in 2001 and after (i.e., for calendar year 2002, the new population would be the 2001 population plus those added in 2002).

1)	**EXISTING HOUSING UNITS/POPULATION**		
a.	Existing (2000) SF Housing Units	=	23,089
b.	Existing (2000) MF Housing Units	=	4,132
c.	TOTAL EXISTING RESIDENTIAL HOUSING UNITS	=	27,221
d.	Existing (2000) SF Population	=	72,554
e.	Existing (2000) MF Population	=	8,785
f.	TOTAL EXISTING RESIDENTIAL POPULATION	=	82,339
2)	**NEW HOUSING UNITS/POPULATION**		
a.	New SF Housing Units Added since June 30, 2000	=	7,717
b.	New MF Housing Units Added since June 30, 2000	=	1,381
c.	TOTAL NEW RESIDENTIAL HOUSING UNITS	=	9,098
d.	New SF Population Added since June 30, 2000	=	24,258
e.	New MF Population Added since June 30, 2000	=	2,937
f.	TOTAL NEW RESIDENTIAL POPULATION	=	27,195
3)	**COMPONENT RATES**		
a.	Existing Residential GPCD Component	=	132 (1)
b.	New Residential SF Interior GPCD Component	=	57 (2)
c.	New Residential MF Interior GPCD Component	=	57 (2)
d.	New Residential SF Exterior GPHUD Component	=	178 (2)
e.	New Residential MF Exterior GPHUD Component	=	77 (2)
f.	Non-Residential GPCD Component	=	53 (3)
4)	**COMPONENT ALLOTMENTS IN ACRE-FEET:**		
a.	Existing Residential Component = 81,339 pop x 132 GPCD x 365/325851	=	12,026 AF/YR
b.	New SF Interior Component = 24,258 pop x 57 GPCD x 365/325851	=	1,549 AF/YR
c.	New MF Interior Component = 2,937 pop x 57 GPCD x 365/325851	=	187 AF/YR
d.	New SF Exterior Component = 7,717 hu x 178 GPHUD x 365/325851	=	1,539 AF/YR
e.	New MF Exterior Component = 1,381 hu x 77 GPHUD x 365/325851	=	119 AF/YR
f.	RESIDENTIAL ALLOTMENT	=	15,420 AF/YR
g.	Non-Residential Component = 108,534 pop x 53 GPCD x 365/325851	=	6,443 AF/YR
h.	NON-RESIDENTIAL ALLOTMENT	=	6,443 AF/YR
i.	Lost/Unaccounted Water Component ≤ 10 percent of total annual use	=	2,196 (4) AF
j.	LOST/UNACCOUNTED FOR ALLOTMENT	=	2,196 AF
k.	TOTAL ALLOTMENT = Res. Component + Non-Res. Component + L/U	=	24,059 AF

AF = acre-feet

(1) The existing GPCD components are listed in Appendix 5F for each large provider. The number given here is for example purposes only.

(2) The New Single Family and Multifamily interior GPCD and exterior GPHUD components are based on the Requirements for the Phoenix AMA described in Section 5.7.1.1.

(3) The Non-Residential GPCD Component will remain constant from the Second Management Plan Final Non-Residential Requirements and are listed in Appendix 5H. The number given here is for example purposes only.

(4) Lost Water Component will vary each year depending on Total Water Use. Cannot exceed 10 percent of Total Use.

APPENDIX 5-D
1995 LARGE MUNICIPAL PROVIDERS POPULATION
1992-1996 AVERAGE WATER USE
PHOENIX ACTIVE MANAGEMENT AREA

Large Municipal Provider	1995 Service Area Population	92 - 96 Avg. Annual Use[1] (AF)	1995 Residential Use (AF)	1995 Non-Residential Use (AF)	92 - 96 Total Use[1] (GPCD)
Adaman Mutual Water Co. [2]	568	244	53	145	311
AJ Water Facilities District	7,570	943	475	322	111
City of Avondale	21,912	3,648	2,645	799	154
AWC - Apache Junction	21,954	4,975	2,623	1,884	206
AWC - Superior	3,485	449	290	120	115
AWC - White Tanks	1,987	355	290	36	160
Berneil Water Company	1,400	856	816	29	591
Town of Buckeye	4,500	980	296	176	209
Carefree Water Company	1,838	1,309	685	503	665
Cave Creek Water Company	2,532	667	313	324	276
City of Chandler	131,946	31,137	18,391	10,080	225
Chaparral City Water Co	13,728	3,984	2,325	1,149	284
Citizens Utilities: Agua Fria	8,485	1,309	610	616	176
Citizens Utilities: Sun City	42,928	13,232	9,784	2,633	273
Citizens Utilities: Sun City West	21,064	5,465	4247	695	234
Desert Hills Water Company [2]	1,418	234	154	74	171
City of El Mirage	11,030	2,101	557	300	173
Town of Gilbert	57,335	13,079	8,479	2,969	222

APPENDIX 5-D
1995 LARGE MUNICIPAL PROVIDERS POPULATION
1992-1996 AVERAGE WATER USE
PHOENIX ACTIVE MANAGEMENT AREA

Large Municipal Provider	1995 Service Area Population	92 - 96 Avg. Annual Use[1] (AF)	1995 Residential Use (AF)	1995 Non-Residential Use (AF)	92 - 96 Total Use[1] (GPCD)
City of Glendale	179,233	39,969	25,837	9,580	210
City of Goodyear	4,536	1,318	526	746	269
H2O Water Company[2]	1,311	237	218	28	167
Litchfield Park Service Co.	5,178	2,240	1,155	870	464
Luke Air Force Base	4,966	1,559	517	549	280
City of Mesa	389,761	78,134	52,261	19,871	187
Paradise Valley Water Company	8,325	8,712	5,646	2,498	904
City of Peoria	70,969	14,199	8,346	3,941	196
City of Phoenix	1,149,486	277,857	170,370	79,644	226
Pima Utilities	9,919	4,607	1,546	2,794	449
Queen Creek Water Company	3,177	1,077	585	119	308
Rio Verde Utilities	1,353	1,693	352	1,074	1165
Rose Valley Water Company[2]	760	169	186	33	258
City of Scottsdale	167,961	58,345	33,865	17,897	327
Sunrise Water Company[2]	1,520	272	223	20	169
City of Tempe	158,695	49,450	22,962	23,244	281
City of Tolleson	4,245	2,025	621	1,271	410
Valley Utilities	2,505	370	332	30	118
Williams Gateway Airpark	503	922	0	850	858

1 Includes Effluent and Spillwater
2 Transitioning from a Small Municipal Provider to a Large Municipal Provider.

APPENDIX 5-E
EXISTING RESIDENTIAL CONSERVATION POTENTIAL
LARGE MUNICIPAL PROVIDERS
PHOENIX ACTIVE MANAGEMENT AREA

Provider	Conservation Potential
Adaman Mutual Water Company	Minimum
Apache Junction Water Facilities District	No Potential
City of Avondale	Minimum
AWC - Apache Junction	No Potential
AWC - Superior	No Potential
AWC - White Tanks	Moderate
Berneil Water Company	Maximum
Town of Buckeye	Minimum
Carefree Water Company	Maximum
Cave Creek Water Company	Minimum
City of Chandler	Moderate
Chaparral City Water Company	Moderate
Citizens Utility - Agua Fria	No Potential
Citizens Utility - Sun City	Minimum
Citizens Utility - Sun City West	Minimum
Desert Hills Water Company	Minimum
City of El Mirage	Minimum
Town of Gilbert	Moderate
City of Glendale	Moderate
City of Goodyear	Minimum
H2O Water Company	Minimum
Litchfield Park Service Company	Maximum
Luke Air Force Base	Moderate
City of Mesa	Minimum
Paradise Valley Water Company	Maximum
City of Peoria	Minimum
City of Phoenix	Moderate
Pima Utilities	Minimum
Queen Creek Water Company	Moderate
Rio Verde Utilities	Minimum
Rose Valley Water Company	Maximum
City of Scottsdale	Moderate
Sunrise Water Company	Moderate
City of Tempe	Moderate
City of Tolleson	Moderate
Valley Utilities	Minimum
Williams Gateway Airpark	No Potential

APPENDIX 5-F
THIRD MANAGEMENT PLAN
EXISTING RESIDENTIAL GALLONS PER CAPITA PER DAY REQUIREMENT
PHOENIX ACTIVE MANAGEMENT AREA

Large Municipal Provider	TMP 1 (2002 - 2004)	TMP 2 (2005 - 2009)	TMP Final (2010 - 4MP)
Adaman Mutual Water Company	108	107	105
AJ Water Facilities District	100	100	100
City of Avondale	118	109	100
AWC - Apache Junction	100	100	100
AWC - Superior	100	100	100
AWC - White Tanks	136	123	111
Berneil Water Company	421	407	392
Town of Buckeye	100	100	100
Carefree Water Company	205	198	191
Cave Creek Water Company	111	109	107
City of Chandler	127	123	119
Chaparral City Water Company	140	136	133
Citizens Utilities: Agua Fria	105	103	100
Citizens Utilities: Sun City	192	184	176
Citizens Utilities: Sun City West	160	157	155
Desert Hills Water Company	102	101	100
City of El Mirage	113	107	100
Town of Gilbert	138	135	131
City of Glendale	124	121	118

APPENDIX 5-F
THIRD MANAGEMENT PLAN
EXISTING RESIDENTIAL GALLONS PER CAPITA PER DAY REQUIREMENT
PHOENIX ACTIVE MANAGEMENT AREA

Large Municipal Provider	TMP 1 (2002 - 2004)	TMP 2 (2005 - 2009)	TMP Final (2010 - 4MP)
City of Goodyear	136	118	100
H2O Water Company	100	100	100
Litchfield Park Service Co.	178	172	165
Luke Air Force Base	100	100	100
City of Mesa	130	116	103
Paradise Valley Water Co.	436	421	406
City of Peoria	130	116	102
City of Phoenix	135	129	123
Pima Utilities	133	127	122
Queen Creek Water Company	194	175	156
Rio Verde Utilities	141	139	137
Rose Valley Water Company	172	166	160
City of Scottsdale	171	166	162
Sunrise Water Company	133	129	124
City of Tempe	128	124	121
City of Tolleson	123	120	117
Valley Utilities	116	108	100
Williams Gateway Airpark	101	101	100

APPENDIX 5-G.1
EXTERIOR WATER USE MODEL FOR NEW RESIDENTIAL DEVELOPMENT
SINGLE FAMILY HOUSING UNITS
PHOENIX ACTIVE MANAGEMENT AREA

SWIMMING POOLS

Average Water Consumption

A. Evaporation[1]

1. Average January 1988 - December 1996 Reference Evapotranspiration (ETo) = 80.17 inches/year
2. Average January 1988 - December 1996 Rainfall = 9.74 inches/year
3. Average pool size = 400 square feet
4. *Calculation:*

80.17 in/yr ETo - 9.74 in/yr Rainfall	=	70.43 in/yr
70.43 in/yr / 12 inches per foot	=	5.87 ft/yr
400 sq ft pool * 5.87 ft/yr * 7.48 gal/cuft	=	**17,560 gal/yr**

B. Backwash[2]

1. Recommended backwash 2 to 4 minutes 23 times per year at 75 to 80 gallons per minute
2. *Calculation*:

2 minutes * 75 gpm * 23 times/year	=	**3,450 gal/yr**

C. Initial Fill[2]

1. Average Pool Size = 400 square feet of surface area by 5 foot depth
2. Fill averaged over the 10 year management period
3. *Calculation*:

400 sq ft * 5 ft * 7.48 gal/cuft / 10 years	=	**1496 gal/pool/yr**

D. Maintenance Refill[2]

1. Average Pool Size = 400 square feet of surface area by 5 foot depth.
2. Allow for complete refill once every 10 years - ADWR assumption
3. *Calculation*:

400 sq ft * 5 ft * 7.48 gal/cuft	=	14,960 gal/pool/yr
14,960 gal/pool/yr / 10 years	=	**1,496 gal/yr**

E. TOTAL ANNUAL DEMAND FOR NEW POOLS

1. *Calculation*:

Evaporation	=	17,560 gal/yr
Backwash	=	3,450 gal/yr
Initial Fill	=	1,496 gal/yr
Maintenance/Refill	=	1,496 gal/yr
TOTAL	=	**24,002 gal/yr**

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1 ETo and Rainfall from Arizona Meteorological Network, Phoenix stations (www.ag.arizona.edu/AZMET)

2 Data from National Spa & Pool Institute, ADWR Phoenix AMA telephone interview, December 1995.

APPENDIX 5-G.1 *(continued)*
EXTERIOR WATER USE MODEL FOR NEW RESIDENTIAL DEVELOPMENT
SINGLE FAMILY HOUSING UNITS
PHOENIX ACTIVE MANAGEMENT AREA

SWIMMING POOLS

F. Installation Rates[3]

1. *Calculation*:

SWIMMING POOL INSTALLATION
PHOENIX ACTIVE MANAGEMENT AREA

Year	Annual # Pools Installed	Annual Housing Unit Completions	% of Total New Housing Units with a Pool
1992	5,798	13,546	43%
1993	7,323	17,296	42%
1994	9,760	21,448	46%
1995	11,063	24,102	46%
Average	**33,944**	**76,392**	**44%**

Total Annual Pool Demand = 24,002 gal/yr * 44% = **10,561 gal/yr**

G. **DEMAND PER HOUSING UNIT PER DAY**

10,561 gal/yr / 365 days = **28.93 GPHUD**

[3] Based on number of pools installed in single family residences (by city) from NSPI, Phoenix AMA, 1992 - 1995 and Housing Units Completion data from Maricopa Association of Governments, 1992 - 1995

APPENDIX 5-G.2
EXTERIOR WATER USE MODEL FOR NEW RESIDENTIAL DEVELOPMENT
SINGLE FAMILY HOUSING UNITS
PHOENIX ACTIVE MANAGEMENT AREA

EVAPORATIVE COOLING

Average Water Consumption[1]

A. Average Annual Demand[2]

1. Coolers with Bleed-Off Systems

2,906 cooling hours per season @ 8 gal/hour	=	23,462 gallons
59.02% utilize bleed-off * 23,462 gal	=	13,846 gallons

2. Coolers without Bleed-Off Systems

2,906 cooling hours per season @ 4 gal/hour	=	11,621 gallons
40.98% without bleed-off * 11,621 gal	=	4,763 gallons

3. *Calculation*:

13,846 gallons + 4,763 gallons	=	**18,609 gallons**

B. Installation[3]

1. Because these data are for *existing* housing units, the AMA has taken the data and made the following assumptions for the occurrence of evaporative cooling in ***new*** housing units:

85 percent use air conditioning only
15 percent use a combination of evaporative coolers and air conditioning
0 percent use evaporative cooling only

2. *Calculation*:

Of the 15 percent with evaporative cooling, assume use occurs during 66 percent of the cooling period = 9 percent

18,609 gallons * 9 percent per year	=	**1,675 gallons/year**

C. **DEMAND PER HOUSING UNIT PER DAY**

1. *Calculation*:

1,675 gal/yr / 365 days/yr	=	**4.59 GPHUD**

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1 M.. Karpisak, Babcock, T., France, G., Zauderer, J., Hopf, S. and Foster, K., "Evaporative Cooler Water Use In Phoenix, Journal, Vol. 90, Issue 4 (April 1998), American Water Works Association.

2 Numbers may not total due to rounding (59.016393442623% & 40.9836065573771%).

3 City of Phoenix telephone survey, 1993.

APPENDIX 5-G.3
EXTERIOR WATER USE MODEL FOR NEW RESIDENTIAL DEVELOPMENT
SINGLE FAMILY HOUSING UNITS
PHOENIX ACTIVE MANAGEMENT AREA

LANDSCAPING

(Assumes a 7500 square foot lot)

Average Water Consumption

A. Turf

1. Turfed area of 900 square feet assumed as the average for all new housing units in the Phoenix AMA.
2. Turf application rate assumes water application at 60% of average annual reference evapotranspiration (ETo) and effective Rainfall at 50% of annual average.
3. Irrigation efficiency for residential sprinkler systems at 75%
4. *Calculation*:

900 sq ft * 3.66 af/ac * 7.48 gal/cuft	=	24,639 gallons/year
24,639 gal/yr / 75% irrigation efficiency	=	**32,987 gallons/year**

B. Trees

1. Water application based on 20% of average growing season (April - September) reference ETo and effective rainfall at 10% of growing season average
2. Assume 14 foot canopy size - requires 98 gallons per inch in June, the month with the lowest rainfall and highest ETo[1].
3. Assume 9 low water using trees
4. Assume 70% irrigation efficiency for residential drip irrigation
5. *Calculation*:

(((56.82 in/yr * 20%)-(3.71 in/yr * 10%))*98 gal/in)/52 weeks)	=	19.77 gallons/week
9 trees * 19.77 gal/wk	=	9,251.00 gallons/year
9,251 gal/yr / 70% irrigation efficiency	=	**13,215.00 gallons/year**

C. Shrubs

1. Water application based on 20% of average growing season (April - September) reference ETo and effective rainfall at 10% of growing season average
2. Assume 4 foot canopy size - requires 8 gallons per inch in June, the month with the lowest rainfall and highest ETo[1].
3. Assume 23 low water using shrubs
4. Assume 70% irrigation efficiency for residential drip irrigation
5. *Calculation*:

(((56.82 in/yr * 20%)-(3.71 in/yr * 10%))* 8 gal/in)/52 weeks)	=	1.65 gallons/week
23 shrubs * 1.65 gal/wk	=	1,970.00 gallons/year
1,970 gal/yr / 70% irrigation efficiency	=	**2,814.00 gallons/year**

D. Additional Landscaped Area

1. Water application based on 19.5% of average annual reference ETo and effective rainfall at 10% of annual average
2. Assume 500 square foot area
3. Assume 56% installation rate (only applied to housing units without pools)
4. *Calculation*:

((80.17 in/yr * 20%)-(9.74 in/yr * 10%))		
/12 inches * 500 sqft * 7.48 cuft/gal	=	4,694.00 gallons/year
4,694 gal/yr / 70% irrigation efficiency	=	6,705.00 gallons/year
6,705 gal/yr * 56% installation rate	=	**3,755.00 gallons/year**

E. **DEMAND PER HOUSING UNIT PER DAY**

1. *Calculation*:

32,987 gal/yr + 13,215 gal/yr + 2,814 gal/yr + 3,755 gal/yr	=	52,771.00 gallons/year
52,771 gal/yr / 365 days	=	**144.58 GPHUD**

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[1] Pima County Cooperative Extension Service, Low4 Program, Landscape water Conservation Workshop materials: "How to Develop a Drip Irrigation Schedule" and "Plant Water Requirements Tucson, Arizona (adjusted for the Phoenix AMA)," unpublished.

APPENDIX 5-H
THIRD MANAGEMENT PLAN
NON-RESIDENTIAL GALLONS PER CAPITA PER DAY REQUIREMENT
PHOENIX ACTIVE MANAGEMENT AREA

Large Municipal Provider	TMP Non-Residential GPCD
Adaman Mutual Water Company	30
AJ Water Facilities District	62
City of Avondale	36
AWC - Apache Junction	34
AWC - Superior	18
AWC - White Tanks	18
Berneil Water Company	18
Town of Buckeye	47
Carefree Water Company	341
Cave Creek Water Company	45
City of Chandler	66
Chaparral City Water Company	119
Citizens Utilities: Agua Fria	19
Citizens Utilities: Sun City	50
Citizens Utilities: Sun City West	26
Desert Hills Water Company	18
City of El Mirage	39
Town of Gilbert	53
City of Glendale	52
City of Goodyear	117
H2O Water Company	18
Litchfield Park Service Co.	124
Luke Air Force Base	184
City of Mesa	51
Paradise Valley Water Co.	240
City of Peoria	45
City of Phoenix	66
Pima Utilities	287
Queen Creek Water Company	30
Rio Verde Utilities	855
Rose Valley Water Company	18
City of Scottsdale	71
Sunrise Water Company	18
City of Tempe	113
City of Tolleson	35
Valley Utilities	18
Williams Gateway Airpark	308

APPENDIX 5-I.1

RESIDENTIAL INTERIOR AND EXTERIOR STANDARD REASONABLE CONSERVATION MEASURES

WATER AUDIT AND FIXTURE RETROFIT PROGRAM FOR EXISTING RESIDENTIAL CUSTOMERS

Description: *Water provider staff or hired consultants visit residences, or resident performs self-audit, to examine water use practices, detect leaks, make recommendations for improved efficiency and install retrofit devices. Water use reduction from installation of devices depends on the life of the device, for example toilet flapper normally last about five years.*

Implementation Levels: *Minimum Conservation Potential: The provider shall notify all existing residential customers of the availability of a self-audit and retrofit kit. The provider shall distribute a kit to all customers who request one. Moderate Conservation Potential: The provider shall perform minimum level requirement, plus a minimum of 10 percent of all pre-1980 housing units shall be audited and retrofitted, free of charge to the customer, by January 1, 2010 either by the homeowner or by a trained auditor. Maximum Conservation Potential: The provider shall perform minimum level requirement, plus a minimum of 20 percent of all pre-1980 housing units shall be audited and retrofitted, free of charge to the customer, by January 1, 2010 either by the homeowner or by a trained auditor.*

The self-audit and retrofit kit shall include, at a minimum, toilet leak detection dye tabs, instructions on measuring flow from fixtures, leak repair and fixture replacement instructions, advice on behavioral changes to save water, a toilet conservation device, a low flow showerhead and faucet aerators. The audit shall include measurement of flow rates from plumbing fixtures and a check for leaks.

The housing units audited or retrofitted to meet this requirement shall not include any housing unit that was audited or retrofitted prior to acceptance into this program for the third management period unless the water use of the housing unit is inefficient.

Monitoring and Reporting Requirements: *The Annual Report required by A.R.S. § 45-632 shall include a report containing information as agreed to at the time of acceptance into the Non-Per Capita Conservation Program sufficient to assess program effectiveness, including information on the method(s) used to contact customers, the annual number of audits and retrofits performed and self-audit kits sent out, and an estimate of the number and volume of leaks found and repaired.*

ORDINANCE OR CONDITION OF NEW SERVICE PROHIBITING INSTALLATION OR REPLACEMENT OF PLUMBING FIXTURES IN RESIDENTIAL HOUSING UNITS UNLESS FIXTURES MEET WATER SAVING STANDARDS

Description: *The provider adopts an ordinance or establishes conditions of new service prohibiting the installation of plumbing fixtures in new residential housing units and the replacement of plumbing fixtures in existing residential housing units unless the fixtures meet water efficiency standards. Plumbing fixtures to be covered and their respective maximum use rates are as follows:*

- *Faucets-kitchen and lavatory* *3.0 gpm*
- *Replacement aerators - kitchen and lavatory* *3.0 gpm*
- *Metering faucets* *.25 gpc*
- *Toilets* *1.6 gpf*
- *Showerheads* *3.0 gpm*
- *Evaporative cooling systems/Decorative fountains must be equipped with water recycling or reuse systems*

Waivers may be available for unusual circumstances (e.g., historic buildings or areas where sanitation or health codes may conflict).

Implementation: *The provider shall adopt and enforce a plumbing ordinance or establish conditions of new service prohibiting the installation of plumbing fixtures in new housing units and the replacement of plumbing fixtures in existing housing units unless the fixtures meet the water savings performance standards outlined in the description above. Implementation of this RCM shall include a proactive inspection and enforcement program that ensures compliance with the applicable ordinance or conditions of service.*

Monitoring/Reporting: *The annual report required by A.R.S. § 45-632 shall include a copy of the current local plumbing ordinance or sample conditions of new service agreement that meet the implementation requirements for this RCM. This shall be submitted one time only (the first year of compliance with the Non-Per Capita Conservation Program) unless there is an amendment to the ordinance or agreement.*

In addition, the provider shall include in the annual report evidence of implementation of the applicable ordinance or conditions of service by reporting the number of certificates of occupancy issued in the service area, the number of permits issued for the replacement of plumbing fixtures in existing housing units, the number of housing units inspected, the number and type of plumbing fixture violations and any enforcement action taken.

A provider that is not a city or town shall also collect and examine all inspection records for new permits issued by governmental entities for the installation of original plumbing fixtures in new housing units and the replacement of plumbing fixtures in existing housing units within the provider's service area and report any plumbing code or plumbing ordinance violations that have not been enforced to the governing body of the entity charged with enforcing the code or ordinance.

Note: This documentation will be used to evaluate the effectiveness of the RCM. It will not be used to require any modification of the negotiated non-per capita conservation program agreement.

AUDIT PROGRAM FOR EXISTING RESIDENTIAL CUSTOMERS

Description: *Trained auditors visit residences to examine outdoor water use practices, or materials are supplied for a self-audit of outdoor water use practices. Areas of emphasis are irrigation scheduling advice, sprinkler and drip systems inspection, evaporative cooler inspection, information on improving water retaining capacity of the soil, information on Xeriscape™ concepts and swimming pool maintenance and evaporation control (i.e., pool covers). This program shall be designed to target those customers with the greatest conservation potential.*

Implementation Levels: *Minimum Conservation Potential: The provider shall notify all existing residential customers of the availability of an exterior water use self-audit packet. The packet shall include at a minimum information on checking irrigation systems for efficiency and leaks, information on checking evaporative coolers for efficiency and leaks, irrigation schedules, and information on Xeriscape™. The provider shall distribute a packet to all customers who request one. Moderate Conservation Potential: The provider shall implement the minimum level program plus 5 percent of total housing units in existence when the provider is accepted into this program shall be audited either by the homeowner or a trained auditor free of charge to the customer. Audits shall be completed by January 1, 2010. Maximum Conservation Potential: The provider shall implement the minimum level program plus 10 percent of total housing units in existence when the provider is accepted into this program shall be audited either by the homeowner or a trained auditor free of charge to the customer. The audits shall be completed by January 1, 2010.*

For both the moderate and maximum levels of implementation, the ratio of audited multifamily housing units to audited single family housing units shall be no greater than the ratio of total multifamily housing units to total single family housing units in the entire service area.

The housing units audited to meet this requirement shall not include any housing unit that was audited prior to acceptance into this program for the third management period unless the water use of the housing unit is inefficient.

Monitoring and Reporting Requirements: *The Annual Report required by A.R.S. § 45-632 shall include a report on the number of housing units audited, plus a follow-up survey of a statistically significant sample of those audited, as agreed to by the director, to determine if audited customers have implemented any changes in exterior use habits, irrigation system, or landscaping.*

LANDSCAPE WATERING ADVICE PROGRAM FOR EXISTING AND NEW RESIDENTIAL CUSTOMERS

Description: *Landscape watering advice helps existing and new homeowners to irrigate efficiently. The components of a landscape watering advice program may include guidelines for irrigation scheduling based on time of day or season and dissemination of weather-based watering information (e.g.: ET rate based on solar radiation, temperature, rainfall and relative humidity). Programs that encourage watering only every other day and only at certain times of day have also been shown to save water.*

Implementation Levels: *Minimum Conservation Potential: The provider shall notify all existing and new residential customers of the availability of information from the provider regarding the general benefits of efficient landscape watering including water and cost savings. This notification shall be through water bill inserts printed directly on bills in a prominent manner, or some other mechanism approved by the director. The provider shall distribute the landscape watering information to all customers who request it. Moderate Conservation Potential: The provider shall mail the landscape watering information to all existing and new residential customers or make it available to the customers at local distribution centers such as schools, libraries, plant nurseries, or model homes and notify all residential customers of the location of the information. Maximum Conservation Potential: The provider shall implement the moderate level programs plus hold workshops on landscape irrigation and/or have a landscape advisor available for telephone advice to customers and/or develop a conservation goal-billing program designed to assist residential customers determine the requirements for landscape water use. The provider shall hold at least one workshop annually for every 100,000 persons in the provider's service area. If there are less than 100,000 persons, the provider shall hold one workshop annually. If the telephone advice option is chosen, the provider shall publicize the telephone number at least once quarterly.*

Monitoring and Reporting Requirements: *The Annual Report required by A.R.S. § 45-632 shall include a report on the methods used to contact customers, the number of pamphlets/brochures distributed, the number of workshops conducted, and the number of phone calls taken to give landscape irrigation advice.*

ORDINANCE OR CONDITION OF NEW SERVICE FOR MODEL HOMES IN NEW RESIDENTIAL DEVELOPMENTS

Description: *Model homes in new developments are required to use low water use landscaping in front yards to set the tone for landscaping by homeowners. This measure helps to educate home buyers about the possibilities of appropriate landscaping for the area. Provision of information on low water use landscaping and/or landscape packages offered to new home buyers reinforces the message.*

Implementation: *The provider shall adopt and enforce an ordinance or establish conditions of new service requiring that new model homes meet water efficient standards. These include limitation of water-intensive landscaping to 20 percent of landscapable area, location of such landscaping where it is functionally useful, use of low water use plants from the Department's Low Water Use/Drought Tolerant Plant List (Appendix 5-L) in the remaining area, and use of efficient irrigation systems in all areas. Information on low water use landscaping and/or landscape packages with low water use landscaping shall be made available and displayed in a prominent manner at the model home site. For purposes of this RCM, the term "water-intensive landscaped area" means an area of land that is watered with a permanent water application system and planted primarily with plants not listed in Appendix 5-L (Low Water Use/Drought Tolerant Plant List), or any modifications to the list, and the total surface area of all water features (including swimming pools of any size, fountains, ponds, water courses, waterfalls, and other artificial water structures) filled or refilled with water from any source.*

Monitoring and Reporting Requirements: *The Annual Report required by A.R.S. § 45-632 shall include a copy of the ordinance or sample conditions of new service agreement used to meet the implementation requirements for this RCM. This shall be submitted one time only (the first year of compliance with the Non-Per Capita Conservation Program) unless there is an amendment to the ordinance or agreement. Each calendar year the provider shall submit a report on the number and location of model homes built during the reporting year.*

In addition to the annual reporting requirements, the provider shall maintain and submit to the Department upon request a copy of the landscape packages or landscape information provided by each developer to new home buyers.

PROHIBIT THE CREATION OF NEW COVENANTS, CONDITIONS AND RESTRICTIONS WHICH REQUIRE THE USE OF WATER-INTENSIVE LANDSCAPING OR WHICH PROHIBIT THE USE OF LOW WATER USE LANDSCAPING IN NEW RESIDENTIAL DEVELOPMENTS

Description: *In an effort to promote and facilitate installation of water conserving landscaping, the provider refuses to serve water to new subdivisions that have covenants, conditions and restrictions that require the use of water-intensive landscaping or prohibit low water use landscaping. This would not prohibit water-intensive landscaping, but would allow homeowners to install the landscaping of their choice.*

Implementation: *The provider shall adopt and enforce an ordinance or establish conditions of new service requiring that developers of new subdivisions neither forbid low water use landscaping nor require water-intensive landscaping through covenants, conditions and restrictions.*

Monitoring and Reporting Requirements: *The Annual Report required by A.R.S. § 45-632 shall include a copy of the ordinance or sample conditions of new service agreement used to meet the implementation requirements for this RCM. This shall be submitted one time only (the first year of compliance with the Non-Per Capita Conservation Program) unless there is an amendment to the ordinance or agreement.*

RESIDENTIAL EXTERIOR
STANDARD RCM CHOICE (1 OF 3)

ORDINANCE OR CONDITIONS OF NEW SERVICE LIMITING USE OF TURF AND OTHER WATER-INTENSIVE LANDSCAPING IN NEW MULTIFAMILY DEVELOPMENTS

Description: *The provider adopts an ordinance or establishes conditions of new service that limits and set criteria for water-intensive landscaping in multifamily developments.*

Implementation: *The provider shall adopt and enforce and ordinance or establish conditions of new service requiring that new multifamily developments meet water conserving landscaping standards, including limitation of water-intensive landscaping to individual patio areas and those areas used for active recreational purposes, and prohibiting water-intensive landscaping in all other areas, including common areas not used for active recreational purposes. In addition, the ordinance or conditions of new service shall require the use of efficient irrigation systems.* ***This RCM can be chosen only by providers with significant conservation potential in the new multifamily sector.***

STANDARD RCM CHOICE (2 OF 3)

ORDINANCE OR CONDITION OF NEW SERVICE LIMITING USE OF TURF AND OTHER WATER-INTENSIVE LANDSCAPING IN COMMON AREAS OF NEW SINGLE FAMILY AND MULTIFAMILY DEVELOPMENTS

Description: *The provider adopts an ordinance or establishes conditions of new service that limits turf and other water-intensive landscaping within common areas of new single family and multifamily developments.*

Implementation: *The provider shall adopt and enforce an ordinance or establish conditions of new service requiring that water-intensive landscaping within all common areas of new housing developments not exceed 10 percent of the total landscapable area of the common area. Those areas used for active recreational purposes shall not be included in calculating the common area.*

STANDARD RCM CHOICE (3 OF 3)

REBATE PROGRAM FOR NEW RESIDENTIAL CUSTOMERS

Description: *A rebate is offered for new landscapes that are designed to be efficient in water use. The landscapes may be required to meet pre-established design, plant selection, installation and maintenance standards.*

Implementation: *The provider shall offer all new residential customers a rebate for installing low water use landscaping. The rebate shall be in the form of cash, a reduction in water bills, or a waiver or rebate of the development (hookup) fee.*

Monitoring and Reporting Requirements: *The Annual Report required by A.R.S. § 45-632 shall include the number of rebates given, the amount of money distributed to participating customers and an estimate of water savings for the reporting year.*

APPENDIX 5-I.2

NON-RESIDENTIAL INTERIOR AND EXTERIOR STANDARD REASONABLE CONSERVATION MEASURES

INTERIOR AUDIT PROGRAM FOR EXISTING FACILITIES

***Description**: The provider offers audits conducted by trained personnel or instructions for a self-audit to existing non-residential customers (excluding turf-related facilities, large scale cooling facilities, and landscaped public rights-of-way). These audits will be designed to include personal sanitation, cooling, and process water use as applicable for each facility. Audits for personal sanitation include visual leak detection, water budget analysis, recommendations for improved water use efficiency, staff education, and a retrofit analysis; cooling audits include education to determine system conductivity, maintenance practices, system operation, and design characteristics. Process water uses are audited where conservation potential exists. After the audit has been conducted the facility compiles information into a post-audit report to be submitted to the provider. Provider staff reviews and makes recommendations to improve water usage at the facility.*

***Implementation:** The provider shall notify all existing non-residential customers (excluding turf-related facilities, large scale cooling facilities and landscaped public rights-of-way) of the availability of an audit performed on-site free of charge by staff or hired consultants, or a self-audit packet that at a minimum shall include information on how to conduct a self-audit and complete a post-audit report to be returned to the provider. The provider shall evaluate each analysis and make recommendations to the facility for water conservation potential. Existing non-residential customers that collectively receive at least 20 percent of the total non-residential water use in the provider's service area (excluding turf-related facilities, large scale cooling facilities, and landscaped public rights-of-way) shall be audited either by the non-residential customer or by trained personnel. The measurement of 20 percent of non-residential use shall be based on the most current water use records available when the provider enters the program. Annual progress requirements will be negotiated between the Department and the provider with the provider required to complete all the necessary audits by January 1, 2010.* ***This RCM shall be implemented in conjunction with the Exterior Audit for Existing Facilities**.*

***Monitoring/Reporting:** The Annual Report required by A.R.S. § 45-632 shall include the number of facilities audited by the provider and the number of facilities that conducted a self-audit and returned a post-audit report to the provider within the reporting year. The annual report shall include the name and type of facility audited and its annual water use for the previous year. The provider shall maintain and make available for the Department's inspection the name, address, phone number, contact person, and audit report for each facility audited.*

In addition to the annual reporting requirements, the provider shall collect, maintain and submit to the Department upon request information on selected facilities that utilize this program in order to allow an effective evaluation of the program. The number of records and type of data to be maintained will be determined at the time the provider enters the program. Note: This evaluation will be used to improve effectiveness of RCMs. It will not be used to require any modification of the negotiated Non-Per Capita Conservation Program agreement.

ORDINANCE OR CONDITION OF NEW SERVICE PROHIBITING INSTALLATION OR REPLACEMENT OF PLUMBING FIXTURES IN NON-RESIDENTIAL FACILITIES UNLESS FIXTURES MEET WATER SAVING STANDARDS

Description: *Provider adopts an ordinance or establishes conditions of new service prohibiting the installation of plumbing fixtures in new non-residential facilities and the replacement of plumbing fixtures in existing non-residential facilities unless the fixtures meet water efficiency standards. Plumbing fixtures to be covered and their respective maximum use rates are as the follows:*

- *Faucets-kitchen and lavatory* *3.0 gpm*
- *Replacement aerators - kitchen and lavatory* *3.0 gpm*
- *Metering faucets* *.25 gpc*
- *Gravity tank-type and flushometer toilets* *1.6 gpf*
- *Electromechanical hydraulic toilets* *1.6 gpf*
- *Blowout toilets* *1.6 gpf*
- *Showerheads* *3.0 gpm*
- *Urinals* *1.0 gpm*
  (automatic, timed, and self-flushing urinals are prohibited)
- *Evaporative cooling systems/Decorative fountains must be equipped with water recycling or reuse systems*

Waivers may be available for unusual circumstances (e.g., hospitals and other areas where sanitation or health codes may conflict).

Implementation: *The provider shall adopt and enforce a plumbing ordinance or establish conditions of new service prohibiting the installation of plumbing fixtures in new non-residential facilities and the replacement fixtures in existing non-residential facilities unless the fixtures meet the water savings performance standards outlined in the description above. Implementation of this RCM shall include a proactive inspection and enforcement program that ensures compliance with the applicable ordinance or conditions of service.*

Monitoring/Reporting: *The annual report required by A.R.S. § 45-632 shall include a copy of the current local plumbing ordinance or sample conditions of new service agreement that meet the implementation requirements for this RCM. This shall be submitted one time only (the first year of compliance with the Non-Per Capita Conservation Program) unless there is an amendment to the ordinance or agreement.*

In addition, the provider shall include in the annual report evidence of implementation of the applicable ordinance or conditions of service by reporting the number of certificates of occupancy issued in the service area, the number of permits issued for the replacement of plumbing fixtures in existing non-residential facilities, the number of non-residential facilities inspected, the number and type of plumbing fixture violations and any enforcement action taken.

A provider that is not a city or town shall also collect and examine all inspection records for new permits issued by governmental entities for the installation of original plumbing fixtures in new facilities and the replacement of plumbing fixtures in existing non-residential facilities within the provider's service area and report any plumbing code or plumbing ordinance violations that have not been enforced to the governing body of the entity charged with enforcing the code or ordinance.

Note: This documentation will be used to evaluate the effectiveness of the RCM. It will not be used to require any modification of the negotiated non-per capita conservation program agreement.

1

NON-RESIDENTIAL INTERIOR
STANDARD RCM

DISTRIBUTION OF CONSERVATION INFORMATION TO ALL NEW NON-RESIDENTIAL CUSTOMERS AND SUBMITTAL OF WATER USE PLAN BY NEW LARGE FACILITIES

Description: *Provider distributes a conservation packet to all new non-residential customers when an application is submitted for a building permit. The conservation packet includes educational material on the best commercially available technologies, current codes affecting water use at each facility, and a standard form approved by the Department to be filled out by the new customer. This form will function as the water use plan to be submitted by all new non-residential customers who may potentially use 10 acre-feet or more of water annually. Turf-related facilities, large scale cooling facilities, and new large produce processing facilities are excluded from the requirement to submit a water use plan as they are required in the Industrial Conservation Program to submit a water conservation plan. Utilization of the plan helps increase the awareness of best available technologies as they become available within each industry.*

The water use plan shall identify all water uses anticipated by the user and the water conservation measures to be utilized. The water use plan shall include at least the following information (where applicable):

- *Water conservation education/training for employees*
- *Use of alternative water sources (i.e., CAP, effluent, remediated groundwater, or other non-groundwater sources)*
- *Operating TDS or conductivity for cooling towers and total cooling capacity*
- *Use of best available technologies in accordance with existing process uses (i.e., recirculating systems for process water, alternative dust control methods, automatic shut-down devices to eliminate continual running of water)*
- *Any plans for the reuse of wastewater or process water at the facility*
- *Type of landscaping and irrigation system*

Implementation: *The provider shall distribute a conservation packet as described above to all new non-residential customers prior to construction when an application is submitted for a building permit (private water companies shall distribute a conservation packet when contacted for new service). As a condition of new service, those non-residential customers who will potentially use 10 acre-feet or more of water annually, excluding turf-related facilities, large scale cooling facilities, and new large produce processing facilities, shall be required to submit a water use plan as outlined in the description above to be reviewed by water provider staff. The Department will supply to the provider the necessary form and guidelines to complete the water use plan at the time the provider enters this program. Where necessary, provider staff shall make recommendations for efficient use of water to the new user.*

Monitoring/Reporting:
The Annual Report required by A.R.S. § 45-632 shall include a copy of the sample conditions of new service agreement used to meet the implementation requirements for this RCM. This shall be submitted one time only (the first year of compliance with the Non-Per Capita Conservation Program) unless there is an amendment to the agreement. The provider shall also include in the annual report the number of conservation packets distributed annually and the number of water use plans received during the reporting year.

In addition to the annual reporting requirements, the provider shall maintain and submit to the Department upon request the water use plans submitted by non-residential customers.

EXTERIOR AUDIT PROGRAM FOR EXISTING NON-RESIDENTIAL CUSTOMERS

***Description**: Trained auditors visit existing non-residential customers (excluding turf-related facilities, large scale cooling facilities, and landscaped public rights-of-way) to examine outdoor water use practices, or materials are supplied for a self-audit of outdoor water use practices. These audits are designed for landscape water use and include a survey of water use practices or scheduling, a visual leak detection analysis, examination of the current irrigation system maintenance and efficiency, and an examination of existing employee education or training. After the audit has been conducted the facility compiles information into a post-audit report to be submitted to the provider. Provider staff reviews and makes recommendations to improve water usage at the facility.*

Implementation:** The provider shall notify all existing non-residential customers (excluding turf-related facilities, large scale cooling facilities, and public rights-of-way) of the availability of an audit performed on-site free of charge by staff or hired consultants, or a self-audit packet that shall include at a minimum information on how to conduct a self-audit and complete a post-audit report to be returned to the provider. The provider shall evaluate each post-audit report and make recommendations to the facility for water conservation potential. Existing non-residential customers that collectively receive at least 20 percent of the total non-residential water use in the provider's service area (excluding turf-related facilities, large scale cooling facilities, and landscaped public rights-of-way) shall be audited either by the non-residential customer or by a trained auditor. The measurement of 20 percent of non-residential use shall be based on the most current water use records available when the provider enters the program. Annual progress requirements will be negotiated between the Department and the provider with the provider required to complete all the necessary audits by January 1, 2010.* ***This RCM shall be implemented in conjunction with the Interior Audit for Existing Facilities.

***Monitoring/Reporting:** The Annual Report required by A.R.S. § 45-632 shall include the number of facilities audited by provider and the number of facilities who conducted a self-audit and returned an post-audit report to the provider within the reporting year. The annual report shall include the name and type of facility audited and its annual water use for the previous year. The provider shall maintain and make available for the Department's inspection the name, address, phone number, contact person, and audit report for each facility audited.*

In addition to the annual reporting requirements, the provider shall collect and maintain information on selected facilities that utilize this program in order to make an effective evaluation of the program. The number of records and type of data to be maintained will be determined at the time the provider enters the program. Note: This evaluation will be used to improve effectiveness of RCMs. It will not be used to require any modification of the negotiated Non-Per Capita Conservation Program agreement.

LANDSCAPE ORDINANCE OR CONDITION OF NEW SERVICE FOR NEW FACILITIES

Description: *Provider requires new non-residential customers to limit water-intensive landscaping, install efficient irrigation systems, and limit water features/fountains.*

Implementation: *The provider shall adopt and enforce an ordinance or establish conditions of new service requiring new non-residential customers with greater than or equal to 10,000 square feet of landscapable area to comply with the following, as applicable: (1) If the new non-residential customer is not a hotel or motel, the water-intensive landscaped area within the facility shall not exceed an area calculated by adding 10,000 square feet plus 20 percent of the facility's landscapable area in excess of 10,000 square feet. Schools, parks, cemeteries, golf courses, common areas of housing developments, and public recreational facilities with water-intensive landscaping greater than or equal to 10 acres are exempt from this provision, as they are regulated under the individual user requirements; (2) If the new non-residential customer is a hotel or motel, the water-intensive landscaped area within the facility shall not exceed an area calculated by adding 20,000 square feet plus 20 percent of the facility's landscapable area in excess of 20,000 square feet; (3) Only efficient irrigation systems shall be used; and (4) The use of water features and/or fountains shall be limited and shall be equipped with water recycling or reuse systems.*

Monitoring/Reporting: *The Annual Report required by A.R.S. § 45-632 shall include a copy of the ordinance or sample conditions of new service agreement used to meet the implementation requirements for this RCM. This shall be submitted one time only (the first year of compliance with the Non-Per Capita Conservation Program) unless there is an amendment to the ordinance or agreement.*

APPENDIX 5-I.3

EDUCATION
STANDARD
REASONABLE CONSERVATION MEASURES

PUBLIC INFORMATION AND EDUCATION PROGRAM

Description: *Educating customers about the need for water conservation is essential to the success of any conservation program. There are many ways to educate and inform the public, including the distribution of information packets, brochures, pamphlets, bill inserts, newsletters, fact sheets, calendars, "tents" in restaurants, conducting "workshops," and radio and TV public service announcements. Another method is the provision of information that allows customers to compare their current water use with the amount of water they used during the preceding billing period and the same billing period in the previous year. Water use tracking information may be effective because it is personalized and is updated and repeated with every billing cycle. Printed materials and public service announcements can be effective for many months to the extent that they are heard, seen or read and acted upon.*

Implementation: *A minimum of once a year, the provider shall supply all customers with information on the following, using methods agreed to at the time of acceptance into the Non-Per Capita Conservation Program: 1) the significance and relevance of water conservation, and methods of conserving water, including information about conservation devices and behavioral changes that save water; and 2) how to participate in other conservation programs offered by the provider under the Non-Per Capita Conservation Program (e.g., audits, rebates, workshops). The provider shall also develop and distribute with every billing, conservation billing in either graphical or numerical format (i.e., graphs or numbers) showing current water use, the amount of water used during the preceding billing period and the same billing period in the previous year.*

Monitoring and Reporting Requirements: *The Annual Report required by A.R.S. § 45-632 shall include examples of the materials provided, a report on the methods used to contact customers, and the number of materials distributed in any form.*

APPENDIX 5-I.4

SUBSTITUTE
REASONABLE CONSERVATION MEASURES

SUBSTITUTE RCM LIST

The Substitute RCM List for the Phoenix AMA is filed in the Department's Phoenix AMA office. A copy of the list effective as of the date of this plan follows in this Appendix. Since the list may be amended in the manner described below, a current list is available upon request from the Phoenix AMA office.

PROCEDURE FOR MODIFICATION OF SUBSTITUTE RCM LIST

1. *A municipal provider who seeks to add an RCM to the Substitute RCM List for the Phoenix AMA may apply at any time to the director for a modification of the list. The application shall be made on a form prescribed and furnished by the director.*

2. *The director shall review each request for a modification of the Substitute RCM List. The director may request additional information from the applicant and may seek information from other sources as may be necessary to determine whether the list should be modified.*

3. *If the director approves the addition of an RCM to the Substitute RCM List, the director shall place the RCM on a supplemental list that shall be considered an addendum to the Substitute RCM List. The supplemental list shall be available upon request from the Phoenix AMA office.*

4. *The director may add an RCM to the Substitute RCM List for the Phoenix AMA on the director's own initiative if the director determines that implementation of the RCM, either by itself or in combination with one or more other RCMs on the Substitute RCM List, will result in a water use efficiency for the applicable water use category equivalent to the efficiency that would result from implementation of one or more of the required RCMs for that water use category.*

SUBSTITUTE REASONABLE CONSERVATION MEASURES

RCM	*Description*	*Implementation*
	Residential Interior	
Low Flow Plumbing Rebate Program for Existing Residential Customers	*Provider grants a financial rebate to residential homeowners who elect to replace existing high water use toilets, showerheads and faucets with low-flow devices, consistent with the AWEPA.*	*Negotiated and Approved by the director*
Toilet Leak Detection & Repair Program for Existing Residential Customers	*Provider supplies non-toxic dye tablets and instructions to conduct a toilet leak detection analysis and suggestions for leak repairs.*	*Negotiated and Approved by the director*
Landscape Retrofit Program for Existing Residential Customers	*Provider grants financial incentives, including rebates, to existing customers for conversion of existing high water use landscapes to low water use landscapes. Provider supplies examples of landscape plans, plant lists, irrigation methods, and information on soil amendments and preparation.*	*Negotiated and Approved by the director*
	Residential Exterior	
Effluent Reuse - Recycled Wastewater for Existing or New Residential Customers	*Provider develops an effluent reuse system for existing or new housing developments and provides incentives for the reuse of effluent at facilities capable of utilizing the resource.*	*Negotiated and Approved by the director*
Low Water Use Ordinance or Condition of New Service for New Residential Customers	*Provider develops conditions of new service or ordinances that limit turf and other water-intensive landscaping in all new developments consistent with the new single family and multifamily residential exterior water use models in the Third Management Plan for the provider's AMA.*	*Negotiated and Approved by the director*
	Non-Residential Interior	
Retrofit Distribution or Rebate Program	*Provider supplies retrofit kits or provides rebates to non-residential facilities that elect to retrofit existing high water using plumbing fixtures to low water using fixtures consistent with the AWEPA.*	*Negotiated and Approved by the director*
Process Water Conservation Program for New or Existing Facilities	*Provider develops a program that identifies the non-residential customers within the provider's service area with the greatest conservation potential and assigns conservation measures aimed at reducing water use in these facilities.*	*Negotiated and Approved by the director*

SUBSTITUTE REASONABLE CONSERVATION MEASURES

RCM	*Description*	*Implementation*
	Non-Residential Exterior	
Rebate Program for Low Water Use Landscaping & Irrigation System Improvements for Existing or New Facilities	*Provider offers financial incentives (e.g., rebates, reduced rates, wholesale prices on plant materials, or financing packages) to non-residential facilities to replace existing landscaping and irrigation system or installation of new landscaping or irrigation systems with low water use landscaping and efficient irrigation technologies.*	*Negotiated and Approved by the director*
Effluent and Wastewater Use Incentives for Existing and New Facilities	*Provider offers incentives for conversion of existing irrigation systems or installation of new irrigation systems capable of utilizing effluent or wastewater (includes all water discharged after an industrial or commercial use, excluding effluent) for landscape watering.*	*Negotiated and Approved by the director*
Ordinance or Condition of Service Requiring The Use of Effluent for New Public Recreation Facilities	*The provider adopts an ordinance or condition of service requiring the use of effluent in new public recreation facilities, including turf-related facilities and other facilities with a water-intensive landscaped area of 10 or more acres. The ordinance or condition of new service shall require the owner of the facility to demonstrate to the Department that the facility will be designed and operated in a manner that conserves water. Publicly owned rights-of-way are exempt from this requirement. For purposes of this RCM, "turf-related facility" and "water-intensive landscaped area" have the meanings prescribed by section 6-301 of Chapter 6.*	*Negotiated and Approved by the director*
	Education	
Training Opportunities	*Provider offers ongoing seminars, workshops, lectures, and videos to promote water conservation to residential or non-residential customers, employees, educators, or professional interest groups. Topics could include landscape design and maintenance, interior water conservation methods, or general background information on regional water supply issues.*	*Negotiated and Approved by the director.*
Youth Programs	*Provider assists local school district(s) to provide water conservation and water supply information to students. Assistance can include classroom presentations, teacher education programs, curriculum, and field trips to water-related facilities.*	*Negotiated and Approved by the director.*

SUBSTITUTE REASONABLE CONSERVATION MEASURES

RCM	*Description*	*Implementation*
	Education	
Demonstration Sites and Exhibits	*Provider establishes, maintains, and promotes facilities, sites, and exhibits that demonstrate water conservation including demonstration gardens, demonstration homes, conservation exhibits, and public activities.*	*Negotiated and Approved by the director.*
Media-Related Outreach	*Provider develops a media-outreach program focused on water conservation including news articles, features, and series, magazine stories, radio and television public service announcements, and television specials. Additionally, novelty items to promote local or regional conservation efforts can be distributed including buttons, posters, and bumper stickers.*	*Negotiated and Approved by the director. Must include a method to evaluate effectiveness and market penetration.*
	System-Related Measures	
Water Audit Program	*Provider has an audit conducted by a trained auditor of the distribution system, accuracy of the water agency records, and systems control equipment. The audit should identify, quantify, and verify water and revenue losses to allow the provider to select and implement programs to reduce water and revenue losses. Such examination should be performed annually to update the results of earlier audits. The audit must include an analysis of the water audit results and possible corrective measures including resulting costs, feasibility, and savings.*	*Negotiated and Approved by the director.*
Leak Detection Program	*Provider implements a leak detection program in conjunction with a water audit (see substitute RCM - Water Audit). The leak detection program must address losses due to leaks, unauthorized use (street, sewer, and fire departments), water department maintenance, and meter under-registration and must include repair, maintenance, and meter testing. Flushing frequency and exercise of valves should also be accounted for.*	*Negotiated and Approved by the director.*

SUBSTITUTE REASONABLE CONSERVATION MEASURES

RCM	*Description*	*Implementation*
Conservation-Based Rate Structure	*Provider develops a water rate structure that results in slowing the increase in water consumption that traditionally accompanies increases in population and per capita income. Pricing structures that may result in conservation are: increasing block rate, lifeline rate, seasonal rate, and excess demand surcharge. To be effective, the rate structure must clearly send a conservation message. The rate structure established should ensure that customers receive the proper signal that allows them to make a choice as to whether or not to implement conservation measures. Additionally, the water rate revision should be accompanied by a public awareness campaign, a water conservation device distribution program, pamphlets on low water use landscaping, or other conservation measures to increase the effectiveness of the program..*	*Negotiated and Approved by the director.*
	System-Related Measures	
Conservation Coordinator	*Provider employs a staff person whose sole responsibility is to ensure the implementation of effective water conservation programs. The employee would act to coordinate conservation efforts in conjunction with utility staff and be the primary contact for the public regarding conservation information. The coordinator could initiate an information campaign including: pamphlets, fact sheets, bill stuffers, public service announcements, and press releases. The coordinator can also coordinate direct conservation activities other than education.*	*Negotiated and Approved by the director. Includes submittal of a complete job description for the position as well as annual goals and objectives for the program.*
Water Tampering and Water Waste	*Provider adopts and enforces ordinances or implements policies regarding excessive and wasteful use of water. Meter reading staff and customers report water theft where ordinances are not applicable. Staff performs regular checks of water delivered and water used in distinct parts of the service areas where there is greater susceptibility to water theft.*	*Negotiated and Approved by the director.*

APPENDIX 5-J
INDIVIDUAL INCIDENTAL RECHARGE FACTOR CALCULATION
PHOENIX ACTIVE MANAGEMENT AREA

Hydrologic Studies
The following information must be provided:

1. A copy of a hydrological study that demonstrates the amount of water supplied by the municipal provider for use within its service area during each of the preceding five years (prior to application to the Non-Per Capita Conservation Program) and the amount of incidental recharge as calculated below that occurred within the municipal provider's service area during each of those years.

2. A copy of a hydrological study that projects the average annual amount of water that the municipal provider will supply for use within its service area during the management period and the average annual amount of incidental recharge as calculated below that will occur within the municipal provider's service area during the management period.

Calculation of the Incidental Recharge and an Incidental Recharge Factor
The following information should be included in the hydrologic studies:

1. A map showing:
   a. Service area boundary.
   b. Location of turfed areas and/or unlined lakes greater than 10 acres where water is provided by the municipal provider applying for the Non-Per Capita Conservation Program.
   c. Location of areas that are served by septic systems.

2. For turfed and water acres:
   a. Combined actual turfed and water acres (of facilities greater than or equal to 10 acres).
   b. Plant consumptive use (actual or using consumptive use rate published in the Second Management Plan), or measured evaporation rates.
   c. Total annual volume of water applied to facility. If only a portion of the water used is supplied by the municipal provider, document the percentage supplied by the provider who is applying for the Non-Per Capita Conservation Program and from other sources.

3. For septic systems:
   a. The number of acres of lots served by septic systems and the number of septic tanks per acre.
   b. Volume of water supplied to that system and documentation of the volume of water incidentally recharged. If only a portion of the water used is supplied by the municipal provider, document the percentage supplied by the provider and from other sources.

4. Total annual volume of water supplied by a provider for use within its service area.

5. Any other data that contribute to incidental recharge within the service area. The Department will review the data and take them under consideration.

APPENDIX 5-J (continued)
INDIVIDUAL INCIDENTAL RECHARGE FACTOR CALCULATION
PHOENIX ACTIVE MANAGEMENT AREA

Calculations:

1. Turf

Annual Incidental Recharge (AF)	=	Total Annual Water Used (AF)	-	[Turfed Acres x Consumptive Use AF/Ac.]

2. Artificial Lakes

Annual Incidental Recharge (AF)	=	Total Annual Water Used (AF)	-	[Lake Acres x Evaporation Rate AF/Ac.]

3. Septic Systems

Annual Incidental (AF)	=	Total Acres of Septic System	x	Number of Septic Systems per Acre	x	Total Annual Water Use per Household (AF)	x	Percent Water Returned for Recharge

4. **Maximum Estimated Annual Incidental Recharge (AF)** = #1 + #2 + #3 + other data approved by ADWR

5. **Incidental Recharge Factor** = $\frac{\text{Annual Incidental Recharge (\#4)}}{\text{Total Annual Volume of Water Pumped and Received.}}$

AF = acre-feet

APPENDIX 5-K
RESIDENTIAL COMPONENT GALLONS PER CAPITA PER DAY CALCULATION DESCRIPTION
PHOENIX ACTIVE MANAGEMENT AREA

A. Residential:

1. Existing Residential Allotment
   a. Determine Base Year 2000 Single Family Population
      Determine Base Year 2000 Multifamily Population
      Sum of Base Year 2000 Single Family and Multifamily Population

   b. Multiply Base Year 2000 Residential Population by the Existing Residential GPCD Component Requirement (Appendix 5F), multiply by 365 days and divide the product by 325,851.

   c. Result is a volumetric allotment, in acre-feet, for the Existing Residential Allotment with expected GPCD reductions included in the annual requirement calculation.

2. New Residential Allotment:
   a. Determine:
      New Single Family Housing Units added since June 30, 2000
      New Single Family Population (post - 2000) for the calendar year
      New Multifamily Housing Units added since June 30, 2000
      New Multifamily Population (post - 2000) for the calendar year

   b. Multiply New Single Family Housing Units and New Multifamily Housing Units by Exterior model GPHUD Rates for New Development:

Single Family	=	178 GPHUD
Multifamily	=	77 GPHUD

      Multiply the sum of the results by 365 days and divide the product by 325,851.

   c. Multiply the sum of the New Single Family Population and the New Multifamily Population by the Interior model GPCD rate of 57 for new residential development. Multiply the result by 365 days and divide the product by 325,851.

   d. The sum of the results in paragraphs b. and c. is the annual volumetric allotment in acre-feet for the New Residential Allotment.

3. **Residential Allotment**
   a. Add together the Existing Residential Allotment to the New Residential Allotment to calculate the **Residential Allotment**, acre feet.

APPENDIX 5-L
LOW WATER USE/DROUGHT TOLERANT PLANT LIST
PHOENIX ACTIVE MANAGEMENT AREA

The Low Water Use/Drought Tolerant Plant List for the Phoenix AMA is filed in the Department's Phoenix AMA office. A copy of the list effective as of the date of this plan follows in this Appendix. Since the list may be amended using the procedure described below, a current list is available upon request from the Phoenix AMA office or from the Department's public information officer in Phoenix.

PROCEDURE FOR MODIFICATION OF LOW WATER USE/DROUGHT TOLERANT PLANT LIST FOR THE PHOENIX ACTIVE MANAGEMENT AREA

A. A person who seeks to add a plant or plants to the Low Water Use/Drought Tolerant Plant List for the Phoenix AMA or to delete a plant or plants from the list may apply at any time to the director for a modification of the list. The application shall be made on a form prescribed and furnished by the director.

B. The director shall review each request for a modification of the Low Water Use/Drought Tolerant Plant List. The director may request additional information from the applicant and may seek information from other sources as may be necessary to determine whether the list should be modified.

C. If the director approves the addition of a plant to the Low Water Use/Drought Tolerant Plant List, the director shall place the plant on a supplemental list that shall be considered an addendum to the Low Water Use/Drought Tolerant Plant List. The supplemental list shall be available upon request from the Department's public information officer or the office of the Phoenix AMA.

D. If the director approves the deletion of a plant from the Low Water Use/Drought Tolerant Plant List, the director shall delete the plant from the list.

E. The director shall conduct an annual review of the Low Water Use/Drought Tolerant Plant List and issue a modified plant list no later than August 15 of the following year. As a result of the review, the director may add plants to the list, delete plants from the list, or both.

APPENDIX 5-L *(continued)*
LOW WATER USE/DROUGHT TOLERANT PLANT LIST
PHOENIX ACTIVE MANAGEMENT AREA

This list was compiled by the Department in cooperation with experts from the Desert Botanical Garden, Arizona Department of Transportation, and various nurserymen and landscape specialists from the Phoenix AMA. Individuals wishing to add low water use plants to this list or delete plants from the list may submit information to the director of the Department of Water Resources for consideration. The director will amend the list as appropriate.

TREES

Botanical Name	**Common Name**
Acacia spp.	Acacia, Wattle
Bauhinia congesta	Anacacho Orchid Tree
Brachychiton populneus	Bottle Tree
Brahea spp.	Fan Palm
Bursera spp.	Elephant Tree
Butia capitata	Jelly Palm
Caesalpinia spp.	Bird-of-Paradise
Callistemon viminalis	Weeping Bottlebrush
Canotia holacantha	Crucifixion Thorn
Casuarina spp.	Beefwood
Catalpax tashkentensis	Chilitapa
Celtis reticulata	Western Hackberry
Ceratonia siliqua	St. John's Bread Tree, Carob Tree
Cercidium spp.	Palo Verde
Cercis canadensis var. texensis	Texas Redbud
Cercis canadensis var. mexicana	Mexican Redbud
Chamaerops humilis	Mediterranean Fan Palm
Chilopsis linearis	Desert-willow
Cupressus arizonica	Arizona Cypress
Cupressus sempervirens	Italian Cypress
Dalbergia sissoo	Sissoo Tree
Eucalyptus spp.	Eucalyptus
Geijera parviflora	Australian-willow
Gleditsia triacanthos	Honey Locust
Holacantha emoryi (Castela emoryi)	Crucifixion Thorn
Leucaena retusa	Golden Ball Lead Tree
Lysiloma spp.	Desert-fern
Olea europaea	Olive
Olneya tesota	Ironwood
Parkinsonia aculeata	Mexican Palo Verde, Jerusalem Thorn
Phoenix canariensis	Canary Island Date Palm
Phoenix dactylifera	Date Palm
Abatilon palmeri	Superstition Mallow
Acacia spp.	Acacia, Wattle
Pinus canariensis	Canary Island Pine

Botanical Name	*Common Name*
Pinus eldarica	Afghan Pine
Pinus halepensis	Aleppo Pine
Pinus pinea	Italian Stone Pine
Pinus roxburghii	Chir Pine
Pistacia spp.	Pistachio
Pithecellobium spp.	Ebony
Pittosporum phillyraeoides	Willow Pittosporum
Prosopis spp.	Mesquite
Quercus spp.	Oak
Rhus lancea	African Sumac
Rhus lanceolata	Prairie Flameleaf Sumac
Schinus molle	California Pepper Tree
Schinus terebinthifolius	Brazilian Pepper Tree
Sophora secundiflora	Texas Mountain-laurel, Mescal Bean
Tamarix aphylla	Athel Tree
Tipuana tipu	Tipu Tree
Ungnadia speciosa	Mexican-buckeye
Ulmus parvifolia cv. *'Sempervirens'*	Evergreen Elm
Vitex agnus-castus	Chaste Tree
Washingtonia spp.	Desert Fan Palm
Xylosma congestum	Xylosma
Ziziphus jujuba	Chinese Jujube

SHRUBS

Aloysia spp.	Beebrush
Ambrosia ambrosioides	Canyon Ragweed
Ambrosia deltoidea	Triangleleaf Bur-sage
Ambrosia dumosa	White Bur-sage
Anisacanthus spp.	Desert Honeysuckle
Artemisia spp.	Sagebrush
Asclepias linaria	Pine-leaf Milkweed
Asclepias subulata	Desert Milkweed
Atriplex spp.	Saltbush
Baccharis spp.	Desert Broom
Bauhinia congesta (lunarioides)	Anacacho
Bauhinia macaranthera	Orchid Tree
Bauhinia ramosissima	Orchid Tree
Berberis haematocarpa	Red Barberry
Berberis trifoliolota	Agarita
Buddleia marrubifolia	Woolly Butterfly Bush
Caesalpinia spp.	Bird-of-Paradise
Calliandra californica	Baja Red Fairy Duster
Calliandra eriophylla	Pink Fairy Duster
Calliandra peninsularis	Fairy Duster
Callistemon citrinus	Lemon Bottlebrush
Callistemon phoeniceus	Salt Resistant Bottlebrush
Callistemon viminalis cv.*'Captain Cook'*	Dwarf Bottlebrush
Calothamnus spp.	Net Bush
Cassia (Senna) spp.	Cassia
Celtis pallida	Desert Hackberry
Chrysactinia mexicana	Damianita
Chrysothamnus nauseosus	Rabbit Brush
Cistus spp.	Rockrose
Condalia globosa	Bitter Condalia
Convolvulus cneorum	Bush Morning Glory, Silverbush
Cordia boissieri	Anacahuita
Cordia parvifolia	Little Leaf Cordia
Dalea spp.	Smoketree, Indigo Bush
Dodonaea viscosa	Hopbush
Encelia spp.	Brittlebush

Botanical Name	*Common Name*
Ephedra spp.	Mormon-tea
Eremophila spp.	Emu Bush
Ericameria laricifolia	Turpentine Bush
Ericameria linearifolia	Turpentine Bush
Eriogonum spp.	Buckwheat
Erythrina flabelliformis	Southwest Coralbean
Euphorbia antisyphilitica	Wax Plant, Candelilla
Euphorbia rigida	Euphorbia
Forestiera neomexicana	Desert Olive
Fraxinus greggii	Littleleaf Ash
Genista hispanica	Spanish Broom
Gutierrezia microcephala	Snakeweed
Hamelia patens	Fire Bush
Hyptis emoryi	Desert-lavender
Jasminum mesnyi	Primrose Jasmine
Jatropha spp.	Limberbush
Juniperus chinensis varieties	Juniper
Justicia spp.	Mexican Honeysuckle, Chuparosa
Krameria parvifolia	Ratany
Lantana camara	Bush Lantana
Larrea tridentata	Creosote Bush
Leucophyllum spp.	Texas Sage, Texas Ranger
Lippia (berlandieri)	Mexican Oregano
Lycium spp.	Wolfberry
Maytenus phyllanthoides	Mangle Dulce
Melaleuca spp.	Australian Myrtle
Mimosa biuncifera	Wait-a-Minute Bush
Mimosa dysocarpa	Velvet Pod Mimosa
Myrtus communis	True Myrtle, Roman Myrtle
Myrtus communis cv. *'Boetica'*	Twisted Myrtle
Myrtus communis cv. *'Compacta'*	Dwarf Myrtle
Nandina domestica	Heavenly-bamboo
Nerium oleander varieties	Oleander
Perovskia atriplicifolia cv. *`Heavenly Blue'*	Russian Sage
Plumbago scandens	Plumbago
Punica granatum varieties	Pomegranate
Pyracantha spp.	Pyracantha, Fire-thorn
Rhus choriophylla	Mearns Sumac
Rhus microphylla	Desert Sumac
Rhus ovata	Sugarbush
Rhus trilobata	Skunkbush
Rhus virens	Evergreen Sumac
Rosmarinus officinalis	Bush Rosemary
Ruellia californica	Ruellia
Ruellia peninsularis	Ruellia
Salvia spp.	Sage
Simmondsia chinensis	Jojoba
Solanum xanti	Solanum
Sophora arizonica	Arizona Sophora
Sophora formosa	Sophora
Tecoma stans	Yellowbells
Tecomaria capensis	Cape Honeysuckle
Teucrium fruticans	Bush Germander
Thamnosma montana	Turpentine Broom
Thevetia peruviana	Yellow Oleander
Trixis californica	Trixis
Vauquelinia spp.	Rosewood
Viguiera deltoidea	Golden Eye
Viguiera tomentosa	Golden Eye
Westringia rosmariniformis	Westringia
Ziziphus obtusifolia	Greythorn

Botanical Name	*Common Name*

GROUNDCOVERS

Acacia spp.	Acacia
Asparagus densiflorus cv. *'Sprengeri'*	Sprenger Asparagus
Atriplex spp.	Saltbush
Baccharis spp.	Desert Broom, Coyote Bush
Clianthus formosus	Sturt's Desert Pea
Convolvulus mauritanicus	Ground Morning Glory
Dalea spp.	Indigo Bush
Gazania spp.	Gazania
Lantana montevidensis	Trailing Lantana
Myoporum parvifolium	Myoporum
Eschscholzia mexicana	Mexican Gold Poppy
Oenothera berlandieri	Mexican Evening Primrose
Oenothera stubbei	Saltillo Primrose
Pentzia incana	Karoo Bush
Rosmarinus officinalis cv.*'Prostratus'*	Prostrate Rosemary
Salvia chamaedryoides	Blue Sage
Salvia farinacea	Mealy Cup Sage
Santolina chamaecyparissus	Lavender Cotton
Santolina virens	Green Santolina
Sesuvium verrucosum	Sea Purslane
Teucrium chamaedrys cv. *`Prostrata'*	Germander
Verbena bipinnatifida	Verbena
Verbena peruviana	Peruvian Verbena
Verbena tenera	Moss Verbena
Verbena rigida	Sandpaper Verbena
Wedelia trilobata	Yellow Dot

SUCCULENTS/ACCENTS

Agave spp.	Century Plant, Agave
Aizoaceae spp.	Ice Plant Family
Aloe spp.	Aloe
Bulbine frutescens	Bulbine
Cactaceae	Cactus Family
Dasylirion spp.	Desert Spoon
Fouquieria spp.	Ocotillo
Hesperaloe spp.	Hesperaloe
Manfreda maculosa	Manfreda
Nolina spp.	Bear-grass
Pedilanthus macrocarpus	Lady Slipper
Yucca spp.	Yucca

ANNUAL WILDFLOWERS

Abronia villosa	Sand-verbena
Argemone pleiacantha	Prickly-poppy
Camissonia brevipes	Yellow Cups
Camissonia cardiophylla	Heart-leaved Primrose
Catharanthus roseus	Madagascar Periwinkle
Centaurea rothrockii	Basket Flower
Cirsium neomexicanum	Thistle
Clarkia amoena	Farewell-to-Spring
Collinsia heterophylla	Chinese-houses
Coreopsis bigelovii	Desert Coreopsis
Cosmos spp.	Cosmos
Dimorphotheca spp.	African Daisy
Eriastrum diffusum	Prickly Stars
Eriophyllum lanosum	Woolly Daisy
Eriophyllum wallacei	Woolly Daisy

Botanical Name	*Common Name*
Eschscholzia californica	California Poppy
Euphorbia heterophylla	Painted Spurge
Gaillardia pulchella	Fire Wheel, Blanket Flower
Geraea canescens	Desert Sunflower
Gilia leptantha	Showy Blue Gilia
Gomphrena globosa	Globe Amaranth
Helianthus annuus	Wild Sunflower
Helichrysum bracteatum	Everlasting Daisy
Helipterum spp.	Helipterum
Ipomoea cristulata	Morning Glory
Ipomoea leptotoma	Morning Glory
Kallstroemia grandiflora	Arizona poppy
Lasthenia chrysostoma (Baeria chrysostoma)	Goldfield
Layia platyglossa	Tidy Tips
Lesquerella gordonii	Yellow Blanket
Linaria spp.	Toadflax
Linum grandiflorum cv. 'Rubrum'	Red Flax
Lupinus arizonicus	Arizona Lupine
Lupinus densiflorus	Lupine
Lupinus sparsiflorus	Desert Lupine
Lupinus succulentus	Arroyo Lupine
Machaeranthera canescens (Aster bigelovii)	Blue Aster
Machaeranthera tanacetifolia (Aster)	Purple Aster, Tahoka Daisy
Matricaria grandiflora	Pineapple Weed
Matthiola longipetala cv. 'Bicornis'	Evening Scented Stock
Mentzelia spp.	Blazing Star
Mimulus bigelovii	Bigelow's Monkeyflower
Mohavea confertiflora	Ghost Flower
Monarda austromontana	Bee Balm
Monoptilon bellioides	Belly Flower
Nama demissum	Purple Mat
Nama hispidum	Purple Mat
Nemophila maculata	Five Spot
Nemophila menziesii	Baby Blue Eyes
Oenothera deltoides	Birdcage Evening Primrose
Oenothera primiveris	Evening Primrose
Orthocarpus purpurascens	Owl's Clover
Papaver rhoeas	Shirley Poppy
Pectis papposa	Chinch Weed
Perityle emoryi	Rock Daisy
Phacelia spp.	Scorpion Weed
Plantago spp.	Indian-wheat
Platystemon californicus	Cream Cups
Proboscidea parviflora	Devil's Claw
Rafinesquia neomexicana	Desert-chicory
Salvia columbariae	Chia
Sisymbrium ambiguum	Purple Rocket
Solanum xanti	Solanum
Tithonia rotundifolia	Mexican Sunflower
Ursinia spp.	Ursinia
Verbesina encelioides	Golden Crown Beard
Viguiera annua	Golden Eye

PERENNIAL WILDFLOWERS

Allionia incarnata	Trailing Windmills
Amsonia palmeri	Amsonia
Anigozanthos spp.	Kangaroo-paw
Anisodontea hypomandrum	African Mallow
Arctotis spp.	African Daisy
Argemone munita	Prickly Poppy

Botanical Name	*Common Name*
Argemone platyceras	Prickly Poppy
Bahia absinthifolia	Bahia
Baileya multiradiata	Desert Marigold
Berlandiera lyrata	Chocolate Flower
Castilleja chromosa	Indian Paintbrush
Castilleja lanata	Indian Paintbrush
Datura inoxia	Sacred Datura, Jimsonweed
Delphinium amabile	Larkspur
Delphinium scaposum	Barestem Larkspur
Dichelostemma pulchellum	Bluedicks
Dyssodia acerosa	Dyssodia
Dyssodia pentachaeta	Dyssodia
Erigeron divergens	Spreading Fleabane
Eupatorium greggii	Eupatorium
Evolvulus arizonicus	Arizona Blue Eyes
Gaura lindheimeri	Desert Orchid
Hesperocallis undulata	Ajo Lily
Hibiscus coulteri	Desert Rose Mallow
Hymenoxys acaulis	Angelita Daisy
Ipomopsis longiflora	Pale Blue Trumpets
Justicia sonorae	Sonoran Justicia
Linum lewisii	Blue Flax
Lotus rigidus	Desert Rock Pea
Machaeranthera gracilis	Yellow Aster
Machaeranthera tortifolia	Mohave Aster
Melampodium leucanthum	Blackfoot Daisy
Mirabilis multiflora	Desert Four O'Clock
Oenothera caespitosa	Tufted Evening Primrose
Penstemon spp.	Penstemon
Portulacaria afra	Elephants Food
Proboscidea altheaefolia	Devil's Claw
Psilostrophe cooperi	Paperflower
Psilostrophe tagetina	Paperflower
Ratibida columnaris	Mexican Hat, Coneflower
Romneya coulteri	Matilija Poppy
Senna covesii (Cassia covesii)	Desert Senna
Sphaeralcea spp.	Globe-mallow
Stachys coccinea	Red Mint, Betony
Tagetes spp.	Marigold
Verbena gooddingii	Goodding Verbena
Zephryanthes spp.	Rain Lily
Zinnia acerosa	Desert Zinnia
Zinnia grandiflora	Rocky Mountain Zinnia

GRASSES

Aristida purpurea	Purple Three-awn
Bouteloua aristidoides	Six-weeks Grama
Bouteloua curtipendula	Side Oats Grama
Bouteloua gracilis	Blue Grama
Erioneuron pulchellum	Fluffgrass
Hilaria rigida	Big Galleta
Muhlenbergia capillaris	Gulf Muhly
Muhlenbergia dumosa	Giant Muhly
Muhlenbergia emersleyi	Bull Grass
Muhlenbergia lindheimeri	Lindheimer Muhly
Muhlenbergia porteri	Bush Muhly
Muhlenbergia rigida	Deer Grass
Pennisetum setaceum cv. *'Cupreum'*	Purple Fountain Grass
Schismus barbatus	Mediterranean Grass
Setaria macrostachya	Plains Bristlegrass

Botanical Name	*Common Name*
Sporobolus cryptandrus	Sand Dropseed
Trichachne californica	Cottontop

VINES

Antigonon leptopus	Coral Vine, Queens Wreath
Bougainvillea spp.	Bougainvillea
Callaeum macroptera (Mascagnia macroptera)	Yellow Orchid Vine
Campsis radicans	Common Trumpet Creeper
Cissus trifoliata	Grape Ivy
Clematis drummondii	Virgin's Bower
Hardenbergia comptoniana	Wild Wisteria
Kennedia nigricans	Black Yellow Vine
Macfadyena unguis - cati	Cat's Claw
Mascagnia lilacina	Purple Mascagnia
Maurandya antirrhiniflora	Snapdragon Vine
Maurandya wislizeni	Snapdragon Vine
Merremia aurea	Yuca
Podranea ricasoliana	Pink Trumpet Vine
Rhynchosia texana	Rosary Bead Vine
Rosa banksiae	Lady Bank's Rose
Solanum jasminoides	Potato Vine

APPENDIX 5-M
THIRD MANAGEMENT PLAN
LOST & UNACCOUNTED FOR WATER REQUIREMENTS

Lost & Unaccounted For Water Includes:

Leaks:
- Distribution Lines
- Sewer Lines
- Storage Tanks
- Storage Ponds
- Hydrants
- Other

Breaks:
- Distribution Lines
- Sewer Lines
- Mains
- Hydrants
- Other

Measurement Errors:
- Meter Under/Over-Registration
- Source Meter Errors
- Flumes/Weirs Errors

Evaporation

Illegal Connections/Water Theft

Phreatophyte Uses

****

Water System Uses Include:

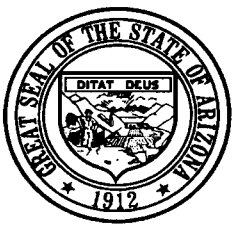
- Residential Metered Deliveries
- Non-Residential Metered Deliveries
- Standpipe Uses
- Fire Flow [1]
- Hydrant Meter Reading
- Hydrant Flow Tests [1]
- Fire Sprinkler System Flow Tests [1]
- Construction [1]
- Dust Control [1]
- Line Flushing (distribution, sewer, or treatment facility) [1]
- Street Cleaning [1]
- Storm Drain Flushing [1]
- Water Tests & Pressure Tests [1]
- Well Purging

[1] Estimates can be provided, using a method approved by the director. Documentation must be submitted with annual report.

CHAPTER

6

Industrial Conservation Program



6.1 INTRODUCTION

The purpose of the Industrial Conservation Program is to move industrial users within the Phoenix Active Management Area (AMA) to the greatest level of water use efficiency economically attainable given the use of the latest available water conservation technology. By definition within the Groundwater Code (Code), industrial users are groundwater users, although they may also receive renewable supplies in addition to their groundwater use. Efficient use of groundwater and the replacement of groundwater sources with renewable supplies during the third management period will ensure that industrial users make effective strides toward contributing to the AMA's statutorily mandated goal of safe-yield of groundwater by the year 2025.

"Industrial use" is defined in the Code 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." A.R.S. § 45-561.5. Industrial users either pump groundwater from their own wells or receive it from irrigation districts pursuant to Type 1 or Type 2 non-irrigation grandfathered rights or groundwater withdrawal permits. These rights or permits have annual volumetric groundwater allotments. The Glossary of Terms at the end of this management plan contains a description of water rights and permits. Non-residential uses, such as commercial, industrial, and institutional facilities supplied by a municipal water provider, are not industrial users as defined under the Code and are administered under Chapter 5, the Municipal Conservation Program. The primary water uses by industrial users are processing, cooling, and landscape watering. While some water uses are common to most industrial facilities, industrial uses are quite diverse, each with its own unique characteristics and conservation potential. For the third management period, there are general conservation requirements that apply to water use characteristics common to all industrial users (section 6.2).

In addition to these general requirements, specific conservation requirements apply to the following industrial uses:

- Turf-Related Facilities;
- Sand and Gravel Facilities;
- Large-Scale Power Plants;
- Large-Scale Cooling Facilities;
- Dairy Operations;
- Cattle Feedlot Operations;
- New Large Landscape Users; and
- New Large Industrial Users

These specific conservation requirements are separately addressed in subsequent sections of this chapter (sections 6.3 through 6.10). In general, each of the subsections contain all or some of the following: (1) an introduction, (2) water use by the subsector, (3) First and Second Management Plan program development, (4) issues and Third Management Plan development, (5) program description, (6) non-regulatory efforts, (7) future directions, and (8) subsector conservation requirements.

Industrial users with groundwater rights or permits used about 4 percent of the AMA's water use in 1995, or about 83,000 acre-feet. Although this is a small proportion of total water use in the AMA, 86 percent of this use is groundwater. Users of non-groundwater sources are relatively uncommon; most users use exclusively groundwater. While it is projected that most new non-residential water uses will be served by municipal water providers and will not become industrial users in the AMA, industrial water use is expected to show some increase through the year 2025. This increase will be the result of growth in the number of facilities such as golf courses and homeowner association common areas that accompany new residential development. While new residential development is required to use renewable water sources

under the Assured Water Supply Rules (AWS Rules), certain non-residential uses associated with these developments have chosen to secure groundwater rights.

Industrial user contribution to safe-yield was expected to be achieved by water use efficiency gained by the conservation requirements described in this chapter, limitations on the creation of new industrial users, and the possibility of the Arizona Department of Water Resources (Department) purchasing and retiring non-irrigation grandfathered rights. Expectations envisioned in the First and Second Management Plans of water conservation and renewable supply use by industrial users have not been completely met by industrial users. For the third management period, the Code requires that industrial conservation programs are designed with consideration of the latest commercially available conservation technology, consistent with reasonable economic return. Although progress has been made by some industrial users to implement more water efficient design, such as target-style golf courses, the economics of implementing water conservation technology has been questioned. Besides addressing water use efficiency, the First and Second Management Plan Industrial Conservation Programs incorporated incentives to encourage renewable supply use by industrial users. These incentives have proven largely ineffective. The relatively low cost of groundwater compared to renewable supplies has strongly deterred existing industrial users from stopping or reducing groundwater use and replacing that use with renewable supplies.

The difficulty of moving industrial users to renewable supplies refocuses attention toward existing and new groundwater withdrawal authority by industrial users. Type 1 and Type 2 non-irrigation grandfathered rights were created in the Code to identify and quantify the amount of groundwater pumped by industrial users at the time of enactment, thus allowing existing industrial users to be "grandfathered in." This grandfathering action would allow them to continue to conduct their business and pump groundwater without undue hardship. Since the creation of the Code, new industrial users were given rights or permits to withdraw groundwater (usually the creation of Type 1 non-irrigation grandfathered rights or the issuance of General Industrial Use groundwater withdrawal permits) only if the new user was not supplied water by a city, town, or private water company, or did not have access to renewable water supplies such as unused or "excess" Central Arizona Project (CAP) water, surface water, or effluent. Although this approach is based on the reasoning that a new industrial use that is supplied water by a city, town, or private water company is likely to be supplied in whole or in part with renewable supplies, the authority to grant new groundwater withdrawal authorities that would increase total groundwater withdrawals remains, contradicting efforts to reduce groundwater overdraft.

Current authorities do not allow the Department to require conversions to renewable resources or to require a replenishment obligation for groundwater used. As a result, the contribution to overdraft by industrial users is disproportionately large and, if current trends continue, is likely to grow. Increased conservation efforts, increased use of renewable supplies, and possible statutory changes regarding the conditions of issuance of new groundwater withdrawal authority are needed for industrial users to effectively contribute toward achieving the safe-yield goal in the AMA by 2025.

6.1.1 Statutory Provisions

The Code requires that all management plans contain a conservation program for industrial users. For the third management period, the director of the Department is required to establish in each plan:

> additional conservation requirements for all non-irrigation uses of groundwater to be achieved by the end of the third management period and may establish intermediate conservation requirements to be achieved at specified intervals during the third management period. . . . For industrial uses including industrial uses within the exterior boundaries of the service area of a city, town, private water company or irrigation district, the program shall require the use of or establish conservation requirements based on the

use of the latest commercially available conservation technology consistent with reasonable economic return. A.R.S. § 45-566(A)(2).

The Code also requires the establishment of conservation requirements for certain municipally served uses called "individual users." A.R.S. § 45-566(A)(2). (See Chapter 5.) Because their water use characteristics and conservation potential were identical to industrial users, municipally served turf-related facilities were regulated as individual users and given conservation requirements identical to turf-related facilities that were industrial groundwater right and permit holders in the First Management Plan; in the Second Management Plan, municipally served large-scale cooling facilities were also regulated as individual users. Thus, regardless of the source of water, whether from municipal water providers or pursuant to a non-irrigation grandfathered groundwater right or permit, all turf-related facilities and large-scale cooling facilities were subject to identical conservation requirements in the Second Management Plan. In 1988, a change to the Code allowed the Department to directly regulate individual users by making the facility, rather than the municipal water provider serving them, responsible for compliance with the conservation requirements in the management plan.

6.1.2 Industrial Program Development

The Industrial Conservation Program has evolved into a more technically sophisticated program since the First Management Plan. This has been the result of considerable input and cooperation by the regulated community, as well as investigative efforts by the Department.

The First Management Plan requirements stressed water use efficiency and other general requirements. The Management Plan included specific conservation programs only for turf-related facilities, electric power plants, sand and gravel facilities, and other industrial users. Conservation requirements for these water use categories continued into the second management period. As a result of consultant studies done for the Second Management Plan, additional conservation requirements were added in the Second Management Plan for new large cooling users, dairy operations, cattle feedlots, new large industrial users, and new large landscape users. In addition, more specific effluent incentive provisions were included for turf-related facilities.

Development of the third management period conservation requirements included extensive participation by a wide cross-section of industry representatives, including facility managers, consultants, municipal representatives, vendors, land developers, architects, and academic research specialists. The following Technical Advisory Committees (TACs) were formed for the development of specific conservation requirements found in the Industrial Conservation Program for the third management period:

- Turf-related facilities (Phoenix AMA only, a separate committee advised the Tucson AMA);
- Dairy operations/feedlots (a joint committee for the Phoenix, Pinal, and Tucson AMAs);
- Cooling towers/electrical power plants (a joint committee for the Phoenix and Tucson AMAs); and
- Sand and gravel facilities (a joint committee for the Phoenix, Pinal, and Tucson AMAs)

Collectively, over 30 meetings were held with the committees over an 18-month period. Committee members had an opportunity to help formulate and put forth conservation requirement alternatives, provide industry perspective and expertise on alternatives and concepts, and review final program alternatives.

Categories of conservation requirements for the third management period are the following:

- general industrial conservation requirements, which apply to all industrial users;
- turf-related facilities (facilities of 10 or more acres of water-intensive landscaping) have an annual allotment based upon the number of acres of turf, bodies of water, and low water use landscaping;
- sand and gravel facilities, which have operating standards and must develop a conservation plan;

- large-scale power plants, which have water efficiency standards for their cooling towers;
- large-scale cooling facilities, which have water efficiency standards;
- dairy operations, which have an annual allotment based on herd size, or may apply for a best management practices program;
- cattle feedlot operations, which have an annual allotment based on herd size;
- new large landscape users, which have landscape efficiency design standards; and
- new large industrial users, which have water use efficiency and conservation plan requirements.

In most instances, specific conservation requirements for the third management period are not significantly different from those in the Second Management Plan. All specific conservation requirement programs have retained essentially the same structure and character. Conservation requirements in the First and Second Management Plans have been effective in improving water use efficiency for certain industrial subsectors. Turf-related facilities, especially golf courses, have been designed with considerably less water-intensive landscaping than in the past. In the Third Management Plan, a number of technical corrections have been made, requirements have been added, additional program alternatives have been included, and renewable supply use incentives have been added or adjusted to be more effective.

Some AMA management plans have a conservation program for metal mining facilities that use more than 500 acre-feet per year. If an industrial user meeting this definition should be constructed in the Phoenix AMA during the third management period, this plan could be modified to include the metal mining facilities conservation program.

6.1.3 Industrial Program Issues

The most significant issues facing the Industrial Conservation Program include the following:

- The need for greater use of renewable supplies by industrial users
- The need to match industrial uses with water quality that may be less than ideal or unsuitable for potable uses in order to make the most efficient use of water in the AMA for both potable and non-potable uses
- The concern raised by the large volume of unused groundwater allotments
- The concern raised by the ability of industrial users to obtain new groundwater withdrawal authority in even the most critical areas of the AMA
- The sector's disproportionately large contribution to overdraft.

6.1.3.1 Use of Renewable Supplies by Industrial Users

First and Second Management Plan incentives encouraging renewable supply use by industrial users have proven less effective than anticipated. Incentives for effluent use were offered to turf-related facilities in the Second Management Plan. If a facility used 100 percent non-groundwater supplies, it was exempt from the Department's conservation requirements. As a rule, most third management plan programs include new or more substantial incentives for the use of effluent or the recycling or reuse of industrial wastewater.

Currently, the only industrial subsector that uses renewable supplies is turf-related facilities that receive effluent, surface water, or CAP water from municipal providers or irrigation districts or, to a lesser degree, private sources. Many factors impede the ability of the industrial sector to directly and indirectly use renewable water supplies and contribute to reaching the safe-yield goal of the AMA. Lack of proximity or right to renewable supplies, reliability, cost, supply ownership, and water quality issues are constraints to the use of effluent and CAP water. While turf-related facilities have had no significant water quality problems using effluent, other industrial users could require pretreatment of effluent to remove salts and other constituents. For example, industry representatives have indicated that concrete does not meet

industry standards if effluent is used in place of groundwater. Although the AMA has either added or bolstered existing renewable supply incentives for the third management period, limited statutory authority exists for overcoming obstacles to the use of renewable supplies by industrial users.

Surface water, primarily from the Salt, Verde, and Agua Fria Rivers, is the only renewable supply that is consistently competitive in cost with groundwater and fairly accessible to industrial users. Use of this supply, however, is limited to industrial users whose lands have appropriated surface water rights within an irrigation district's boundaries. It may also be available, in rare cases, if they directly divert surface water from a river or stream pursuant to a surface water right. This source is not a viable option for new industrial uses outside of irrigation district boundaries.

CAP water is legally available to industrial users either through an original allocation subcontract with the Central Arizona Water Conservation District (CAWCD), the managing entity of CAP, or through a contract for "excess" CAP water (CAP water that has not been put to use by those with original subcontracts). Long-term, continuously available CAP water for use by industrial users, however, is limited. Only one industrial user currently has a CAP allocation and year-to-year contracts for excess CAP water are not a reliable long-term source; once other subcontractors use their CAP supply, there will be no excess CAP water available to industrial users. Industrial users may arrange an agreement to have allocated or excess CAP water conveyed through a municipal provider's distribution system or through an irrigation district's canals and laterals.

Effluent generally must be conveyed to users in dedicated systems. Effluent is available either from small package plants built by a developer of a master planned community, which are designed to treat influent from the community and distribute it to a non-residential use within that community (such as a golf course), or from larger regional wastewater treatment plants. Much of the influent from mature, older areas of Phoenix, Glendale, Scottsdale, Tempe, and Mesa goes to the 91st Avenue Wastewater Treatment Plant, which is downstream from most industrial users in the Phoenix metropolitan area. Piping effluent to industrial users in older areas would require the development of an extensive effluent distribution system from the plant to users. Currently, neither municipal water providers nor industrial users have much incentive to assume the financial burden of developing such a system. Municipal water providers are increasingly developing distribution systems to carry effluent to non-residential users from wastewater treatment plants in areas of new growth. It is easier and cheaper to develop such systems in new growth areas than in older areas. This is especially true in North Scottsdale, Phoenix north of the CAP canal, Chandler, and Gilbert. While this will likely forestall new industrial groundwater uses in those areas of the AMA, the cost of developing such systems is usually greater than the cost of groundwater. Of all renewable supplies, effluent is the one source that will grow and be most readily available to industrial users. Most effluent is delivered to individual users served by municipal water providers and is not used by industrial users. Individual users used over 4,000 acre-feet of effluent in 1995 while industrial right holders used over 3,000 acre-feet of effluent in 1995.

Only a decade ago, industrial users who wanted to use renewable supplies had no other choice other than to use them directly. Today, industrial users who cannot directly use surface water, CAP water, or effluent may do so indirectly. One method would have the industrial user obtain a water storage permit, lease space at an underground storage facility, and recharge the renewable supply back into the aquifer. (See Chapter 8.) Credits for such storage are accrued by the industrial user and may be expended or "recovered" by pumping groundwater from the industrial user's wells. Usually when water is recovered, it is legally considered the same as the source that was stored; if effluent is stored at an underground storage facility, then the credits recovered are legally considered effluent. Although this option alleviates the need to build costly distribution systems to industrial users, indirect use of renewable supplies has expenses that usually make the option more costly than pumping groundwater. Industrial users who want to store renewable supplies must obtain the necessary permits, purchase the water for storage, pay for leasing space at a facility, and pay for pumping (recovery) costs. Perhaps a more likely option for the industrial user is to

purchase credits from a party that has stored water and is willing to sell their credits. The industrial user can then use the purchased credits to recover a renewable supply that has been stored.

6.1.3.2 Matching Water Quality and Uses

Each industrial user category has its own water chemistry requirements related to the particular product or process involved. Some users may require high quality groundwater while others do not. For example, turf-related facilities are able to use effluent without any significant adverse impact, and sand and gravel facilities can use effluent for aggregate washing. Poor quality groundwater may be acceptable for certain industrial uses. Use of industrial wastewater may also be a potential water supply and should be investigated. Obvious constraints on its use include location of the supply in relation to the facility, cost, and pre-treatment needs.

In 1997, the Legislature enacted legislation significantly revising the Water Quality Assurance Revolving Fund (WQARF) program to provide incentives for the use of remediated groundwater to facilitate the treatment of contaminated groundwater. Among other things, the WQARF legislation provides that when determining compliance with management plan conservation requirements, the Department shall account for groundwater withdrawn pursuant to approved remedial action projects under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or Title 49, Arizona Revised Statutes, consistent with the accounting for surface water. Laws 1997, Ch. 287, § 51(B). See Chapter 7, section 7.4.4.6.3. Groundwater withdrawn pursuant to an approved remedial action project retains its legal character as groundwater for all other purposes under Title 45, Arizona Revised Statutes, including all other laws regulating groundwater withdrawal and use such as the assessment of withdrawal fees pursuant to A.R.S. § 45-611, *et seq.*, as well as laws regulating water exchanges as set forth in A.R.S. § 45-1001, *et seq.*, the transportation of groundwater as set forth in A.R.S. § 45-541, *et seq.*, withdrawals of groundwater for transportation to active management areas as set forth in A.R.S. § 45-551, *et seq.*, and underground water storage, savings, and replenishment as set forth in Title 45, Chapter 3.1, Arizona Revised Statutes.

For each approved remedial action project, the annual amount of groundwater that is eligible for the remediated groundwater accounting incentive is the maximum annual volume of groundwater that may be withdrawn pursuant to the project, as specified in the consent decree or other document approved by the Environmental Protection Agency (EPA) or Arizona Department of Environmental Quality (ADEQ). However, if the project was approved prior to June 15, 1999 and the maximum annual volume of groundwater that may be withdrawn pursuant to the project is not specified in a consent decree or other document approved by the EPA or ADEQ, the annual amount of groundwater that is eligible for the remediated groundwater accounting incentive is the highest annual use of groundwater withdrawn pursuant to the project prior to January 1, 1999. The director may modify the annual amount of groundwater that is eligible for the accounting incentive if an increase in withdrawals is necessary to further the purpose of the project or if a change is made to the consent decree or other document approved by the EPA or ADEQ.

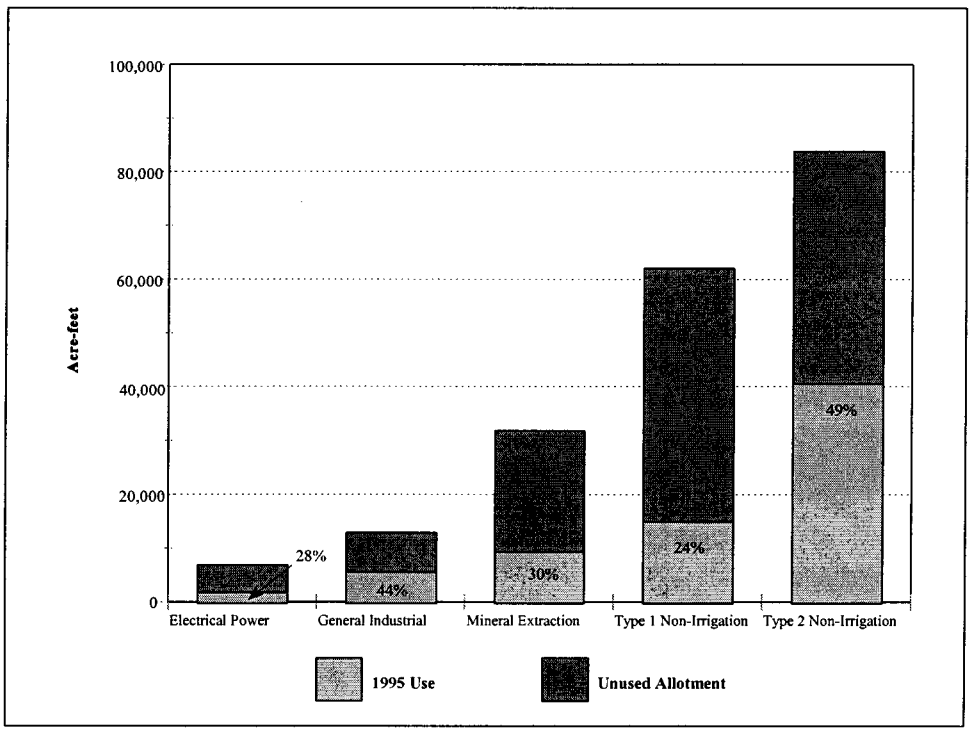
In order to qualify for the remediated groundwater accounting incentive, a person must notify the director in writing of the anticipated withdrawal of the groundwater prior to its withdrawal. The notification must include a copy of a document approved by ADEQ or the EPA such as the Remedial Action Plan (RAP), Record of Decision (ROD) or consent decree. Unless specified in the document, the notification must include the volume of groundwater that will be pumped annually pursuant to the project, the time period to which the document applies, and the annual authorized volume of groundwater that may be withdrawn pursuant to the project. The notification must also include the purpose for which the remediated groundwater will be used and the name and telephone number of a contact person. Additionally, at the time the notice is given, the person must be using remediated groundwater pursuant to the approved remedial action or must have agreed to do so through a consent decree or other document approved by ADEQ or the EPA. Remediated groundwater which qualifies for the accounting must be metered and

reported separately from groundwater that does not qualify for the accounting. (See section 6-204 of the Conservation Requirements for All Industrial Users.)

6.1.3.3 Unused Allotment

A large volume of unused groundwater right and permit allocations are associated with the industrial sector. Groundwater rights and permits held by industrial users in 1995 totaled over 212,000 acre-feet. Use pursuant to these rights and permits was only 34 percent of the total allotment in 1995. Figure 6-1 shows total use and total allotment for Power, Mineral Extraction, Type 1 non-irrigation grandfathered rights, and Type 2 non-irrigation grandfathered rights in the AMA in 1995. Type 2 non-irrigation grandfathered rights are not appurtenant to the land and may be used anywhere in the AMA for any non-irrigation purposes. They may be bought, sold, or leased in whole and in part. Type 2 rights have the greatest flexibility for potential use in the future, possibly in areas or subbasins where groundwater decline is already or will be severe. With over 43,000 acre-feet of Type 2 non-irrigation grandfathered rights not used in 1995, these rights may prove to be a major obstacle to reducing groundwater dependence in the industrial sector. While some of the unused allotments may never actually be put to use, it is not possible to predict future utilization. If these 43,000 acre-feet were pumped, it would be a serious hindrance to reaching safe-yield unless it were offset through replenishment with imported renewable supplies. Type 1 rights and some Type 2 rights may be extinguished for assured water supply credits (mineral extraction and electric power Type 2 rights may not be extinguished for this purpose) by municipal water providers. In addition, beginning in 2006, the Department may collect fees from groundwater users to purchase and retire grandfathered groundwater rights. Both mechanisms are opportunities that are currently available to permanently extinguish existing industrial rights.

FIGURE 6-1
1995 WATER USE AND ALLOTMENTS
PHOENIX ACTIVE MANAGEMENT AREA



6.1.3.4 Groundwater Withdrawal Permits

General Industrial Use (GIU) Permits are issued under A.R.S. § 45-515 for industrial uses located outside of service area boundaries pursuant to certain conditions. Permits may also be issued for mineral extraction and metallurgical processing under A.R.S. § 45-514. These permits allow groundwater pumping in addition to withdrawals pursuant to existing industrial rights. The total permitted GIU volume in the Phoenix AMA in 1995 was nearly 12,900 acre-feet, although the amount used was approximately 5,700 acre-feet. Historically, permits have been readily issued and the number of permit applications may increase in the future as the availability of Type 2 rights to serve industrial uses becomes more limited.

6.1.3.5 Sector Equity to Reduce Overdraft

While some industrial users use surface water, effluent, CAP water, or industrial wastewater, the vast majority of industrial water use is of groundwater. Although industrial use is a relatively small water use sector (4 percent of AMA water use) compared to municipal and agricultural uses, industrial use accounts for a disproportionately large amount of groundwater overdraft, despite incentives included in the First and Second Management Plans to encourage the use of renewable water supplies. Because industrial users have the legal authority to withdraw groundwater up to the annual allotment of their rights or permits, and since the cost of pumping groundwater is relatively low compared to the cost of most other sources of water, there is little economic incentive for industrial users to switch to renewable water supplies. If financial incentives remain inadequate, groundwater use by industrial users may increase in the future.

In the Phoenix AMA, significant amounts of industrial groundwater right allotments are unused, representing a potential increase in groundwater pumping allowable under statute. The industrial user also has relative ease of obtaining further groundwater withdrawal authority, either by converting an irrigation grandfathered right to a Type 1 non-irrigation grandfathered right or by obtaining an industrial use permit. The access to large quantities of unused groundwater allotments and the ability for the sector to increase withdrawal authority illustrates how capable the sector is at further contributing to the problem of overdraft.

Users in other sectors have limits imposed on their abilities to mine groundwater. The agricultural sector is limited to irrigating land that was legally irrigated from 1975 to 1979. Under AWS Rules, new municipal growth is restricted in the amount of groundwater that may be used to serve such development; renewable resources must be used. When a municipal provider pumps water in excess of the AWS Rules, it must pay a replenishment tax to the Central Arizona Groundwater Replenishment District (CAGRD), which uses the revenue generated by the tax to replenish the aquifer.

The industrial sector has none of these restrictions. It can continue to pump or establish pumping in areas or subbasins where municipal providers have undertaken great expense to stop groundwater pumping to improve physical availability of groundwater in the area. Although industrial users account for 4 percent of total water use in the AMA, they use 7 percent of the groundwater and account for 13 percent of groundwater overdraft.

6.1.4 Future Directions

Maintaining water use efficiency, providing conservation and technical assistance, and developing opportunities for renewable resource use are the most likely future directions for industrial users. The future of industrial users in relation to the AMA's goal of safe-yield by 2025 is largely shaped by the potential for growth in groundwater use and constraints from replacing groundwater use with renewable supplies.

For the industrial sector to contribute more to the achievement of the AMA management goal of safe-yield, viable renewable resource use mechanisms must be put in place. Although most effluent is municipally controlled and is projected to be used by municipally served turf-related facilities, potential may exist for CAP and effluent use by industrial users in the future. For this to occur, there must be either regional infrastructure cost sharing opportunities for direct use that make it economically viable to use a renewable supply, or low cost replenishment mechanisms whereby pumped groundwater would be replenished by a renewable supply elsewhere in the AMA under certain conditions.

Groundwater pumping by industrial users in critical areas of the AMA is of particular concern. Critical areas may include areas of severe overdraft, rapidly declining water levels, land subsidence and earth fissuring, or areas vulnerable to degraded water quality. The Department may develop water management strategies to address localized water conditions, promoting withdrawals in areas experiencing groundwater recharge and restricting withdrawals from areas experiencing severe declines. For industrial uses, this could mean limiting Type 1 non-irrigation grandfathered right conversions, buying out or providing incentives for extinguishing existing grandfathered rights in specified areas, or limiting new General Industrial Use permits and industrial users in critical areas.

Once created, Type 1 non-irrigation rights have the authority to pump groundwater in perpetuity in such areas. In addition, little can be done to prevent a Type 2 non-irrigation right to move into a critical area from other parts of the AMA. Only limited ability exists to prevent the issuance of groundwater withdrawal permits in a critical area.

Apart from the groundwater right retirement provision in the Code and the groundwater right extinguishment provisions in the AWS Rules, no statutory authority exists to reduce industrial groundwater rights. The Department has decided not to include a grandfathered right purchase and retirement program in the Third Management Plan at this time. The extent to which the extinguishment provisions will limit industrial use is impossible to predict. In the future, it may be necessary to explore groundwater replenishment approaches to offset a portion of the industrial use of groundwater. Expanding the authority of the CAGRD to recharge excess CAP water outside of the Assured Water Supply Program or establishing a separate replenishment authority for industrial users are possible approaches. Statutory change would be necessary to implement either mechanism.

It may be reasonable to consider either conditioning the issuance of a GIU permit on the permit holder's agreement to replenish the aquifer with a renewable supply or changing the statutory language to place more conditions on obtaining a GIU permit. Alternatively, a legislative change to allow the director to deny an application for a GIU permit if the permit would have an adverse effect in areas of the AMA deemed to have critical conditions may need to be considered.

Industrial water uses may change as new technologies are developed during the third management period. Research may need to be conducted during the third management period to investigate water-conserving opportunities arising from the use of these technologies by industrial users. This research could be used to develop conservation requirements for the Fourth Management Plan.

6.2 ALL INDUSTRIAL USERS

6.2.1 Introduction

The conservation requirements in this section apply to all industrial water users. In addition to these requirements, certain industrial users are also required to comply with conservation requirements specific to their type of water use under other sections of this chapter. For example, a sand and gravel facility is required to comply with the requirement in this section to use low-flow plumbing devices at the facility to the maximum extent possible, and must also comply with the conservation requirements in section 6.4.6 of this chapter.

The following industrial users are required to comply with the conservation requirements for all industrial users in this section, as well as conservation requirements for their specific type of water use in other sections of this chapter: turf-related facilities, sand and gravel facilities, large-scale power plants, large-scale cooling facilities, dairy operations, cattle feedlot operations, new large landscape users, and new large industrial users. All remaining industrial users are referred to in this section as "other industrial users" and are required to comply only with the conservation requirements for all industrial users in this section.

6.2.2 Water Use by Other Industrial Users

Other industrial users in the Phoenix AMA used approximately 12,500 acre-feet of water in 1995, which accounts for approximately 15 percent of the total groundwater withdrawals by industrial users in the Phoenix AMA. Many different types of commercial and manufacturing uses are included in this category. The largest volume of water is used in the aerospace, food processing, electronics, hospital, and non-durable goods manufacturing industries. Water uses commonly include cooling; landscaping; and sanitary, kitchen, and industrial processing.

In the Phoenix AMA, 304 water rights and permits are associated with this category. The total annual groundwater allotment of rights and permits associated with this category, excluding dewatering and poor quality water permits, is nearly 71,000 acre-feet. Other than 12,000 acre-feet of Type 1 non-irrigation grandfathered rights associated with the Estrella development in Goodyear, no owner holds a very large allotment.

While some users are expected to grow in the future, total demand for other industrial users is expected to remain approximately the same as current water use levels through the year 2025. It is anticipated that most future industrial development will be served by municipal providers because commercial and industrial development generally occurs within their service areas.

6.2.3 Program Development and Issues

In the First Management Plan, other industrial users were required to avoid waste and to make efforts to recycle water. In addition, they were prohibited from using single-pass cooling or heating in their facilities. These requirements and others were included in the Second Management Plan for all industrial users.

Consultant studies conducted in preparation of the Second Management Plan investigated water use associated with landscaping, heating and cooling, and sanitary and kitchen water use practices. These studies identified areas of water conservation potential, and appropriate water conservation techniques. The Department has determined that the findings from these studies still apply to current industrial use practices. In addition, a 1996-97 Tucson AMA study, funded by a conservation assistance grant, investigated water use practices at cooling towers and yielded additional information on water conservation potential for those facilities (Conservation Assistance Grant CA95TU(E)I16-00).

The following techniques are recommended for achieving water conservation in the industrial sector:

- Reusing or recycling water
- Avoiding single-pass cooling unless the water is reused
- Use of low flow plumbing fixtures
- Use of low water use landscaping with efficient irrigation systems
- Developing site-specific water conservation plans for large facilities

Most of these techniques are included in the conservation requirements for all industrial users detailed below. They apply to other industrial users as well as industrial users subject to conservation requirements for their specific type of water use. The Third Management Plan requirements are intended to send a strong conservation message to all industrial users to use water efficiently.

The Department also inventoried the other industrial user category during the planning process for the Third Management Plan to determine if any user groups with sufficient usage and conservation potential to warrant specific conservation requirements existed. The diverse nature of water uses within this category makes it difficult to formulate volumetric conservation requirements that address the various types of industries. There are, however, some opportunities for water conservation. The greatest conservation potential within the other industrial users category is in cooling and landscape watering, which are uses common to most facilities. Commercial landscapes are usually maintained by contractors whose priority is a lush appearance and who may not adjust automatic irrigation controller clocks to match weather conditions. Smaller cooling towers may not be managed as efficiently as larger towers, nor with water conservation as high a priority.

6.2.4 All Industrial Users Conservation Program

The program for all industrial users during the third management period is similar to the Second Management Plan program. All industrial users are required to avoid waste and to make diligent efforts to recycle water. Single-pass cooling or heating is not allowed unless the water is reused, and low-flow plumbing fixtures must be used as required by the state or local plumbing code. Since January 1, 1994, the Arizona Statewide Plumbing Code has required the use of low-flow fixtures in new construction throughout the state, and some local plumbing ordinances have even more stringent standards.

Two landscaping requirements are included for the third management period. For an industrial user not regulated as a turf-related facility, there is a requirement to use low water use landscape plants for landscaping where feasible, and to water with efficient irrigation systems. Improving irrigation efficiency can be a source of major water savings whether the plants have high or low water needs. The Department encourages all facilities to irrigate efficiently regardless of the type of vegetation planted. In addition, industrial users are prohibited from serving groundwater to vegetation planted in a public right-of-way after January 1, 2002, unless the plants are listed in Appendix 5-L, Low Water Use/Drought Tolerant Plant List for the Phoenix AMA, and are prohibited from serving groundwater to a water feature in the right-of-way if installed after January 1, 2002.

6.2.5 Industrial Conservation Requirements and Monitoring and Reporting Requirements for All Industrial Users

6-201. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, unless the context otherwise requires, the following words and phrases used in sections 6-202 through 6-203 of this chapter shall have the following meanings:

1. *"Industrial process purposes" means water that is used by an industrial user directly in the creation or manufacture of a product.*

2. *"Industrial use" means 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.*

3. *"Industrial user" means a person who uses water for industrial uses.*

4. *"Low-flow plumbing fixture" means a lavatory faucet, lavatory faucet replacement aerator, kitchen faucet, kitchen faucet replacement aerator, shower head, urinal, water closet, or evaporative cooler designed to meet the use rates specified in A.R.S. § 45-312 and 313 or the applicable county or city code, whichever is more restrictive.*

5. *"Single-pass cooling and heating" means the use of water without recirculation to increase or decrease the temperature of equipment, a stored liquid, or a confined air space.*

6. *"Wastewater" means water that is discharged after an industrial or municipal use, excluding effluent.*

6-202. Conservation Requirements

Beginning on January 1, 2002 or upon commencement of water use, whichever is later, and continuing thereafter until the first compliance date for any substitute conservation requirement in the Fourth Management Plan, an industrial user shall comply with the following requirements:

1. *Avoid waste; use only the amount of water from any source, including effluent, reasonably required for each industrial use; and make diligent efforts to recycle water.*

2. *Do not use water for non-residential single-pass cooling or heating purposes unless the water is reused for other purposes.*

3. *Use low-flow plumbing fixtures as required by Title 45, Chapter 1, Article 12, Arizona Revised Statutes, or any applicable county or city code, whichever is more restrictive.*

4. *Use plants from the Low Water Use/Drought Tolerant Plant List, Phoenix AMA (Appendix 5-L), or any modifications to the list, for landscaping to the maximum extent feasible and water with a water efficient irrigation system. An industrial user regulated as a turf-related facility under sections 6-301, et seq., or as a new large landscape user under section 6-901, et seq., is exempt from this requirement.*

5. *Do not serve or use groundwater for the purpose of watering landscaping plants planted on or after January 1, 2002 within any publicly owned right-of-way of a highway, street, road, sidewalk, curb, or shoulder which is used for travel in any ordinary mode, including pedestrian travel, unless the plants are listed on the Low Water Use/Drought Tolerant Plant List, Phoenix AMA (Appendix 5-L), or any modifications to the list. The director may waive this requirement upon request from the industrial user if a waiver of this requirement is in the public interest. This requirement does not apply to any portion of a residential lot that extends into a publicly owned right-of-way.*

6. *Do not serve or use groundwater for the purpose of maintaining water features, including fountains, waterfalls, ponds, water courses, and other artificial water structures, installed after January 1, 2002 within any publicly owned right-of-way of a highway, street, road, sidewalk, curb, or shoulder that is used for travel in any ordinary mode, including pedestrian travel. The director may waive this requirement upon request from the industrial user if a waiver of this requirement is in the public interest. This requirement does not apply to any portion of a residential lot that extends into a publicly owned right-of-way.*

6-203. Monitoring and Reporting Requirements

A. Requirements

For calendar year 2002 or the calendar year in which the facility first begins to use water, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute monitoring and reporting requirement in the Fourth Management Plan, an industrial user shall, except as provided for in subsection B of this section, include the following information in its annual report required by A.R.S. § 45-632:

1. *The total quantity of water by source, including effluent, withdrawn, diverted, or received during the calendar year for industrial process purposes, as measured with a measuring device in accordance with the Department's measuring device rules. A.A.C. R12-15-901, et seq.*

2. *The total quantity of water by source, including effluent, withdrawn, diverted, or received during the calendar year for purposes other than industrial process purposes listed in paragraph 1 of this subsection, as measured with a measuring device in accordance with the Department's measuring device rules. A.A.C. R12-15-901, et seq.*

3. *An estimate of the quantity of wastewater generated during the calendar year.*

4. *An estimate of the quantity of wastewater recycled during the calendar year.*

5. *A description of the primary purposes for which water from any source, including effluent, is used.*

6. *The number of acres of land that were planted with low water use plants during the calendar year as a result of removal of plants not on the Low Water Use/Drought Tolerant Plant List, Phoenix AMA (Appendix 5-L), or any modifications to the list, if more than one acre, and the method of irrigation for those acres. An industrial user regulated as a turf-related facility under sections 6-301, et seq., or as a new large landscape user under section 6-901, et seq., is exempt from this requirement.*

B. Exemption

An industrial user who holds a Type 1 or Type 2 non-irrigation grandfathered right or a groundwater withdrawal permit in the amount of 10 or fewer acre-feet per year is exempt from the requirements set forth in subsection A of this section, unless the industrial user holds more than one such right or permit in the aggregate amount of more than 10 acre-feet per year and withdraws more than 10 acre-feet of water during the calendar year pursuant to those rights or permits.

6-204. Remediated Groundwater Accounting for Conservation Requirements

A. Accounting

Groundwater withdrawn pursuant to an approved remedial action project under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or Title 49, Arizona Revised Statutes, and used by a person subject to a conservation requirement established under this chapter, shall be accounted for consistent with the accounting for surface water for purposes of determining the person's compliance with the conservation requirement, subject to the provisions of subsections B through D of this section.

B. Amount of Groundwater Eligible for Accounting

For each approved remedial action project, the annual amount of groundwater that is eligible for the remediated groundwater accounting provided in subsection A of this section is the project's annual authorized volume. The annual authorized volume for a remedial action project approved on or after June 15, 1999 is the maximum annual volume of groundwater that may be withdrawn pursuant to the project, as specified in a consent decree or other document approved by the United States Environmental Protection Agency (EPA) or the Arizona Department of Environmental Quality (ADEQ). The annual authorized volume for a project approved prior to June 15, 1999 is the highest annual use of groundwater withdrawn pursuant to the project prior to January 1, 1999, except that if a consent decree or other document approved by the EPA or ADEQ specifies the maximum annual volume of groundwater that may be withdrawn pursuant to the project, the project's annual authorized volume is the maximum annual volume of groundwater specified in that document. The director may modify the annual authorized volume for a remedial action project as follows:

1. *For an approved remedial action project associated with a treatment plant that was in operation prior to June 15, 1999, a person may request an increase in the annual authorized volume at the same time the notice is submitted pursuant to subsection C of this section. The director shall increase the annual authorized volume up to the maximum treatment capacity of the treatment plant if adequate documentation is submitted to the director demonstrating that an increase is necessary to further the purpose of the remedial action project and the increase is not in violation of the consent decree or other document approved by the EPA or ADEQ.*

2. *A person may request an increase in the annual authorized volume of an approved remedial action project at any time if it is necessary to withdraw groundwater in excess of the annual authorized volume to further the purpose of the project. The director shall increase the annual authorized volume up to the maximum volume needed to further the purpose of the project if adequate documentation justifying the increase is submitted to the director and the increase is not in violation of the consent decree or other document approved by the EPA or ADEQ.*

3. *The director shall modify the annual authorized volume of an approved remedial action project to conform to any change in the consent decree or other document approved by the EPA or ADEQ if the person desiring the modification gives the director written notice of the change within thirty days after the change. The notice shall include a copy of the legally binding agreement changing the consent decree or other document approved by the EPA or ADEQ.*

C. Notification

To qualify for the remediated groundwater accounting provided in subsection A of this section, the person desiring the accounting must notify the director in writing of the anticipated withdrawal of groundwater pursuant to an approved remedial action project under CERCLA or Title 49, Arizona Revised Statutes, prior to the withdrawal. At the time the notice is given, the person desiring the accounting must be using remediated groundwater pursuant to the approved remedial action project or must have agreed to do so through a consent decree or other document approved by the EPA or ADEQ. The notice required by this subsection shall include all of the following:

1. *A copy of a document approved by ADEQ or the EPA, such as the Remedial Action Plan (RAP), Record of Decision (ROD) or consent decree, authorizing the remediated groundwater project. Unless expressly specified in the document, the person shall include in the notice the volume of groundwater that will be pumped annually pursuant to the project, the time period to which the document applies, and the annual authorized volume of groundwater that may be withdrawn pursuant to the project.*

2. *The purpose for which the remediated groundwater will be used.*

3. *The name and telephone number of a contact person.*

4. *Any other information required by the director.*

D. Monitoring and Reporting Requirements

To qualify for the remediated groundwater accounting for conservation requirements as provided in subsection A of this section, groundwater withdrawn pursuant to the approved remedial action project must be metered separately from groundwater withdrawn in association with another groundwater withdrawal authority for the same or other end use. A person desiring the remediated groundwater accounting for conservation requirements shall indicate in its annual report under A.R.S. § 45-632 the volume of water withdrawn and used during the previous calendar year that qualifies for the accounting.

6.3 TURF-RELATED FACILITIES

A turf-related facility is any facility, including schools, parks, cemeteries, golf courses, or common areas within a housing subdivision, with ten or more acres of water-intensive landscaped area. Turf-related facilities regulated under the Industrial Conservation Program obtain groundwater pursuant to Type 1 or Type 2 non-irrigation grandfathered rights or groundwater withdrawal permits. In addition, a large number of turf-related facilities are served groundwater by municipal water providers and are also subject to the conservation requirements set forth in this section through provisions of the Municipal Conservation Program (see Chapter 5). These municipally served facilities are called individual users.

Second Management Plan conservation requirements and other factors have driven changes in the water use patterns of turf-related facilities. New facilities are designed with less water-intensive acreage, both existing and new facilities employ technology that applies water more efficiently, and facility management has become more cognizant of the need for water conservation.

6.3.1 Water Use by Turf-Related Facilities

Turf-related facilities apply water for growing turfgrass and other landscaping plants and for filling and maintaining water levels in bodies of water. Water application efficiency is determined by the type of water application system that is utilized, maintenance of the system, water application scheduling, site topography, soil type, weather conditions, and water quality. In the Phoenix AMA, 393 turf-related facilities (both industrial users and individual users) exist, including golf courses, parks, schools, cemeteries, common areas of residential developments, and other miscellaneous facilities.

A direct relationship exists between the number of acres of water-intensive landscaping being maintained within a facility and a facility's water use. In 1995, turf-related facilities in the Phoenix AMA encompassed a total of 20,400 acres of turf and 2,100 acres of water surface area. From 1989 through 1995, the average annual water application rate on turf acres within turf-related facilities ranged between 3.9 and 5.1 acre-feet per acre. Golf courses tend to be the largest turf-related facilities, typically having at least 80 acres of turf. Parks and schools make up the majority of the smaller turf-related facilities, usually having less than 30 turf acres. Water use for maintaining bodies of water is higher than for maintaining turf and low water use landscaping because evaporation from the water surface (approximately 6.2 acre-feet per acre per year) is higher than the consumptive use and evaporation rates for plants. Unlined or inadequately sealed water bodies can lose significant volumes of water through seepage. The bodies of water associated with turf-related facilities are most often constructed on golf courses, although numerous residential developments and a few parks feature bodies of water. In 1995, turf-related facilities in the Phoenix AMA maintained a total of 1,450 acres of low water use landscaping that was irrigated with a permanent watering system, such as a drip irrigation system. Application rates for this type of landscaping are much lower than for turfgrass.

"Water use efficiency" refers to the relationship between the physiological needs of the plants being watered and the amount of water actually applied. Turf-related watering is normally expressed in terms of acre-feet per acre per year. Average turf application rates at turf-related facilities may be estimated by subtracting the estimated water use for low water use landscaping and water surface area (calculated by multiplying the number of acres of low water use landscaping and water surface area by the application rates of 1.5 acre-feet per acre and 6.2 acre-feet per acre, respectively) from the total water use and then dividing the remaining water use by the total acres of turf. In 1995, the estimated turf application rates for different types of facilities in the Phoenix AMA varied from 3.3 to 8.0 acre-feet per acre per year. This range is indicative of the broad spectrum of water use patterns among the types of turf-related facilities. Parks and schools tend to have the lowest application rates, while golf courses and common areas of housing developments tend to have the highest rates. Facility acreage attributes and water application rates are detailed in Table 6-1.

Turf-related facility water use in the Phoenix AMA has increased from over 87,700 acre-feet in 1987 to nearly 97,200 acre-feet in 1995. While total water use has increased, it continues to remain below the cumulative management plan maximum annual water allotment of over 108,000 acre-feet for turf-related facilities.

TABLE 6-1
1995 ACREAGE AND WATER USE BY TURF-RELATED FACILITIES
(INDUSTRIAL USERS AND MUNICIPAL INDIVIDUAL USERS)
PHOENIX ACTIVE MANAGEMENT AREA

Turf-related Facilities		Acreage			Water Application	
Type	Number	Turf	Water Surface Area	Low Water Use Landscaped Area	Total Water Use (Acre-Feet)	Estimated Turf Application Rate (acre-feet/acre)[1]
Golf Courses	129	14,545	819	1,146	68,639	4.5
Parks	86	1,947	139	44	7,238	3.4
Cemeteries	13	418	3	1	1,531	3.6
Common Areas	29	541	1,139	226	10,468	8.0
Schools	124	2,602	0	13	7,806	3.3
Miscellaneous	13	332	45	22	1,468	4.5
Total[2]	**393**	**20,394**	**2,145**	**1,450**	**97,151**	**4.3**

[1] Average application rates for turf acres were derived by subtracting the estimated water use of water surface area and low water use landscaped area from the reported 1995 water use and dividing by the number of turfed acres reported on 1995 water use reports.

[2] Numbers may not add up exactly due to rounding.

Turf-related facility water demand is met through various sources, including:

- Groundwater pumped pursuant to Type 1 and Type 2 non-irrigation grandfathered rights, pumped pursuant to groundwater withdrawal permits, served by municipal water providers, or delivered by irrigation districts;
- Surface water served by municipal water providers, delivered by irrigation districts, or diverted pursuant to surface water rights;
- Effluent served by municipal providers or delivered by private sources;
- CAP water served by a municipal water provider, delivered by an irrigation district, delivered by the CAWCD pursuant to a CAP subcontract, or by any other agreement; and
- Effluent or CAP water stored underground and recovered pursuant to water storage (recharge) credits.

Turf-related facilities may use a single source or multiple sources of water. It is not unusual for a turf-related facility to receive multiple sources of water from multiple water rights or providers.

Since 1989, groundwater has remained the single largest source of water for turf-related facilities, followed by surface water, CAP water, and effluent (see Figure 6-2). Surface water and groundwater use has not increased significantly in recent years, while there has been increased use of CAP water and effluent.

FIGURE 6-2
WATER SOURCES FOR TURF-RELATED FACILITIES, 1995
PHOENIX ACTIVE MANAGEMENT AREA

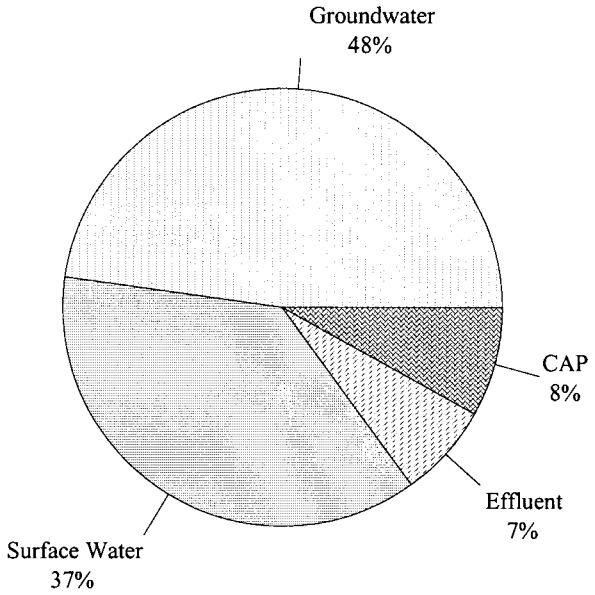


Table 6-2 further breaks down how different water sources are used by different types of turf-related facilities. Golf courses account for most of the groundwater used by turf-related facilities. However, of all the effluent and CAP water used by turf-related facilities, most is used by golf courses. Municipal providers have targeted golf courses for expanding their deliveries of these sources. Most schools and parks are located on lands with water served by a municipal provider and are less dependent on groundwater pumping for their use.

The high proportion of groundwater use by golf courses is explained in part by the fact that a majority of golf courses are industrial groundwater right or permit holders (see Table 6-3). By contrast, a clear majority of schools and parks are served by municipal providers or irrigation districts, who are more likely to have access to non-groundwater sources.

Annual water demand by turf-related facilities, whether pumped, received pursuant to grandfathered groundwater rights or groundwater withdrawal permits, or delivered by municipal water providers, will grow from over 97,000 acre-feet in 1995 to between 163,000 and 179,000 acre-feet by 2025 (163,000 acre-feet assuming Third Management Plan requirements are met, 179,000 acre-feet assuming current use trends continue). Most of the increase is projected to come from new golf courses, with the number of courses projected to more than double to 268 by the year 2025. Golf course projections are tied to the projected development patterns of subregional areas of the AMA. Water use by park, common area, and miscellaneous facilities is projected to grow commensurate with population. Although school construction will likely correlate to population growth as well, most new schools are expected to be designed with minimal turf and will not qualify as turf-related facilities. School and cemetery water use is projected to grow slowly. As has been the trend since 1985, most future golf courses are projected to be served by municipal water providers. The same is true for new parks and schools. Deliveries of effluent and CAP water to these facilities are anticipated to become increasingly prevalent in the future.

TABLE 6-2
1995 TURF-RELATED FACILITY WATER USE
BY FACILITY TYPE AND WATER SOURCE
(INDUSTRIAL USERS AND MUNICIPAL INDIVIDUAL USERS)
PHOENIX ACTIVE MANAGEMENT AREA

Type	Groundwater	Surface Water	Central Arizona Project	Effluent	Total[1]
Golf Courses	39,239	16,275	7,410	5,715	68,639
Parks	1,150	5,884	4	200	7,238
Cemeteries	741	791	0	0	1,531
Common Areas	4,137	5,189	0	1,142	10,468
Schools	1,010	6,796	0	0	7,806
Miscellaneous	276	1,025	168	0	1,468
Total[1]	**46,554**	**35,959**	**7,582**	**7,056**	**97,151**

[1]Numbers may not add up due to rounding.

TABLE 6-3
TURF-RELATED FACILITY WATER USE
MUNICIPALLY SERVED INDIVIDUAL USERS VERSUS INDUSTRIAL USERS
PHOENIX ACTIVE MANAGEMENT AREA

Turf-related Facilities	Number of Facilities		Water Use (1995)	
Type	Municipal	Industrial	Municipal	Industrial
Golf Courses	60	69	27,609	41,030
Parks	81	5	6,333	905
Cemeteries	6	7	674	857
Common Areas	13	16	4,814	5,655
Schools	115	9	7,393	413
Miscellaneous	9	4	1,102	366
Total	**284**	**110**	**47,924**	**49,227**

6.3.1.1 Golf Courses

In the Phoenix AMA, golf courses include 9-hole to 72-hole facilities. Golf courses are the largest turf-related facilities, usually having more than 80 acres of water-intensive landscaping. Non-regulation courses are shorter than 6,200 yards in total length while regulation courses are longer than 6,200 yards in total length and have 18 or more holes. Generally, non-regulation courses have less turfed acres than regulation courses. Golf courses are composed of tees, greens, fairways, and roughs. The most frequently

used types of warm season grass are common or hybrid bermuda grass (*Cynodon*) with hybrid bermuda or bent grass (*Agrostis*) used primarily on greens. All golf courses overseed their tees and greens with rye grass (*Lolium*) in winter unless they have bentgrass greens. During the 1990s, some golf courses began using lower water use grass species buffalo grass (*Buchloe*) and experimenting with species such as curly mesquite grass (*Hilaria*) and purple three-awn (*Aristida*) in rough areas as a water conservation measure. A high proportion of resort golf courses overseed at least the fairways during the winter months. There is a great deal of variability in overseeding patterns on public and private courses. Some courses in the AMA prefer to avoid the expense, maintenance, and stress to the turf associated with overseeding the fairways. Some golfers appreciate the better playability associated with dormant Bermuda grass. Other facility managers feel strongly that a green appearance in the winter months is required to attract visitors to golf courses in Arizona. There is a strong emphasis on turf appearance for all golf courses, particularly resort courses and those associated with housing developments, which places a premium on aesthetics rather than maximum playability and water conservation during the winter.

Golf course water application systems are often more sophisticated than those at other turf-related facilities. Most have a system with a control panel and field satellites that can override the central controller. Computerized controlled irrigation systems and pump stations with flexibility in operating sprinkler heads are now commonplace; newer systems provide much greater savings in energy and water costs than water delivery systems from ten years ago. Most of the newer systems can incorporate weather stations, which assist in scheduling water application to more accurately replace the amount of water lost through evaporation and transpiration. Most courses apply water to greens and tees with spray heads; larger turf areas are watered with large radius heads. Water is typically pumped into the watering system from a storage tank or a body of water that is an integral part of the golf course.

Turf managers who are knowledgeable of the capabilities of water conservation technologies and practices are critical to program effectiveness. Taking advantage of a computerized system's ability to adjust water distribution uniformity (the percentage of points within the area being watered that receive equivalent amounts of water), routinely leveling heads, and frequently verifying proper operation of all controllers and heads are all examples of prudent management.

In the Phoenix AMA, 129 golf courses were in existence in 1995. These courses used 68,639 acre-feet of water in 1995, or 71 percent of the water use by turf-related facilities that year. Sixty-nine courses are served primarily by groundwater pumped by wells pursuant to non-irrigation grandfathered rights or groundwater withdrawal permits and are therefore regulated as industrial users in this Plan. Sixty are served primarily by municipalities or other sources. Twenty courses (five municipally served and 15 industrial users) receive water from more than one source. Thirty-three golf courses in the Phoenix AMA receive water from irrigation districts, most notably Salt River Project, either as a primary or a secondary source.

The total turfed area associated with the 60 golf courses served by municipal systems in the Phoenix AMA is over 5,700 acres. Golf courses classified as industrial users have over 8,700 acres planted in turf. Over 535 acres of lakes are associated with golf courses classified as industrial users; golf courses on municipal systems contain approximately 280 acres of lakes. Twenty golf courses in the Phoenix AMA are watered with effluent, which is 8 percent of the total water use by golf courses. Thirteen courses are watered with CAP water, or nearly 11 percent of the total water use by golf courses. Many of these courses are served untreated CAP water by the City of Scottsdale with the intention of converting them to effluent use.

Golf course demand has increased slowly since 1987, even with the addition of 23 new courses. While application rates increase proportionately with evapotranspiration rates in dry, hot years, application rates do not drop off as significantly in years with lower evapotranspiration rates. The average application rate for golf courses was 4.5 acre-feet per acre per year in 1995.

6.3.1.2 Parks

Public parks maintain turf for playing surfaces, for aesthetic reasons, and for erosion control. Maintenance of public parks is usually coordinated through a central office without the presence of on-site staff on a daily basis. Parks commonly have inefficient water application systems, although newer parks are installing more efficient systems, including drip irrigation and controllers with water budgeting capacity. Large radius impact heads are frequently used. Vandalism is a significant problem, requiring specialized tamper-proof heads. Bermuda grass is usually the only species planted, with rye grass overseeding limited to a few baseball fields. Relaxed turf appearance standards allow parks to "deficit irrigate," or to apply somewhat less water than the consumptive use requirement of turf. This, combined with a lack of overseeding, permits much lower application rates than those achieved by golf courses.

In 1995, 86 parks in the Phoenix AMA were identified as turf-related facilities. Eighty-one were served primarily by municipal water providers and five were industrial users. Twenty-nine of the municipally served parks received water from more than one source, while none of the industrial use parks received water from any source other than their own wells. Municipally served parks contain a total of over 1,732 acres of turf, nearly 120 acres of lakes, and nearly 44 acres of low water use landscaping. Industrial use parks contain a total of nearly 215 acres of turf and 19 acres of lakes.

Total reported water use for parks was 7,238 acre-feet in 1995. The average water application rate for parks in the Phoenix AMA was 3.4 acre-feet per acre per year. Only 14 percent of the park demand is served by groundwater withdrawn pursuant to industrial rights; the remainder is served by municipal providers. Effluent use by parks regulated as turf-related facilities is minimal, accounting only for 3 percent of park demand. However, several new parks are served solely with effluent and are not regulated as turf-related facilities. Most of the parks in the AMA are smaller than 20 acres in size.

6.3.1.3 Schools

The main function of turf in school yards is to provide an appropriate surface for active play. School managers have determined that using low water application rates can save money without adversely impacting turf use. Bermuda grass is the only species used and is seldom overseeded. Although athletic fields tend to be maintained at a higher turf quality than the balance of school yards, relaxed appearance standards and limited overseeding allow much lower application rates than those achieved by golf courses and homeowners association common areas. Often turfed acres on school grounds are deficit irrigated without sacrificing the function of the turf.

Water application systems at schools are usually relatively inflexible. In older schools, outdated equipment, including quick coupler systems, is common. Newer facilities have in-place heads with manual or electromechanical control. Some schools have converted non-play areas to drip irrigation. Due to budget constraints, it is difficult for schools to install computerized controllers so systems are frequently operated manually.

In the Phoenix AMA, 124 schools have 10 or more acres of turf and are regulated as turf-related facilities. Adjacent elementary and middle schools that share turf areas were counted as single facilities. Nine of these schools are considered to be industrial users withdrawing water from their own wells, with an amount accounting for 5 percent of total school demand. The remaining 115 schools receive water primarily from municipal sources. Of the municipally served schools, 41 received water from more than one source, while two industrial use schools had multiple sources of water. The total turfed acreage associated with all schools is 2,602 acres; there are no associated lakes. Schools in the AMA reported using a total of 7,806 acre-feet in 1995. Water use by schools has remained fairly constant since 1987.

Turf acreage within schools is small compared to other turf-related facilities. Water application rates for turf at schools are low, with an average of 3.3 acre-feet per acre per year. None of the schools regulated as turf-related facilities in the Phoenix AMA exclusively receive effluent or CAP water for turf-related watering.

6.3.1.4 Cemeteries

Cemeteries have several unique characteristics that affect water conservation potential. Cemeteries are developed in stages and are committed to maintaining grave sites in perpetuity in a manner acceptable to clients. Interment activities also cause problems in scheduling water application. Many cemetery operators believe they need to promote an image of a quiet, cool resting place and further believe turf appearance is important to achieve that image. Turf aesthetic requirements of cemeteries are similar to those of golf courses. Because cemeteries are developed in sections, the water application system is installed as new areas are opened. The water application system in older areas is often quite different from the system in recently developed sections. The result is often a complex control system that is difficult to manage. Most cemeteries use electromechanical controllers with a large number of heads on each controller. Large radius heads or raised spray heads are frequently used to allow watering around headstones. Several facilities are now upgrading their systems and installing drip irrigation for trees and shrubs.

In 1995, thirteen cemeteries in the Phoenix AMA contained 10 or more acres of turf or other water-intensive landscaping. Six of these cemeteries were served primarily by municipal water providers while seven were industrial users, withdrawing groundwater from their own wells. Three of the 13 cemeteries received water from more than one source. The total turfed acres associated with cemeteries in the AMA was 428 in 1995. Four of the cemeteries also contained lakes as a part of the facility, totaling 2.9 surface acres.

Water use by cemeteries has remained fairly constant since 1987. Cemeteries in the Phoenix AMA have an average of 33 turf acres. Water application rates are low for cemeteries, with an average of 3.6 acre-feet per acre. Total annual water use reported by these facilities was over 1,500 acre-feet in 1995.

6.3.1.5 Common Areas

Common areas are characterized as recreational or open space areas associated with housing developments that contain 10 or more acres of water-intensive landscaping. In general, these areas are a combination of turfed areas and water bodies. In many cases, water bodies predominate the landscaping. Appearance is an overriding concern for common areas. It is a traditional view that it is necessary to have turf in common areas. When turf is planted, its appearance is deemed an important factor in attracting potential home buyers and satisfying the aesthetic concerns of existing residents. As a result, turfed areas are typically overseeded and have relatively high water application rates. However, many newer developments are being designed with little or no turf, opting for low water use landscaping instead. Examples include Mountain Park Ranch, Tatum Ranch, and Las Sendas. The attractive design and lush appearance of low water use landscaping appears to have proven a successful and desirable amenity of newer developments.

Once common areas are developed and the housing development has been built out, developers usually relinquish control of the common area to the homeowners' association. Homeowners' associations typically hire a landscape management company to maintain common areas and are not highly involved in the daily management practices of the facilities.

There are 29 common area facilities in the Phoenix AMA. Thirteen of the facilities are served primarily by municipal providers. The remaining 16 are served by their own wells. Seven of the industrial use facilities have multiple water sources; three of the municipally served common area facilities have more than one

source of water. The total turfed area associated with municipally served common area facilities is nearly 237 acres. Total water surface area in these same facilities is nearly 485 acres. Common area facilities within the Phoenix AMA receiving water from their own wells have a total turfed area of nearly 304 acres and water bodies covering nearly 655 acres. Effluent accounts for nearly 11 percent of common area water use. Prior to the passage of the Lakes Bill in 1987 (A.R.S. § 45-131, *et seq.*), there was a rush to construct lakes in common areas of master-planned communities. The Lakes Bill effectively prohibits the use of most groundwater and surface water for the filling and refilling of common area lakes built after 1987. Since then, the construction of lakes for common areas has diminished. Those lakes that have been constructed since 1987 are usually filled with effluent.

Water use for common areas was reported at 10,468 acre-feet in 1995; the average application rate was 8.0 acre-feet per surface area acre per year. This rate is significantly higher than the use rates of other turf-related facilities and is caused by evaporation losses from the lakes, seepage from unlined or improperly lined lakes, the practice of overseeding turf in the fall and winter, and the general emphasis on aesthetic appearance over water use efficiency by homeowners associations.

6.3.1.6 Miscellaneous Facilities

There are 13 turf-related facilities within the Phoenix AMA that do not fit into any of the previously described categories. These facilities have been grouped into a category termed "miscellaneous turf-related facilities." This category includes industrial parks, a major international airport, and a state prison facility. With the diversity of miscellaneous facilities comes a corresponding diversity in water irrigation systems, system management, aesthetic needs for turf, and water application practices.

Four of the miscellaneous facilities are served by their own wells. Nine are served by municipal water providers. Two facilities receive water from more than one source. Total water use by miscellaneous turf-related facilities in 1995 was 1,468 acre-feet.

6.3.2 First and Second Management Plan Program Development

The First Management Plan conservation requirements established a maximum annual water allotment for each turf-related facility and stressed water use efficiency. The First Management Plan provided for the adjustment of turf application rates if effluent was used.

During the first management period, several turf-related facilities were converted from groundwater to effluent use by municipal providers. These providers began to develop effluent distribution systems and these efforts are being continued. The exclusion of direct effluent deliveries from the gallons per capita per day (GPCD) calculation in the Municipal Conservation Program and the increasing regulatory costs for discharging effluent also served as incentives for providers to serve effluent to turf-related facilities when available.

At the beginning of the first management period, water management practices such as evapotranspiration-based water application scheduling by turf-related facilities was uncommon. Due in good part to First Management Plan conservation requirements, such water management practices have become common.

Development of the Second Management Plan conservation requirements involved extensive data collection regarding water use patterns in Arizona and the conservation options available to turf-related facility managers. The Department relied heavily on input from the Turf Advisory Committees in the Tucson and Phoenix AMAs consisting of golf course, park, cemetery, and school turf managers; turf irrigation specialists; extension agents; and golf course designers.

The Department hired a consultant to analyze the water conservation practices used in the turf industry and the potential for water conservation. The study evaluated technologies, including management practices and design alternatives, associated with water conservation. A primary finding of the study was that management of the water application system, rather than the use of a specific water application system, is the most important factor in efficient landscape watering. The consultant and advisory committees concluded that a combination of good management and the latest water application systems was shown to be very effective in reducing water use.

For the Second Management Plan, the Department chose not to require specific conservation techniques due to the widely varied nature of turf-related facilities. Instead, the approach for the First Management Plan was continued and turf-related facilities were given a maximum annual water allotment. The allotment approaches of the First and Second Management Plans permitted turf managers to consider the characteristics of the facility, evaluate conservation alternatives, and decide how to most effectively apply the allotment to meet the facility's needs.

The Second Management Plan included an overall decrease in allowable application rates for all turf-related facilities, caps on maximum annual water allotments for new golf courses, a limitation on the allowable water-intensive landscaped area within new cemeteries, plus a more specific effluent incentive. In setting the annual water allotments, actual water use figures were collected from over 400 turf-related facilities in all AMAs. Data on the consumptive use of the grass species most frequently used; water application efficiency achievable with available technologies; evaporative losses from bodies of water based on pond evaporation data; management practices and technologies currently in place; conservation potential associated with additional technologies, practices, and design alternatives; and germination requirements for establishing new turf were compiled and analyzed.

Based on these factors, the Department established annual application rates in the Phoenix AMA of 4.9 acre-feet per acre for turf acres, 6.2 acre-feet per acre for bodies of water and 1.5 acre-feet per acre for low water use landscaping. Adjustments to the application rates were provided for establishing new turf, using high salinity water, filling or refilling bodies of water, and revegetating acreage disturbed during construction. For golf courses, the amount of turf acres that received 4.9 acre-feet per acre was limited to 5 acres per hole. Golf courses were given application rates of either 3.0 or 4.0 acre-feet per acre for a limited amount of turf acres in excess of 5 acres per hole.

The Department continued to encourage the use of effluent in the Second Management Plan. As an incentive, effluent use, if 50 percent or more of total water use, was discounted 15 percent to 20 percent when determining a facility's compliance with its maximum annual water allotment.

A review of short-term weather data in the 1980s indicated that a three-year averaging method would adequately compensate for weather fluctuations when determining a facility's compliance with its allotment. A provision for finding a facility in compliance on either an annual or a three-year average basis was included in the Second Management Plan.

The Second Management Plan has proven most successful in changing the design of new facilities by reducing turfed acres without sacrificing function. Water use is highly correlated with the number of turfed acres within the facilities. Recent school and park designs have usually eliminated turf except where essential for recreational purposes, thus reducing water use. Most parks and schools built during the second management period in the Phoenix AMA have less than 10 acres of water-intensive landscaping and for that reason are not regulated as turf-related facilities. Golf course designers have been able to design lower acreage courses without affecting appearance and playability. Generally, improvements in water management and irrigation technology have allowed turf-related facilities to increase the percent of acreage that is overseeded while maintaining efficient water application rates and staying within their maximum turf allotment.

Table 6-4 compares landscaping acres per hole for existing and new regulation size golf courses. Since 1985, under both the First and Second Management Plans, new courses have substantially less turf and lake acres per hole.

TABLE 6-4
AVERAGE LANDSCAPING ACRES PER HOLE, EXISTING AND NEW GOLF COURSES
PHOENIX ACTIVE MANAGEMENT AREA

Type of Acres	Existing Regulation Golf Courses (Pre-1985 Courses)	New Regulation Golf Courses (Post-1984 Courses)
Turf	6.6	4.8
Lake	0.4	0.2
Low Water Use Landscaping	0.2	1.5

Few turf-related facilities in the Phoenix AMA have had difficulty complying with their maximum annual water allotment during the second management period. Facilities that have been out of compliance with the requirements have chosen to implement long-lasting conservation technologies, such as relining of leaking bodies of water; permanent removal of turf; or the renovation of aging, inefficient watering systems.

6.3.3 Issues and Third Management Plan Program Development

The Code provides that the conservation programs for industrial users shall require the use of or shall establish conservation requirements based on the latest commercially available and economically feasible water conservation technologies. For turf-related facilities, such technologies include: (1) the use of weather-based water application scheduling and water budgeting; (2) accurate, well-designed water application systems and computerized control mechanisms; (3) golf course design that concentrates water-intensive landscaping in areas that come into play; and (4) polyvinyl chloride (PVC) liners for bodies of water. Using new low water use and drought tolerant turfgrasses, improving conservation knowledge and awareness by facility management, and converting industrial users to renewable supplies are ways turf-related facilities could further contribute to the AMA goal of safe-yield.

Technical Advisory Committees (TACs) in the Phoenix and Tucson AMAs consisting of golf course, park, school, and cemetery turf managers; golf course directors; golf course architects; industry association representatives; and land developers have contributed to the development of the Third Management Plan conservation program for turf-related facilities. The TACs aided the Department in identifying second management period water use efficiency and water supply and conservation program effectiveness issues, provided and reviewed data and information relevant to the issues, and participated in developing program alternatives for the third management period. In some cases, subcommittees were formed to address a specific issue and to make a program recommendation to the committee as a whole. These committees and the Department identified the following issues of relevance:

- The allotment methodology
- Application rates for turf
- Weather adjustment
- Renewable supply incentives

6.3.3.1 Allotment Methodology and Application Rates

The Second Management Plan annual application rates of 4.9 acre-feet per acre for turf acreage, 6.2 acre-feet per acre for bodies of water, and 1.5 acre-feet per acre for low water use landscaping applied to all turf-related facilities. However, for golf courses, the turf application rate of 4.9 acre-feet per acre per year is limited to a maximum of 5 acres of turf per golf hole. Turf acres in excess of 5 acres per hole received a lower application rate of 4.0 acre-feet per acre per year if planted prior to 1985 and 3.0 acre-feet per acre per year if planted after 1984.

The total allocation given to golf courses for turf and low water use landscaping in excess of 5 acres of landscaping per hole was subject to a cap. For regulation golf courses in existence prior to 1985, the allocation was limited to an allocation for those acres in excess of 5 acres per hole that were planted prior to 1985, or an amount calculated by multiplying 5 acre-feet by the number of holes in the facility, whichever was greater. For regulation golf courses that came into existence after 1984, the allocation was limited to an amount calculated by multiplying 5 acre-feet by the number of holes in the facility. For non-regulation golf courses in existence prior to 1985, the allocation was limited to those acres in excess of 5 acres per hole that were planted prior to 1985. Non-regulation golf courses that came into existence after 1984 received no allocation for turf and low water use landscaping in excess of 5 acres per hole.

During Third Management Plan development, some representatives of the golf industry argued that the second management period application rates for turf and the cap on the allotment for golf courses constructed after 1984 denied golf courses their legal right to sufficient groundwater to meet their actual needs consistent with their selected business practices. They felt that the Department's program unreasonably prevented the complete overseeding of golf courses, interfered with reasonable management of longer courses needed to attract high-visibility tournaments, and resulted in target-style courses that imposed unreasonable skill demands on inexperienced and older players. They asserted that the allocations were not supported by sufficient data. Other TAC members felt that Second Management Plan application rates and allotment limitations were supported by scientific research and that, while potentially challenging to superintendents and designers, the allotments were adequate assuming the use of high-quality water application systems and conscientious water management practices.

Factors influencing turf watering needs include temperature, solar radiation, humidity, wind, and soil moisture. Based on research conducted at the University of Arizona Desert Turf Research Center (Brown, Gilbert, and Kopec, 1996) and 1988 to 1996 weather data from the Arizona Meteorological Network (AZMET) Phoenix Encanto, Phoenix Greenway, and Litchfield Park Stations, high-quality turf with winter overseeding would need to be irrigated with 4.1 to 5.2 acre-feet per acre per year, depending upon the weather conditions of that year, not including rainfall. This research supports the adequacy of the Second Management Plan's 4.9 acre-feet per acre per year application rate for maintaining overseeded turf.

The research found that using water sources with certain qualities may lead to long-term root zone salt accumulation. Additional investigation is needed to determine if typical rainfall distribution will adequately flush accumulated salts that are contained in certain water sources beyond the turfgrasses' root zone or, if rainfall is not sufficient, if continuous water application at a slightly higher rate or periodic flushing at a much higher application rate would best balance salt management and water application efficiency.

When turf acres are planted in excess of 5 acres per hole at a golf course, these acres are typically used to create broader fairways and larger greens than comparable golf courses with fewer turf acres. These outlying areas are in play less frequently than turf down the center of the fairways or closer to the tees. As a result, the wear and stress on grass in outlying areas are much lower. Lower levels of wear and stress reduce water demand for the turf acres in excess of 5 acres per hole. In addition, overseeding for aesthetic concerns may not be as necessary for areas of a golf course that do not frequently come into play. These

factors support the adequacy of the Second Management Plan's annual application rates of 3.0 or 4.0 acre-feet per acre for turf in excess of 5 acres per hole.

The Third Management Plan allotment methodology allows target type courses to apply water to turf at a higher application rate than the 4.9 acre-feet per acre per year rate given for turf acres. Under the Third Management Plan, some or all low water use landscaping will qualify for this application rate if the amount of turf is less than 5 acres per hole. If low water use landscaping is well designed and carefully managed to take maximum advantage of rainfall, over spray, and this generous application rate, most of the allocation that is provided for low water use acreage may be applied to turfed acres.

Historic water use and research in California indicates that the higher unirrigated perimeter to turfed acre ratios, typical of target-style courses, may result in higher water demand per acre than that of more traditionally designed courses. Increased evapotranspiration may occur within 200 feet of perimeters adjacent to unweathered or low water use areas. On narrow fairways these zones may coincide, and water demand for the entire turfed area may increase on the order of 5 percent. To sufficiently quantify this effect for possible inclusion in management plan requirements, additional research should be conducted in the desert regions of Arizona.

Because regional variation in rainfall, wind speed, soil type, root zone depth, and course topography can all have potential negative impacts on turf water demand, application rates deemed sufficient for the majority of facilities were agreed upon by the TAC. Individual facilities with special circumstances that could render these application rates unreasonable can seek relief through the administrative review process. A.R.S. § 45-575.

6.3.3.2 Weather Adjustment

Long-term weather data indicates that the mid-1980's and early 1990s represented a comparatively "wet" period. Historically, rainfall in the Phoenix AMA tends to be cyclic, with "dry" or "wet" periods that may last as long as four or five years. Wet years early in the second management period were followed by a protracted period of hot summer weather combined with sparse or late summer rains. Consequently, in 1996 and 1997, an unusually large number of turf-related facilities began to experience difficulty in complying with their annual water allotments.

Alternatives to the three-year averaging mechanism provided for determining compliance in the Second Management Plan were considered to more adequately compensate for weather fluctuations, including a flexibility account and a five-year averaging provision. For the third management period, the Department chose not to extend the three-year averaging provision to five years. The length of a five-year averaging provision would result in a considerable lag between the time the annual allotment was exceeded and when corrective action could be taken. Instead, the Department opted for a flexibility account for the third management period that contains both credit and debit limits. The account will encourage and reward careful management through the accrual of credits. Credit and debit limits for the flexibility account have been set at 20 percent of the maximum annual water allotment.

6.3.3.3 Renewable Supply Incentives

While many new facilities are served alternative water sources by municipal providers, existing industrial users continue to pump groundwater. Conservation requirements strive for efficient use but cannot eliminate the contribution to overdraft by industrial users. The availability of Type 2 non-irrigation grandfathered rights through purchase or lease, the conversion of irrigation rights to Type 1 non-irrigation grandfathered rights, the issuance of groundwater withdrawal permits, and the delivery of groundwater by municipal water providers and irrigation districts are all prospects that could increase groundwater use by turf-related facilities in the future and further increase overdraft in the Phoenix AMA.

The Phoenix AMA does not have a region-wide reclaimed water system. This constrains the ability of turf-related facilities to directly use effluent. Most of the wastewater generated in mature, developed areas of Phoenix, Glendale, Sun City, Scottsdale, Tempe, and Mesa is directed to the 91st Avenue Wastewater Treatment Plant. It is downstream from most users and much of its effluent is sent to Palo Verde Nuclear Generating Station and Buckeye Water Conservation and Drainage District. In areas of newer development, many providers appear to be moving away from this centralized system in favor of building or constructing localized wastewater treatment plants.

The cost of using renewable water supplies is a major consideration for those turf-related facilities operating their own wells because it is usually considerably cheaper to pump and use groundwater than to purchase effluent from municipal water providers. In 1997, the cost of effluent served by municipal water providers ranged from less than $100 per acre-foot to over $500 per acre-foot. While these rates are usually less than potable water service from municipal water providers, effluent rates tend to be partially subsidized by potable water sales and other revenue-generating activities.

In the Second Management Plan, the effluent use incentive was structured so that if at least 50 percent of a facility's applied water was effluent, the volume of effluent used was discounted against the allotment. The amount of the discount was 15 percent if up to 90 percent of the total water use was effluent and 20 percent if 90 percent or more of the total water use was effluent. Also, the cap placed on the allocation given for bodies of water within new golf courses did not apply to bodies of water filled entirely with effluent.

The cost and availability of effluent delivery and the policies of municipal water providers and local jurisdictions primarily determine effluent use for turf-related watering in the Phoenix AMA. In addition to reserving high-quality groundwater for potable uses, serving effluent for turf-related watering provides further community benefits. Excluding direct deliveries of effluent from a municipal provider's gallons per capita per day conservation requirement makes effluent delivery attractive to water providers. Effluent reuse also eases peak demand impact on potable water systems. Avoidance of lengthy permitting processes and treatment costs incurred when effluent is discharged into public waterways makes reuse attractive to wastewater treatment authorities. Effluent reuse can also help to reduce groundwater pumping in areas with substantial water level declines or land subsidence potential.

The Department and the Third Management Plan Turf TAC discussed several incentives that would further encourage effluent use by both municipally provided facilities and industrial users during the third management period. Because effluent is an underutilized supply, the Department chose to discount all direct effluent use by 40 percent. The incentive will provide a significant discount to encourage effluent use where supplies are expensive. It will also encourage and reward the construction of wastewater treatment plants to produce effluent in new developments where supplies may be limited until residential development nears completion. With the incentive, the Department acknowledges the need for efficient use of all water supplies, while providing a higher potential application rate to facilities using higher percentages of effluent.

The Department and the TAC also explored options to allow a turf-related facility to mitigate water use in excess of the annual water conservation allotment. If more groundwater is used at a turf-related facility than allowed by its annual water allotment, a net benefit could be provided to the aquifer either through recharging without earning credits (known as storing "non-recoverable" water) or extinguishing existing recharge credits at a higher rate than the excess groundwater used at the facility. Issues considered included the rates of recharge required, conditions to ensure no wasteful practices are condoned, the effect on water conservation efforts, and the effect of excessive pumping on localized groundwater conditions.

The Department determined that this option will not be included as a part of the conservation requirements for turf-related facilities during the third management period. In the meantime, the option of extinguishing

recharge credits or storing non-recoverable water in particular areas as a compliance mechanism will be considered during the third management period, even in advance of a violation. Owners and operators of turf-related facilities who anticipate an allotment violation are encouraged to develop a proactive response program in cooperation with the Department (see Chapter 10).

6.3.4 Turf-Related Facilities Conservation Program

The conservation requirements for turf-related facilities in the third management period include a maximum annual water allotment and additional requirements, provisions to encourage reduction in turfed acres, allotment adjustments for special circumstances, and an effluent use incentive.

6.3.4.1 Maximum Annual Water Allotment

The maximum annual water allotment is composed of a base allotment and any pertinent allotment additions.

6.3.4.1.1 Base Allotment

The core of the conservation program for turf-related facilities is the maximum annual water allotment. The allotment is calculated differently depending on the type of facility, but generally there is a direct relationship between the number of acres to which water is applied and the volume of the allotment. The turf acres, water surface acres, and low water use landscaped areas are multiplied by acre-foot per acre application rates to calculate the allotment.

Allotments for turf-related facilities other than golf courses are calculated by multiplying acreage by the appropriate application rates shown in Table 6-303-1. The approach used for these facilities allows for the expansion of landscaped area.

In developing the water allotment formula for golf courses, the Department recognized that the latest conservation technology includes course design that concentrates water-intensive landscaping into areas that come into play and water management practices that adjust water application schedules for weather conditions and seasons of highest play. For pre-1985 golf courses, the allotment is based on the highest number of landscaped and water surface areas in existence at the facility between 1980 and 1984. Post-1984 golf course allotments are capped or restricted by limiting the number of landscaped acres and water surface areas for which an allotment is given. The purpose of the cap is to encourage efficient design, construction, water application, and overseeding practices.

In response to advisory committee concerns regarding the need for design flexibility of regulation courses, the Department developed separate allotment calculation methods for championship length (regulation) and non-championship length (non-regulation) golf courses. The allotment calculations for pre-1985 non-regulation and regulation length courses are shown in Tables 6-304-1 and 6-304-2, respectively, and for post-1984 non-regulation and regulation length courses in Tables 6-305-1 and 6-305-2, respectively. Pre-1985 and post-1984 golf courses may expand or develop any number of water-intensive landscaped acres. However, water use must not exceed the maximum annual water allotment, which assumes acreage restrictions. Although the allotment is calculated on a per acre basis, the facility manager has discretion on how to use the allotment within the facility.

Allotments for pre-1985 golf courses are calculated based on acres of historic turf, water surface area, and low water use landscaping. For the first 5 acres per golf hole, the application rate for turf acres is limited to 4.9 acre-feet per acre. This acreage is referred to as planted acres and may include low water use landscaping if there are less than 5 acres of turf per golf hole. Historic turf and historic low water use landscaping (acres in existence from 1980 through 1984) in excess of planted acres receive lower

application rates. Any additions to existing regulation golf courses are also considered to be part of existing golf courses, but will receive still lower application rates. For the allotment in addition to the planted acres, existing championship golf courses may receive a maximum of 5 acre-feet per hole or the full allotment for historic acres, whichever is greater.

Post-1984 golf course allotments are calculated similarly to pre-1985 golf courses but with several differences. Post-1984 non-regulation length courses do not receive an allotment for turf or low water use landscaped acres in excess of planted acres. Post-1984 regulation golf courses receive an application rate for historic turf acres and historic low water use landscaped area (acres in existence from 1985 through 1989) not included in planted acres. However, the application rate is lower for historic turf than the application rate for historic turf acres within a pre-1985 golf course.

For pre-1985 golf courses, the allotment for water surface area is based on the highest number of water surface acres in existence from 1980 through 1984. The allotment for water surface area within any expanded portion of a pre-1985 golf course is capped at an amount calculated by multiplying the application rate of 6.2 acre-feet per acre by 0.14 acre per hole. For post-1984 golf courses, the allotment for water surface area is based on the highest number of water surface acres in existence within the facility from 1985 to 1989 that were entitled to an allotment under the First Management Plan or an amount calculated by multiplying the application rate of 6.2 acre-feet per acre by 0.14 acre per hole, whichever is greater. Allotments for bodies of water entirely filled and refilled with direct use effluent or effluent recovered within the area of impact are not included in the 0.14 surface acres per hole cap.

6.3.4.1.2 Allotment Additions

Under certain circumstances, a turf-related facility is entitled to an addition to its base allotment. In some cases, the allotment addition is effective only for one year; in other cases, the allotment addition is effective for a longer period. The following sections describe allotment additions allowed in the Third Management Period.

6.3.4.1.2.1 Reduction of Turfed Acreage

Conservation requirements for the third management period continue to provide an incentive to reduce water- intensive landscaped area. For pre-1985 and post-1984 golf courses, the maximum annual allotment is based on the maximum area of turf and bodies of water developed at each facility from 1980 through 1984 and from 1985 through 1989, respectively. Thus, removal of acreage planted from 1980 to 1984 for a pre-1985 golf course and from 1985 to 1989 for a post-1984 golf course will not decrease the facility's allotment. All turf-related facilities are encouraged to minimize the water-intensive landscaping to areas consistent with the intended use and enjoyment of the facility.

6.3.4.1.2.2 Allotment Addition for the Establishment of Newly Turfed Area

An allotment addition is given to turf-related facilities for the establishment of newly planted turf. The allotment addition is 1.0 acre-foot per acre of newly turfed area and is limited to the calendar year in which the turf is planted. For golf courses, the allotment addition is limited to an amount calculated by multiplying the number of holes present within the newly turfed area by 5 acre-feet of water.

6.3.4.1.2.3 Allotment Addition for Revegetation

A revegetation allotment addition is available to facilities that establish low water use or other site-adapted landscaping plants after construction or renovation and which will need only temporary supplemental water application. This allotment addition of up to 1.5 acre-feet per acre for a maximum of three calendar years is quantified and granted on an individual basis through an application process. The quantity and

duration of the allotment adjustment is determined through the Department's evaluation of each application. This adjustment is separate from the low water use landscaping application rate of 1.5 acre-feet per acre included in the maximum annual water allotment calculation and is not included in the allotment caps for low water use landscaped area within golf courses.

6.3.4.1.2.4 Allotment Addition for Filling Bodies of Water

New turf-related facilities receive a one-time allotment addition to fill bodies of water within the facility. The allotment addition is equal to the volume used for initial filling of the body of water and is given only for the year in which the body of water is filled. Any facility may also apply for an allotment addition to refill a body of water which has been emptied for maintenance work to eliminate or reduce seepage losses. The allotment addition may be given only for the year in which the body of water is refilled.

6.3.4.1.2.5 Allotment Addition for Leaching

When high levels of total dissolved solids are present in the water supply, a turf-related facility may need an additional amount of water for leaching, or deep percolation, to prevent salts from accumulating in the root zone. If salts are allowed to accumulate in the soil, the salinity will eventually reach levels toxic to turfgrass. Since most water supplies in the Phoenix AMA are of a quality that does not require an additional leaching allowance, a leaching allowance was not included in the maximum annual water allotment calculation. However, if a facility's water supply has a concentration of 1,000 milligrams per liter of total dissolved solids (approximately 1.5 millimhos per centimeter of electrical conductivity) or greater, the turf-related facility may apply to the Department for an allotment addition for leaching.

6.3.4.2 Additional Conservation Requirements

All turf-related facilities are required to prepare and maintain a water conservation plan. The plan must outline the water management practices and technologies the facility will utilize to maximize water use efficiency.

Turf-related facilities that are schools, parks, or common areas are required to design, construct, and maintain grounds in a manner that will minimize water-intensive landscaped areas consistent with reasonable use and enjoyment of the facility.

A turf-related facility that is a cemetery must limit the water-intensive landscaped area within any portion of the cemetery that was neither in operation as of December 31, 1984 nor substantially commenced as of December 31, 1984 so that no more than 75 percent of the total cemetery operating area is landscaped with plants not listed on the Low Water Use/Drought Tolerant Plant List for the Phoenix AMA (see Appendix 5-L). This restriction does not apply to an expansion of a cemetery onto contiguous land that was under the same ownership as the cemetery as of December 31, 1984.

6.3.4.3 Effluent Use Adjustment

In the Phoenix AMA, effluent is the only water supply that is expected to increase in availability throughout the third management period. Effluent's high nutrient content makes it an excellent supply for turf-related watering, as long as the nutrient load is carefully matched to plant needs and over-application of potential groundwater pollutants is avoided. Despite the availability and suitability of effluent for turf watering, effluent is currently underutilized as a source of water for turf-related facilities.

To encourage the maximum use of effluent on turf-related facilities during the third management period, the Department has modified the effluent incentive offered in the Second Management Plan. While the maximum annual water allotment does not change under this incentive, each acre-foot of effluent used will

be counted as 0.6 acre-foot when compliance with the maximum annual water allotment is determined. This adjustment does not apply to effluent stored in a storage facility pursuant to a water storage permit that is recovered outside the area of impact of the stored water.

6.3.4.4 Flexibility Account

To compensate for fluctuating weather conditions, each turf-related facility will have a flexibility account with credit and debit limits. In wetter years or with careful management, facilities may accrue a credit balance up to 20 percent of a facility's annual allotment. When weather conditions or water management decisions cause a facility's water use to exceed its annual allotment in any year, accrued credits are expended. If all credits are exhausted, a facility may accrue a debit balance up to 20 percent of the allotment. A violation will occur only when all credits have been exhausted and the debit maximum is exceeded. Prudent facility managers will take advantage of wet years and the latest conservation technologies to accumulate as many credits as allowed in order to compensate for fluctuations in water demand during hot or dry years.

6.3.4.5 Monitoring and Reporting Requirements

The conservation requirements for the third management period include monitoring and reporting requirements for all turf-related facilities. All turf-related facility water use will be assumed to be for landscape watering purposes unless other water uses are metered separately. For example, if water for domestic uses at a park is not metered, it will count against the facility's allotment. This provision encourages facilities to install enough meters to ensure that turf-related watering is accurately reported.

6.3.5 Non-Regulatory Efforts

During the second management period, over $16,000 was awarded under the Conservation Assistance Grant Program to assist turf-related facilities with the dissemination of turfgrass water use information. Two grants awarded to the University of Arizona provided funding for continuation of the Phoenix AZMET Node (PAN), which is a free public access computer bulletin board system operating in the City of Phoenix Water Conservation Office. The PAN provides access to a variety of information, including weather data for the Phoenix area, reference and turf evapotranspiration data, and lawn watering guides. This information assists large turf facility operators with irrigation scheduling.

Opportunities for future research abound in turf-related water conservation, and conservation assistance funds may be used during the third management period to address several research needs. Anecdotal evidence for golf courses in central and southern Arizona suggests that target style courses may be subject to increased advective effect from adjacent desert areas. Further study is needed to quantify the potential water demand impacts of factors such as advection that may be inherent in lower acreage facility designs. New computer controlled watering systems, which isolate watering needs of specific areas of turf, could prove to be a useful source of data for verifying this phenomenon. Many computer controlled irrigation systems have been introduced into the market in the last decade. How well turf-related facility managers understand and employ the latest commercially available water application technologies is not well documented.

Long-term use of water sources high in total dissolved solids, such as effluent, may lead to the need for the application of additional water to leach or flush salts below the root zone. Quantifying the long-term implications of using these sources would enhance understanding of the effects, if any, on water application rates.

The watering needs of low water use landscaping must be precisely quantified to determine whether the annual application rate of 1.5 acre-feet per acre is appropriate. Some evidence suggests the rate may be excessive, especially after the plants have become established.

6.3.6 Future Directions

To achieve the safe-yield goal in the Phoenix AMA, a reduction in all groundwater use must occur. The current Code provisions limit the Department's ability to achieve this goal. They allow continuing withdrawal of groundwater by existing users, as well as additional withdrawals by new industrial users. Management plan conservation requirements can reduce groundwater pumping by industrial users only to the extent that the requirements are consistent with reasonable economic return. Absent additional authority specifically addressing the appropriateness of using high quality groundwater for turf-related watering, the management plans can only require water use efficiency that is economically justified.

Increased utilization of renewable water supplies combined with efforts to maximize water application efficiency become key factors in meeting the AMA's water management goals. Renewable water supply use requirements or broader groundwater use prohibitions targeting specific water uses, as in the "Lakes" Bill (A.R.S. § 45-131, *et. seq.*), are possible approaches. A change to the statutes that would allow the CAGRD to replenish mined groundwater not associated with the demonstration of an assured water supply combined with a replenishment obligation for all or a portion of mined groundwater used by turf-related facilities, would facilitate greater utilization of renewable supplies and would reduce groundwater overdraft.

The relationship of turf-related watering to groundwater overdraft must be evaluated and quantified. Approximately one-half of turf-related water demand in 1995 was met with groundwater. Although some component of applied water may be incidentally recharged, deep percolation of water that may contain fertilizers and other horticultural chemicals could lead to serious water quality issues and must not be encouraged.

Stronger conservation-oriented technology and water management practice requirements should be considered from both a regulatory and non-regulatory perspective for the fourth management period. From a regulatory perspective, application rates for turf acres and low water use landscaping acres used to calculate the maximum annual groundwater allotments need to be further scrutinized under actual field conditions. Research will also need to be conducted to quantify the effects of increased evapotranspiration by turf adjacent to low water use areas. As a result of such research, fourth management period conservation requirements may include an allotment-based requirement that is different from the method used for the second and third management periods, incorporating application rates for turf and low water use landscaping that more closely resemble efficient water use needs for different types of landscaping in actual field conditions. Required use of conservation technologies and practices should be further evaluated as a regulatory alternative to enforceable allotments. From a non-regulatory approach, legislation that increases funding for conservation, education, and augmentation could assist turf managers in implementing effective water management practices, evaluating effective water conservation technology, and constructing renewable water supply conveyance infrastructure.

Development of incentive programs should continue during subsequent management periods. If necessary, efforts to broaden participation in water storage and recovery options could continue, as well as renewable supply utilization incentives. Providing additional assistance and education for increased water management efficiency must be a priority to reduce the demand side of the safe-yield equation.

6.3.7 Industrial Conservation Requirements and Monitoring and Reporting Requirements for Turf-Related Facilities

6-301. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes and section 6-101 of this chapter, unless the context otherwise requires, the following words and phrases used in sections 6-301 through 6-306 of this chapter shall have the following meanings:

1. *"Additional low water use landscaped area" means:*

   a. *For a pre-1985 golf course that is a regulation golf course, low water use landscaped area that was added to the facility after December 31, 1984 and that is not included in the facility's planted acres.*

   b. *For a post-1984 golf course that is a regulation golf course, low water use landscaped area that was added to the facility after January 1, 1990 and that is not included in the facility's planted acres.*

2. *"Additional turf acres" means:*

   a. *For a pre-1985 golf course that is a regulation golf course, turf acres that were added to the facility after December 31, 1984 and that are not included in the facility's planted acres.*

   b. *For a post-1984 golf course that is a regulation golf course, turf acres that were added to the facility after January 1, 1990 and that are not included in the facility's planted acres.*

3. *"Body of water" means a constructed body of water or interconnected bodies of water, including a lake, pond, lagoon, or swimming pool, that has a surface area greater than 12,320 square feet when full and that is filled or refilled primarily for landscape, scenic or recreational purposes, or regulatory storage.*

4. *"Common area" means an area or areas that is owned and operated as a single integrated facility and that is used for recreational or open space purposes. A common area is maintained for the benefit of the residents of a housing development.*

5. *"Contiguous" means in contact at any point or part of the same master-planned community. Two parcels of land are contiguous even if they are separated by one or more of the following: a road, easement, or right-of-way.*

6. *"Direct use effluent" means effluent transported from a facility regulated pursuant to Title 49, Chapter 2, Arizona Revised Statutes, to an end user. Direct use effluent does not include effluent that has been stored pursuant to Title 45, Chapter 3.1, Arizona Revised Statutes.*

7. *"Effluent recovered within the area of impact" means effluent that has been stored pursuant to Title 45, Chapter 3.1, Arizona Revised Statutes, and recovered within the stored effluent's area of impact. For purposes of this definition, "area of impact" has the same meaning as prescribed by A.R.S. § 45-802.01.*

8. *"Golf course" means a turf-related facility used for playing golf with a minimum of nine holes and including any practice areas.*

9. *"Historic low water use landscaped area" means:*

   a. *For a pre-1985 golf course, the highest number of acres of low water use landscaped area in existence within the facility during any one calendar year from 1980 through 1984.*

   b. *For a post-1984 golf course, the highest number of acres of low water use landscaped area in existence within the facility during any one calendar year from 1985 through 1989.*

10. *"Historic total water surface area" means:*

   a. *For a pre-1985 golf course, the highest number of acres of total water surface area, excluding the surface area of any bodies of water entirely filled and refilled with effluent, which were in existence within the facility during any one calendar year from 1980 through 1984, plus the lesser of: (1) the number of acres of total water surface area, excluding the surface area of any bodies of water entirely filled and refilled with effluent, in existence within any portion of the facility that was expanded after December 31, 1984 and (2) an area calculated by multiplying the number of holes located within any portion of the facility that was expanded after December 31, 1984 by .14 acre per hole.*

   b. *For a post-1984 golf course, the highest number of acres of total water surface area, excluding the surface area of any bodies of water entirely filled and refilled with effluent, which were in existence within the facility during any one calendar year from 1985 through 1989 and that were entitled to an allotment of water under the management plan for the first management period.*

11. *"Historic turf acres" means:*

   a. *For a pre-1985 golf course, the highest number of acres of turf acres within the facility during any one calendar year from 1980 through 1984.*

   b. *For a post-1984 golf course, the highest number of acres of turf acres within the facility during any one calendar year from 1985 through 1989.*

12. *"Hole" means a component of a golf course consisting at a minimum of a tee and a green. A practice area or driving range is not a hole.*

13. *"Landscape watering" means the application of water from any source, at a turf-related facility to a water-intensive landscaped area, a low water use landscaped area, and revegetation acres.*

14. *"Low water use landscaped area" means an area of land at least one acre in aggregate, which is located in a turf-related facility, which is watered by a permanent water application system within the landscaped area, and planted primarily with plants listed in Appendix 5-L, Low Water Use/Drought Tolerant Plant List, Phoenix AMA, or any modifications to the list. Mature vegetation planted in a low water use landscape area must cover at least 50 percent of the area.*

15. *"Newly turfed area" means, for a calendar year, an area of land planted with a warm-season grass species that was not planted with a warm-season grass species during the preceding calendar year.*

16. *"Overseeded area" means an area of land planted during the calendar year in question with a cool season grass species that grows over dormant warm season grasses during the fall/winter period.*

17. *"Planted acres" means the total turf acres and low water use landscaped area of a golf course, up to a maximum of 5 acres per hole. In determining a facility's planted acres, turf acres shall be counted first.*

18. *"Post-1984 golf course" means either of the following:*

    a. *A golf course that was neither in operation as of December 31, 1984 nor substantially commenced as of December 31, 1984.*

    b. *A golf course that was either in operation as of December 31, 1984 or substantially commenced as of December 31, 1984 and that was substantially modified after December 31, 1984.*

19. *"Pre-1985 golf course" means a golf course that was either in operation as of December 31, 1984 or substantially commenced as of December 31, 1984 and includes any expanded portion of the golf course. If a pre-1985 golf course is substantially modified after December 31, 1984, it becomes a post-1984 golf course.*

20. *"Regulation golf course" means a golf course of at least 18 holes that is 6,200 yards or more in length per 18 holes as measured from back of the tee ground furthest from the green down the center line of the hole to the center of the green.*

21. *"Substantially commenced as of December 31, 1984" means, with regard to the construction of a turf-related facility, that the owner or operator of the facility had obtained all pre-construction permits and approvals required by federal, state, or local governments for the facility by December 31, 1984, or had made a substantial capital investment in the physical on-site construction of the facility by December 31, 1984.*

22. *"Substantially modified" means that at least 50 percent of the water-intensive landscaped area within the turf-related facility was reconfigured.*

23. *"Total cemetery area" means an area of land being used for cemetery-related purposes, including any area of land covered by grave markers or by cemetery-related buildings, walks, pathways, and landscaping, but not including roads, parking lots, and any areas of land being held for future expansion of the cemetery.*

24. *"Total water surface area" means the total surface area of all bodies of water that are an integral part of the water-intensive landscaped area of a turf-related facility. Bodies of water used primarily for swimming purposes are not an integral part of the water-intensive landscaped area of a turf-related facility.*

25. *"Turf acres" means an area of land within a turf-related facility that is watered with a permanent water application system and planted primarily with plants not listed in*

Appendix 5-L, Low Water Use/Drought Tolerant Plant List, Phoenix AMA, or any modifications to the list.

26. *"Turf-related facility" means any facility, including 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 include, but are not limited to, those facilities listed in Appendix 6B.*

27. *"Water-intensive landscaped area" means, for a calendar year, the turf acres and the water surface acres within a turf-related facility.*

6-302. Conservation Requirements for All Turf-Related Facilities

A. Maximum Annual Water Allotment

Beginning with calendar year 2002 or the first full calendar year after commencement of landscape watering, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute conservation requirement in the Fourth Management Plan, an industrial user who uses water at a turf-related facility shall not withdraw, divert, or receive water for landscape watering purposes at the turf-related facility during a year in an amount that exceeds the turf-related facility's maximum annual water allotment for the year as calculated in sections 6-303 through 6-305.

B. Conservation Plan

No later than January 1, 2002 or 180 days after receiving official notice of conservation requirements, whichever occurs later, an industrial user who uses water at a turf-related facility shall prepare a conservation plan for the facility that contains an accurate and detailed description of the conservation technologies, including management practices, that are applied at the facility when water is used for landscape watering purposes. The industrial user shall maintain the conservation plan until the first compliance date for any substitute requirement in the Fourth Management Plan.

C. Limiting Water-Intensive Landscaped Area

1. *Beginning on January 1, 2002 or upon commencement of landscape watering, whichever occurs later, and continuing until the first compliance date for any substitute requirement in the Fourth Management Plan, an industrial user who uses water at a turf-related facility that is not a cemetery or golf course shall design, construct, and maintain the grounds of the facility in a manner that minimizes the water-intensive landscaped area of the facility consistent with the use of the facility. All of the facility's water-intensive landscaping shall be planted in those areas directly associated with the turf-related facility's primary purposes.*

2. *Beginning on January 1, 2002 or upon commencement of landscape watering, whichever occurs later, and continuing until the first compliance date for any substitute requirement in the Fourth Management Plan, an industrial user who uses water at a turf-related facility that is a cemetery shall limit the water-intensive landscaped area within any portion of the cemetery that was neither in operation as of December 31, 1984 nor substantially commenced as of December 31, 1984 so that no more than 75 percent of the total cemetery area within that portion of the cemetery is planted with plants not listed in Appendix 5-L, Low Water Use/Drought Tolerant Plant List, Phoenix AMA, or any*

modifications to the list. This requirement shall not apply to any expanded portion of a cemetery in operation as of December 31, 1984 or substantially commenced as of December 31, 1984 if the expanded portion of the cemetery was under the same ownership as the cemetery as of December 31, 1984.

6-303. Calculation of Maximum Annual Water Allotment for Turf-Related Facilities that are not Golf Courses

For each calendar year, the maximum annual water allotment for a turf-related facility that is not a golf course shall be calculated by multiplying the number of acres in existence within the facility during the calendar year in each of the categories listed in Table 6-303-1 by the applicable application rate for each category listed in Table 6-303-1 and then adding together the products plus any allotment additions allowed under section 6-306.

If turf acres, low water use landscaped area, or total water surface area are removed from a facility during the third management period, the maximum annual allotment for the facility shall be equal to the allotment calculated for the facility pursuant to this section as if the acres had not been removed.

TABLE 6-303-1
APPLICATION RATES FOR
TURF-RELATED FACILITIES THAT ARE NOT GOLF COURSES
From 2002 until the first compliance date for any substitute requirement in the Fourth Management Plan

Type of Landscaping:	***Application rate: (acre-feet per acre per calendar year)***
1. Turf acres	*4.9*
2. Total water surface area	*6.2*
3. Low water use landscaped area	*1.5*

6-304. Calculation of Maximum Annual Water Allotment for Pre-1985 Golf Courses

A. Pre-1985 Golf Courses that are not Regulation Golf Courses

For each calendar year, the maximum annual water allotment for a pre-1985 golf course that is not a regulation golf course shall be calculated by multiplying the number of acres in existence within the facility during the calendar year in each of the categories listed in Table 6-304-1 by the applicable application rate for each category listed in Table 6-304-1, subject to the limitations set forth in footnote 1 in that table, and then adding together the products plus any allotment additions allowed under section 6-306.

TABLE 6-304-1
APPLICATION RATES FOR PRE-1985 GOLF COURSES
THAT ARE NOT REGULATION GOLF COURSES
From 2002 until the first compliance date for any substitute requirement in the Fourth Management Plan

Type of Landscaping:	***Application rate: (acre-feet per acre per calendar year)***
1. Planted acres	*4.9*
2. Historic turf acres not included in planted acres	*4.0*
3. Historic low water use landscaped area not included in planted acres	*1.5*
4. Total water surface area[1]	*6.2*

[1] *In determining the number of acres of total water surface area in existence within the facility, the total surface area of all bodies of water not filled and refilled entirely with direct use effluent or effluent recovered within the area of impact shall be limited to an area calculated by multiplying the number of holes present within the facility during the year by .14 acre per hole, or the facility's historic total water surface area, whichever is greater. For purposes of this paragraph, a body of water allowed under an interim water use permit issued pursuant to A.R.S. § 45-133 shall be deemed to be filled and refilled entirely with direct use effluent or effluent recovered within the area of impact if the body of water will be filled and refilled entirely with direct use effluent or effluent recovered within the area of impact after the permit expires.*

B. Pre-1985 Golf Courses that are Regulation Golf Courses

For each calendar year, the maximum annual water allotment for a pre-1985 golf course that is a regulation golf course shall be calculated by multiplying the number of acres in existence within the facility during the calendar year in each of the categories listed in Table 6-304-2 by the applicable application rate for each category listed in Table 6-304-2, subject to the limitations set forth in footnotes 1, 2, and 3 in that table, and then adding together the products plus any allotment additions allowed under section 6-306.

TABLE 6-304-2
APPLICATION RATES FOR PRE-1985 GOLF COURSES
THAT ARE REGULATION GOLF COURSES
From 2002 until the first compliance date for any substitute requirement
in the Fourth Management Plan

Type of Landscaping:	***Application rate: (acre-feet per acre per calendar year)***
1. Planted acres	*4.9*
2. Historic turf acres not included in planted acres[2]	*4.0*
3. Additional turf acres[1,2]	*3.0*
4. Historic low water use landscaped area not included in planted acres[2]	*1.5*
5. Additional low water use landscaped area[1,2]	*1.5*
6. Total water surface area[3]	*6.2*

[1] If the sum of the allotments for the facility's historic turf acres not included in planted acres (line 2) and historic low water use landscaped area not included in planted acres (line 4) exceeds an amount calculated by multiplying the number of holes present within the facility during the year by 5 acre-feet of water per hole, the application rates for the facility's additional turf acres (line 3) and additional low water use landscaped area (line 5) shall be zero.

[2] If the sum of the allotments for the facility's historic turf acres not included in planted acres (line 2) and historic low water use landscaped area not included in planted acres (line 4) is less than an amount calculated by multiplying the number of holes present within the facility during the year by 5 acre-feet of water per hole, the total allotment for the facility's historic turf acres not included in planted acres (line 2), historic low water use landscaped area not included in planted acres (line 4), additional turf acres (line 3) and additional low water use landscaped area (line 5) shall not exceed an amount calculated by multiplying the number of holes present within the facility during the year by 5 acre-feet of water per hole.

[3] In determining the number of acres of total water surface area in existence within the facility, the total surface area of all bodies of water not filled and refilled entirely with direct use effluent or effluent recovered within the area of impact shall be limited to either an area calculated by multiplying the number of holes present within the facility during the year by .14 acre, or the facility's historic total water surface area, whichever is greater. For purposes of this paragraph, a body of water allowed under an interim water use permit issued pursuant to A.R.S. § 45-133 shall be deemed to be filled and refilled entirely with direct use effluent or effluent recovered within the area of impact if the body of water will be filled and refilled entirely with direct use effluent or effluent recovered within the area of impact after the permit expires.

6-305. Calculation of Maximum Annual Water Allotment for Post-1984 Golf Courses

A. Post-1984 Golf Courses that are not Regulation Golf Courses

For each calendar year, the maximum annual water allotment for a post-1984 golf course that is not a regulation golf course shall be calculated by multiplying the number of acres in existence within the facility during the calendar year in each of the categories listed in Table 6-305-1 by the applicable application rate for each category listed in Table 6-305-1, subject to the limitations set forth in footnote 1 in that table, and then adding together the products plus any allotment additions as allowed under section 6-306.

TABLE 6-305-1
APPLICATION RATES FOR POST-1984 GOLF COURSES
THAT ARE NOT REGULATION GOLF COURSES
From 2002 until the first compliance date for any substitute requirement in the Fourth Management Plan

Type of Landscaping:	***Application rate: (acre-feet per acre per calendar year)***
1. Planted acres	*4.9*
2. Historic turf acres not included in planted acres	*0.0*
3. Historic low water use landscaped area not included in planted acres	*0.0*
4. Total water surface area[1]	*6.2*

[1] In determining the number of acres of total water surface area in existence within the facility, the total surface area of all bodies of water not filled and refilled entirely with direct use effluent or effluent recovered within the area of impact shall be limited to an area calculated by multiplying the number of holes present within the facility during the year by .14 acre per hole, or the facility's historic total water surface area, whichever is greater. For purposes of this paragraph, a body of water allowed under an interim water use permit issued pursuant to A.R.S. § 45-133 shall be deemed to be filled and refilled entirely with direct use effluent or effluent recovered within the area of impact if the body of water will be filled and refilled entirely with direct use effluent or effluent recovered within the area of impact after the permit expires.

B. Post-1984 Golf Courses that are Regulation Golf Courses

For each calendar year, the maximum annual water allotment for a post-1984 golf course that is a regulation golf course shall be calculated by multiplying the number of acres in existence within the facility during the calendar year in each of the categories listed in Table 6-305-2 by the applicable application rate for each category listed in Table 6-305-2, subject to the limitations set forth in footnotes 1 and 2 in that table, and then adding together the products plus any allotment additions allowed under section 6-306.

TABLE 6-305-2
APPLICATION RATES FOR POST-1984 GOLF COURSES
THAT ARE REGULATION GOLF COURSES
From 2002 until the first compliance date for any substitute requirement in the Fourth Management Plan

Type of Landscaping:	***Application rate: (acre-feet per acre per calendar year)***
1. Planted acres	*4.9*
2. Historic turf acres not included in planted acres[1]	*3.0*
3. Additional turf acres[1]	*3.0*
4. Historic low water use landscaped area not included in planted acres[1]	*1.5*
5. Additional low water use landscaped area[1]	*1.5*
6. Total water surface area[2]	*6.2*

[1] *The sum of the allotments for the facility's historic turf acres not included in planted acres (line 2), additional turf acres (line 3), historic low water use landscaped area not included in planted acres (line 4) and additional low water use landscaped area (line 5) shall not exceed an amount calculated by multiplying the number of holes present within the facility during the year by 5 acre-feet of water per hole.*

[2] *In determining the number of acres of total water surface area in existence within the facility, the total surface area of all bodies of water not filled and refilled entirely with direct use effluent or effluent recovered within the area of impact shall be limited to an area calculated by multiplying the number of holes present within the facility during the year by .14 acre per hole, or the facility's historic total water surface area, whichever is greater. For purposes of this paragraph, a body of water allowed under an interim water use permit issued pursuant to A.R.S. § 45-133 shall be deemed to be filled and refilled entirely with direct use effluent or effluent recovered within the area of impact if the body of water will be filled and refilled entirely with direct use effluent or effluent recovered within the area of impact after the permit expires.*

6-306. Allotment Additions

A. Newly Turfed Area Establishment Addition

For any year in which a warm-season turfgrass species is planted at a turf-related facility, the facility shall receive an allotment addition of 1.0 acre-foot of water per acre of newly turfed area. For golf courses, the newly turfed area establishment addition shall not exceed an amount calculated by multiplying the number of holes present within the newly turfed area by 5 acre-feet of water.

B. Revegetation Addition

The owner or operator of a turf-related facility may apply to the director for an allotment addition to revegetate areas within or around the facility after initial construction or renovation. The director may allow up to an additional 1.5 acre-feet of water per acre for up to three years if the following conditions apply to the acres for which the revegetation addition is sought:

1. *The plants that are planted are listed in Appendix 5-L, Low Water Use/Drought Tolerant Plant List, Phoenix AMA, or any modifications to the list, or were adapted to the site prior to construction;*

2. *The aggregate area to be watered exceeds one acre and has at least 50 percent vegetative cover at maturity;*

3. *An allotment is not provided for the revegetation area under sections 6-303, 6-304, or 6-305; and*

4. *All of the water applied is measured and reported as part of the total water use of the facility.*

C. *Body of Water Fill and Refill Addition*

1. *A turf-related facility shall receive a one-time body of water fill allotment addition equal to the volume of water used for the initial filling of any new body of water added after January 1, 2002 within the facility. The facility shall receive the allotment addition only for the calendar year in which the body of water is filled.*

2. *If a body of water at a turf-related facility is drained or partially drained to allow for repairs to reduce water losses, the owner or operator of the facility may apply to the director for an addition to the facility's maximum annual water allotment in the amount of water necessary to refill the body of water. The director shall grant the allotment addition if the director determines that drainage of the body of water was necessary to allow for repairs to reduce water losses. The facility shall receive the allotment addition only for the calendar year in which the body of water is filled.*

D. *Leaching Allotment Addition*

The owner or operator of a turf-related facility may apply to the director for an allotment addition for leaching purposes. The director shall approve the application if the water supply used for landscape watering at the facility contains at least 1,000 milligrams per liter of total dissolved solids. If the director approves an allotment addition for leaching purposes, the director shall calculate the additional allotment as follows:

$$\textbf{Leaching Allotment Addition} = \left(\frac{1}{1 - \left(\frac{EC_w}{5EC_e - EC_w} \right)} - 1 \right) \times \frac{CU}{0.85}$$

Where:

Ec_w	=	*Electrical conductivity of water used*
Ec_e	=	*Tolerance of the grass species grown to the soil salinity in electrical conductivity of the soil saturation extract*
CU	=	*Consumptive use requirement for the grass species*

Any allotment addition granted under this subsection shall remain in effect until the water supply used for landscape watering at the facility contains less than 1,000 milligrams per liter of total dissolved solids or until the first compliance date for the facility's conservation requirements in the Fourth Management Plan, whichever occurs first.

6-307. ***Combined Allotments for Contiguous Facilities***

The maximum annual water allotments for contiguous turf-related facilities under one ownership or operation may be combined. All or a portion of the combined maximum water allotment may be applied to any part of the contiguous facilities.

6-308. *Nothing in this chapter shall be construed as authorizing the use of more groundwater or surface water than may be used pursuant to any groundwater or appropriable surface water rights or permits associated with the use. Nor shall this chapter be construed as authorizing the use of water from any source in any manner that violates Chapter 1 or Chapter 2 of Title 45, Arizona Revised Statutes.*

6-309. ***Compliance with Maximum Annual Water Allotment***

A. ***Effluent Use Adjustment***

For purposes of determining compliance with the maximum annual water allotment requirement, the director shall count each acre-foot of direct use effluent or effluent recovered within the area of impact used at the facility for landscape watering purposes during the calendar year as 0.6 acre-foot of water.

B. ***Flexibility Account***

The director shall determine if a turf-related facility is in compliance with its maximum annual water allotment through the maintenance of a flexibility account for the facility according to the following:

1. *Beginning with calendar year 2002 or the first full calendar year after commencement of landscape watering, whichever is later, a flexibility account shall be established for a turf-related facility with a beginning balance of zero acre-feet.*

2. *Following each calendar year in which groundwater is withdrawn, diverted, or received for landscape watering purposes at the facility, the director shall adjust the turf-related facility's flexibility account as follows:*

    a. *Subtract the total volume of water from any source, including effluent as adjusted under subsection A of this section used by the facility for landscape watering purposes during that calendar year, from the facility's maximum annual water allotment for that year.*

    b. *If the result in subparagraph a of this paragraph is positive, credit the flexibility account by this volume.*

    c. *If the result in subparagraph a of this paragraph is negative, debit the flexibility account by this volume.*

3. *The account balance existing in a turf-related facility's flexibility account, after the adjustment provided for in paragraph 2 of this subsection is made, shall carry forward, subject to the following limitations:*

    a. *The maximum positive account balance allowed in the flexibility account of a turf-related facility after any credits are registered pursuant to paragraph 2,*

subparagraph b of this subsection, shall be calculated by multiplying the facility's maximum annual water allotment for the calendar year for which the credits are registered by 0.2. If the account balance exceeds the maximum positive account balance after the credits are registered, the balance carried forward shall be equal to the maximum positive account balance.

b. The maximum negative account balance allowed in the flexibility account of a turf-related facility after any debits are registered pursuant to paragraph 2, subparagraph c of this subsection shall be calculated by multiplying the facility's maximum annual water allotment for which the debits are registered by -0.2. If the account balance exceeds the maximum negative account balance after the debits are registered, the balance carried forward shall be equal to the maximum negative account balance.

C. Compliance Status

If the adjustment to a turf-related facility's flexibility account at the end of a calendar year as provided for in subsection B, paragraph 2 of this section causes the account to have a negative account balance which exceeds the maximum negative account balance allowed in the flexibility account for the calendar year as calculated in subsection B, paragraph 3 of this section, the industrial users who use water at the facility are in violation of the facility's maximum annual water allotment for that calendar year in an amount equal to the difference between the facility's flexibility account balance and the maximum negative balance allowed in the facility's account for that year.

6-310. Monitoring and Reporting Requirements for Turf-Related Facilities

1. An industrial user who uses water at a turf-related facility that commences landscape watering within any new turfed acres, low water use landscaped area or water surface acres after January 1, 2002 shall submit to the director documentation of the new acres no later than 90 days after commencing of landscape watering to the new acres or receiving notice of these conservation requirements, whichever is later. The scale of the submitted documents, extent of turf acres, water surface acres, and low water use landscaped area must clearly be shown. Documentation may consist of one or more of the following:

a. As-built plans certified by a registered professional such as a civil engineer, golf course designer, or landscape architect.

b. Aerial photography at a scale no smaller than 1"=200'.

c. A survey of the facility certified by a registered professional such as a civil engineer or land surveyor.

d. Any other documentation upon approval by the director.

2. For calendar year 2002 or the calendar year in which landscape watering commences, whichever occurs later, and for each calendar year thereafter until the first compliance date for any substitute monitoring and reporting requirements in the Fourth Management Plan, an industrial user who uses water at a turf-related facility shall include in the annual report required by A.R.S. § 45-632 the following information:

a. *The total quantity of water by source, disaggregated by source, including effluent, withdrawn, diverted, or received during the calendar year for landscape watering purposes at the facility, as measured with a measuring device in accordance with the Department's measuring device rules. A.A.C. R12-15-901, et seq.*

b. *The total amount of effluent, disaggregated by direct use effluent, effluent recovered within the area of impact and effluent recovered outside the area of impact that was withdrawn or received during the calendar year for landscape watering purposes as measured with a measuring device in accordance with the Department's measuring device rules, A.A.C. R12-15-901, et seq.*

c. *The number of acres of total water surface area within the facility during the calendar year.*

d. *The number of acres of low water use landscaped area within the facility during the calendar year.*

e. *The number of acres of turf acres within the facility during the calendar year, not including newly turf area.*

f. *The number of acres of newly turfed area within the facility during the calendar year.*

g. *The number of turf acres removed within the facility during the calendar year.*

h. *The number of acres of total water surface area added or removed within the facility during the calendar year.*

i. *The number of acres of low water use landscaped area added or removed within the facility during the calendar year.*

j. *If the facility is a golf course, the number of planted acres within the facility during the calendar year.*

k. *If the facility is a golf course, the number of acres of historic turf acres not included in planted acres within the facility.*

l. *If the facility is a golf course, the number of acres of historic low water use landscaped area not included in planted acres within the facility.*

m. *If the facility is a golf course, the number of acres of historic total water surface area within the facility.*

n. *If the facility is a golf course, the length of the course as measured from the back of each tee ground furthest from the associated green then down the center line of the hole to the center of the green.*

o. *If the facility is a regulation golf course, the number of acres of any additional low water use landscaped area within the facility during the calendar year.*

p. *If the facility is a regulation course, the number of acres of any additional turf acres, including newly turf acres, within the facility during the calendar year.*

q. The number of acres approved by the director for a revegetation addition pursuant to section 6-306, subsection B, within the facility during the calendar year.

r. The quantity of water used to fill or refill a body of water within the facility during the calendar year for which an allotment addition is sought pursuant to section 6-303, subsection B.

s. The number of acres of overseeded area within the facility during the calendar year.

t. If the facility is a golf course, the number of holes within the facility during the calendar year.

u. If the facility is a golf course, the number of holes added within newly turf area during the calendar year.

v. An estimate of the quantity of water from any source, including effluent, used for each purpose other than landscape watering purposes at the facility during the calendar year. Any water used at the facility that is not measured separately from the water used for landscape watering shall be counted by the director as water used by the facility for landscape watering for purposes of calculating the compliance with the maximum annual water allotment.

3. A single annual report may be filed for contiguous turf-related facilities that are under the same ownership or operation if the allotments for the facilities are combined pursuant to section 6-307. The annual report shall report water use and landscaped areas of the contiguous facilities as required in subsection 2 in this section.

6.4 SAND AND GRAVEL FACILITIES

6.4.1 Introduction

Sand and gravel facilities regulated under the Third Management Plan are facilities that produce sand and gravel and use more than 100 acre-feet of water from any source in a calendar year. Sand and gravel facilities include the activities of mining aggregate, mixing concrete, and producing asphaltic concrete.

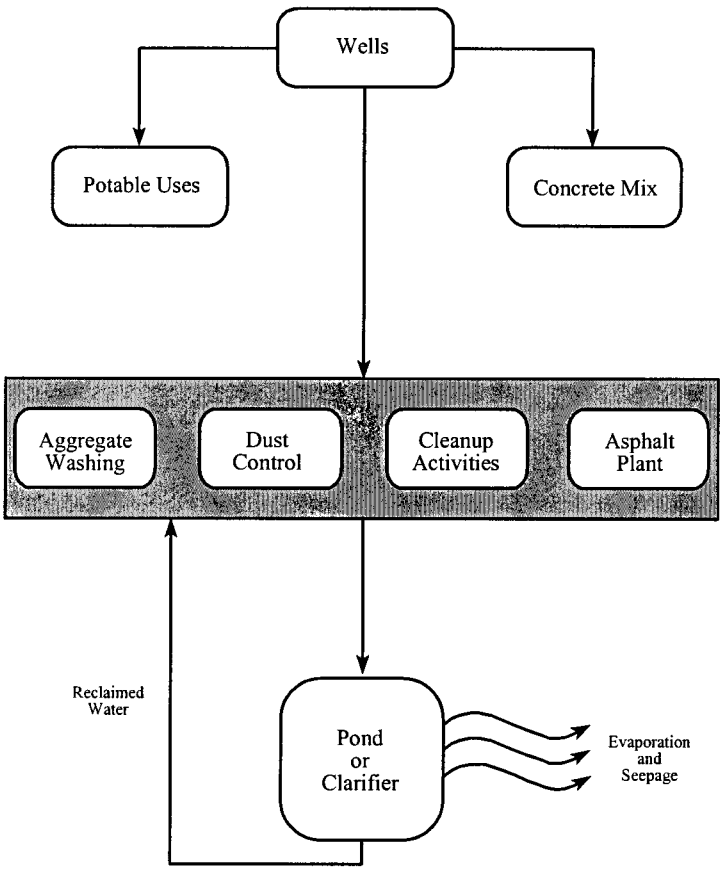
6.4.2 Water Use by Sand and Gravel Facilities

In the Phoenix AMA, approximately 20 sand and gravel facilities are located along the banks of the Salt and Agua Fria Rivers. Virtually all sand and gravel facilities pump groundwater pursuant to non-irrigation grandfathered rights or groundwater withdrawal permits. In 1995, sand and gravel facilities in the Phoenix AMA held grandfathered rights and groundwater withdrawal permits with a combined annual allotment of nearly 26,200 acre-feet of groundwater. When groundwater levels are high enough that areas where the mined material (aggregate) is inundated with water, pumping and removing the water becomes necessary.

Dewatering permits authorizing the withdrawal of another 7,000 acre-feet of groundwater per year have been assigned to sand and gravel facilities in the Phoenix AMA for this purpose.

Since adoption of the Second Management Plan, operators of sand and gravel facilities have annually withdrawn between approximately 8,200 acre-feet and 13,600 acre-feet of water. It is projected that water use by sand and gravel facilities in the AMA will grow commensurate with economic activity in the AMA and will be approximately 21,800 acre-feet per year by the year 2025.

FIGURE 6-3
DIAGRAM OF WATER FLOW IN A TYPICAL SAND AND GRAVEL FACILITY



Sand and gravel facilities mine unconsolidated stream deposits to produce construction materials. The aggregate must be sorted according to grain size and washed to remove fine-grained particles. Aggregate washing accounts for the bulk of water use by sand and gravel facilities. In addition to using water for aggregate washing, water is used for the following purposes: (1) to produce ready-mix concrete, bricks, blocks, and asphaltic concrete; (2) to control dust; (3) to wash the outside of vehicles; (4) to wash the inside of mixer drums; (5) to wash other equipment; (6) to cool equipment; (7) to cool material; and (8) for domestic purposes. Figure 6-3 illustrates how water is cycled in a typical sand and gravel facility.

Most sand and gravel facilities recycle wash water using excavated pits called disposal ponds. Sediment-laden wash water is

pumped or diverted into a pit or series of pits where sediment is allowed to settle out. After this sediment settles out, the water is recycled to the plant and used to wash more material. Water can also be pumped from the pond for dust control, truck washing, or other cleaning activities.

Geologic and hydrologic conditions at many facilities may result in a large amount of seepage to incidentally recharge to the aquifer from disposal ponds. Because most facilities are located along major riverbeds, depth to groundwater is usually quite shallow. Some facilities even require dewatering to lower the water table to allow excavation to occur. Therefore, a large portion of seepage loss may become a component of the groundwater pumped by sand and gravel facilities.

An alternative method of recycling wash water is the use of clarifiers. A clarifier is a device that accelerates the settling of sediment without creating the need for a large disposal pond. Chemical flocculants are usually used in conjunction with clarifiers to further enhance the removal of solid particles from the wash water.

The ability of sand and gravel facilities to save water varies because of differences in geology, availability and cost of land and water, product demand and price, and other factors. It may therefore be economically feasible to use the latest commercially available conservation technology at some facilities but not at others. Because recycled water can be used for most purposes at a sand and gravel facility, the maximum savings of water can occur in the recycling of wash water from aggregate washing and, to a lesser extent, the recycling of water used for wet scrubbers at asphalt plants.

A number of conservation techniques may be employed to reduce the amount of water used to control dust raised by trucks traveling on haul roads. Binding agents, pavement, or other surface treatments may be used. Water used for cleanup activities may be made more efficient by metering truck washing and by using alternative methods to clean truck mixer drums. Such methods are the "rock out method," which involves agitating rock inside the mixer drums for the purpose of cleaning excess concrete, or using chemical set-arresting agents, which prevent excess concrete from adhering to the mixer drums.

Sand and gravel facilities that have asphalt plants may have air emissions from the plant cleaned by either baghouses or wet scrubbers. Of these two methods, baghouses do not require water.

6.4.3 Program Development and Issues

The First Management Plan required sand and gravel facilities to recycle wash water using disposal ponds or clarifiers. This requirement ensured that sand and gravel facilities reduced their water use. The First Management Plan requirements were carried over into the second management period.

To identify the most economical conservation methods for each facility, sand and gravel facility operators were required during the second management period to evaluate specific water saving methods and submit a conservation plan to the Department. In addition to the conservation requirements identified in the First and Second Management Plans, there are a number of economically feasible ways water use for dust control and cleanup activities can be reduced. However, because conditions and characteristics at each facility vary, flexibility is needed to allow facility operators to select the requirements most appropriate for their facility.

6.4.4 Sand and Gravel Conservation Program

The First and Second Management Plan requirements for recycling wash water are included for the third management period because implementation of recycling improves water use efficiency. All sand and gravel facilities can apply these techniques.

In addition to recycling wash water, sand and gravel facility operators must implement two additional conservation measures, one related to water used for dust control and the other related to cleanup activities. The facility operator must choose the conservation measure to be implemented in each category from a list of approved measures. The measures chosen must be the most appropriate for the facility for the third management period.

Similar to the Second Management Plan, sand and gravel operators will be required to evaluate specific water saving methods and submit a conservation plan to the Department during the third management period. The conservation plan must be submitted to the director by January 1, 2002 or within 180 days after notification of the conservation requirements, whichever is later.

Implementation of water conservation practices or technologies can result in increased profits. Sand and gravel facility operators should analyze conservation methods to identify those that will result in a positive economic return. Operators will be required to perform an economic feasibility analysis of three potential conservation practices-disposal pond surface area reduction, use of clarifiers, and the use of an alternative water supply to groundwater. The following potential costs and savings may be analyzed in the economic feasibility analysis:

- Labor (including planning, construction, operation, maintenance, and management time);
- Equipment (values amortized over the projected life of the equipment);
- Land value (including value of mineral reserves);
- Water costs (including pumping costs, well maintenance, and withdrawal taxes);
- Costs for chemicals and raw materials;
- Fuel or energy costs;
- Industrial wastewater disposal costs;
- Changes in revenue caused by changing production rates, minimizing "down-time," or increasing the size of reserves; and
- Regulatory permitting costs.

6.4.5 Future Directions

In the Phoenix AMA, sand and gravel facilities use water pursuant to non-irrigation grandfathered rights or groundwater withdrawal permits. Other potential water sources include CAP water, effluent, and poor quality groundwater, but none of these sources are currently being used by the sand and gravel industry in the AMA. Both CAP and effluent cost significantly more than groundwater and are not readily available. Groundwater pumping costs are especially low for most sand and gravel facility operators because the facilities are generally located where groundwater levels are close to the surface. In the future, sand and gravel operators may choose to increase their use of CAP water, effluent, or poor quality groundwater for many uses at the facility. The Fourth Management Plan could provide additional incentives for their use.

6.4.6 Industrial Conservation Requirements and Monitoring and Reporting Requirements for Sand and Gravel Facilities

6-401. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, unless the context otherwise requires, the following words and phrases used in sections 6-402 through 6-404 of this chapter shall have the following meanings:

1. *"Alternative water supply" means a water source other than groundwater of drinking water quality.*

2. *"Sand and gravel facility" means a facility that produces sand and gravel and that uses more than 100 acre-feet of water from any source per calendar year. For purposes of this definition, the annual water use shall include all water used by the facility regardless of the nature of the use.*

3. *"Rock out method" means agitating rock inside concrete truck mixer drums for the purpose of cleaning excess concrete from the drums.*

4. *"Wash water" means water used for washing or sorting sand, gravel, or other aggregates.*

6-402. Conservation Requirements

A. Standard Conservation Requirements

Beginning on January 1, 2002 or upon commencement of water use, whichever occurs later, and continuing thereafter until the first compliance date for any substitute conservation requirements in the Fourth Management Plan, an industrial user who uses water at a sand and gravel facility shall comply with the following conservation requirements:

1. *If sufficient land area for construction and operation of disposal ponds is available at a reasonable price, the industrial user shall construct disposal ponds at the sand and gravel facility. All wash water, all water used for wet scrubbers at asphalt plants, all runoff from cleanup operations and all drainage from sand and gravel piles shall be discharged or diverted into the disposal ponds unless prohibited by state or federal environmental regulations. The disposal ponds shall contain a barge pump or sump pump of sufficient capacity, together with any necessary additional equipment, to assure the maximum reclamation of the water. The water shall be reclaimed and reused at the sand and gravel facility unless prohibited by state or federal regulations.*

2. *If sufficient land area for the construction and operation of disposal ponds is not available at a reasonable price, clarifiers shall be used at the sand and gravel facility for reclaiming wash water, all water used for wet scrubbers at asphalt plants, runoff from cleanup operations and all drainage from sand and gravel piles. The clarifiers shall be designed and operated to assure the maximum reclamation of water. The water shall be reclaimed and reused at the sand and gravel facility unless prohibited by state or federal regulations.*

3. *At least one of the following techniques or technologies designed to reduce water use for dust control shall be implemented at the sand and gravel facility:*

   a. *The placement of binding agents on all haul roads;*

   b. *The paving of all haul roads;*

   c. *The placement of recycled asphalt on all haul roads;*

   d. *The placement of medium sized aggregate or "pea gravel" on all haul roads; or*

   e. *A technology or technique designed to reduce water use for dust control not included in subparagraphs a through d of this paragraph that demonstrates water savings equivalent to any of the technologies or techniques listed in subparagraphs a through d, and that has been approved by the director.*

   The industrial user shall have sole discretion in determining whether to implement more than one of the above technologies.

4. *At least one of the following techniques or technologies designed to reduce water use for cleaning shall be implemented at the sand and gravel facility:*

   a. *Use of metered timers for truck washing and other cleanup activities;*

   b. *Use of the "rock out method" of cleaning concrete from truck mixer drums;*

   c. *Use of concrete set-arresting agent chemical applications to clean concrete from truck mixer drums; or*

   d. *A technology or technique designed to reduce water use for cleaning that is not included in subparagraphs a through c of this paragraph that demonstrates water savings equivalent to any of the measures listed in subparagraphs a through c and that has been approved by the director.*

   The industrial user shall have sole discretion in determining whether to implement more than one of the above technologies.

B. Substitute Conservation Requirements

1. *An industrial user who uses water at a sand and gravel facility may apply to the director to use conservation technologies other than the standard conservation requirements prescribed in subsection A of this section. The director may approve the use of substitute conservation technologies if both of the following apply:*

   a. *The industrial user has submitted a detailed description of the proposed substitute technologies and the water savings that can be achieved by the use of those technologies, and*

   b. *The director determines that the proposed substitute conservation technologies will result in a water savings equal to or greater than the savings that would be achieved by the standard conservation requirements prescribed in section 6-402.*

2. *If the director approves an industrial user's request to use conservation technologies other than the standard conservation requirements prescribed in subsection A of this section, the industrial user shall comply with the substitute conservation technologies approved by the director beginning on the date determined by the director and continuing until the first compliance date for any substitute conservation requirement in the Fourth Management Plan.*

C. Conservation Plan

Not later than January 1, 2002 or within 180 days after receiving notice of these conservation requirements, whichever is later, an industrial user who uses water at a sand and gravel facility, including an industrial user who acquires ownership of an existing sand and gravel facility after January 1, 2002, shall submit to the director a plan to improve the efficiency of water use at the facility on a form provided by the director. The plan shall analyze the economic feasibility of implementing all of the following at the facility:

1. *Disposal pond surface area reduction.*

2. *The use of clarifiers for recycling water.*

3. *Use of an alternative water supply if such a supply is available within a one mile radius of the facility.*

6-403. Monitoring and Reporting Requirements

For calendar year 2002 or the calendar year in which the sand and gravel facility first commences using water, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute monitoring and reporting requirement in the Fourth Management Plan, an industrial user who uses water at a sand and gravel facility shall include the following information in its annual report required by A.R.S. § 45-632.

1. *The quantity of water reclaimed from disposal ponds or clarifiers during the calendar year, as measured with a measuring device in accordance with the Department's measuring device rules. A.A.C. R12-15-901, et seq.*

2. *The quantity of water from any source, including effluent, supplied to the wash plant during the calendar year, as measured with a measuring device in accordance with the Department's measuring device rules. A.A.C. R12-15-901, et seq.*

3. *The quantity of water from any source, including effluent, supplied to the asphalt plant during the calendar year, as measured with a measuring device in accordance with the Department's measuring device rules. A.A.C. R12-15-901, et seq.*

4. *The aggregate surface area of any disposal ponds.*

5. *The average depth of any disposal ponds.*

6. *The estimated quantity of water from any source, including effluent, used during the calendar year for:*

a. *Industrial process purposes. Water used for industrial process purposes includes water used for sanitary waste disposal but does not include water for cooling and cleaning purposes.*

b. *Non-domestic cooling purposes.*

c. *Non-domestic cleaning purposes. Water use for non-domestic purposes includes truck washing, truck mixer drum washing, or other non-domestic cleaning purposes.*

d. *Road dust control.*

e. *Landscape watering.*

f. *Other purposes.*

7. *The tonnage of material washed during the calendar year.*

6.5 LARGE-SCALE POWER PLANTS

6.5.1 Introduction

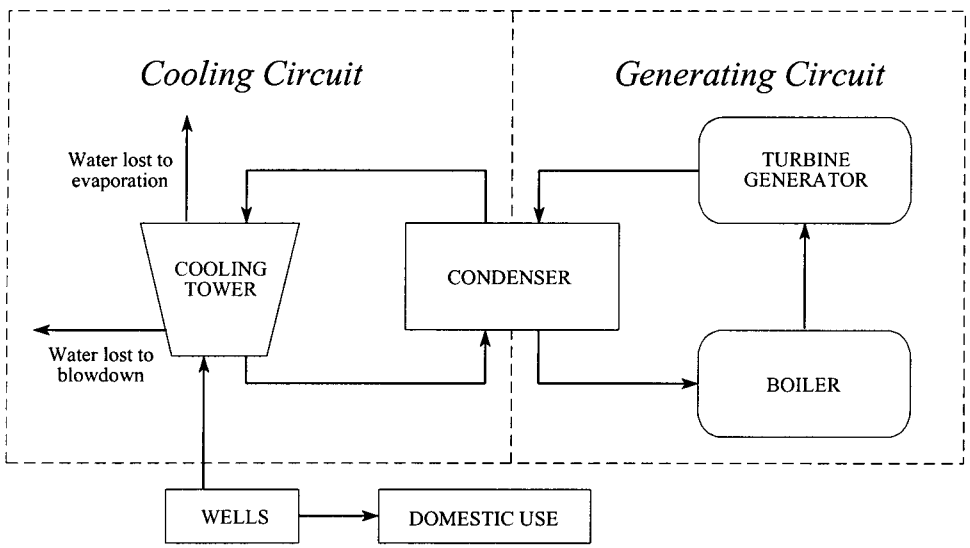
The Department regulates power plants that produce or are designed to produce more than 25 megawatts of electricity. The electric power industry uses cooling towers to dissipate excess heat that builds up in the electrical generation process. The major consumptive use of water at these facilities is evaporation from cooling towers. Because of the large volume of water used in towers, conservation requirements for the electric power industry require facilities to achieve a high level of efficiency in cooling tower operation.

6.5.2 Water Use by Large-Scale Power Plants

The electric power industry in the Phoenix AMA currently holds water rights to over 12,000 acre-feet of groundwater per year pursuant to Type 1 non-irrigation grandfathered rights and Type 2 non-irrigation grandfathered rights limited to use for electrical power generation. Four large-scale power plants (including Palo Verde Nuclear Generating Station) currently are industrial users in the Phoenix AMA. Groundwater use was over 3,830 acre-feet in 1995. While the major water source for Palo Verde is effluent and not groundwater, the other facilities rely exclusively on groundwater. Groundwater used by these plants is not projected to parallel population growth increases because power needed to meet this demand is likely to be imported, rather than generated within the AMA.

Most large-scale power plants have two water use circuits, referred to here as the generating circuit and the cooling circuit. Figure 6-4 illustrates water flow in a typical electrical power plant. In the generating circuit, water is heated in the boiler to form steam, which turns the turbines. The turbines in turn drive the generators, which create electricity. The steam must be cooled and condensed into water before being recycled back to the boiler. The conversion of water to steam and back to water in the generating circuit is completed in a closed system, so water is efficiently recycled with little loss.

FIGURE 6-4
DIAGRAM OF WATER FLOW IN A TYPICAL POWER PLANT



At the condenser, heat is transferred from the steam in the generating circuit to the cooled water in the cooling circuit. Because this heat exchange occurs through the walls of the condenser piping, water in the two circuits does not mix. The heated water in the cooling circuit is pumped to a cooling tower where it is cooled by evaporation. The cooled water is then recirculated back to the condenser. Evaporation losses in the cooling tower constitute the main consumptive use of water at large-scale power plants. As a portion of the cooling circuit water evaporates in the cooling tower, dissolved minerals become concentrated in the remaining water. Due to the high mineral concentrations, corrosion, mineral deposition, and biological fouling can result and can lead to reduced cooling efficiency and equipment damage. Use of chemical treatments can prolong water use in a tower, but periodically, mineral-laden water must be discharged or "blown down" to prevent minerals from precipitating on equipment. Replacement water, known as "make-up water," is added to replace water lost to evaporation and blowdown.

The "cycles of concentration" or "concentration ratio" achieved in a tower indicate how efficiently water is being used. Cooling towers that are consistently operated at higher cycles of concentration consume less water than towers consistently operated at lower cycles of concentration. Cycles of concentration can be determined by dividing the concentration of a constituent in the blowdown water by the concentration of this same constituent in the make-up water. Total dissolved solids content is one commonly used constituent for calculating the cycles of concentration. For example, if the total dissolved solids concentration in blowdown water is 1,500 milligrams per liter (mg/L), and the total dissolved solids content of make-up water is 300 mg/L, the tower is operating at 5 cycles of concentration. Cycles of concentration can also be calculated using electrical conductivity measurements, water volumes, and other conservative mineral constituents (mineral constituents whose concentrations are not altered by the addition of treatment chemicals).

6.5.3 Program Development and Issues

Conservation requirements for the electric power industry were generally the same in the First and Second Management Plans. Facilities in operation by the end of 1984 were required to reach 7 cycles of concentration in cooling towers before blowing down water. Facilities that went into operation after 1984 were required to reach 15 cycles of concentration. For large-scale power facilities in operation by the end of 1984, achieving 7 cycles of concentration is a realistic ceiling on water use efficiency. Above 7 cycles of concentration, the potential for additional water savings decreases while the potential for equipment damage and the cost of chemical additives both increase. Large-scale power facilities can be designed to achieve 15 cycles of concentration, but the technology to accomplish this needs to be built into the plant from the outset and represents an additional expense.

Third Management Plan regulations keep the core requirements from earlier management periods with some modifications to address cooling tower operational time periods and periods of changing water quality. In the Third Management Plan, the cycles of concentration requirement has been revised to apply only when cooling towers are in full operational mode, dissipating heat created during the generation of electricity. Some large-scale power plants generate electricity only during summer months when demand for electric power peaks. During non-generating months, compliance with the cycles of concentration requirements may not be possible because even though water is recirculated to keep tower surfaces wetted, tower evaporation fans are turned off to reduce electricity use. This reduces the normal rate of evaporation. When the recirculating water eventually becomes stagnant, it needs to be blown down even if 7 (or 15) cycles of concentration have not been reached.

Individual cooling towers are periodically shut down and rebuilt. New structural pieces may be installed in towers during this process. If chemically treated lumber is used, concentrations of arsenic, copper, and chromium may build up in tower water. This water must be discharged before these concentrations exceed environmental standards even if 7 (or 15) cycles of concentration have not been reached. As groundwater is withdrawn from greater depths, mineral and trace metal concentrations can increase. When this

groundwater is used to provide make-up water to cooling towers, concentrated minerals in the recirculating water can precipitate and cause equipment damage. The potential also exists for trace metals to build up in recirculating water and exceed sewer system discharge standards for Publicly Owned Treatment Works or exceed National Pollutant Discharge Elimination System standards. In the Third Management Plan, the director may adjust the 7 (or 15) cycles of concentration requirement for cooling towers at large-scale power plants in cases where, because of leaching from new tower components, deterioration of make-up water supplies, or other reasons, facilities are likely to experience equipment damage or come into conflict with environmental discharge regulations if they comply with the cycles of concentration requirement. Facilities must submit documentation of potential problems to support their requests to have cycles of concentration requirements reduced.

Use of effluent in cooling towers is encouraged as an alternative to groundwater use. The feasibility of this use depends on a number of factors including, among others, the availability of effluent, the volume and timing of water demand at the towers, water quality considerations, cost, any constraints on groundwater supplies, and site-specific factors such as other on-site uses for the effluent. The chemical composition of this renewable water source can vary seasonally and even daily depending on the quality, volume and source of wastewater flowing into wastewater treatment facilities. In the Third Management Plan, cooling towers at power plants are exempted from cycles of concentration requirements for the first 12 months in which effluent constitutes 50 percent or more of a tower's water supply. During this period, the power plant operator can collect data on the concentration and variability of constituents in the effluent-served cooling towers which may limit the cycles of concentration that can safely be reached and maintained. After the 12-month exemption period, the facility must either comply with the required cycles of concentration standards or propose an alternative cycles of concentration standard for effluent-served towers based on the data collected during that year.

Several additional changes have been made to the Third Management Plan to more accurately reflect facility operations. The definition of "continuous blowdown and make-up" has been revised to clarify that this term refers to continuous blowdown and make-up or frequent periodic blowdown and make-up of recirculating water. Monitoring and reporting requirements have been revised to allow total dissolved solids, other conservative mineral constituents, or electrical conductivity to be used to determine cycles of concentration. Monitoring and reporting requirements have also been revised to allow monitoring in time increments consistent with operational periods for cooling towers.

6.5.4 Large-Scale Power Plant Program

The Third Management Plan requires that power plants in operation as of the end of 1984 achieve an annual average of 7 cycles of concentration in cooling towers, while facilities that went into operation after 1984 are required to achieve an annual average of 15 cycles of concentration in their cooling towers. The cycles of concentration requirement applies only during periods when facilities are generating electricity and applies only to fully operational towers that are dissipating heat from the power generation process. In addition to achieving 7 (or 15) cycles of concentration, facilities must discharge blowdown water and add make-up water to cooling towers on a continuous basis and divert the maximum possible volume of on-site wastewater (other than blowdown water and sanitary wastewater) to the cooling process.

Facilities may be granted adjustments to their full cycles of concentration requirements in cases where, due to the quality of recirculating water, adhering to the 7 (or 15) cycles of concentration standard is likely to result in equipment damage or blowdown water exceeding environmental discharge standards. Cooling towers at power plants are exempted from cycles of concentration requirements during the first 12 months in which effluent constitutes more than 50 percent of tower water supply. After this period, facilities may request an adjustment to full cycles of concentration requirements for effluent-served towers based on the water quality of the effluent supply.

Facilities may apply to the director to use alternative conservation technologies in place of achieving 7 (or 15) cycles of concentration if the use of the proposed alternative technologies will result in equal or greater water savings. Facilities may also request a waiver from conservation requirements on the basis that cooling tower blowdown water is completely reused. Facilities must periodically measure and annually report blowdown water volumes, make-up water volumes and the chemical concentration of blowdown and make-up water. In addition, facilities must report the amount of electricity generated, the periods when they are not generating electricity, and the volume of water used for purposes other than electric power generation.

6.5.5 Non-Regulatory Efforts

Conservation assistance funds in the Tucson AMA are supporting a study of the tolerance of common landscape plants to industrial wastewater of various salinities, including blowdown water with high concentrations of total dissolved solids from an electric power plant. The goal of this study is to determine whether landscapes can successfully be irrigated with blowdown water rather than groundwater. An experimental project by Arizona Public Service in the Phoenix AMA uses cooling tower blowdown water from an electric power plant to grow halophytes (salt tolerant plants), which are being used to vegetate an urban wildlife refuge adjacent to the facility. Depending on the results of these studies, cooling tower blowdown water may be useful for replacing the use of groundwater to water existing vegetation at some locations.

6.5.6 Future Directions

In the Phoenix AMA, large-scale power plants are supplied by Type 1 and Type 2 non-irrigation grandfathered rights designated for use in electrical energy generation. Other potential water sources include CAP water and effluent, but neither of these are currently being used by the electric power industry in the AMA. The third management period requirements include a temporary exemption from the cycles of concentration standards if a facility converts to the use of at least 50 percent effluent, with the option to revise cycles of concentration requirements if needed to make long-term use of effluent viable. If this option is used during the third management period, the information gained can be used to direct research and regulatory directions in the fourth management period. Reuse of industrial wastewater in cooling towers and the use of cooling tower blowdown water for landscaping watering are water-conserving measures that should continue to be examined to determine the advantages and constraints of these conservation strategies.

6.5.7 Industrial Conservation Requirements and Monitoring and Reporting Requirements For Large-Scale Power Plants

6-501. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, unless the context otherwise requires, the following words and phrases shall have the following meanings:

1. *"Blowdown water" means water discharged from a cooling tower recirculating water stream to control the buildup of minerals or other impurities in the recirculating water.*

2. *"Conservative mineral constituent" means a component of recirculating water in a cooling tower, the concentration of which is not significantly modified by precipitation, loss to the atmosphere, or the addition of treatment chemicals.*

3. *"Continuous blowdown and make-up" means patterns in cooling tower operation that include continuous blowdown and make-up or frequent periodic blowdown and make-up of recirculating water.*

4. *"Cycles of concentration" means the ratio of the concentration of total dissolved solids, other conservative mineral constituents or electrical conductivity in the blowdown water, to the concentration of this same constituent or electrical conductivity in the make-up water.*

5. *"Effluent-served cooling tower" means a cooling tower served by a make-up water supply which, on an annual average basis, consists of 50 percent or more effluent.*

6. *"Fully operational cooling tower" means a cooling tower that is functioning to dissipate heat from a large-scale power plant that is generating electricity.*

7. *"Large-scale power plant" means an industrial facility that produces or is designed to produce more than 25 megawatts of electricity.*

8. *"Limiting constituent" means a chemical, physical, or biological constituent present in recirculating cooling tower water which, due to potential physical or biological factors, or due to potential exceedence of any federal, state, or local environmental standards upon discharge as blowdown, should not be allowed to accumulate in recirculating cooling tower water above a certain concentration.*

9. *"Make-up water" means the water added to the cooling tower recirculating water stream to replace water lost to evaporation, blowdown, or other mechanisms of water loss.*

10. *"Post-1984 power plant" means either:*

    a. *A large-scale power plant that does not qualify as a pre-1985 power plant, and includes any expanded or modified portion of the power plant if the expansion or modification includes the construction or modification of one or more cooling towers, or*

b. Any expanded or modified portion of a pre-1985 power plant if the expansion or modification includes the construction or modification of one or more cooling towers and was not substantially commenced as of December 31, 1984.

11. "Pre-1985 power plant" means a large-scale power plant that either produced electric power as of December 31, 1984 or was substantially commenced as of December 31, 1984 and includes any expanded or modified portion of such a power plant if the expansion or modification was substantially commenced as of December 31, 1984 and included the modification or construction of one or more cooling towers.

12. "Substantially commenced as of December 31, 1984" means, with regard to the construction, expansion, or modification of a large-scale power plant, that all preconstruction permits and approvals required by federal, state, or local governments for the construction, expansion, or modification of the plant were obtained by December 31, 1984 or that a substantial capital investment in the physical on-site construction of the project was made within the 12 months prior to December 31, 1984.

6-502. Conservation Requirements for Pre-1985 Power Plants

Beginning on January 1, 2002 and continuing thereafter until the first compliance date for any substitute conservation requirement in the Fourth Management Plan, an industrial user who uses water at a pre-1985 power plant shall comply with the following requirements:

1. An annual average of 7 or more cycles of concentration shall be achieved at fully operational cooling towers during periods when the power plant is generating electricity.

2. Blowdown water shall be discharged on a continuous basis, and make-up water shall be provided on a continuous basis.

3. The maximum amount of wastewater feasible, excluding blowdown water and sanitary wastewater, shall be diverted to the cooling process.

6-503. Conservation Requirements for Post-1984 Power Plants

Beginning on January 1, 2002 or upon commencement of water use, whichever occurs later, and continuing thereafter until the first compliance date for any substitute conservation requirement in the Fourth Management Plan, an industrial user who uses water at a post-1984 power plant shall comply with the following requirements:

1. An annual average of 15 or more cycles of concentration shall be achieved at fully operational cooling towers during periods when the power plant is generating electricity.

2. Blowdown water shall be discharged on a continuous basis, and make-up water shall be provided on a continuous basis.

3. The maximum amount of wastewater feasible, excluding blowdown water and sanitary wastewater, shall be diverted to the cooling process.

6-504. Cycles of Concentration Adjustment Due to the Quality of Recirculating Water

A. An industrial user who uses water at a large-scale power plant may apply for an adjustment to the cycles of concentration requirements set forth in section 6-502 or section 6-503,

whichever is applicable, for any year in which compliance with the cycles of concentration requirements would likely result in damage to cooling towers or associated equipment or exceedence of federal, state, or local environmental discharge standards because of the quality of recirculating water. To apply for an adjustment to the cycles of concentration requirements based on recirculating water quality, an industrial user shall submit a request in writing to the director which includes the following information:

1. *Historic, current, and projected water quality data for the relevant constituent(s).*

2. *Documentation describing the potential damage to cooling towers or associated equipment or documentation of environmental standards that are likely to be exceeded, whichever applies.*

B. *The director shall grant the request if the director determines that compliance with the cycles of concentration requirements set forth in section 6-502 or section 6-503, whichever is applicable, would likely result in damage to cooling towers or associated equipment or exceedence of federal, state, or local environmental discharge standards because of the quality of recirculating water.*

6-505. Exemption and Cycles of Concentration Adjustment Due to the Quality of Effluent Make-up Water Supplies

A. *The cycles of concentration requirements set forth in sections 6-502 and 6-503 do not apply to any effluent-served cooling tower at a large-scale power plant during the first 12 consecutive months in which more than 50 percent of the water supplied to the cooling tower is effluent.*

B. *After the 12-month exemption period expires, the industrial user who uses water at the large-scale power plant may apply to the director for a cycles of concentration adjustment to lower the cycles of concentration requirement for the effluent-served cooling tower if compliance with the requirement would not be possible due to the presence of a limiting constituent in the effluent supplying the tower. To apply for an alternative cycles of concentration requirement to address such a limiting constituent, an industrial user shall submit a request in writing to the director which includes the following information:*

1. *The limiting constituent that is present in the effluent supplying the tower which results in the need to blow down a greater annual volume of water than that required in section 6-502 or section 6-503, whichever is applicable.*

2. *Documentation describing the concentration at which this limiting constituent should be blown down, and the reason for the alternative blowdown level.*

The director shall grant the request if the director determines that the presence of a limiting constituent in the effluent supplying the cooling tower results in the need to blow down a greater annual volume of water than that required in section 6-502 or section 6-503, whichever is applicable. Any cycles of concentration adjustment granted pursuant to this paragraph shall apply only while the tower qualifies as an effluent-served cooling tower.

6-506. Alternative Conservation Program

An industrial user who uses water at a large-scale power plant may apply to the director to use conservation technologies other than those prescribed in section 6-502 or section 6-503,

whichever is applicable. The director shall approve the use of alternative conservation technologies if both of the following apply:

1. *The industrial user files with the director a detailed description of the proposed alternative technologies and the water savings that can be achieved by the use of the alternative technologies.*

2. *The director determines that the alternative conservation technologies will result in water savings equal to or greater than the savings that would be achieved by the applicable conservation technologies prescribed in section 6-502 or section 6-503.*

6-507. Waiver

A. *An industrial user who uses water at a large-scale power plant may apply to the director for a waiver of any applicable conservation requirement in section 6-502 or section 6-503 by submitting a detailed long-term plan for beneficial reuse of 100 percent of the blowdown water outside the cooling circuit. Reuse of blowdown water includes the discharge of blowdown water into pipes, canals, or other means of conveyance if the discharged water is transported to another location at the plant or off the plant for reuse.*

B. *The director shall grant a waiver request if the director determines that implementation of the plan will result in the beneficial reuse of 100 percent of cooling water outside the cooling circuit. If a waiver request is granted, the industrial user shall implement the plan in accordance with the implementation schedule submitted to and approved by the director.*

6-508. Monitoring and Reporting Requirements

A. *For calendar year 2002 or the calendar year in which water use first commences, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan, an industrial user who uses water at a large-scale power plant shall include in its annual report required by A.R.S. § 45-632 the following information:*

1. *Cooling capacity (in tons) of each cooling tower at the facility.*

2. *Frequency of use and use periods of each cooling tower at the facility.*

3. *Source of water providing make-up water to each cooling tower at the facility.*

4. *For each cooling tower at the facility that is exempt from cycles of concentration requirements pursuant to section 6-505, subsection A, or for which a cycles of concentration adjustment was granted pursuant to section 6-505, subsection B, the percentage of water served to the tower during the year that was effluent.*

5. *For all fully operational cooling towers subject to cycles of concentration requirements under section 6-502 or section 6-503:*

    a. *The total quantity of blowdown water discharged from the cooling towers for each month or partial month when the facility was generating electricity during the calendar year.*

b. The total quantity of make-up water used at cooling towers for each month or partial month when the facility was generating electricity during the calendar year.

c. The weighted average concentration of total dissolved solids or other conservative mineral constituent in make-up water and blowdown water at the cooling towers for each month or partial month when the facility was generating electricity during the calendar year, either:

1) Determined by direct analysis, or

2) Calculated based on average monthly electrical conductivity readings if the following conditions have been met: (a) correlations between electrical conductivity and total dissolved solids or between electrical conductivity and another conservative mineral constituent have been established over a period of one year or more in make-up and blowdown water and (b) documentation of these correlations has been provided to the director.

6. For each fully operational cooling tower that is exempt from cycles of concentration requirements pursuant to section 6-505, subsection A, or for which an adjusted cycles of concentration requirement was granted pursuant to section 6-504 or section 6-505, subsection B:

a. The total quantity of blowdown water discharged from the cooling tower for each month or partial month when the facility was generating electricity during the calendar year.

b. The total quantity of make-up water used at the cooling tower for each month or partial month when the facility was generating electricity during the calendar year.

c. The weighted average concentration of total dissolved solids or other conservative mineral constituent in make-up water and blowdown water at the cooling tower for each month or partial month when the facility was generating electricity during the calendar year, either:

1) Determined by direct analysis, or

2) Calculated based on average monthly electrical conductivity readings if the following conditions have been met: (a) correlations between electrical conductivity and total dissolved solids or between electrical conductivity and another conservative mineral constituent have been established over a period of one year or more in make-up and blowdown water and (b) documentation of these correlations has been provided to the director.

7. All time periods when the facility was not generating electricity.

8. The amount of electricity generated each month or each partial month when the facility was generating electricity during the calendar year.

9. The estimated quantity of water from any source, including effluent, used during the calendar year for each purpose other than electric power generation purposes.

B. *A single annual report shall be filed for a pre-1985 power plant and a post-1984 power plant that are contiguous and owned by the same owner. The report shall describe the combined operations of the pre-1985 and post-1984 power plants as required in subsection A of this section.*

C. *All water measurements required in this section shall be made with a measuring device in accordance with the Department's measuring device rules. A.A.C. R12-15-901, et seq.*

6.6 LARGE-SCALE COOLING FACILITIES

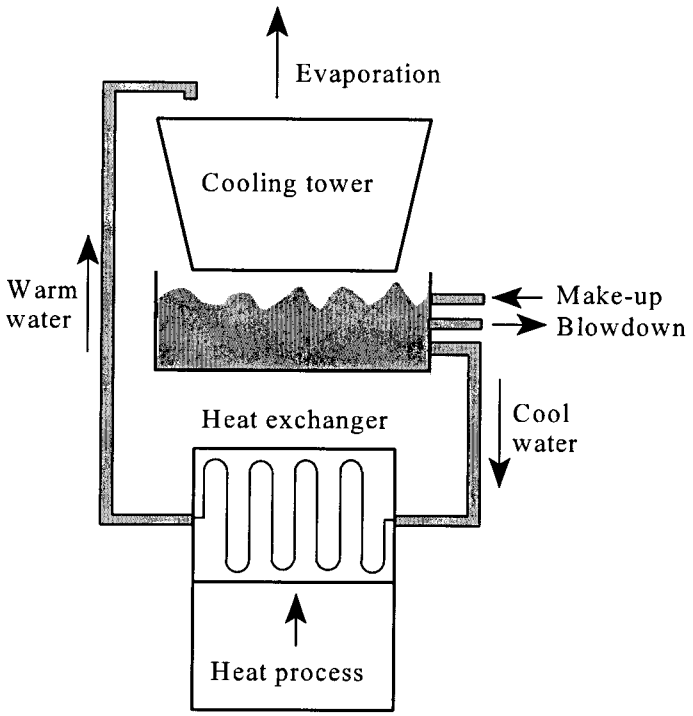
6.6.1 Introduction

The purpose of cooling tower operation is to cool water that has absorbed the heat load of a heat-generating process. Cooling towers are present at a variety of commercial, industrial, and institutional facilities. Large-scale cooling facilities are defined as facilities with an aggregate cooling capacity of a minimum of 1,000 tons. The minimum cooling unit that is added to create the aggregate total of 1,000 tons is 250 tons in size. Most large-scale cooling facilities are served by municipal water providers. These facilities are termed individual users. Water providers are responsible for the Individual Users' compliance with industrial conservation requirements unless they have notified the Department of the existence of the individual user as provided in section 5-112 of the Municipal Conservation Requirements (Chapter 5), in which case the individual user is responsible for compliance. Large-scale cooling facilities served by their own wells are regulated directly by the Department and are responsible for complying with industrial conservation requirements.

6.6.2 Water Use by Large-Scale Cooling Facilities

The main function of water in a cooling tower is to absorb heat from a heat-generating process and dissipate this heat through evaporation, as shown in Figure 6-5. Because a portion of the recirculating water is lost through evaporation, this is considered an "open" recirculating cooling loop.

FIGURE 6-5
AN OPEN RECIRCULATING COOLING LOOP



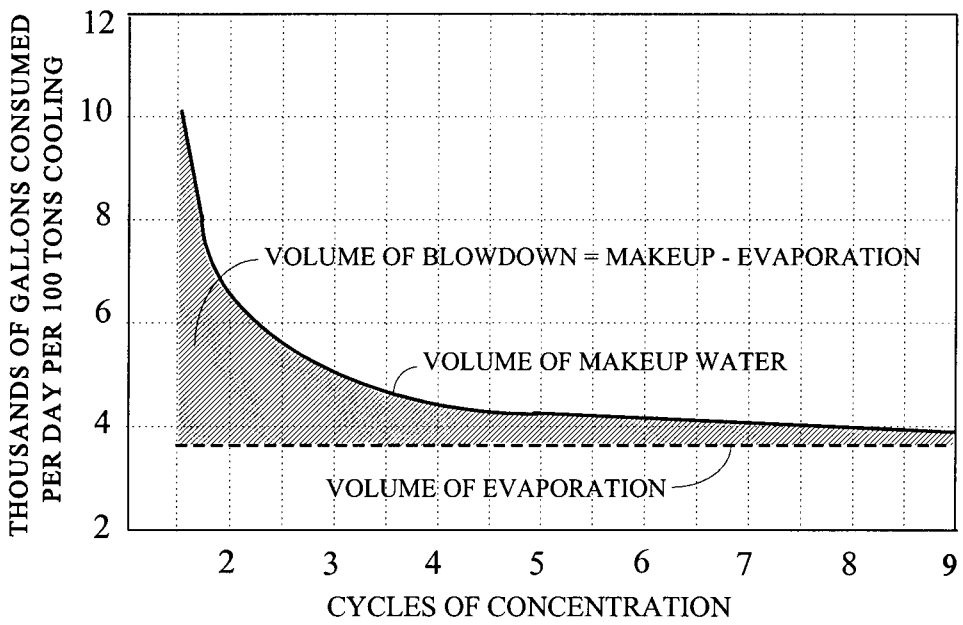
The equipment served by a cooling tower varies from industry to industry; the most common is equipment used to reject heat from a large Heating, Ventilation, and Air Conditioning system (known as an HVAC system). Various equipment configurations are used to transfer heat from its source to the cooled water stream coming from the cooling tower. This transfer typically occurs inside a heat exchanger (Figure 6-5).

As a portion of cooling tower water evaporates, dissolved minerals become concentrated in the remaining water. Problems such as corrosion, mineral deposition, and biological fouling can result. These conditions reduce cooling efficiency and damage equipment. Chemical treatments including biocides, scale inhibitors, corrosion inhibitors, and addition of sulfuric acid can prolong the time mineral-laden water can safely be recirculated in towers. Mineral-laden water must be periodically discharged to prevent the excessive buildup of minerals and the possible precipitation of these minerals onto equipment surfaces. This discharge is known as "blowdown." Replacement water, known as "make-up water," is added back to the tower's recirculating water stream to replace the water lost to evaporation and blowdown.

The "cycles of concentration" or "concentration ratio" achieved in a tower indicate how efficiently water is being used in the tower. Cycles of concentration can be determined by dividing the concentration of a constituent in the blowdown water by the concentration of this same constituent in the make-up water. The concentration of total dissolved solids, a measure of the overall dissolved mineral content in water, is one commonly used constituent for calculating the cycles of concentration. For example, if the total dissolved solids concentration in blowdown water is 1,500 milligrams per liter (mg/L), and the total dissolved solids content of make-up water is 300 mg/L, the tower is operating at 5 cycles of concentration. Cycles of concentration can also be calculated using electrical conductivity measurements, water volumes, and other conservative constituents (mineral constituents whose concentrations are not altered by precipitation, loss to the atmosphere, or the addition of treatment chemicals).

Figure 6-6 illustrates the relationship between the cycles of concentration achieved in a tower and the volume of water lost through evaporation and blowdown and replaced by make-up water. At lower concentration cycles, the tower loses water through both evaporation and blowdown. At higher cycles of concentration, the rate of water consumption levels off until almost all water loss is due to evaporation. Evaporation cannot be reduced since that mechanism provides the cooling function of the tower. However, blowdown can be minimized by operating the tower at optimal efficiency. The larger the tower is, the more water will be saved as the cycles of concentration increase.

FIGURE 6-6
RELATIONSHIP BETWEEN THE CYCLES OF CONCENTRATION AND THE AMOUNT OF WATER CONSUMED BY COOLING TOWER



Cooling tower water use cannot be determined directly from water supply records because water supplies to large facilities serve a number of water needs besides cooling towers. In the absence of direct records, water use at cooling towers has been based on an estimation of the number, size, and efficiency of towers in the Phoenix AMA. Lists of large water customers served by municipal water providers in the Tucson AMA were reviewed to locate hospitals, manufacturing plants, commercial buildings, department stores, grocery stores, schools, and other facilities with large cooling demands. Questionnaires were sent to these facilities to determine tower size and water use efficiency. Based on lists of large water customers, survey

results, and the size of non-residential water use in the Phoenix AMA relative to the Tucson AMA, it is estimated there are about 3,000 towers of all sizes in the Phoenix AMA.

The size or cooling capacity of a tower is often described in units of tons. Cooling capacity tonnage indicates the rate at which the cooling tower can reject heat. Cooling tower capacities can range from as little as 50 tons to over 1,000 tons. Large industrial or commercial facilities may have several large towers. As discussed in the next section, third management period conservation requirements apply to facilities with a total cooling capacity of 1,000 tons or more. Based on the survey results, approximately 100 facilities may fit into this regulatory category. Assuming towers at these facilities average 1,000 tons in capacity and operate 24 hours a day at 3 cycles of concentration, they would use approximately 22,800 acre-feet of water annually. These estimates need to be confirmed with additional field data.

Future water use by regulated cooling towers will depend on the size and number of newly constructed facilities and the cycles of concentration achieved at all regulated towers. Assuming cooling tower construction parallels population growth, the number of towers in the Phoenix AMA could nearly double by 2025. At three cycles of concentration, facilities subject to third management period conservation requirements could use 42,600 acre-feet per year by 2025.

6.6.3 Program Development and Issues

There were no conservation requirements in the First Management Plan for cooling towers other than for towers serving the electric power industry (section 6.5 of this chapter). Beginning in the Second Management Plan, regulations went into effect for "new large cooling users," defined as facilities with an aggregate tower capacity in excess of 250 tons which went into operation after January 1, 1990. Cooling towers at facilities in this category were required to achieve a concentration of 2,000 mg/l of total dissolved solids in recirculating water before blowing it down. The cutoff date of January 1, 1990 was intended to focus on new facilities with cooling towers, which could be identified as they established hook-ups with water providers. This identification process has proved to be difficult, and a complete list of facilities subject to Second Management Plan requirements has not been developed.

The Third Management Plan includes several changes intended to increase the effectiveness of conservation requirements for cooling towers. The facilities subject to regulation have been expanded from "new" facilities to facilities of all ages, because cooling technology has not changed significantly over time, and age alone does not preclude towers at facilities from achieving water use efficiency. At the same time, the size of regulated facilities has been shifted upwards to include only those facilities with an aggregate cooling capacity of 1,000 tons or more. In determining the aggregate cooling capacity of a facility, only cooling towers that are 250 tons or more in size are considered, and only towers of this size or larger have specific blowdown requirements. This size cutoff excludes small capacity towers at which it may not be cost effective to conduct monitoring and install chemical feed equipment. Eliminating the January 1, 1990 cutoff date increases the number of facilities subject to regulation and increases the potential water savings. Identifying facilities subject to Third Management Plan requirements should be facilitated by concentrating on larger scale industries, commercial buildings, and institutions which need 1,000 tons or more of cooling capacity.

In the Second Management Plan, facilities were required to achieve a recirculating water concentration of 2,000 mg/l of total dissolved solids in cooling towers before blowing down. Blowdown standards in the Third Management Plan have been shifted from total dissolved solids to silica- and hardness-based standards. While the concentration of total dissolved solids is relatively easy to estimate using electrical conductivity as a surrogate and the 2,000 mg/l cutoff level addresses to some extent the water quality variations in make-up water supplies, silica and total hardness are more useful as indicators of the maximum concentration cycles that can safely be achieved in a tower. Silica can build up in recirculating water and damage equipment by precipitating a layer of "glass" inside piping. This silica layer reduces

heat transfer and requires expensive repairs. The total hardness of water is a measure of the presence of calcium and magnesium salts, which can precipitate to form scale inside cooling towers and associated piping.

The purpose of Third Management Plan regulations is to effectively move large-scale cooling facilities toward more water-conserving management practices while operating within a range that safely avoids mineral precipitation in cooling towers and associated piping. As required in the Code, conservation requirements for industrial users must be based on the use of the latest commercially available conservation technology consistent with reasonable economic return. Conservation requirements in the Third Management Plan focus on standards that can be achieved using conventional chemical treatment to extend cycles of concentration in cooling towers. This is the most efficient proven conservation technology currently available without major capital outlays. Several new commercially available technologies for tower operation and maintenance are available but have drawbacks because they are unproven technologies, they have high initial capital costs, or they do not work efficiently at high desert temperatures.

In the Third Management Plan, large-scale cooling facilities must achieve concentrations of either 120 mg/l of silica or 1,200 mg/l of total hardness, whichever is reached first, before blowing down the recirculating water from towers with 250 tons or more of cooling capacity. The solubility limit of silica in water is around 150 mg/l. Allowing facilities to discharge water when silica reaches 120 mg/l provides a margin of safety against costly equipment damage. The solubility limit of total hardness is a function of the chemical treatment used in a tower. Large cooling towers can generally operate safely at concentrations of around 1,200 mg/l total hardness in the recirculating water so this was selected as the Third Management Plan total hardness standard. Total hardness is typically expressed as an equivalent concentration of calcium carbonate ("hardness as calcium carbonate"), though both calcium and magnesium salts are included in this expression.

Third Management Plan cooling tower blowdown requirements apply only when towers are functioning to dissipate heat. Some towers are operated periodically based on seasonal or workload patterns, rather than being operated continuously. During periods when they are not dissipating heat, water may still need to be recirculated through towers to keep surfaces wetted, but evaporation fans may be turned off to reduce electricity use. This reduces the normal rate of evaporation. When the recirculating water becomes stagnant, it needs to be blown down whether or not blowdown standards have been met.

Use of effluent in cooling towers is encouraged as an alternative to groundwater use. The feasibility of this use depends on a number of factors including the availability of effluent, the volume and timing of water demand at the towers, water quality considerations, cost, any constraints on groundwater supplies, and site-specific factors such as other on-site uses for the effluent. The chemical composition of this renewable water source can vary seasonally and even daily depending on the quality, volume, and source of wastewater flowing into wastewater treatment facilities. For the third management period, a cooling tower at a large-scale cooling facility is exempt from cooling tower blowdown requirements for the first 12 months in which effluent constitutes 50 percent or more of the water supply to that tower. During this period, the facility operator will collect data on the concentration and variability of constituents in make-up water that may limit the cycles of concentration that can safely be reached and maintained. After the 12-month exemption period, the facility must either comply with the silica/total hardness blowdown standards for the tower or propose an alternative blowdown standard based on the data collected during that year.

For all facilities subject to Third Management Plan requirements, in cases where the build up of constituents other than silica or total hardness in cooling tower recirculating water is likely to result in damage to cooling towers or is likely to result in exceeding environmental discharge standards, facilities may apply to use an alternative blowdown standard.

6.6.4 Large-Scale Cooling Facility Program

Large-scale cooling facilities are facilities with a total cooling capacity of 1,000 tons or more. The following Third Management Plan conservation requirements apply to cooling towers that are located at large-scale cooling facilities and that have 250 tons or more of cooling capacity.

- Fully operational cooling towers with 250 tons or more of cooling capacity must achieve either 120 mg/l of silica or 1,200 mg/l of total hardness in recirculating water, whichever is reached first, before blowing down.
- If needed, a facility may apply for an alternative blowdown standard for any tower using effluent. During the initial 12-month period during which 50 percent or more of the water used by a tower is effluent, the tower is exempt from blowdown standards.
- If needed, a facility may apply for an alternative blowdown standard for any tower if compliance with blowdown requirements would likely result in damage or exceedence of environmental discharge standards because of the accumulation of a limiting constituent other than silica or total hardness.
- Facilities must record monthly and report annually the volumes of tower make-up water and blowdown water and the concentrations of silica, total hardness, or approved alternative constituent, in both make-up water and blowdown water.

6.6.5 Non-Regulatory Efforts

The Phoenix AMA has partially funded industrial, commercial, and institutional water conservation workshops sponsored by the Arizona Municipal Water Users Association. The workshops provided classroom instruction, site visits, and mentoring of individual water auditing efforts by participants as part of a water audit certification program. Cooling towers were among the several uses audited.

To encourage water conservation in facilities of all sizes, a cooling tower training video has been prepared which describes how water can be conserved by improving the efficiency of tower maintenance. The video and an accompanying workbook were prepared through a Tucson AMA conservation assistance grant.

6.6.6 Future Directions

Identification of the regulated community is a high priority for the cooling tower program during the third management period. During this period, data on the number, size, and efficiency of cooling towers will be collected. Based on the collected data, the effectiveness of these programs will be determined. Fourth management period requirements will be adjusted accordingly. New cooling tower maintenance technologies will continue to be investigated and can be incorporated into future conservation requirements.

Experiences gained by facilities converting to effluent use in the third management period can be used to direct research and regulatory directions in the fourth management period. Reuse of industrial wastewater in cooling towers and the use of cooling tower blowdown water for landscape watering should continue to be examined to determine the advantages and constraints of these recycling approaches.

6.6.7 Industrial Conservation Requirements and Monitoring and Reporting Requirements for Large-Scale Cooling Facilities

6-601. Definitions

In addition to the definitions set forth in Cchapters 1 and 2 of Title 45 of the Arizona Revised Statutes , unless the context otherwise requires, the following words and phrases shall have the following meanings:

1. *"Blowdown water" means water discharged from a cooling tower recirculating water stream to control the buildup of minerals or other impurities in the recirculating water.*

2. *"Conservative mineral constituent" means a component of recirculating water in a cooling tower, the concentration of which is not significantly modified by the addition of treatment chemicals.*

3. *"Cycles of concentration" means the ratio of the concentration of a conservative mineral constituent or electrical conductivity in the blowdown water to the concentration of this same constituent or electrical conductivity in the make-up water.*

4. *"Effluent-served cooling tower" means a cooling tower served by a make-up water supply which on an annual average basis consists of 50 percent or more effluent.*

5. *"Fully operational cooling tower" means a cooling tower that is functioning to dissipate heat.*

6. *"Large-scale cooling facility" means a facility which has control over cooling operations with a total combined cooling capacity greater than or equal to 1,000 tons. For the purposes of this definition, the minimum cooling tower size which shall be used to determine total facility cooling capacity is 250 tons. A large-scale cooling facility does not include a large-scale power plant that utilizes cooling towers to dissipate heat.*

7. *"Large-scale power plant" means an industrial facility that produces or is designed to produce more than 25 megawatts of electricity.*

8. *"Limiting constituent" means a chemical, physical, or biological constituent present in recirculating cooling tower water which, due to potential physical or biological factors or due to potential exceedence of any federal, state, or local environmental standards upon discharge as blowdown, should not be allowed to accumulate in recirculating cooling tower water above a certain concentration.*

9. *"Make-up water" means the water added back into the cooling tower recirculating water stream to replace water lost to evaporation, blowdown, or other mechanisms of water loss.*

6-602. Conservation Requirements

A. Conservation Requirements

Beginning on January 1, 2002 or upon commencement of water use, whichever occurs later, and continuing thereafter until the first compliance date for any substitute conservation

requirement in the Fourth Management Plan, an industrial user who uses water at a large-scale cooling facility shall comply with the following requirements:

Each fully operational cooling tower with greater than or equal to 250 tons of cooling capacity at the facility shall achieve a cycles of concentration level that results in blowdown water being discharged at an average annual minimum of either 120 mg/l silica or 1,200 mg/l total hardness, whichever is reached first.

B. Exemptions and Alternative Blowdown Standards

1. *The requirement set forth in subsection A of this section does not apply to a large-scale cooling facility in any year in which 100 percent of facility blowdown water is beneficially reused.*

2. *The requirement set forth in subsection A of this section does not apply to any effluent-served cooling tower at a large-scale cooling facility during the first 12 consecutive months in which more than 50 percent of the water supplied to the cooling tower is effluent. After the 12-month period expires, the person using water at the effluent-served cooling tower may apply to the director to use an alternative blowdown level from that required in subsection A of this section if compliance with the blowdown requirement would not be possible due to the presence of a limiting constituent other than silica or total hardness in the effluent supplying the tower. To apply for an alternative blowdown level to address such a limiting constituent, an industrial user shall submit a request in writing to the director which includes the following information:*

   a. *The limiting constituent other than silica or total hardness that is present in the effluent supplying the tower which results in the need to blow down a greater annual volume of water than that required under subsection A of this section.*

   b. *Documentation describing the concentration at which this limiting constituent should be blown down and the reason for the alternative blowdown level.*

   The director shall grant the request if the director determines that the presence of a limiting constituent other than silica or total hardness in the effluent supplying the cooling tower results in the need to blow down a greater annual volume of water than that required under subsection A of this section. Any alternative blowdown level granted pursuant to this paragraph shall apply only while the tower qualifies as an effluent-served cooling tower.

3. *An industrial user may apply to the director to use an alternative blowdown level from that required in subsection A of this section if compliance with the blowdown requirement would likely result in damage to cooling towers or associated equipment or exceedence of federal, state, or local environmental discharge standards because of the accumulation of a limiting constituent other than silica or total hardness in recirculating water. To apply for an alternative blowdown level for such a limiting constituent, an industrial user shall submit a request in writing to the director which includes the following information:*

   a. *Historic, current, and projected water quality data for the relevant limiting constituent(s).*

b. Documentation describing the potential damage to cooling towers or associated equipment, or documentation of environmental standards that are likely to be exceeded, whichever applies.

The director shall grant the request if the director determines that compliance with the blowdown level set forth in subsection A of this section would likely result in damage to cooling towers or associated equipment or exceedence of federal, state, or local environmental discharge standards because of the accumulation of a limiting constituent other than silica or total hardness in recirculating water.

6-603. Monitoring and Reporting Requirements

For calendar year 2002 or the calendar year in which water use first commences, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute monitoring and reporting requirement in the Fourth Management Plan, an industrial user who uses water at a large-scale cooling facility shall include in its annual report required by A.R.S. § 45-632 the following information for all cooling towers with 250 tons or more of cooling capacity at the facility:

1. Capacity in tons of each cooling tower.

2. Number of days per month that each cooling tower was fully operational.

3. For each cooling tower that is exempt from cycles of concentration requirements or for which an alternative blowdown level has been granted, pursuant to section 6-602, subsection B, paragraph 2, the percentage of water served to the tower during the year that was effluent.

4. The quantity of water from any source, specified by source, which was used for make-up water on a monthly basis during the calendar year as measured with a measuring device in accordance with the Department's measuring device rules, A.A.C. R12-15-901, et seq.

5. The quantity of water which was blown down on a monthly basis during the calendar year as measured with a measuring device in accordance with the Department's measuring device rules, A.A.C. R12-15-901, et seq.

6. The average monthly concentrations of silica, total hardness, or other approved limiting constituent established under section 6-602, subsection B, paragraph 2 or 3, in make-up and blowdown water for those portions of each month when cooling towers were fully operational during the calendar year, reported in mg/l or other measurement units established under section 6-602, subsection B, paragraph 2 or 3, and either:

a. Determined by direct analysis; or

b. Calculated based on average monthly electrical conductivity readings for those portions of each month when cooling towers were fully operational if the following conditions have been met: (a) correlations between electrical conductivity and silica, between electrical conductivity and total hardness, or between electrical conductivity and another approved limiting constituent established pursuant to section 6-702 subsection B, paragraph 2 or 3, have been established over a period of one year or more in make-up and blowdown water; and (b) documentation of these correlations has been provided to the director.

6.7 DAIRY OPERATIONS

6.7.1 Introduction

The Department regulates dairy operations that annually house a monthly average of 100 or more lactating cows per day. The majority of water use at dairy operations occurs for animal drinking needs, udder washing, barn cleanup, and animal cooling.

6.7.2 Water Use by Dairy Operations

There are 86 dairy operations in the Phoenix AMA, which are clustered southeast of Chandler, Gilbert, and Mesa, and in the West Valley. Dairy operations in the AMA hold Type 1 and Type 2 non-irrigation grandfathered rights and groundwater withdrawal permits that have a combined annual allotment of nearly 15,700 acre-feet. Water use in 1995 was over 8,400 acre-feet. Water use by dairy operations has been steadily increasing since 1989 and it is projected this trend will continue through the year 2025. However, many variables may affect this projection. As urban development in the Phoenix metropolitan area expands further outward, many dairy operations have chosen to relocate away from new residential development, in some cases opting for a more rural environment such as that found in the Pinal AMA. Other dairies, however, prefer to stay closer to processing facilities located in the AMA.

Figure 6-7 shows how water is used at a dairy. A significant amount of water is used for the milking cycle. The first step in the milking cycle at most dairy operations is moving the cows into a holding pen, where the udders are washed before milking. Sprinklers, arranged in a grid pattern on the floor of the pen, are turned on to wash the udders. The cows may be cooled during udder washing to enhance milk production. The animals are then moved to the milking parlor for milking, after which they are returned to the corral area through return lanes. Each time the cycle is completed, the holding pen and parlor areas are cleaned, milk lines are washed, milking equipment is cleaned and sanitized, and manure is removed.

A number of dairy management decisions affect water use. Animal cooling to reduce heat stress and enhance milk production is an increasingly common management practice. Cooling is usually done when temperatures exceed 85 to 90 degrees Fahrenheit and may be done at a number of points in the milking cycle, including the holding pen corral, at the parlor exit, along the fenceline feeding area, or in the corral area. Approximately 95 percent of dairy operations in the AMAs cool their cows during some portion of the milking cycle. Cooling practices have increased during the past decade and are expected to continue to increase in the future. Whereas at many existing dairy operations lactating cows are often cooled at only one or two of the possible locations, newly designed dairy operations incorporate cooling wherever possible.

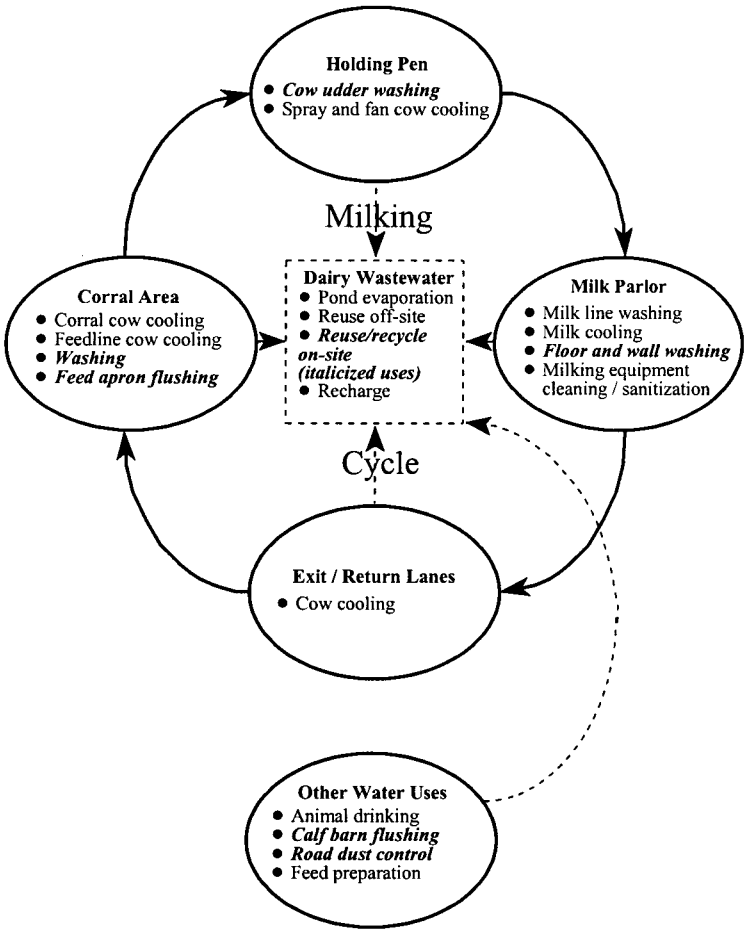
Milking cycle frequency is another management decision that affects water use. Cows may be milked two, three, or even four times daily. Increasing the number of milking cycles per day will increase water use. Dairy managers evaluate the benefits of milking two or three times per day based upon parlor capacity, milk yield, staffing, and other economic factors. If future market demand requires increasing milk pounds of production per cow, milking three or four times a day could become commonplace.

Aside from the milking cycle, water is used for drinking needs, dust control, and, at some dairy operations, feed preparation. Water used for drinking needs varies depending upon whether the animal present at the facility is a lactating cow (a cow producing milk) or a non-lactating animal (calves, heifers, dry cows, bulls, and steers). A lactating cow drinks an average of 30 gallons of water per day and a non-lactating animal drinks an average of 15 gallons per day, with some seasonal variation.

Whether replacement animals and non-lactating animals are housed on or off-site can significantly affect water use. Each dairy keeps lactating and mature dry cows on-site at a ratio that remains relatively

constant throughout the year, with some variation due to weather and breeding. Another management decision is whether replacement animals, such as calves and heifers, are housed on-site. Typically, if replacement animals are housed on-site, the total number of replacement animals plus mature dry cows equals the number of lactating cows. Some dairy managers prefer to purchase replacement animals as needed or raise the animals in cooler climates until they near calving age. Approximately 33 percent of Arizona dairy operations raise their replacement animals off-site.

FIGURE 6-7
WATER USE AT A TYPICAL DAIRY OPERATION



Italicized items can use reused and/or recycled water
Not all water uses shown on this chart exist at every dairy

Within the milking cycle, the dairy industry practices that have the most significant water conservation potential are the udder washing process, the practice of water recycling, and, to a lesser extent, cleaning and sanitization. The typical udder washing cycle consists of a one minute washing, a two minute break, followed by a three minute washing. At many dairy operations, more water is used in the udder washing process during the summer months, though no increase is warranted for sanitation reasons. Summer water use can be reduced with little or no additional management or equipment costs. Many dairy operations have invested in automatic timers to manage the udder wash system. Timers reduce the potential for excessive manual washing, provided the timer is used appropriately. Proper management is the best way to control water use, and the use of automatic timers can result in significant water savings. Other factors affect the amount of water used for udder washing. Regular and frequent washing of the corral walkway areas reduces the potential for soiled udders and thus reduces wash water needs. Periods of wet weather result in muddy corrals, requiring longer udder washing cycles or increased washing of corral walkways and milking areas.

Another important water conservation practice for dairy operations is recycling of wastewater generated by the dairy. Wastewater may be conveyed to a lagoon where it evaporates, delivered off-site for non-dairy uses (such as irrigating crops), or recycled and reused at the dairy. Many opportunities for recycling exist at a dairy. Milk cooling using vacuum pumps produces discharged water that can be captured and used in the udder washing cycle or for certain other washing and cleaning purposes. At some facilities, depending on how the recycled water is used initially, this water can be captured a second time and used again. For example, recycled water used for udder washing may be recycled again to wash corral walkways. Recycling offers the dairy manager several benefits, including lower water costs, less wastewater to dispose of, less freestanding water, drier conditions, and cleaner cows. Recycling should be evaluated and implemented wherever feasible in new dairy operations. However, health and sanitary requirements may prohibit the use of recycled water for certain water uses at a dairy.

At many dairy operations, the amount of water used for cleaning and sanitizing the holding pen, milking parlor, and milk transport lines after each milking increases during the summer months, though no increase may be warranted. Summer water use for this purpose can easily be reduced with little or no additional management or equipment costs.

6.7.3 Program Development and Issues

During the first management period, dairy operations did not have any specific conservation requirements. When the Second Management Plan was developed, the Department conducted a study to identify dairy water use patterns, processes, and associated water use to determine conservation potential for dairy operations. Several dairy operations were visited during the study. Experts from the University of Arizona reviewed and supplemented the study and had significant input on the conservation requirements. Conservation requirements for the second management period established a maximum annual water allotment for dairy operations effective in the year 2000. The maximum annual water allotment was determined using per animal water use needs for lactating cows and non-lactating animals, and could vary depending on the number of animals at the facility. Upon application, the Department could approve an additional allocation of water for a dairy operation above its annual allotment if the dairy operation demonstrated that milking, sanitary, or cooling needs would require more water.

During the second management period, rapid changes in cooling technologies and the increased diversity in dairy size and design made it difficult for some dairy operations to conform to an allotment-based conservation requirement like that included in the Second Management Plan. In an effort to have higher milk production efficiency, newer dairy operations tend to employ more cooling practices and incorporate more methods to recycle or reuse water.

The Department was informed by the Dairy TAC that future dairy facilities will have to be larger and utilize these new cooling technologies in order to be economically competitive. These practices are designed to increase the milk yield per lactating cow, and will require more water than historical use indicates. The conservation program for the third management period provides dairy operations the opportunity to choose one of two conservation programs. Dairy operations may continue to be regulated under an allotment-based program identical to Second Management Plan requirements or may apply for requirements that are specified as "best management practices."

6.7.4 Dairy Operation Conservation Program

6.7.4.1 Allotment-Based Requirements

The amount of water required by a dairy depends on the number of cows and non-lactating animals housed at the dairy, the breed of cow, the dairy management practices, and the type and water use efficiency of the technology employed. Table 6-5 summarizes daily water needs for each dairy process, assuming the use of appropriate water conservation technologies and practices. The water needs listed are based on two assumptions: (1) milking is done three times per day per lactating animal and (2) cooling is done during the milking cycle for at least a portion of the herd.

The assumptions of Table 6-5 are the basis for the annual water allotment for dairy operations. When calculating the total annual allotment, lactating cows are allotted 105 gallons per animal per day (GAD) while non-lactating animals are allotted 20 GAD. The allotment is calculated annually and will vary with the monthly average of lactating cows and non-lactating animals per day present at the dairy each year.

TABLE 6-5
WATER NEEDS AT A TYPICAL DAIRY

Operation	Water Use Allocation (Gallons per Day)	
	Lactating Cow	Non-lactating Animal
Drinking needs[1]	30	15
Udder washing - based on 72 minutes/day at 8 gallons/minute; 16 cows per spray head. Varies with number of milkings per day.[1]	35	0
Barn clean-up and sanitizing. Varies with number of milkings per day.[1]	20	0
Animal cooling management option, site-specific	10	0
Calf barn cleanup	0	5
Milk cooling tower (if present)	5	0
Miscellaneous	5	0
TOTAL	**105**	**20**

[1] Assumes three milkings per day

Upon application, the Department may approve an additional allocation of water for a dairy operation above its annual allotment if the dairy operation demonstrates that one or more of the following conditions exist:

- Milking is being done more than three times daily;
- Technologies that are designed to achieve industry health and sanitation objectives, such as the recommended pre-milking sanitation method, are being used; or
- Animal cooling technologies designed to increase milk production are being used that require more than 10 gallons per lactating cow per day.

In consideration of weather variability, the Department has included a three-year averaging provision in the maximum annual water allotments in the third management period. The water use of three consecutive years can be averaged to determine if compliance with the Third Management Plan allotment has been achieved.

6.7.4.2 Best Management Practices Requirements

As an alternative to the annual allotment requirement, a dairy may submit an application to the director to be regulated under the Best Management Practices Program. This program requires that a combination of best management practices (BMPs) be implemented, which include effective management and the installation of specific conservation technologies in the following water use categories:

- Delivery of drinking water for dairy animals;
- Udder washing and milk parlor cleaning;
- Corral design and maintenance;

- Cleaning and sanitization of milking equipment;
- Dust control, calf housing cleaning, and feed apron flushing;
- Dairy animal cooling; and
- Dairy animal feed preparation.

Implementation of all the standard BMPs listed in Appendix 6C will have a specific measurable result. While most of the standard BMPs are applicable to all dairies, the water use activities associated with some of the standard BMPs may not exist at all dairies. If a dairy cannot implement a standard BMP, the dairy may apply to implement a substitute BMP with a specific measurable result that demonstrates a water savings equivalent to the water savings associated with the standard BMP. If a substitute BMP is not possible, the dairy may apply for a waiver of the standard BMP. The director may grant a waiver only for the following standard BMPs: (1) BMP 2.1.2 (Udder Wash System); (2) BMP 2.2.2 (Milking Parlor Floor and Wall Washing); (3) BMP 4.1.1 (Milk Cooling and Vacuum Pump); (4) all of the standard BMPs in Water Use Category No. 5 (Dust Control, Calf Housing Cleaning and Feed Apron Flushing); (5) all of the standard BMPs in Water Use Category No. 6 (Dairy Animal Cooling); and (6) all of the standard BMPs in Water Use Category No. 7 (Dairy Animal Feed Preparation).

Five years after a dairy is accepted for regulation under the Best Management Practices Program (BMP Program), the director will review the dairy's BMPs to determine if they are still appropriate. If the BMPs are no longer appropriate due to an expansion of the dairy or a change in management practices, the director will require a modification to the BMPs.

6.7.5 Non-Regulatory Efforts

Dairy operations stand to benefit from a conservation assistance grant that is supporting the construction and study of an on-site demonstration of dairy wastewater treatment through constructed wetlands. Wastewater from cow barns (from cow washing, etc.) is collected and solids are removed. The wastewater is then cycled through a series of wetland cells. The quality of water obtained from this process is closely monitored. This treatment facility will attempt to assess the ability of constructed wetlands to produce water suitable for reuse in the dairy or for recharge.

Research is needed to further investigate the quantity of water required for various processes at a dairy operation. This should include the water use of new technologies designed to increase milk production.

6.7.6 Future Directions

Although newer dairy operations tend to use more water for cow cooling than older dairy operations by employing more cooling technologies and practices, thoughtful design will allow dairy operations to reuse and recycle more water than they have in the past. The latest "state of the art" dairy operations even collect and use rainfall. Fourth management period conservation requirements may need to be adjusted with the increased utilization of more water-intensive technologies. Any adjustment to current allotments must be based on more reliable data from a verifiable study. Alterations to allotments or to BMPs must be based on additional research that either quantifies the water requirements associated with these new technologies or provides new information on existing technologies.

6.7.7 Industrial Conservation Requirements and Monitoring and Reporting Requirements for Dairy Operations

6-701. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, unless the context otherwise requires, the following words and phrases used in sections 6-702 through 6-705 of this chapter shall have the following meanings:

1. *"Dairy animal" means a lactating cow or a non-lactating animal present at a dairy operation.*

2. *"Dairy operation" means a facility that houses a monthly average of 100 or more lactating cows per day during a calendar year as calculated in 6-702 .*

3. *"Dairy wastewater" means any water that has been put to a beneficial use at the dairy operation, including water containing dairy animal wastes.*

4. *"Lactating cow" means any cow that is producing milk that is present on-site at a dairy operation and receives water through the dairy operation's watering system.*

5. *"Non-lactating animal" means a calf, heifer, mature dry cow, bull, or steer that is present on-site at a dairy operation and receives water through the dairy operation's watering system.*

6-702. Maximum Annual Water Allotment Conservation Requirements

A. Maximum Annual Water Allotment

Beginning on January 1, 2002 or upon commencement of water use, whichever is later, and continuing thereafter until the first compliance date for any substitute conservation requirement in the Fourth Management Plan, an industrial user shall not withdraw, divert, or receive water for use at a dairy operation during a calendar year in a total amount that exceeds the dairy operation's maximum annual water allotment for the year as calculated in subsection B below, unless the industrial user applies for and is accepted into the Best Management Practices Program described in section 6-704 below.

B. Calculation of Maximum Annual Water Allotment

A dairy operation's maximum annual water allotment for a calendar year shall be as follows:

1. *Calculate the average daily number of lactating cows and non-lactating animals that are present during the calendar year. The average daily number of lactating cows and non-lactating animals present during the calendar year shall be calculated as follows:*

   a. *On the last day of each month, determine the total number of lactating cows and non-lactating animals present at the dairy operation.*

   b. *For each category of animal, add together the total number of such animals present at the dairy operation on the last day of each month during the year in question and then divide the result by 12. The quotient is the average daily number of lactating cows and non-lactating animals present during the calendar year.*

2. *Calculate the dairy operation's maximum annual water allotment for the calendar year as follows:*

   a. *Multiply the average daily number of lactating cows present during the calendar year by 105 gallons per animal per day (GAD) and then convert to acre-feet per year as follows:*

$$C_L \times \frac{105\ GAD}{325{,}851\ g/af} \times d/yr = \text{Maximum annual water allotment for lactating cows (acre-feet per year)}$$

   Where: C_L = *Average daily number of lactating cows*
   GAD = *Gallons per animal per day*
   g/af = *Gallons per acre-foot*
   d/yr = *Days in the year*

   The result is the dairy operation's maximum annual water allotment for lactating cows for the calendar year.

   b. *Multiply the average daily number of non-lactating animals present during the calendar year by 20 gallons per animal per day (GAD) and then convert to acre-feet per year as follows:*

$$A_N \times \frac{20\ GAD}{325{,}851\ g/af} \times d/yr = \text{Maximum annual water allotment for non-lactating animals (acre-feet per year)}$$

   Where: A_N = *Average daily number of non-lactating animals*
   GAD = *Gallons per animal per day*
   g/af = *Gallons per acre-foot*
   d/yr = *Days per year*

   The result is the dairy operation's maximum annual water allotment for non-lactating animals for the calendar year.

   c. *Add the dairy operation's maximum annual water allotment for non-lactating animals for the calendar year as calculated in subparagraph b of this paragraph and the dairy operation's maximum annual water allotment for lactating cows for the calendar year as calculated in subparagraph a of this paragraph. The sum is the maximum annual water allotment for the dairy operation for the calendar year, except as provided in subparagraph d of this paragraph.*

   d. *Upon application, the director may approve an additional allocation of water for the dairy operation consistent with industry health and sanitation objectives if the dairy operation requires more than its maximum annual water allotment because of one or more of the following:*

      1) *Milkings per lactating cow occur more than three times daily;*

      2) *Technologies are used to achieve industry health and sanitation objectives that require additional water use; and*

3) *Technologies are designed and/or implemented for cooling lactating cows and non-lactating animals, which increase milk production.*

3. *Nothing in this section shall be construed to authorize a person to use more water from any source than the person is entitled to use pursuant to a groundwater or appropriable water right or permit held by the person. Nor shall this section be construed to authorize a person to use water from any source in a manner that violates Chapter 1 or Chapter 2 of Title 45, Arizona Revised Statutes.*

6-703. Compliance with Maximum Annual Water Allotment

An industrial user who uses water at a dairy operation is in compliance for a calendar year with the dairy operation's maximum annual water allotment if the director determines that either of the following applies:

1. *The volume of water withdrawn, diverted, or received during the calendar year for use at the dairy operation, less the volume of dairy wastewater delivered from the dairy operation to the holder of a grandfathered groundwater right for a beneficial use, is equal to or less than the dairy operation's maximum annual water allotment for the calendar year; or*

2. *The three-year average volume of water withdrawn, diverted, or received for use at the dairy operation during that calendar year and the preceding two calendar years is equal to or less than the dairy operation's three-year average maximum annual water allotment for that calendar year and the preceding two calendar years. In calculating the three-year average volume of water withdrawn, diverted, or received for use at the dairy operation, the volume of dairy wastewater delivered from the dairy operation to the holder of a grandfathered right for a beneficial use shall not be counted.*

6-704. Best Management Practices Program Conservation Requirements

A. Criteria for Approval of Application

An industrial user who uses water at a dairy operation may apply for regulation under the Best Management Practices Program (BMP Program) by submitting an application on a form provided by the director. The director shall approve a complete and correct application for regulation under the BMP Program if the director determines that the applicant will implement all of the standard best management practices (BMPs) described in Appendix 6C, unless the director approves a substitution of a standard BMP under subsection D of this section or a waiver of a standard BMP under subsection E of this section. If the director approves a substitution of a standard BMP, the director shall approve the application if the director determines that the applicant will implement the substitute BMP or BMPs in addition to any remaining standard BMPs.

B. Exemption from Maximum Annual Water Allotment Conservation Requirements

An industrial user accepted for regulation under the BMP Program is exempt from the maximum annual water allotment conservation requirements set forth in section 6-702 beginning on January 1 of the first calendar year after the industrial user's application for the BMP Program is approved, unless the director approves an earlier date.

C. Compliance with Best Management Practice Program

Beginning on a date established by the director and continuing thereafter until the first compliance date for any substitute conservation requirement established in the Fourth Management Plan, an industrial user accepted for regulation under the BMP Program shall comply with all standard BMPs listed in Appendix 6C, unless the director approves a substitution of a standard BMP under subsection D of this section, or a waiver of a standard BMP, under subsection E of this section. If the director approves a substitution of a standard BMP, the industrial user shall comply with the substitute BMP or BMPs in addition to any remaining standard BMPs. The standard BMPs listed in Appendix 6C are broken into the following seven categories: (1) delivery of drinking water for dairy animals; (2) udder washing and milking parlor cleaning; (3) corral design and maintenance; (4) cleaning and sanitizing milking equipment; (5) dust control, calf housing cleaning, and feed apron flushing; (6) dairy animal cooling; and (7) dairy animal feed preparation.

D. Substitution of Best Management Practices

1. *The director may allow an industrial user applying for the BMP Program to replace a standard BMP listed in Appendix 6C with a substitute BMP if the director determines that the standard BMP cannot be achieved and that implementation of the substitute BMP will result in water use efficiency equivalent to that of the standard BMP. To apply for a substitution of a standard BMP, the industrial user shall include in its application for the BMP Program an explanation of why the standard BMP is not achievable and a description of how the substitute BMP will result in water use efficiency equivalent to that of the standard BMP.*

2. *An industrial user regulated under the BMP Program may apply to the director for a substitution of an existing BMP that is no longer appropriate for the industrial user's dairy operation. The director may allow the industrial user to replace the existing BMP with a substitute BMP if the director determines that the substitute BMP will result in water use efficiency equivalent to that of the existing BMP.*

E. Waiver of Best Management Practices

1 *The director may waive a standard BMP listed in paragraph 3 of this subsection if the director determines that the standard BMP cannot be achieved and that no substitute BMP is appropriate. To apply for a waiver of a standard BMP listed in paragraph 3, the industrial user shall include in its application for the BMP Program an explanation of why the standard BMP is not achievable and why no substitute BMP is appropriate.*

2. *An industrial user regulated under the BMP Program may apply to the director for a waiver of an existing BMP listed in paragraph 3 of this subsection if the BMP is no longer appropriate for the industrial user's dairy operation. The director may waive the BMP if the director determines that the existing BMP is longer appropriate for the industrial user's dairy operation and that no substitute BMP is appropriate.*

3. *Only the following standard BMPs may be waived by the director under this subsection: (1) BMP 2.1.2 (Udder Wash System); (2) BMP 2.2.2 (Milking Parlor Floor and Wall Washing); (3) BMP 4.1.1 (Milk Cooling and Vacuum Pump); (4) all of the standard BMPs in Water Use Category No. 5 (Dust Control, Calf Housing Cleaning, and Feed Apron Flushing); (5) all of the standard BMPs in Water Use Category No. 6 (Dairy*

Animal Cooling); and (6) all of the standard BMPs in Water Use Category No. 7 (Dairy Animal Feed Preparation).

F. Five Year Review of Best Management Practices

Five years after an industrial user is accepted for regulation under the BMP Program, the director shall review the industrial user's BMPs to determine whether any changes in the BMPs are warranted. If the director determines that any of the existing BMPs are no longer appropriate due to an expansion of the dairy operation or a change in management practices at the operation, the director shall notify the industrial user in writing of that determination and the director and the industrial user shall make a good faith effort to stipulate to a modification of the BMPs so that they are appropriate for the expanded operation or the change in management practices.

If the director and the industrial user are unable to stipulate to a modification to the BMPs within 180 days after the director notifies the industrial user of the determination that one or more of the existing BMPs are no longer appropriate, or such longer time as the director may agree to, the industrial user shall no longer be regulated under the BMP Program, but shall thereafter be required to comply with the maximum annual water allotment conservation requirements set forth in section 6-702.

If the director and the industrial user stipulate to a modification of the BMPs, the industrial user shall comply with the modified BMPs by a date agreed upon by the director and the industrial user and shall continue complying with the modified BMPs until the first compliance date for any substitute conservation requirement in the Fourth Management Plan.

G. Change in Ownership of Dairy Operation

1. *If an industrial user regulated under the BMP Program sells or conveys the dairy operation to which the BMPs apply, the new owner of the dairy operation shall continue to be regulated under the BMP Program until January 1 of the first calendar year after acquiring ownership of the dairy operation. Except as provided in paragraph 2 of this section, beginning on January 1 of the first calendar year after acquiring ownership of the dairy operation, the new owner shall comply with the maximum annual water allotment conservation requirements set forth in section 6-702. The new owner may at any time apply for regulation under the BMP Program.*

2. *If the new owner submits a complete and correct application for regulation under the BMP Program prior to January 1 of the first calendar year after acquiring ownership of the dairy operation, the new owner shall continue to be regulated under the BMP Program until the director makes a determination on the application. If the director denies the application, the new owner shall be required to comply with the maximum annual water allotment conservation requirements set forth in section 6-702 immediately upon notification of the denial or January 1 of the first calendar year after acquiring ownership of the dairy, whichever is later. If the director approves the application, the new owner shall continue to be regulated under the BMP Program until the first compliance date for any substitute conservation requirement in the Fourth Management Plan.*

6-805. Monitoring and Reporting Requirements

For the calendar year 2002 or the calendar year in which water use is commenced at the dairy operation, whichever occurs later, and for each calendar year thereafter until the first compliance date for any substitute monitoring and reporting requirements in the Fourth Management Plan, an industrial user who uses water at a dairy operation shall include the following information in its annual report required by A.R.S. § 45-632:

1. *The total quantity of water from any source, including effluent, withdrawn, diverted, or received during the calendar year, for use by the dairy operation as measured with a measuring device in accordance with the Department's measuring device rules, A.A.C. R12-15-901, et seq.*

2. *The total quantity of water delivered during the calendar year to any uses other than the dairy operation from the well or wells which serve the dairy operation as measured with a measuring device in accordance with the Department's measuring device rules, A.A.C. R12-15-901, et seq.*

3. *The total quantity of dairy wastewater delivered to grandfathered rights other than the dairy operation, as measured with a measuring device in accordance with the Department's measuring device rules, A.A.C. R-12-15-901, et seq.*

4. *The total number of lactating cows and non-lactating animals which were present on-site at the dairy operation on the last day of each month during the calendar year.*

5. *If the dairy operation is regulated under the BMP Program, any documentation as required by the director which demonstrates compliance with the program.*

6.8 CATTLE FEEDLOT OPERATIONS

6.8.1 Introduction

The Department regulates cattle feedlot operations that annually house a monthly average of 100 or more beef cattle per day. Water is primarily used for animal drinking and dust control.

6.8.2 Water Use by Cattle Feedlots

Cattle feedlot operations in the Phoenix AMA have non-irrigation grandfathered rights or groundwater withdrawal permits to withdraw more than 2,200 acre-feet of groundwater per year. In 1995, 800 acre-feet was pumped by feedlot operations. It is projected that the number and the water use of feedlot operations will not increase in the AMA. Historically, there has been a decline in the number of feedlot operations in the AMA due to urban encroachment.

The only component of cattle feedlot water use having a significant conservation potential is dust control watering. Cattle feedlots control dust by applying water to the land surface using either a mobile tank and large gun sprinkler, portable water lines with small nozzles, or a permanently installed sprinkler system. Each of these methods provides satisfactory dust control if water coverage is adequate and enough water is applied. If a permanent sprinkler system is installed, sprinkler heads should be selected and arranged to eliminate overspray, water application in excess of infiltration rates, and runoff.

Overall management of the system is the most important factor in efficient dust control watering. Many cattle feedlots could conserve water by using proper management techniques for their dust control water systems. Proper management techniques include removing excess manure to less than two inches in depth and increasing the number of cattle per pen to increase pen moisture. Dust can also be controlled by surfacing roads between pens. All of these management practices reduce dust, thereby reducing the need to apply water.

Conservation potential also exists in the areas of landscape watering and water system losses. Most cattle feedlot operations already use a float control system. Because this is the latest available conservation technology for cattle drinking water systems, no significant water savings can be achieved in that area.

6.8.3 Program Development

No conservation requirements for cattle feedlot operations existed during the first management period. Starting with the Second Management Plan, feedlots were assigned a maximum annual water allotment based on reasonable daily maximum requirements for animal drinking, dust control, and miscellaneous water use needs.

6.8.4 Cattle Feedlot Operation Conservation Program

The conservation requirements for cattle feedlot operations for the third management period remain unchanged from those in the Second Management Plan. The conservation requirements for cattle feedlot operations outlined in this management plan include a maximum annual water allotment for each facility based on the use of specific conservation technologies. For the Second Management Plan, representatives from the cattle feedlot industry and cattle feedlot experts from the University of Arizona College of Agriculture reviewed and verified that the equation used to determine the maximum annual water allotment for a feedlot allocates a reasonable amount of water to cattle feedlots.

The equation is based on the number of gallons of water reasonably required per animal per day (GAD). To determine this amount, three components of cattle feedlot water use were considered: (1) cattle

drinking water requirements, (2) dust control watering requirements, and (3) other uses. The amount of water required for each component varies with the number of cattle processed by the feedlot. Drinking water requirements for cattle include water intake, water spilled while drinking, and evaporation losses from watering tanks. Drinking water requirements are estimated to be 15 GAD. Dust control watering requires approximately 10 GAD. Other uses, including water used for feed mixing, health and environmental controls, system losses, and fire protection total 5 GAD. Total water requirements for a cattle feedlot operation are 30 GAD. These requirements are continued for the third management period.

6.8.5 Future Directions

It is possible that more stringent air quality standards established during the third management period or beyond may require increased dust control measures for cattle feedlot operations. Water use for dust control may increase to comply with the standards. Fourth or fifth management period conservation requirements will need to be cognizant of any changes in this regard and make any necessary adjustments to the requirements.

6.8.6 Industrial Conservation Requirements and Monitoring and Reporting Requirements for Cattle Feedlot Operations

6-801. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, unless the context otherwise requires, the following words and phrases used in sections 6-802 through 6-803 of this chapter shall have the following meanings:

1. *"Beef cattle" means cattle or calves fed primarily for meat production.*

2. *"Cattle feedlot operation" means a facility that houses and feeds an average of 100 or more beef cattle per day during a calendar year as calculated in section 6-802.*

6-802. Maximum Annual Water Allotment Conservation Requirements

A. Maximum Annual Water Allotment

Beginning on January 1, 2002 or upon commencement of water use, whichever is later, and continuing thereafter until the first compliance date for any substitute conservation requirement in the Fourth Management Plan, an industrial user shall not withdraw, divert, or receive water for use at a cattle feedlot operation during a calendar year in a total amount that exceeds the cattle feedlot's maximum annual water allotment for the year as calculated in subsection B below.

B. Calculation of Maximum Annual Water Allotment

A cattle feedlot operation's maximum annual water allotment for a calendar year shall be determined as follows:

1. *Calculate the average daily number of beef cattle present during the calendar year. The director shall calculate the average daily number of beef cattle present during the calendar year as follows:*

   a. *Determine the total number of beef cattle present at the cattle feedlot operation on the last day of each month during the calendar year.*

   b. *Add together the total number of beef cattle present at the cattle feedlot operation on the last day of each month during the year in question and then divide the result by 12. The quotient is the average daily number of beef cattle present at the cattle feedlot operation during the calendar year.*

2. *Multiply the average daily number of beef cattle present at the cattle feedlot operation during the calendar year by a water allotment of 30 gallons per animal per day (GAD), and then convert to acre-feet per year as follows:*

$$C_B \times \frac{30\ GAD}{325{,}851\ g/acre\text{-}foot} \times d/yr = \text{Maximum annual water allotment for the cattle feedlot operation (acre-feet/year)}$$

Where: C_B = *Average daily number of beef cattle*
GAD = *Gallons per animal per day*
g/acre-foot = *Gallons per acre-foot*
d/yr = *Days in the year*

C. Compliance with Maximum Annual Water Allotment

An industrial user who uses water at a cattle feedlot operation is in compliance for a calendar year with the cattle feedlot operation's maximum annual water allotment if the director determines that either of the following applies:

1. *The volume of water withdrawn, diverted, or received during the calendar year for use at the cattle feedlot operation is equal to or less than the cattle feedlot operation's maximum annual water allotment for the calendar year; or*

2. *The three-year average volume of water withdrawn, diverted, or received for use at the cattle feedlot operation during that calendar year and the preceding two calendar years is equal to or less than the cattle feedlot operation's three year average maximum annual water allotment for that calendar year and the preceding two calendar years.*

D. *Nothing in this section shall be construed to authorize a person to use more water from any source than the person is entitled to use pursuant to a groundwater or appropriable water right or permit held by the person. Nor shall this section be construed to authorize a person to use water from any source, including effluent, in a manner that violates Chapter 1 or Chapter 2 of Title 45, Arizona Revised Statutes.*

6-803. Monitoring and Reporting Requirements

For calendar year 2002 or the calendar year in which water use is first commenced at the cattle feedlot operation, whichever occurs later, and for each calendar year thereafter until the first compliance date for any substitute monitoring and reporting requirements in the Fourth Management Plan, an industrial user who uses water at a cattle feedlot operation shall include the following information in its annual report required by A.R.S. § 45-632:

1. *The total quantity of water from any source, including effluent, withdrawn, diverted, or received during the calendar year for use at the cattle feedlot operation as measured with a measuring device in accordance with the Department's measuring device rules. A.A.C. R12-15-901, et seq.*

2. *The total number of beef cattle that were present on-site at the cattle feedlot operation on the last day of each month during the calendar year.*

6.9 NEW LARGE LANDSCAPE USERS

6.9.1 Introduction

New large landscape users are industrial users with substantial water-intensive landscaped area that was planted after January 1, 1990. The conservation program differentiates between two types of large landscape users: non-residential facilities that are hotels or motels and non-residential facilities that are not hotels or motels. If the facility is not a hotel or motel, conservation requirements apply to landscapable areas in excess of 10,000 square feet. If the facility is a hotel or motel, requirements apply to landscapable areas in excess of 20,000 square feet.

If a facility has ten or more acres of water-intensive landscaped area and is a school, park, common area within a housing subdivision, cemetery, or golf course, or is listed in Appendix 6B, it is defined as a turf-related facility and is subject to specific conservation requirements discussed in 6.3 of this chapter.

6.9.2 Water Use by New Large Landscape Users

Water use associated with landscaping is directly related to the size of the landscaped area, the types of vegetation planted, and the efficiency of the irrigation method used. Although low water use residential landscaping is becoming increasingly common in the Phoenix metropolitan area, significant water use is associated with the water-intensive landscaping of industrial parks, large commercial and institutional facilities, and resorts. Many municipal water providers have ordinances that place some conditions on new non-residential landscaping. While these ordinances have multiple objectives, they also have provisions that address water conservation. Some of these provisions include the placement of plants based on their water needs, the planting of low water use plants in certain areas, and the preservation of native vegetation.

No new large landscape users were identified during the second management period. While many large resorts and commercial facilities are constructed within water provider service areas, the potential exists for new facilities to have their own groundwater rights or permits. It is difficult to predict the growth of new large landscape users, but the potential for future facility construction and for significant water use will increase as the Phoenix area grows.

6.9.3 Program Development and Issues

Consultant studies conducted for the Second Management Plan indicated that significant reductions in landscape water use can be achieved using the following techniques:

- Improving water application efficiency through proper irrigation scheduling, using more sophisticated control systems, converting to drip irrigation, and grouping plants with similar water needs;
- Reducing the size and perimeter of turfed areas and limiting their placement to functional areas and areas of high visual impact;
- Using drought-resistant plant species adapted to the desert;
- Using proper planting, fertilization, and maintenance techniques;
- Grading sites to direct rainfall into planted areas; and
- Avoiding the use of water-intensive plants within rights-of-way, thus emphasizing the community's commitment to low water use designs.

The findings from these studies still apply for the third management period. A lush, colorful, low water use landscape watered by a permanent drip irrigation system is often considered more desirable for commercial and industrial landscape applications. This type of landscape results in water savings of 50 to 75 percent of the amount used by a well-maintained turf (water-intensive) landscape.

The distinction in the program between hotel or motel landscapes and landscapes that are associated with facilities that are not hotels or motels is intended to address the contention by the lodging industry that for certain hotel and motel developments there is an economic benefit from planting high water use landscape plant material, thus economically justifying a larger water-intensive area.

6.9.4 New Large Landscape User Program

The new large landscape user program for the Third Management Plan is similar to that in the Second Management Plan. In addition to the requirements that apply to all industrial users, new large landscape users must limit the percentage of water-intensive landscaped area above a specified square footage. The facility must limit its water-intensive landscaped area to the greater of the following: 1) 10,000 square feet (20,000 square feet for hotels and motels) plus twenty percent of the area in excess of 10,000 square feet (20,000 square feet for hotels and motels); and 2) the total surface area of all bodies of water within the facility that qualify as water intensive landscaped area.

Water-intensive landscaping includes not only high water using plants such as turf, but also bodies of water such as ponds. However, it does not include any area of land watered exclusively with direct use effluent or effluent recovered within the area of impact, bodies of water used primarily for swimming, bodies of water filled and refilled exclusively with direct use effluent or effluent recovered within the area of impact and bodies of water allowed under an interim water use permit pursuant to the Lakes Bill if the body of water will be filled and refilled exclusively with direct use effluent or effluent recovered within the area of impact after the permit expires. Direct use effluent or effluent recovered within the area of impact is effluent that is either used directly or is stored underground and then recovered within the area of impact. If 100 percent wastewater is used to water the landscape, the requirements do not apply. For example, if there is sufficient cooling tower blowdown water and greywater available from the operations of a hotel, this wastewater could be used to water any amount of water-intensive landscaped area up to 10 acres. Once a water-intensive landscaped area equals or exceeds 10 acres in size, it is defined as a turf-related facility and is subject to regulation under that program.

6.9.5 Non-Regulatory Efforts

The Phoenix AMA has funded a grant that involves researching different drip irrigation methods for watering low water use landscaping. The goal is to ascertain the appropriate number, placement, and capacity of drip irrigation systems during the life cycle of low water using plants and trees. Information for efficiently managing low water use landscaping while maintaining a lush appearance may encourage more industrial users to adopt low water use landscaping instead of water-intensive landscaping where feasible.

Grant projects with the City of Chandler will research the use of cooling tower blowdown water and industrial process water to irrigate landscape plants. It is possible that findings from the research will be transferable and will be able to be widely implemented.

6.9.6 Industrial Conservation Requirements and Monitoring and Reporting Requirements for New Large Landscape Users

6-901. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, unless the context otherwise requires, the following words and phrases used in sections 6-902 and 6-903 of this chapter shall have the following meanings:

1. *"Direct use effluent" means effluent transported from a facility regulated pursuant to Title 49, Chapter 2, Arizona Revised Statutes, to an end user. Direct use effluent does not include effluent that has been stored pursuant to Title 45, Chapter 3.1, Arizona Revised Statutes.*

2. *"Effluent recovered within the area of impact" means effluent that has been stored pursuant to Title 45, Chapter 3.1, Arizona Revised Statutes, and recovered within the stored effluent's area of impact. For purposes of this definition, "area of impact" has the same meaning as prescribed by A.R.S. § 45-802.01.*

3. *"Landscapable area" means the entire area of a lot less any areas covered by structures, parking lots, roads, or any other area not physically capable of being landscaped.*

4. *"New large landscape user" means a non-residential facility that has a water-intensive landscaped area in excess of 10,000 square feet and that has landscaping planted and maintained after January 1, 1990 or bodies of water, other than bodies of water used primarily for swimming purposes, filled and maintained after January 1, 1990, or both. Turf-related facilities as defined in section 6-301 of this chapter are excluded from this definition.*

5. *"Water-intensive landscaped area" means, for the calendar year in question, all of the following areas within a non-residential facility:*

    a. *Any area of land that is planted primarily with plants not listed in Appendix 5-L, Low Water Use/Drought Tolerant Plant List, Phoenix AMA, or any modifications to the list, and watered with a permanent water application system, except any area of land that is watered exclusively with direct use effluent or effluent recovered within the area of impact.*

    b. *The total water surface area of all bodies of water within the facility, except bodies of water used primarily for swimming purposes, bodies of water filled and refilled exclusively with direct use effluent or effluent recovered within the area of impact, and bodies of water allowed under an interim water use permit pursuant to A.R.S. § 45-133 if the bodies of water will be filled and refilled exclusively with direct use effluent or effluent recovered within the area of impact after the permit expires.*

6-902. Conservation Requirements

A. Conservation Requirements for New Large Landscape Users that are not Hotels or Motels

Beginning on January 1, 2002 and continuing thereafter until the first compliance date for any substitute conservation requirement in the Fourth Management Plan, the water-intensive landscaped area within a new large landscape user that is not a hotel or motel shall not

exceed the greater of the following: 1) an area calculated by adding 10,000 square feet plus 20 percent of the facility's landscapable area in excess of 10,000 square feet; and 2) the total water surface area of all bodies of water within the facility that are allowed under A.R.S. § 45-131, et seq., and that qualify as water-intensive landscaped area.

B. Conservation Requirements for New Large Landscape Users that are Hotels or Motels

Beginning on January 1, 2002 and continuing thereafter until the first compliance date for any substitute conservation requirement in the Fourth Management Plan, the water-intensive landscaped area within a new large landscape user that is a hotel or motel shall not exceed the greater of the following: (1) an area calculated by adding 20,000 square feet plus 20 percent of the facility's landscapable area in excess of 20,000 square feet; and (2) the total water surface area of all bodies of water within the facility that are allowed under A.R.S. § 45-131, et seq., and that qualify as water-intensive landscaped area.

C. Waiver of Conservation Requirements for the Use of 100 Percent Wastewater

The conservation requirements set forth in sections 6-902.A and B shall not apply to a new large landscape user in any year in which all of the water used for landscaping purposes within the facility is wastewater.

6-903. Monitoring and Reporting Requirements

For calendar year 2002 or the calendar year in which the facility first begins to use water, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute monitoring and reporting requirement in the Fourth Management Plan, an industrial user that applies water to a new large landscape user shall include the following information in its annual report required by A.R.S. § 45-632:

1. *The total quantity of water from any source, including effluent, withdrawn, diverted, or received for use on the facility during the reporting year for landscape watering purposes, including bodies of water filled or refilled during the calendar year, as measured with a measuring device in accordance with the Department's measuring device rules. A.A.C. R12-15-90,1 et seq.*

2. *The total amount of landscapable area within the facility.*

3. *The total amount of water-intensive landscaped area at the facility broken down into the area planted primarily with plants not on the Low Water Use/Drought Tolerant Plant List (except any area watered exclusively with direct use effluent or effluent recovered within the area of impact) and the surface area of all bodies of water (except bodies of water used primarily for swimming purposes, bodies of water filled and refilled exclusively with direct use effluent or effluent recovered within the area of impact, and bodies of water allowed under an interim water use permit if the bodies of water will be filled and refilled exclusively with direct use effluent or effluent recovered within the area of impact after the permit expires).*

6.10 NEW LARGE INDUSTRIAL USERS

6.10.1 Introduction

New large industrial users are industrial users that use over 100 acre-feet per year and commence use after January 1, 2000. In the Second Management Plan, new large industrial users were defined as industrial users that use over 100 acre-feet of water per year and commenced use after January 1, 1990. As of August, 1998, six new large industrial users had been identified during the second management period in the Phoenix AMA that are not industrial users subject to specific conservation requirements discussed elsewhere in this chapter.

6.10.2 Water Use Characteristics and Trends

In 1995, there were six industrial facilities in the Phoenix AMA, other than cattle feedlots, sand and gravel facilities, turf-related facilities, electric power plants, and dairy operations that individually used more than 100 acre-feet of water during the year. The six facilities are mining, integrated circuit manufacturing, milling, defense systems, ice manufacturing, and riparian areas maintained by the Arizona Game and Fish Department. The combined water use of these facilities during 1995 was approximately 3,100 acre-feet. This use was pursuant to nine Type 2 non-irrigation grandfathered rights with allotments totaling 8,560 acre-feet. An additional 15 grandfathered rights and groundwater withdrawal permits withdrew over 100 acre-feet in 1995 but commenced operation prior to January 1, 1990. Another 84 grandfathered rights and withdrawal permits have allotments over 100 acre-feet per year; these rights and permits are either being used to withdraw less than 100 acre-feet per year or are not being used at all. The combined allotments for these rights and permits total over 48,500 acre-feet. Although some of this large volume could potentially be used to serve new large industrial users, the number and water use of additional new large industrial users is difficult to predict. New large commercial or manufacturing facilities are often constructed within service areas of municipal water providers and become their customers.

6.10.3 Program Development and Issues

No requirements for new large industrial users existed in the First Management Plan. The Second Management Plan contains a specific conservation requirement for new industrial users that use over 100 acre-feet of water per year. New industrial users were required to prepare and submit a water conservation plan that addresses the water conservation opportunities at the facility. The user is required to develop a plan that:

- Describes the level of water conservation that can be achieved;
- Identifies the water uses and conservation opportunities within the facility;
- Describes an ongoing water conservation education program for employees; and
- Includes an implementation schedule.

The Department has determined that a conservation plan is a reasonable requirement to continue in the third management period, considering the large volume of unused allotments that could be used for new large industrial uses and the corresponding opportunity to design water conservation into new or expanding facilities. When facilities expand, even after operation has commenced, there are additional water conservation opportunities associated with being able to "build in" water-conserving designs. This is typically more economical and more feasible than retrofitting a facility that is not expanding.

6.10.4 New Large Industrial User Program

The new large industrial user program for the third management period is identical to that of the second management period. In addition to the conservation requirements that apply to all industrial users, new

large industrial users must prepare and submit a water conservation plan to the director. However, if the user is required to submit a conservation plan under another section of this chapter, it can combine the plans and submit one plan.

The water conservation plan must show how much conservation can be achieved at the facility. It must identify how water is used at the facility and how it can be conserved in major water use areas. The plan must also describe an employee water conservation education program at the facility and a schedule of implementation of the conservation measures.

6.10.5 Industrial Conservation Requirements and Monitoring and Reporting Requirements for New Large Industrial Users

6-1001. Definitions

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes and section 6-201 of this chapter, "new large industrial user" means an industrial user that begins using more than 100 acre-feet of water per year for industrial purposes after January 1, 2000.

6-1002. Conservation Requirements

A. *Not later than January 1, 2002 or within 180 days after the end of the first calendar year in which the facility first uses more than 100 acre-feet of water for industrial purposes, whichever is later, a new large industrial user shall submit to the director a plan to improve the efficiency of water use by the facility. The plan shall:*

1. *Specify the level of water conservation that can be achieved assuming the use of the latest commercially available technology consistent with reasonable economic return;*

2. *Identify water uses and conservation opportunities within the facility, addressing water used for the following categories as appropriate: landscaping; space cooling; process-related water use, including recycling; and sanitary and kitchen uses;*

3. *Describe an ongoing water conservation education program for employees; and*

4. *Include an implementation schedule.*

B. *If a person required to submit a plan under subsection A of this section is required to submit a conservation plan under another section of this chapter, the person may combine the plans into a single conservation plan.*

REFERENCES

Brown, P., Gilbert, J., and D. Kopec, 1996. *Final Report to the Arizona Department of Water Resources, Turfgrass Irrigation Scheduling Using Weather Based Estimates of Evapotranspiration for High and Low Traffic Turfs.* Contract No. CA94TU103-00, May 31, 1996.

APPENDIX 6A
CONSERVATION ALTERNATIVES FOR TURF-RELATED FACILITIES
PHOENIX ACTIVE MANAGEMENT AREA

The Department conducted a study of conservation technologies and management techniques available to turf-related facilities. These conservation alternatives are categorized into:

A. Incorporation of conservation considerations into the facility design,
B. Irrigation technologies,
C. Irrigation scheduling and management,
D. Turf management options,
E. Pond and reservoir management, and
F. Turf maintenance staff education.

A. FACILITY DESIGN	DESCRIPTION / CONSERVATION POTENTIAL
1. General	Develop a master plan for the design (for new facilities) or redesign (for existing facilities) that incorporates water conserving elements. An important element of a facility designed with water efficiency in mind is adequate irrigation design. A well designed and properly installed irrigation system reduces water use and results in a high quality and attractive turf and landscape. In addition to what is listed below, the irrigation technologies, turf selection, and pond/reservoir construction guidelines outlined in sections B through F below are all relevant for designing or redesigning turf-related facilities with water conservation as a goal.
2. Golf Courses	
a. Minimize and level turf; use cart paths	Design measures include: narrow fairways, reduced fairway length, more tee choices per hole, less rough area, smaller greens, flatter courses, fewer slopes, no turf in front of tees, a complete cart path system, and zero lot line fairways placed side by side. Smaller greens, tees, roughs, and fairways reduce total irrigation water demand. Flatter courses have less water loss from runoff than sharply sloped courses. A cart path system reduces soil compaction and wear and tear on the turf.
b. Water harvesting	Use catch basins to divert storm water and runoff to storage ponds; perforate the pipe collection system to funnel water to storage ponds; slope fairways toward ponds; design cart paths to drain into lake; and collect water from adjacent developments. Water harvesting allows for increased reuse of irrigation water and the retention of "free" water on-site.

A. FACILITY DESIGN	DESCRIPTION / CONSERVATION POTENTIAL
c. Zone areas of different water demand separately	Areas to zone: level and sloped areas; windy and protected areas; tees, greens, fairways and rough; turf and non-turf areas; soils with different percolation rates; separate, difficult-to-manage areas; shady and non-shady areas. Incorporate separate valving for zoned areas. This reduces the amount of water lost to evaporation, runoff, and percolation below the root zone and eliminates over-watering to accommodate dry or hard-to-irrigate areas. It is especially important for new design.
d. Individualized head layout that responds to facility configuration	Use small heads on tees and greens, 1/2-circle heads at edge of turf area. Eliminates runoff and over-irrigating to compensate for dry areas.
e. Looped lateral system	Has a lower pressure differential than a linear irrigation system. Improves the uniform distribution of irrigation water. Lower differential between wet and dry spots.
f. Use of vegetative or other wind barriers	Reduces evaporation.
g. Involve golf course superintendent in original design	Application of water conservation methods and techniques gained through hands-on experience.
h. Use native or low water use landscaping in non-turf areas	Low water demand plant materials reduce amount of water needed to irrigate non-turf areas.
i. Design facility to ensure compliance with Department requirements	Minimizes probability that facility will use more than the maximum annual allotment.
j. Design facility to accommodate effluent as source water	Separate turf/landscaping distribution system from potable distribution system. Select valves, heads, emitters, etc. that are able to function easily with effluent quality water.
3. Non-Golf Course Turf Facilities	
Maximize areas of low water use plants and inorganic mulches in non-play/minimal use areas	Less turf area being used; less area to irrigate.

B. IRRIGATION TECHNOLOGIES	DESCRIPTION / CONSERVATION POTENTIAL
1. Controllers	Controllers regulate irrigation scheduling. The controller activates a valve at a preset time and turf is irrigated for a preset period of time. Each valve controls one set of sprinkler heads. The number of controllers and valve stations depends on the area of turf, the size of the valve, and the design of the irrigation system. The use of controllers does not guarantee water savings, but when programmed and operated by an experienced manager they are a good conservation tool.
a. Electromechanical controllers	A motor turns rotary switches that activate relays. While the least efficient of the controllers, these low cost controllers can result in a 30 to 40 percent water savings over quick coupler systems.
b. Centralized system controller	Quick, accessible control over entire facility's irrigation scheduling.
c. Solid-state controllers	Electronic accuracy -- precision irrigation application and timing, individual station programing, multicycling, multiple programming, longer station timing for drip irrigation, capability to interface with a rain shut-off switch or wind sensor.
d. Computerized controllers	The most sophisticated and accurate method of irrigation timing available, but costs make it appropriate only for larger facilities. Real-time water budgeting capabilities are its most important feature. Specific features include: (1) individual stations can be controlled, (2) operator can precisely limit water to desired saturation point eliminating runoff and percolation below the root zone, (3) historical evapotranspiration (ET) rates can be programmed into scheduling, (4) can interface with weather monitoring system and current reference ET and soil moisture information, and (5) pinpoints excess flows by station.
2. Heads	There are a wide variety of head and nozzle choices available to fit specific irrigation needs. Properly selected heads and nozzles determine the uniformity of coverage and eliminate overspray, water application in excess of infiltration rates, runoff, and evaporation. Matched precipitation rates allow uniform application of irrigation water. Select head size according to turf area.
a. Valve in head sprinklers or one valve - one head	Allow for pinpoint irrigation accuracy for large turf areas and irrigation zoning. Drawbacks are that they reduce the ability to use rain shut-off switches and do not allow the controller to regulate/ coordinate with the rest of the system.

B. IRRIGATION TECHNOLOGIES	DESCRIPTION / CONSERVATION POTENTIAL
b. Low volume/low pressure spray heads	Prevents runoff, wind distortion, and evaporation from standing water in areas with a low infiltration rate for smaller turf areas; improves uniformity; reduces application rates; and allows larger areas to be irrigated with a given amount of water. Lower differential between wettest and driest spots.
c. Low trajectory heads	Prevents wind distortion, evaporation.
d. Gear driven heads	More uniform water application.
e. Pressure compensating bubblers	More uniform water application in non-turf areas.
f. Matched precipitation rate heads	Allows more uniform irrigation coverage when grouped with similar pattern heads.
3. Valves	
a. Electric valves	Precise irrigation timing.
b. Check valves	Prevents low head drainage, wet areas around heads, and backflow.
c. Master valve	Opens when system is operated; closed system completes cycle. Installed above all automatic valves. Valve prevents discharge of water, except when system is in a running cycle, as in the case of a break in the line or a malfunctioning valve.
4. Sensors	
a. Automatic rain shut-off switch	System shuts down when rainfall exceeds a preselected amount with automatic return to schedule when water in collector evaporates; prevents overwatering. Interfaces with central controller or satellite controllers.
b. Wind sensor	System shuts down when wind speed reaches a preset velocity at which wind draft and evaporation are excessive. Cycle resumes when wind speed tapers off.
c. Soil moisture sensor	Allows more precise adjustment of time and frequency of irrigation. Eliminates excessive water application. Low utility on large turf areas because of too much variability. Can be directly wired to controller for more automatic use. Portable soil probes useful for checking localized dry spots. Good for an analysis of system efficiency.
d. Infrared sensor	Allows assessment of plant water needs through use of infrared light.
5. Other	
a. Drip irrigation of non-turf areas	Water applied where needed. Non-turf application. Eliminates evaporation. Significant water savings. Also yields improved plant growth.

B. IRRIGATION TECHNOLOGIES	DESCRIPTION / CONSERVATION POTENTIAL
b. Excess flow-sensing device/ low pressure shut off switch	Prevents water waste. Sensitive to low pressure caused by breaks in the line or a missing head. Shuts system down in event preset pressure is reached.
c. Flow meter	Permits accurate measurements of water use to facilitate irrigation scheduling and budgeting.
d. Pressure regulators	Permits maintenance of design pressure, eliminates evaporation and wind drift because of head misting. Especially important for drip systems.

C. IRRIGATION SCHEDULING AND MANAGEMENT	DESCRIPTION / CONSERVATION POTENTIAL
1. Irrigation Program Techniques	An effective combination of the following irrigation techniques will help eliminate evaporation, runoff, and water application in excess of the infiltration rate.
a. Deep irrigation and longer periods between irrigations to develop root system	Turf with a well developed root system can endure more stress. Turf can exploit more stored water. Good soil infiltration and percolation is required.
b. Deficit irrigation	Deficit irrigation involves keeping turf somewhat stressed to develop a deep root system. Irrigation frequency can be adjusted to reduce consumptive water demand of turf. Turf with a well developed root system can endure more stress and can exploit water stored in deeply wetted soil profile. Research is needed to determine which turf types adjust the most favorably to deficit irrigation. Turf under deficit regime can survive more easily if no other stress is added. Requires careful management. Especially appropriate for less intensely used areas such as roughs and fairways.
c. Short, repeat irrigation cycles (cycle and soak)	Prevents runoff on sloped areas. Prevents evaporation of standing water in areas with low infiltration rates. Eliminates excess water applications. More effective in cool season because of low evaporation rates. Can only be done efficiently with a solid state controller. Useful on compacted soils and for germinating rye grass.
d. Daily visual inspection to assess water needs	Irrigation can be evaluated by micro-areas, irrigation adjustments can accommodate area differences. Instant adjustments can be made to accommodate wet spots and dry spots. Dew patterns can be observed in the early morning to detect abnormal head spray patterns.
e. Night irrigation	Less wind distortion, less evaporation, ET rate at the lowest point of the day. Need automatic controllers to be effective.

C. IRRIGATION SCHEDULING AND MANAGEMENT	DESCRIPTION / CONSERVATION POTENTIAL
f. Daily logging of local or on-site weather conditions or use of a controller that is linked to an on-site weather station	Assesses irrigation needs to permit a more exact irrigation application on a daily basis. Allows application of water to exactly compensate for water used that day. Permits long-term irrigation scheduling and budgeting.
g. Use of soil tests to determine soil characteristics, especially percolation rate, available water capacity, degree of soil compaction, and nutrient requirements	Knowing soil characteristics permits matching of percolation rate and irrigation rate, reduces evaporation and runoff, and avoids applying more water than can be held in the root zone or deeper than necessary. Signals need for treatment of soil compaction. Provides accurate information for computation of gypsum or sulphur requirement and for precise replacement of nutrients.
h. Manually irrigate small dry spots - use quick coupler hose or other manual method	Eliminates overwatering by using a set of heads or one large radius head to wet a small area.
2. Irrigation equipment maintenance	A routine preventative maintenance program for irrigation equipment results in the decrease of water loss and misapplication of water.
a. Heads	Check for wear, clogging, check pattern for consistency. Check after mowing for breaks. Adjust nozzles and heads as needed. Replace broken or worn parts.
b. Pipes	Check for leaks or breaks. Repair or replace as needed.
c. Valves	Check for leaks, sticking, buried or exposed wires, protect wiring. Replace or fix as needed. Promotes exact station timing control.
d. Controllers	Check for correct timing, sticking, non-functioning. Fix or replace as needed. Replace backup batteries at least once a year (or after each power failure).
e. Meters	Check meters for accuracy and sticking. Repair as necessary. Prevents mismeasurement of irrigation water. Improves water budgeting capability.
f. Pressure	Maintain design pressure. Readjust valve flow or replace pressure regulators as necessary. Prevents water loss through leaks, evaporation.
3. Water Use Planning	
a. Water budgeting	Use historical weather patterns, use local ET rate for turfgrasses, measure use against budget, adjust use accordingly. Regulates water use at a prescribed level. Allows operator to ensure compliance with annual allotment.

C. IRRIGATION SCHEDULING AND MANAGEMENT	DESCRIPTION / CONSERVATION POTENTIAL
b. Accurate measurement	Daily measurement of water use using pump flow meter (gallons per minute), measurement by computerized controller system, or hour meter in conjunction with flow capacity. Allows manager to keep accurate water use records. Use to compare with established goal and to evaluate performance.
c. Accurate records	Daily logging of water use and weather conditions. Monthly water use reports. Allows manager to assess historical water use and weather data for use in future irrigation budgeting.
d. Establish irrigation priorities for periods of water shortage	Enables manager to plan for seasonal water requirements.
e. Separate metering of landscape water use	Allows manager to keep accurate water use records.
f. Use landscape water management software	Software can calculate an efficient irrigation schedule.
4. Non-Groundwater Source Water	
Use effluent whenever feasible	Replacing groundwater pumpage with effluent use constitutes a water conservation management option. Existing nutrients in effluent (especially nitrogen) may reduce fertilizer needs. Operational concerns associated with effluent use (additional leaching needs due to salts, clogged emitters, etc.) require special attention. Many existing facilities are successfully using effluent in place of groundwater.

D. TURF MANAGEMENT OPTIONS	DESCRIPTION / CONSERVATION POTENTIAL
1. Turf Selection	
a. Select turf for low water demand	Hierarchy of turf types from highest to lowest water demand: (warm season grasses) bent grass, hybrid bermuda, common bermuda, desert and range grasses; and (cool season grasses) annual rye and perennial rye.
b. Select non-traditional turf or non-turf alternatives for rough and non-play areas	Choose blue gramma, schismus, three-awn, buffalo grass, vine mesquite, curly mesquite, and/or giant mesquite, and/or giant bermuda
c. In cool seasons, select non-turf alternative for fairways and rough	Options include: Leave turf dormant; use ferrous sulfate; dye dormant turf green; apply liquid fertilizer to turf to aid chlorophyll production in frost-free areas. Eliminates late fall/winter water use associated with overseeding with rye. Some irrigation necessary to keep dormant grasses tough and wear resistant. Keeps bud nodes from drying out, prevents desiccation. Rye grass uses approximately 8-10 inches of extra water per year.
2. Winter Overseeding	
a. Time winter overseeding by soil temperature, not calendar dates	Most favorable soil temperature for overseeding is between 72 and 78 degrees Farenheight, at a 4-inch depth. Overseeding at these lower temperatures decreases water use and evaporation, leads to a minimal fall transition period with less competition from bermuda.
b. Eliminate total scalping of summer turf	When scalped, bermuda has a difficult time coming back in the spring and requires more water and fertilizer to do so, especially hybrid bermuda. Aerate and apply gypsum if needed to reduce salts before seeding to improve infiltration rate. Reduces runoff, evaporation from standing surface water. Increases water, air, fertilizer penetration into the root zone.
3. Turf Removal	
Develop a master plan for turf removal	Turf alternatives include: desert revegetation, drought tolerant ornamental planting, desert and range grasses, and desert flowers. Permanently reduces turf water use on specific areas.
4. Fertilizer	Healthy, well-fed turf tends to have a better developed root system to balance fertilizer needs with water demand. This reduces overall water demand. Over fertilizing, however, can result in higher water requirements because of faster growth rate.
a. Use less nitrogen to retard turf growth	Turfgrass ET rate decreases with slower turf growth rate. Water demand decreases as ET rate decreases.

D. TURF MANAGEMENT OPTIONS	DESCRIPTION / CONSERVATION POTENTIAL
b. Use slow release fertilizers during warm season	Reduces growth spurts that increase water demand. Eliminates peaks and valleys of turf growth.
c. Use soil tests to assess fertilizer needs	A more precise application of fertilizer reduces growth spurts that increase water demand.
d. Apply nitrogen in the fall to cool season turfgrasses	Avoid application at time of spring green-up of warm season turf. Decreases early water demand of warm weather turf.
e. Monitor potassium levels and keep readily available in periods of high temperature and drought stress	Permits turf to resist stress. Reduces turfgrass wilting tendency.
f. Apply dry fertilizers when feasible	Avoids water needs associated with liquid applications.
g. Apply growth regulators as fertilizer	Grass blades grow horizontally rather than vertically, reducing ET rate.
5. Soil Compaction and Low Permeability	Compaction is a problem for all turf areas, except areas with very sandy soil. Infiltration, percolation, aeration, and plant available moisture are altered by soil compaction. Water use efficiency is enhanced in non-compacted soils. Changes in soil structure cause water loss by evaporation and runoff, in addition to influencing plant growth. Causes reduced root growth.
To alleviate soil compaction and improve soil permeability:	
a. Aerate	Soil cultivation enhances infiltration, percolation, and soil moisture content. Permits water, air, and chemicals to reach root zone of turf.
b. Use soil tests to assess soil salinity and pH	High salinity increases potential for runoff, reduces infiltration and percolation rate. High pH increases water demand.
c. Apply gypsum	Replaces sodium in the soil and allows it to leach out. Improves infiltration and percolation.
d. Apply sulphur or sulphuric acid	Lowers pH of soil.
e. Control high traffic areas	Reduces compaction. Options include: Change traffic pattern; restrict traffic from specific areas; restrict carts to cart paths; smaller, more frequent applications in high traffic areas.
f. Install cart paths	Paths should be installed throughout golf course or at least in heavily traveled areas (e.g., around greens and tees). Reduces impact of cart traffic on soil structure, reduces compaction.

D. TURF MANAGEMENT OPTIONS	DESCRIPTION / CONSERVATION POTENTIAL
g. Apply wetting agents	Can be applied manually or injected automatically through the irrigation system. Increases infiltration rate. Especially useful for sandy soils that have developed a hydrophobic condition.
h. Use geotextiles, plastic, or concrete pavers cut out for turf	Relieves wear and tear on soil structure and turf. Reduces soil compaction.
I. Apply rules, such as the 90° rule, to minimize cart traffic on fairways	Reduces compaction.
6. Turf Damage	
a. Keep carts off turf during hot periods to reduce tire wilt	Wilted turf has a higher water demand. Damaged turf requires water to bring it back.
b. Control number of golf rounds played on hot days	Relieves stress on turf; reduces use of extra irrigation water to bring turf back.
c. Allow for maximum recovery time of turf before using muddy or damaged areas	Reduces damage from soil compaction; reduces use of extra irrigation water to bring turf back.
7. Thatch Control	
Institute a systematic thatch control program	Methods to control thatch include: verticutting, slicing, and spiking. Thatch increases the potential for runoff, decreases the infiltration rate, raises water demand.
8. Mowing Practices	
Incorporate turf mowing practices that reduce ET rate	A few practices are: mow turf at prescribed height; use reel mower; use sharp mower blades; mow frequently; do mowing late day or night. Mowing practices are dependent on use and budget. Turf grass water use increases with mowing height and declines with mowing frequency.

E. POND AND RESERVOIR MANAGEMENT	DESCRIPTION / CONSERVATION POTENTIAL
1. Surface Area	
a. Eliminate ponds or reservoirs that are not being used for storage	Reduces evaporation and seepage.
b. Decrease pond surface area to depth ratio	Reduces evaporation.
c. Use chemical surface coating or mechanical covers	Reduces evaporation.
2. Seepage	
a. Drain pond and reline with heavy duty plastic film and/or concrete	Most efficient method to eliminate pond leakage. PVC liners completely eliminate seepage.
b. Convert open streams and channels that deliver irrigation water to covered pipelines	Eliminates evaporation and seepage.

F. TURF MAINTENANCE STAFF EDUCATION	DESCRIPTION / CONSERVATION POTENTIAL
1. Staff Hiring, Retention and Education	Good management involves all staff members at a facility.
a. Staff education	Staff education should focus on water conservation, irrigation techniques, and irrigation technology. Encourage, support financially, and give time off for seminars and workshops on water conservation and irrigation techniques.
b. Promote in-house	Staff retention yields more employees skilled in water conservation techniques.
c. Pay adequate salaries	Decreases staff turnover, retains staff skilled in water conservation techniques.
d. For large turf-related facilities, hire an irrigation manager whose sole responsibility is irrigation and turf management	Irrigation manager can concentrate on irrigation and water conservation.
e. Create operators conservation incentive	Give bonus calculated on water saved.
f. Hire staff with education and experience in agronomic area	Irrigation and turf management skills and education assist in successful water conservation efforts.

APPENDIX 6B
TURF-RELATED FACILITIES
PHOENIX ACTIVE MANAGEMENT AREA

Parks

Amberwood Park
Arrowhead Meadows Park
Barrios Unidos Park
Benedict Park
Cactus Park - Phoenix
Cactus Park - Scottsdale
Carriage Lane Park
Cave Creek Park
Chandler Sports Complex
Chaparral Park - Glendale
Chaparral Park - Scottsdale
Cesar Chavez Park
Cielito Park
Circle K Park
Conocido Park
Cortez Park
Coyote Basin Park
Crossed Arrows Park
Daley Park
Deer Valley Park
Desert Breeze Park
Desert Foothills Parks
Desert Horizon Park
Desert Star Park
Desert West Sports Complex
El Dorado Park
El Oso Park
El Prado Park
El Reposo Park
Emerald Park
Encanto Park
Esteban Park
Estrella Mountain Regional Park
Fitch Park
Folley Park
Fountain Park
Freestone Park
Gene Autry Ballpark
Granada Park
Greenfield Park
Grovers Park
Harmony Park
Harry Bonsall Sr. Park
Heritage Park
Hermosa Park
Hohokam Park
Holmes Retention Basin
Hoopes Park
Indian School Park - Phoenix
Indian School Park - Scottsdale
Jefferson Park
Kingsborough Park
Kiwanis Park
Kleinman Park
La Pradera Park
Little Canyon Park
Los Alamos Park
Los Olivos Park
Madison Park
Margaret T. Hance Park
Mariposa Park
Marivue Park
Maryvale Baseball Facility
Maryvale Park
McCormick Railroad Park
McKellips Lake and Vista del Camino
Moon Valley Park
Mountain View Park - Chandler
Mountain View Park - Mesa
Mountain View Park - Phoenix
Mountain View Park - Scottsdale
Old Crosscut Canal Linear Park
Optomist Park
Palo Verde Park
Papago Baseball Facility
Papago Park - Tempe
Paradise Cove Park
Paradise Valley Park
Peoria Sports Complex
Pierce Park
Pima Park
Pioneer Park
Red Mountain Park
Reed Park
Rio Salado Park
Riverview Park
Roadrunner Park
Rose Lane Park
Rose Mofford Sports Complex
Royal Palm Park
Saguaro Ranch Park
Sandpiper Park
Scottsdale Ranch Park
Sereno Park
Shawnee Park
Sherwood Manor Park

Silvergate Park
Sonrisa Park
Sueno Park
Sun Ray Park
Sunburst Paradise Park
Sunnyslope Park
Sunridge Park
Sweetwater Park
Tempe Diablo Stadium
Turtle Rock Basin
Venturoso Park
Victory Lane Sports Complex
Vista Canyon Park
Washington Park
West World

Schools

Agua Fria Union North High School
Aqua Fria Union South High School
Alhambra High School
Apache Junction Junior High School
Apache Junction High School
Apollo High School
Arcadia High School
Arizona State University
Avondale Elementary School - Central
Avondale Elementary School - La Canada
Barcelona North and South Elementary Schools
Barry Byron Elementary School
Barry Goldwater High School
Bicentennial North and South Elementary Schools
Bogle Junior High School
Bourgade Catholic High School
Brimhall Junior High School
Buckeye Union High School
Cactus High School/Foothills Elementary School
Cactus Shadows High School/Desert Arroyo Middle School
Camelback High School
Carl Hayden High School
Cartwright Elementary School
Central High School
Chandler High School
Chaparral High School
Cherokee Elementary School
Clarendon Elementary School
Cochise Elementary School
Cocopah Middle School
Coronado High School
Cortez High School
Deer Valley High School/Desert Sky Middle School
Desert Horizon Elementary School
Desert Sands Junior High School
Desert Shadows Middle School
Dobson High School
Don Mensendick Elementary School/ William C. Jack Elementary School
Dysart Middle School
El Mirage Elementary School
Erie Elementary School
Estrella Middle School
Fees Junior High School/Rover Elementary School
Frank Borman Middle School
Fremont Junior High School
Frye Elementary School
Galveston Elementary School
Gilbert Elementary School/Mesquite Junior High School
Gilbert Junior High School
Gililland Junior High School
Glenn F. Burton Elementary School
Glendale American Elementary School
Glendale Community College
Glendale High School
Glendale Landmark Middle School
Grand Canyon University
Greenfield Junior High School/Kennedy Elementary School
Greenway High School
Greenway Middle School
Harold W. Smith Elementary School
Heatherbrae Elementary School
Hendrix Junior High School
Hohokam Elementary School
Holiday Park Elementary School
Horizon Elementary School
Horizon High School
Independence High School
Kino Junior High School
Knox Elementary School
Kyrene del Pueblo Middle School/Kyrene de la Paloma Elementary School
Kyrene Middle School/C.I. Waggoner Elementary School
Litchfield Elementary School
Luke Elementary School
Madison Park Elementary School
Marcos de Niza High School

Maryvale High School
McClintock High School
Melvin E. Sine Elementary School
Mesa Community College
Mesa High School/Franklin East Elementary School
Mesa Junior High School/Lowell High School
Mohave Middle School
Moon Valley High School
North Canyon High School
O'Connor Elementary School
Paradise Valley High School
Peoria High School
Peralta Elementary School
Phoenix College
Pima Elementary School
Poston Junior High School/Field Elementary School
Powell Junior High School/Redbird Elementary School
Pueblo Elementary School
Queen Creek Middle School and Elementary School
Red Mountain High School
Rhodes Junior High School
Saguaro High School
Salk Elementary School
Seton Catholic High School
Sevilla Elementary School
Shadow Mountain High School
South Mountain Community College
South Mountain High School
Stapley Junior High School
Starlight Park Elementary School
Sunnyslope High School
Sunrise Middle School/Liberty Elementary School
Sunrise Mountain High School
Supai Middle School
Taylor Junior High School/Irving Elementary School
Tempe High School
Thunderbird-The American Graduate School of International Management
Thunderbird Adventist Academy
Thunderbird High School
Tolleson Junior High School
Tolleson Union High School
Trevor G. Browne High School
Villa de Paz Elementary School
Washington High School
Western Sky Middle School
Westview High School
Westwood High School/Carson Junior High School/Emerson Elementary School
Willis Junior High School

Golf Courses

Adobe Dam Family Golf Center
ASU Karsten Golf Course
Ahwatukee Country Club
Alta Mesa Country Club
Ancala Country Club
Apache Creek Golf Club
Apache Sun Golf Club
Apache Wells Country Club
Arizona Biltmore Country Club
Arizona Country Club
Arizona Golf Resort
Arrowhead Country Club
Augusta Ranch Golf Course
Bellair Golf Course
Boulders Golf Course, The
Briarwood Country Club
Camelback Golf Club
Cave Creek Golf Course
Chuparosa Golf Course
Club Terravita Golf Course
Club West Golf Club
Continental Golf Course
Coronado Golf Course
CottonFields Golf Club
Cottonwood Country Club
Country Club at DC Ranch, The
Coyote Lakes Golf Club
Coyote Ridge Golf Club
Deer Valley Golf Course
Desert Forest Golf Club
Desert Highlands Golf Club
Desert Mountain Golf Club
Desert Sands Golf Course
Desert Springs Golf Club
Desert Trails Golf Course
Dobson Ranch Golf Course
Dove Valley Ranch Golf Club
Dreamland Villa Golf Course
Eagle's Nest Golf Club
Echo Mesa Golf Course
El Caro Golf Club
Encanto Golf Course
Estancia Club, The
Estrella Mountain Golf Course

Estrella Mountain Ranch Golf Course
Falcon Golf Club
Family Golf Center at Mesa
Fiesta Lakes Golf Course
500 Club Golf Course
Foothills Golf Club
Fountain Hills Golf Club
Fountain of the Sun Country Club
Gainey Ranch Golf Club
Glen Lakes Golf Course
Gold Canyon Golf Resort
Golf Club at Eagle Mountain, The
Grandview Golf Club
Granite Falls Golf Club
Grayhawk Golf Club
Great Eagle Golf Club
Greenfield Lakes Golf Course
Hillcrest Golf Club
Ironwood Country Club
Johnson Ranch Golf Club
Ken McDonald Golf Course
Kierland Golf Club
Kokopelli Golf Resort
Lakes at Ahwatukee Golf Course, The
Lakes East Golf Course (Sun City)
Lakes West Golf Course (Sun City)
Legend at Arrowhead, The
Legend Trail Golf Club
Leisure World Country Club
Links at Queen Creek, The
Longbow Golf Club
Maryvale Golf Course
McCormick Ranch Golf Club
Mesa Country Club
Moon Valley Country Club
Mountain Shadows Golf Club
Oakwood Golf Course
Ocotillo Golf Club
Orange Tree Golf Resort
Painted Mountain Golf Club
Palm Valley Golf Club
Palmbrook Country Club
Palo Verde Country Club
Palo Verde Golf Course
Papago Golf Course
Paradise Valley Country Club
Paradise Valley Park Golf Course
Pebblebrook Golf Course
Pepperwood Golf Course
Phantom Horse Golf Club on South Mountain
Phoenician Golf Club, The
Phoenix Country Club
Phoenix Golf School
Pinnacle Peak Country Club
Pointe Golf Club on Lookout Mountain, The
Pueblo El Mirage Country Club
Quail Run Golf Course
Queen Valley Golf Course
Rancho Manana Golf Club
Raven Golf Club at South Mountain
Red Mountain Ranch Country Club
Rio Verde Country Club
Riverview Golf Course - Mesa
Riverview Golf Course - Sun City
Roadhaven Resort
Rolling Hills Golf Course
Royal Palms Golf Course
San Marcos Golf and Country Club
Scottsdale Country Club
Scottsdale Golf Center
Scottsdale Shadows Golf Course
Shalimar Country Club
Springfield Golf Resort
Stardust Golf Course
Stonecreek, The Golf Club
Sun City Country Club
Sun City North Golf Course
Sun City South Golf Course
Sun Lakes Country Club
Sun Village Resort and Golf Club
Sunbird Golf Resort
Sunland Springs Village Golf Course
Sunland Village East Golf Course
Sunland Village Golf Club
SunRidge Canyon Golf Club
Superstition Springs Golf Club
Tatum Ranch Golf Club
Tempe Family Golf Center
Thunderbird Golf Resort
Toka Sticks Golf Course
Tonto Verde Golf Club
Tournament Players Club of Scottsdale
Traditions Golf Course
Trail Ridge Golf Course
Troon North Golf Course
Troon Golf and Country Club
Union Hills Country Club
Viewpoint Golf Resort
Villa de Paz Golf Course
Villa Monterey Golf Course
Westbrook Village Golf Club
Western Skies Golf Club
Wigwam Resort, The
Wildfire Golf Club

Willowcreek Golf Course and Willowbrook GolfClub

Cemeteries	
City of Mesa Cemetery	Paradise Memorial Gardens
East Resthaven Park Cemetery	Phoenix Memorial Park
Green Acres Mortuary	St. Francis Cemetery
Greenwood Memory Lawn Cemetery and Mortuary	Sunland Memorial Park
Holy Cross Cemetery	Sunwest Cemetery
Mountain View Memorial Gardens	Tempe Double Butte Cemetery
	West Resthaven Park Cemetery

Common Areas of Housing Developments	
Anderson Springs	McCormick Ranch Property Owners Association
Arrowhead Homeowners Association - Sierra Verde	Oakwood Hills
Arrowhead Lakes Homeowners Association	Ocotillo Community Association
Dobson Ranch Homeowners Association - Lakes	Park Shadows Apartments
Dobson Ranch Homeowners Association - Turf	Pecos Ranch
Estrella Community Association	Scottsdale Ranch Community Association
Foothills Community Association	Springs, The
Garden Lakes	Sun Harbor Community Association
Gila Springs	Sun Lakes Homeowners Association No. 1 - Phase I Common Areas
Islands, The	Sun Lakes Homeowners Association No. 2 - Phase II Common Areas
Kingswood Parke	Sun Lakes Marketing - Phase III Common Areas
Lago Estancia	Superstition Springs Homeowners Association
Lake Biltmore Village	Val Vista Lakes
Lakes Community Association, The	Ventana Lakes
Lakewood	
Leisure World Homeowners Association	

Miscellaneous	
Arizona State University Research Park	Sky Harbor International Airport
Glen Harbor Business Park	Tempe Town Lake
Honeywell	Turf Paradise
Perryville State Prison	The Wigwam Resort

APPENDIX 6C
DAIRY OPERATION BEST MANAGEMENT PRACTICES PROGRAM
STANDARD BEST MANAGEMENT PRACTICES

WATER USE CATEGORY 1. DELIVERY OF DRINKING WATER FOR DAIRY ANIMALS	
Description: The level of milk production, season of year, and type of dairy animal housing has a significant effect on the water intake of a dairy animal. The drinking water needs of a lactating cow will vary from 25 to 45 gallons per day. As milk production per cow per day increases, drinking water intake will also increase. Conservation of dairy animal drinking water could best be accomplished by preventing and promptly repairing leaks in the drinking water system.	
BMP 1.1	Install and maintain valves and floats throughout the drinking water system to allow for the isolation of leaks in lines and tanks. The Annual Report required by A.R.S. § 45-632 shall include a water system map of the dairy facility showing the location of all valves and floats. This map shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change in the location of the valves or floats.
BMP 1.2	Inspect the drinking water system for leaks daily to ensure that leaks are promptly identified and repaired to prevent water loss. If a leak occurs, stop water flow by isolating the area of the leak and/or repair the leak within 72 hours.
WATER USE CATEGORY 2. UDDER WASHING AND MILKING PARLOR CLEANING	
Description: Udder washing and milking parlor cleaning is the single largest water use at a dairy operation. Floor and wall wash and sanitation of the milking area is necessary for producing a safe product. These systems can be either manual or semi-automatic. The amount of water used also depends on weather conditions not under the control of dairy management. Udder washing and milking parlor cleaning offer the greatest conservation potential at a dairy through management of the system.	
2.1 <u>UDDER WASH SYSTEM</u>	
BMP 2.1.1	Install and operate the udder washing system with automatic timers. When udder washing, use a maximum of one minute of water for the soak cycle followed by a minimum of two minutes off and a maximum of three minutes of water for the wash cycle followed by one minute off. Repeat with a second wash cycle if needed.
BMP 2.1.2	Install a grid no larger than six feet by five feet between sprinkler heads on wash pens installed or renovated after January 1, 2002. The Annual Report required by A.R.S. § 45-632 shall include a water system map of the dairy facility showing the location of all sprinkler heads and the dimensions of the wash pens. This map shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change to the location of the sprinkler heads or to the dimensions of the wash pens.

BMP 2.1.3	Install lockout devices so that the wash system can be used only once per group of cows, unless exceptional conditions require an override of the lockout device. The Annual Report required by A.R.S. § 45-632 shall include a water system map of the dairy facility showing the location of all lockout devices. This map shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change to the location of the lockout devices.
BMP 2.1.4	Establish and implement an inspection schedule to properly maintain and replace spray heads and timing devices. Inspect all spray heads and timing devices daily to ensure that they are operating correctly. If a device is found to be malfunctioning, repair or replace the device within 72 hours.
2.2 MILKING PARLOR FLOOR AND WALL WASHING	
BMP 2.2.1	Equip all parlor hoses with shutoff valves. Inspect all hoses and valves daily. If a leak occurs, stop water flow by isolating the area of the leak and/or repair the leak within 72 hours.
BMP 2.2.2	If a semi-automatic floor flush system is used, it must be equipped with a timing device to limit the duration of cleaning and be designed to use no more water than necessary unless the water used is water recycled within the dairy operation. The Annual Report required by A.R.S. § 45-632 shall include a description of the flush system that includes the flush schedule and the amount of water used for each flush. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change to the timing device.
WATER USE CATEGORY 3. CORRAL DESIGN AND MAINTENANCE **Description:** Proper corral design and maintenance will reduce water use in the cow wash pen prior to milking by reducing the amount of wash time necessary to clean the cows. Sloping and maintaining the corral in a dry condition keeps the cows in a cleaner condition.	
BMP 3.1	Slope corrals to prevent standing water and to promote drainage to the waste water system. The Annual Report required by A.R.S. § 45-632 shall include a dairy facility map that shows the corral design and the direction of slope. This map shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change to corral design.
BMP 3.2	Scrape, harrow, or drag corrals to eliminate holes and maintain corrals in a dry condition. The Annual Report required by A.R.S. § 45-632 shall include a description of corral maintenance for wet and dry conditions and a maintenance schedule. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change in corral maintenance.

APPENDIX 6C
DAIRY OPERATION BEST MANAGEMENT PRACTICES PROGRAM
STANDARD BEST MANAGEMENT PRACTICES

WATER USE CATEGORY 4. CLEANING AND SANITIZING MILKING EQUIPMENT

Description: Cleaning and sanitizing milking equipment is necessary to provide a safe dairy product. Water is also used in pre-coolers and vacuum pumps during the milking operation. Water used for this purpose is usually between 5 and 10 percent of the total water use at the dairy operation. This water can be recycled for other uses at the dairy.

4.1 MILK COOLING AND VACUUM PUMP

BMP 4.1.1 If the milk cooling and vacuum pump system is water-cooled and is not a closed system, reuse water from the system to wash cow udders or pens, or for any other uses, consistent with state and federal sanitary codes.

The Annual Report required by A.R.S. § 45-632 shall include a description and diagram of water reuse from the milk cooling and vacuum pump system. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change in how water is reused from the milk cooling and vacuum pump system.

4.2 MILK LINE WASHING

BMP 4.2.1 Install and operate the milk line washing system with an automatic or semi-automatic timing device.

The Annual Report required by A.R.S. § 45-632 shall include a description of how the milk line washing system operates. The description shall include the number of cycles per washing and the amount of water used per washing. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change in the number of cycles per washing and the amount of water used per washing.

4.3 BACK-FLUSH SYSTEMS

BMP 4.3.1 Maintain and service all back-flush systems in accordance with the manufacturer's design specifications and maintenance schedule.

The Annual Report required by A.R.S. § 45-632 shall include the manufacturer's design specifications and a maintenance schedule. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change to the back-flush system.

APPENDIX 6C
DAIRY OPERATION BEST MANAGEMENT PRACTICES PROGRAM
STANDARD BEST MANAGEMENT PRACTICES

WATER USE CATEGORY 5. DUST CONTROL, CALF HOUSING CLEANING, AND FEED APRON FLUSHING **Description:** Control of dust, wastes, and feed residues are necessary for fly control, sanitation, and animal health. This requires water for cleaning and flushing feed aprons and calf housing and for wetting roadways. Conservation potential in this category includes recycling and reusing water, avoiding waste, and employing simple technologies that can reduce the amount of water needed for dust control.	
BMP 5.1	If the dairy flushes the cow feed apron, design the systems to recycle water from the cow udder wash system or to pump wastewater and recycle it from the lagoon or wetland area. The Annual Report required by A.R.S. § 45-632 shall include a description of how water is recycled at the operation, an estimate of the amount of water recycled, and the method of estimation. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change to how water is recycled.
BMP 5.2	If the calf housing utilizes a flush system to remove animal wastes, design and manage the system so that it uses only the minimum amount necessary and equip with a timer to minimize the duration of each flush. The Annual Report required by A.R.S. § 45-632 shall include a description of how the system is designed and managed to minimize water use, the length of time of each flush, the number of times per day on average that the system is in operation, and a water system map of the facility showing the location of the timer. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change to the design or operation of the flush system.
BMP 5.3	If dust control practices are used at the facility, the following dust control methods should be used: paving, aggregate, chemical binding agents, or dairy wastewater if consistent with state and federal standards. If potable water is used for dust control it must be used as efficiently as possible. The Annual Report required by A.R.S. § 45-632 shall include a description of the dust control technology(ies) used, the area on which dust control is practiced, and the amount of water used for dust control. If water use is estimated, provide a description of how water use is estimated. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change to dust control practices.

APPENDIX 6C
DAIRY OPERATION BEST MANAGEMENT PRACTICES PROGRAM
STANDARD BEST MANAGEMENT PRACTICES

WATER USE CATEGORY 6. DAIRY ANIMAL COOLING

Description: Dairy animal cooling is an effective method to improve milk production per cow and reproductive efficiency, which are important factors in dairy profitability. Animal cooling is also an important factor in improving animal health. The amount of water required depends on the type of method or methods used to cool cows, the maintenance practices for the system, and the hours of usage. Methods to conserve water for each cooling system are available to dairy farm management.

6.1 HOLDING PEN COOLING

BMP 6.1.1 Design and operate independent fan and spray systems to ensure that water is used efficiently under all weather conditions.

The Annual Report required by A.R.S. § 45-632 shall include a diagram demonstrating that fans and spray systems are used independently and provide information on how the system is managed depending on weather conditions. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change to the fan and spray systems.

6.2 COW EXIT AND RETURN LANES COOLING

BMP 6.2.1 Use leaf gate, wand switch, electric eye, or motion (proximity) indicators to automatically activate the water valve.

The Annual Report required by A.R.S. § 45-632 shall include a description of the activation device used at the dairy operation including the length of time the water valve is in operation and the amount of water used; include the average number of times per day that the device is activated in a year. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change in activation device.

6.3 FEED LINE COOLING

BMP 6.3.1 Locate the feed line cooling system to take advantage of prevailing winds in order to place water directly on the dairy animal. Equip the system with timers to control the duration of use.

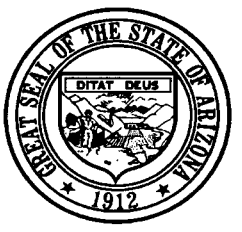
The Annual Report required by A.R.S. § 45-632 shall include a water system map of the dairy facility showing the location of all timers and the direction of prevailing winds. Report the length of time the timer is in operation, and the average number of times per day that the system is in operation in a year. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change in the feed line cooling system or timers.

6.4 CORRAL SHADE COOLERS	
BMP 6.4.1	Equip corral shade coolers with thermostats or timers to control operation time. The Annual Report required by A.R.S. § 45-632 shall include a water system map of the dairy facility showing the location of all thermostats or timers and report the average daily length of time the coolers are in operation in a year. This information shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change in the thermostats or timers.
BMP 6.4.2	Establish an inspection schedule to ensure regular maintenance of nozzles and water filter systems. The Annual Report required by A.R.S. § 45-632 shall include an inspection and maintenance schedule. This schedule shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change in the maintenance schedule.
WATER USE CATEGORY 7. DAIRY ANIMAL FEED PREPARATION **Description:** Water is used in the preparation of dairy animal feed at dairy operations to pre-soak cereal grain for processing (rolling and flaking). A large use of water in feed preparation is its addition to the total mixed ration (TMR) to improve feed intake. The amount of water needed depends on the dryness of the feed in the ration. The total amount of water added to the feed could equal 20 percent of the ration. The greatest conservation potential for feed preparation rests with leak detection and prevention.	
BMP 7.1	Install shutoff valves at each water source used for feed preparation to allow for the isolation of leaks. If a leak occurs, isolate the area of the leak and/or repair the leak within 72 hours. The Annual Report required by A.R.S. § 45-632 shall include a water system map of the facility showing the location of all valves. This map shall be submitted one time only (the first annual report following acceptance into the BMP Program) unless there is a change in the location of the valves.

CHAPTER

7

Groundwater Quality Management Program



7.1 INTRODUCTION

Water quality is a vital component in the management of the Phoenix Active Management Area's (AMA) water supply. The Arizona Department of Water Resources' (Department) role in water quality relates to the impacts of water quality on available water supplies. Protecting and managing water quality maximizes the overall quantity of usable water, and matching the best use to the quality of water is a significant aspect of meeting the Department's water management objectives. This chapter defines the Department's role and authority in meeting groundwater quality management objectives during the third management period and addresses water quality impacts on the management of water supplies in the Phoenix AMA.

Generally, the Department's responsibilities include enhancement of groundwater quality protection programs, assistance in the clean up of contaminated areas, and assistance in matching water quality with the highest beneficial use. In the third management period, the Department will play a greater role in water quality issues because of increased responsibilities and funding for water quality management activities provided for in the 1997 Water Quality Assurance Revolving Fund (WQARF) Program reform legislation. Laws 1997, Ch. 287. Furthermore, the utilization of renewable supplies such as Central Arizona Project (CAP) water and treated effluent as well as the designation of end uses for remediated groundwater will play a larger role in water supply activities during the third management period.

In general, groundwater in the Phoenix AMA is of acceptable quality for most uses. Most of the groundwater supplies in the Phoenix AMA meet federal and state drinking water standards, though contaminant levels exceed primary safe drinking water standards in a few areas. Groundwater withdrawals from wells within these identified areas have been discontinued or are in the process of being cleaned up through remedial activities. Other areas of known contamination which are not being remediated are monitored to ensure that contaminants do not spread and adversely impact groundwater quality.

7.2 GOALS AND OBJECTIVES

The Department's goals and objectives for groundwater quality management for the third management period are complicated due to the Department's dual responsibilities to achieve reductions in withdrawals of groundwater, and to facilitate remediation of contaminated groundwater by implementing incentives for the use of remediated groundwater. The WQARF reform legislation of 1997 creates several incentives for the use of remediated groundwater. In response to the fact that many sites with groundwater contamination have not been cleaned up, the Legislature mandated incentives for remediated groundwater use which could result in a significant increase in groundwater withdrawals. These incentives to use remediated groundwater present a unique groundwater management problem because they may be in conflict with an underlying objective of the Groundwater Code (Code), which is to "achieve reductions in withdrawals of groundwater" to attain the management goal of each AMA.

The Department recognizes that the goal of remediating contaminated groundwater is an important one and intends to facilitate such remediation by implementing incentives for remediated groundwater use. However, as the agency entrusted with the responsibility of managing and conserving Arizona's long-term water supplies, the Department also has the responsibility to ensure that the minimum amount of groundwater necessary to achieve remedial action objectives is pumped and to ensure that where practicable new groundwater uses are not created and groundwater supplies are conserved. While the Department believes that it is possible to both achieve reductions in withdrawals of groundwater and provide incentives for the use of remediated groundwater, it recognizes that there is a delicate balance between the two responsibilities which will involve coordinated efforts between Arizona Department of Environmental Quality (ADEQ) and the Department to ensure that, on a case-by-case basis, no more groundwater is withdrawn than is necessary.

To implement its groundwater quality management challenge, the Department will "coordinate and confer" with ADEQ regarding "water plans, water resource planning, water management, wells, water rights and permits, and other appropriate provisions of [title 45] pertaining to remedial investigations, feasibility studies, site prioritization, selection of remedies and implementation of the [WQARF] program pursuant to title 49, chapter 2, article 5." A.R.S. § 45-105(B)(4)(c). To this end, the Department is in the process of creating a draft Memorandum of Understanding between the two agencies.

The Department's goals and objectives for groundwater quality management for the third management period are the following:

- to ensure that remediation of contaminated groundwater uses the minimal amount of groundwater necessary to facilitate the objectives of each remedial action project.

- to ensure that end uses of remediated groundwater minimize groundwater withdrawals and are consistent with the safe-yield goal.

- to ensure that water quality considerations affecting Department programs that extend beyond the scope of the WQARF program are also addressed in order to preserve groundwater quality and quantity. Some of these considerations include well construction and abandonment standards, well spacing, assured water supply, recharge, and groundwater withdrawal permits.

Pursuant to the WQARF Program, the Department will respond to the highest ranked sites on the WQARF site registry. The Department's objectives are to ensure that remedial action projects are not an impediment to achieving the management goals for each AMA, and that cleanups are performed in a prudent and efficient manner from a water management perspective.

7.3 STATUTORY PROVISIONS

ADEQ is the agency primarily responsible for regulating water quality. The Department also has some limited responsibilities in this area. Statutory provisions pertaining to the Department's limited authority to regulate groundwater quality are discussed below.

The Code grants the Department authority to regulate groundwater. Under the Code, the Department has the following authority and responsibilities relating to water quality:

- "[T]he director may ... [f]ormulate plans and develop programs for the practical and economical development, management, conservation and use of surface water, groundwater and the watersheds in this state, including the management of water quantity and quality." A.R.S. § 45-105(A)(1).

- "[T]he director may ... [c]onduct feasibility studies and remedial investigations relating to groundwater quality and enter into contracts and cooperative agreements under § 104 of the comprehensive environmental response, compensation, and liability act [CERCLA] of 1980 (P.L. 96-510) to conduct such studies and investigations." A.R.S. § 45-105(A)(16).

- For the third management period, the director "shall, in cooperation with the department of environmental quality, include in each [management] plan an assessment of groundwater quality in the active management area and any proposed program for groundwater quality protection. Any such program shall be submitted to the Legislature for any necessary enabling legislation or coordination with existing programs of the department of environmental quality." A.R.S. § 45-566(A)(7).

- "[T]he director shall consult with the department of environmental quality on water quality considerations in developing and implementing management plans under this article." A.R.S.§ 45-573.

The WQARF legislation, as revised in 1997, expands the Department's role in water quality management. The Department's responsibilities and authority under WQARF, which will be explained in greater detail later in this chapter, include the following:

- "[T]he director of water resources, in consultation with the director of environmental quality, may inspect wells for vertical cross-contamination of groundwater by hazardous substances and may take appropriate remedial actions to prevent or mitigate the cross-contamination ...." A.R.S. § 45-605(A).

- "[T]he director [of water resources] shall notify an applicant for a permit or a person who files a notice of intent to drill a new or replacement well if the location of the proposed well is within a subbasin where there is a site [with existing or future groundwater contamination presenting a risk of vertical cross-contamination by the well]." The director is also required to adopt rules relating to vertical cross-contamination and new or replacement wells. A.R.S. § 45-605(E).

- "[T]he director of environmental quality and the director of water resources shall coordinate their efforts to expedite remedial actions, including obtaining information pertinent to site investigations, remedial investigations, site management and beneficial use of remediated water." A.R.S. § 49-290.01(C).

- The director of water resources may waive permits, approvals or authorizations if they "unreasonably limit the completion of a remedial action." A.R.S. § 49-290.01(A). The director of water resources may also waive any regulatory requirement under title 45 if the requirement conflicts with the selected remedy in a remedial action as long as the waiver does not "result in adverse impacts to other land and water users." A.R.S. § 49-290.01(D).

- "The department of water resources shall include in its management plans ...provisions to encourage the beneficial use of groundwater that is withdrawn pursuant to approved remedial action projects ...." Laws 1997, Ch. 287, § 51. In order to encourage the beneficial use of remediated groundwater, "the department of water resources shall account for groundwater withdrawn pursuant to approved remedial action projects under CERCLA or title 49, Arizona Revised Statutes, consistent with the accounting for surface water" for purposes of determining compliance with management plan conservation requirements. Laws 1997, Ch. 287, § 51(B).

- "For each calendar year until 2025, the use of up to an aggregate of sixty-five thousand acre-feet of groundwater withdrawn within all active management areas pursuant to approved remedial action projects under CERCLA or title 49, Arizona Revised Statutes, shall be considered consistent with the management goal of the active management area as prescribed in section 45-576, subsection I, paragraph 2, Arizona Revised Statutes." Additionally, in the third management period, 50 percent of the total volume of groundwater withdrawn pursuant to remedial action projects and in excess of the aggregate volume of 65,000 acre-feet shall be considered consistent with the management goal of the AMA. Laws 1997, Ch. 287, § 52.

- "The department of environmental quality and the department of water resources shall develop a method of sharing data, including cooperative data base development and integration between the departments, that will provide the departments with the information necessary to protect the resources of the state." Laws 1997, Ch. 287, § 53.

- "The directors of environmental quality and water resources shall enter into an agreement to coordinate the well inspection and remediation programs and to rank wells within an area of contamination according to each well's potential to act as a conduit to spread contamination and to determine the appropriate remedial action regarding the wells with a potential to act as a conduit, including well reconstruction, well abandonment or no action." Laws 1997, Ch. 287, § 54.

7.4 THE REGULATION OF GROUNDWATER QUALITY IN ARIZONA

To understand the Department's role in regulating groundwater quality, it is important to understand the broad framework of laws and programs impacting both groundwater and surface water quality. Since groundwater quantity and quality issues are so interrelated, ADEQ and the Department work together to prevent and mitigate groundwater quality and quantity problems. ADEQ has the lead role in protecting the state's groundwater and surface water quality, while the Department secondarily manages groundwater quality concerns. This section will discuss the regulatory agencies responsible for administering laws impacting groundwater and surface water quality as well as the federal laws and state programs impacting groundwater quality and secondarily surface water quality.

7.4.1 Water Quality Regulatory Agencies

Water quality protection programs in Arizona are based on both federal and state law and are primarily administered by either ADEQ or the U.S. Environmental Protection Agency (EPA) Region IX. ADEQ has the responsibility to administer state water quality programs pursuant to state statutes and to administer federal water quality programs for which the EPA has delegated its authority to the state, sometimes referred to as state primacy. EPA has the responsibility to administer federal water quality programs pursuant to federal statutes but delegates its authority to states where the state demonstrates that it can adequately administer the program and the federal statute provides for the delegation of authority to states.

ADEQ has authority pursuant to the Environmental Quality Act (EQA) of 1986 (A.R.S. § 49-101, *et seq.*) to set water quality standards and to regulate discharges that have the potential to impact the quality of groundwater by requiring that discharges are subject to aquifer protection permits (APP). ADEQ has authority under the Clean Water Act (CWA) to set Arizona's surface water quality standards and to certify that discharges subject to federal permits do not violate state water quality standards.

EPA Region IX retains authority to administer the CWA National Pollutant Discharge Elimination System (NPDES) permits and the pretreatment program, while the U.S. Army Corps of Engineers, Los Angeles District, has authority to administer CWA permits for the discharge of dredge or fill materials in Arizona's waters. EPA Region IX also has authority to require groundwater monitoring and remediation in accordance with CERCLA.

7.4.2 Federal Laws Impacting Groundwater Quality

The Safe Drinking Water Act (SDWA) is the primary federal law regulating groundwater quality. In particular, it regulates drinking water which includes groundwater. The CWA, which regulates surface water, also impacts groundwater quality. The CERCLA and the Resource Conservation and Recovery Act (RCRA) impact groundwater management through the regulation of hazardous waste and sites contaminated by hazardous waste. Following is a brief overview of these federal laws and their impacts on the Department's water quality management.

7.4.2.1 Safe Drinking Water Act

The Safe Drinking Water Act was enacted in 1974 to regulate drinking water. ADEQ has been delegated authority by the EPA to implement the SDWA and "to ensure that all potable water distributed or sold to

the public through public and semi-public water systems is free from unwholesome, poisonous, deleterious, or other foreign substances and filth or disease causing substances or organisms." A.R.S. § 49-351(A).

There are two types of standards set by the SDWA: national primary drinking water regulations and national secondary drinking water regulations. National primary drinking water regulations may either be primary Maximum Contaminant Levels (MCLs) or Treatment Techniques (TT) requirements. Primary MCLs are the maximum permissible level of a constituent in a public water system and constitute the enforceable standard for safe drinking water. TT requirements set action levels for constituents such as lead and copper that cannot be directly detected or removed by water systems. National secondary drinking water regulations, referred to as secondary Maximum Contaminant Levels (SMCLs), set non-enforceable numeric standards for the aesthetic quality of the water, such as taste, odor, or color. Waters with contaminants above the SMCLs are not typically expected to cause health problems. ADEQ has adopted the EPA MCLs as state Drinking Water Standards and has the authority to adopt more stringent standards as well.

Although the Department does not directly regulate drinking water quality, the presence of contaminants in groundwater does negatively impact water quality for municipal providers and poses significant water management issues for drinking water systems.

7.4.2.2 Clean Water Act

The CWA, first passed in 1972, is the comprehensive federal statute regulating surface water quality. The CWA contains six major elements: (1) the NPDES permit program which regulates discharges of pollutants by any person to the nations waters and is designed to protect the chemical and biological integrity of the nation's waters, (2) technology-based effluent standards that apply to the quality of a discharge from a facility, (3) state ambient water quality standards, (4) dredge and fill permits designed to protect the physical and biological integrity of the nation's waters, (5) oil and hazardous substance spill liability, and (6) federal grant programs for improvement of municipal water treatment.

Under the NPDES permit program, all point source dischargers of pollutants into "waters of the United States" must obtain a permit. The jurisdictional reach of the CWA extends to "navigable waters" which are defined as "waters of the United States, including the territorial seas." 33 U.S.C. § 1362(7). EPA and the Corps define "waters of the United States" to include interstate waters; waters which are used, were used in the past or may be susceptible to use in interstate or foreign commerce; tributaries to such waters; the territorial sea and wetlands. 40 C.F.R. § 122.2; 33 C.F.R. § 328.3(a). A frequently cited definition of "waters of the United States" is:

> any waterway within the United States also including normally dry arroyos through which water may flow, where such water will ultimately end up in public waters such as a river or stream, tributary to a river or stream, lake, reservoir, bay, gulf, sea or ocean within or adjacent to the United States. *U.S. v. Phelps Dodge Corp.*, 391 F. Supp. 1181 (D. Ariz. 1975).

Based on this "tributary rule," the CWA has potential application to dry land which drains into a water of the U.S. Additionally, EPA interprets waters of the U.S. to include wetlands, areas susceptible to use as habitat by migratory wildfowl, and areas where industries engaged in interstate commerce discharge. 44 Fed. Reg. 32854, 32858 (June 7, 1979); 51 Fed. Reg. 41206, 41217 (Nov. 13, 1986). "Point source" means:

> any discernible, confined and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal

feeding operation or vessel or other floating craft, from which pollutants are or may be discharged. 33 U.S.C. § 1362(11).

"Pollutant" includes dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal and agricultural waste discharged into water. 33 U.S.C. § 1362(6). Based on the expansive definitions of "waters of the U.S.," "point source" and "pollutant," the jurisdictional reach of the CWA NPDES program is quite broad. EPA has also implemented an NPDES storm water permit program that regulates municipal and industrial runoff which eventually discharges to waters of the United States.

NPDES permits that allow discharges to canals or river systems as a result of remedial projects or by wastewater treatment facilities are important to the Department's overall water management strategy. As a result, the Department provides input on related reports and draft NPDES permits that may impact the water management activities in the state. Furthermore, non-point source contamination of groundwater by such substances as nitrate, sulfate, and dissolved solids can render large volumes of groundwater unusable for many purposes and pose serious water management problems. Therefore, the Department monitors statutory and programmatic developments as well as permits and reports related to non-point source discharges under the CWA.

The CWA also provides for area-wide, long range planning processes to mitigate water quality control problems in selected areas which result from urban and industrial wastewater. Because such planning processes provide a comprehensive review of wastewater treatment and reuse options, the Department participates in such plans and amendments and provides technical assistance to local councils of government who administer the plans.

7.4.2.3 Comprehensive Environmental Response, Compensation, and Liability Act

CERCLA and the Superfund Amendments and Reauthorization Act, commonly referred to as the federal Superfund program, authorize investigation and remediation of groundwater contaminated by releases of hazardous substances. Groundwater remediation may be required to comply with MCL standards, although less stringent standards may be approved by EPA on a case-by-case basis through a technical waiver process. In Arizona, CERCLA establishes a comprehensive response program which is administered by ADEQ in cooperation with the EPA. The Department also plays an advisory role in this process.

Under Section 105 of CERCLA, the EPA is required to annually update the National Priorities List (NPL) of Superfund sites. The sites are proposed for inclusion on the NPL after being assessed as to the release of hazardous substances that threaten public health and the environment. Two significant components in the Superfund process are site investigation (Remedial Investigation) and evaluation of possible cleanup alternatives (the Feasibility Study). During the Remedial Investigation, information is gathered to determine the general nature, extent, and sources of contamination at a site. Once the final cleanup plan has been selected, EPA formalizes this decision by signing a "Record of Decision" (ROD). The ROD also contains a Responsiveness Summary which is EPA's response to public comments on the Remedial Investigation, Feasibility Study, and Proposed Plan. Design and actual cleanup activities (Remedial Design and Remedial Action) can then proceed.

The Department regularly participates in the CERCLA program activities, primarily for sites located within AMA boundaries. The Department's concern at CERCLA sites is that any groundwater that is withdrawn and remediated be put to reasonable and beneficial use. The Department participates on CERCLA technical committees and serves in an advisory capacity for monitoring and extraction well installation, source control projects, and permitting.

7.4.2.4 Resource Conservation and Recovery Act

RCRA established a national hazardous waste management program in 1976. Under RCRA, hazardous waste permits are issued for the treatment, storage, and disposal (TSD) of hazardous wastes. Individual permits issued to these facilities specify design, performance and operational standards which include groundwater monitoring. Hazardous waste facilities also undergo a closure process once operations are reduced or terminated. Moreover, corrective action may be required at TSD facilities and may include groundwater monitoring.

ADEQ has been delegated authority for the implementation of RCRA requirements in Arizona. The Department's participation at RCRA sites is important for water management activities, particularly in regard to well siting, use permits, and end use issues.

7.4.3 ADEQ Programs that Impact Department Groundwater Quality Activities

The EQA established the ADEQ and created a strong and comprehensive water quality management structure. ADEQ's programs that protect groundwater resources include water quality assessments, groundwater monitoring, pollutant discharge, permitting activities, and remediation activities. The following are selected water quality protection programs which fall under the jurisdiction of ADEQ and have a direct impact on Department activities.

7.4.3.1 Aquifer Water Quality Standards

Arizona's Aquifer Water Quality Standards (AWQSs) are the cornerstone of the state's groundwater protection program. Arizona has adopted the federal primary MCLs, established under SDWA, as numeric AWQSs. A.A.C. R18-11-406. These standards apply to aquifers classified and protected for drinking water use. Because all aquifers in Arizona are classified and protected for drinking water use, Arizona's AWQSs are enforceable standards for water quality in all of Arizona's aquifers. A.R.S. § 49-224(B).

ADEQ may reclassify an aquifer within an AMA, upon consultation with the appropriate Groundwater Users Advisory Council and upon conducting a public hearing, for a projected use other than drinking water if the identified aquifer is hydrologically isolated from the other aquifers or other portions of the same aquifer, water from the identified aquifer is not being used as drinking water, and the benefits to the public of the resulting water quality degradation outweigh the costs. A.R.S. § 49-224(c).

Arizona has also adopted narrative AWQSs to regulate pollutant discharges for which no numeric standards have been developed. Arizona's narrative AWQSs include the following: (1) a discharge shall not cause a pollutant to be present in an aquifer classified for a drinking water protected use in a concentration which endangers human health, (2) a discharge shall not cause or contribute to a violation of a surface water quality standard established for a navigable water of the state, and (3) a discharge shall not cause a pollutant to be present in an aquifer which impairs existing or reasonably foreseeable uses of water in an aquifer. A.A.C. R18-11-405.

7.4.3.2 Aquifer Protection Program

The most comprehensive ADEQ groundwater protection program is the APP system, established by the EQA in 1986 and implemented by rule in 1989. An individual or general permit is required for any person who discharges or who owns or operates a facility that discharges a pollutant from a facility either directly into an aquifer or to the land surface or the vadose zone in such a manner that there is a reasonable probability that the pollutant will reach an aquifer. A.R.S. §§ 49-201(11), 49-241. Discharging facilities that require either an individual or general permit to operate include surface impoundments, solid waste disposal facilities, injection wells, land treatment facilities, facilities which add a pollutant to an assortment

of salt formations, dry well or underground cave or mine, mine tailings piles and ponds, mine leaching operations, large septic tank systems, effluent recharge projects, point source discharges to waters of the U.S. and sewage or sludge ponds and waste water treatment facilities. A.R.S. § 49-241(B). Classes or categories of facilities which are exempted from APP requirements are identified in A.R.S. § 49-250. General permits are issued by rule and individual permits must be applied for.

APPs require a demonstration that AWQSs are maintained and the Best Available Demonstrated Control Technology (BADCT) is applied. For individual APPs, compliance with AWQSs is measured at a designated point of compliance. BADCT requirements ensure that the greatest degree of discharge reduction is achieved through an evaluation of site-specific engineering, environmental, and economic criteria.

APPs may require compliance with best management practices (BMPs). BMPs are often site design techniques for the purpose of water quality protection. BMPs may be adopted for on-site facilities for urban runoff, storm sewers, silvicultural activities, and septic tank systems. Agricultural general permits require compliance with BMPs for nitrogen fertilizer application and concentrated animal feeding operations. ADEQ is required to monitor compliance with the established BMPs and to measure BMPs effectiveness.

Department staff receives and reviews all APPs for any impacts on Departmental programs and water management. In particular, the Department coordinates with ADEQ to review APP applications for potential harmful water quality impacts on groundwater conditions. Pursuant to A.A.C. R18-9-109, ADEQ advises the Department of each APP application received for a facility that is a recharge project or an underground storage and recovery project. One of the conditions for the issuance of an underground storage facility permit is that ADEQ must determine that the facility is not in a location which will result in pollutants being leached to the groundwater table so as to cause unreasonable harm. A.R.S. § 45-811.01(C). Facilities exempt from APP provisions may instead be required by the Department in consultation with ADEQ to meet other requirements to mitigate harmful water quality impacts to the aquifer.

7.4.3.3 Wellhead Protection Program

An important addition to Arizona's groundwater protection program has been the development of the Wellhead Protection Program which fulfills federal requirements of section 1428 of the SDWA by designating Wellhead Protection Areas around public drinking water systems. The Wellhead Protection Program is a voluntary program which encourages the protection of all wells, not just public drinking water system wells. Local entities that have the authority to control land use and exercise other management options can implement wellhead protection, therefore encouraging the creation of local programs.

7.4.3.4 Reuse Permits

Reuse permits are issued to facilities which provide wastewater for reuse. A reuse permit specifies the amount of effluent to be reused and its chemical quality. ADEQ wastewater reuse rules (A.A.C. R18-9-701, *et seq.*) set the criteria for the use of treated effluent, or reclaimed water, for purposes such as agricultural irrigation, turf irrigation, and recharge. The current reuse rules prescribe numeric reclaimed water quality criteria and monitoring requirements for specific reuse applications. In general, these rules prescribe allowable limits for pH, total fecal coliform, turbidity, enteric viruses, and certain parasites. Reuse may be limited depending on the quality of source water and the intended use.

Wastewater reuse rules undergo periodic updating through the ADEQ's rule making process. The Department reviews any proposed changes to the wastewater reuse rules to ensure the protection of public health and groundwater supplies while maximizing the use of a significant renewable water supply. The

Department evaluates effluent reuse permits issued by the ADEQ and encourages the use of treated effluent where appropriate.

7.4.3.5 Underground Storage Tanks

ADEQ's Underground Storage Tank (UST) program was developed to ensure the proper operation of underground storage tanks and to prevent and remediate releases. Under state regulation and RCRA amendments, the UST program consists of notification requirements, technical standards for new and existing USTs, leak detection and closure criteria, corrective actions for remediation, and financial responsibility demonstrations. Leaking USTs in a concentrated area can present detrimental impacts on groundwater quality and supplies.

The Department has the authority to issue poor quality groundwater withdrawal permits for water contaminated by USTs. The Department can provide guidance for UST site remediation projects to ensure the beneficial use of remediated water.

7.4.3.6 Water Quality Assurance Revolving Fund

The WQARF Program, sometimes referred to as the state Superfund program, was created as part of the EQA. WQARF monies are used to protect the waters of our state against hazardous substances, and may be used in conjunction with federal funds. Funds can be used for statewide water quality monitoring, health and risk assessment studies, and remediating hazardous substances which threaten the waters of the state. Mitigation of non-hazardous substances is also allowed under specified conditions. A.R.S. § 49-286. Each year, ADEQ develops a list of environmentally threatened sites which qualify for WQARF monies. Funds are used at those sites to mitigate existing contamination or to prevent further spread of pollutants which may threaten our water supplies. A priority list is developed by ADEQ based on such things as the degree of risk to the environment and other available funding sources.

Some of the key legislative changes made in the 1997 WQARF reform package include: establishment of a proportional share liability for cost allocation to responsible parties; creation of the neutral party arbitration process, with incentives to encourage early settlements, and disincentives to responsible parties which do not enroll in the neutral party arbitration process; new ADEQ funding mechanisms designed to protect existing wells against migrating contamination from WQARF sites; the creation of a comprehensive WQARF site registry, which consolidates a number of separate lists which were previously used; the inclusion of petroleum releases in the WQARF Program under some circumstances; and increased flexibility in the selection of groundwater remedies.

ADEQ follows a process for management and cleanup of WQARF sites that consists of site identification and characterization, site prioritization, remedy selection, identification of end uses, implementation and monitoring, and closure. The criteria to be used in evaluation of response actions include practicability, risk, cost, and benefit. This process also includes a comparison of alternatives based on established statutory criteria, developing a Remedial Action Plan, providing public comment, and issuing a Record of Decision. The Department of Water Resources will actively coordinate with ADEQ in the planning and implementation of groundwater cleanup actions under WQARF.

7.4.3.7 Water Infrastructure Finance Authority

In 1989, the Arizona Legislature created the Wastewater Management Authority to administer funds granted to the state pursuant to the federal SDWA. These funds, which required a 20 percent state match, were loaned to wastewater treatment systems in the state for assistance in meeting requirements of the SDWA. The ADEQ made loans for this purpose from monies in the ADEQ wastewater treatment revolving fund.

In 1997, this administrative body was amended by the Legislature and renamed the Water Infrastructure Finance Authority (WIFA). The authority for WIFA was expanded to make loans available to drinking water systems in addition to wastewater treatment systems for assistance in meeting requirements of the SDWA. The state funding source was also changed so that monies made available to these systems are now derived from the drinking water revolving fund. The Department participates on the advisory board which oversees the WIFA and has an interest in viability of water systems and SDWA compliance.

7.4.4 Department of Water Resources Programs Related to Groundwater Quality

The Department protects groundwater quality by considering groundwater quality issues in its permitting process and water quantity management programs. As a result of WQARF reform legislation of 1997, the Department has increased its responsibility in the program to coordinate and provide assistance to WQARF activities. Among other things, the bill provides for:

- annual funding for Department WQARF activities,
- database development and coordination with ADEQ,
- groundwater withdrawn pursuant to certain cleanups to be accounted for in the same manner as surface water for the purpose of determining compliance with conservation requirements,
- amendment of the Assured Water Supply Rules,
- active involvement by the Department in all phases of site assessment, remediation, management, operation, and planning strategies,
- a WQARF Advisory Board on which the Department has a seat, and
- a well inspection program through which wells that are contributing to vertical cross-contamination may be identified and modified.

The Department's existing permits and programs which involve groundwater quality issues as well as its new programs for groundwater quality protection based on the WQARF legislation are discussed in the following section.

7.4.4.1 Poor Quality Groundwater Withdrawal Permits

Appropriate use of poor quality groundwater conserves the existing supply of potable groundwater. The Department issues poor quality groundwater withdrawal permits to allow the withdrawal of groundwater which, because of its quality, has no other beneficial use at the present time. A.R.S. § 45-516. Withdrawal permits are issued by the Department, and the withdrawal must be consistent with the AMA management plan. Permits are usually issued in conjunction with CERCLA, WQARF, or leaking UST sites for pump and treat operations. To increase the appropriate uses of poor quality groundwater during the third management period, the Department continues to encourage matching poor quality groundwater with beneficial uses within the AMA.

7.4.4.2 Assured Water Supply

The Assured Water Supply Program (AWS Program) is a consumer protection program that ensures that new subdivisions have a secure supply of water with adequate quality for at least 100 years. Pursuant to A.R.S. § 45-576, before land may be subdivided, the developer of the property must either obtain a Certificate of Assured Water Supply for the subdivision from the Department or must establish the development as a customer of a municipal water provider that the Department has designated as having an assured water supply.

Pursuant to rules governing the AWS Program set forth at A.A.C. R12-15-701, *et seq.*, in order to establish an assured water supply, the applicant must prove that a supply of water is physically, legally, and continuously available for the 100-year period to meet the demands of the development that will be the

subject of the certificate, or in the case of a designation, to meet current and committed demands of the water provider for the 100-year period. The applicant must also establish that projected water use will be consistent with achievement of the management goal for the active management area and that the applicant has the financial capability to construct the physical facilities necessary to serve the development. In addition, the applicant must establish that the water supply pledged for assured water supply purposes is of adequate quality.

In assessing the quality of a groundwater supply pledged for assured water supply purposes, the Department works closely with ADEQ to determine whether the groundwater supply meets ADEQ standards for the purposes for which the water is pledged. If the groundwater is not of adequate quality, the applicant may need to find alternative water sources or to expend additional resources treating the groundwater to meet the ADEQ standards.

7.4.4.3 Underground Water Storage and Recovery

Underground water storage, also known as recharge, will play an important role in achieving the Phoenix AMA's goal of safe-yield. Recharge projects will store CAP water that is currently not used directly. Credits for recharged CAP water will then be available to water providers and developers to establish an assured water supply. Other stored CAP water, particularly that stored underground by the Arizona Water Banking Authority, will be available to protect municipal and industrial CAP users from future shortages or outages on the CAP system. In addition, recharge of effluent can be used as a tool to allow more complete use of that resource.

The underground water storage program is administered by the Department. Permits must be obtained from the Department prior to undertaking recharge activities. The Department coordinates closely with ADEQ to ensure that underground water storage does not adversely impact existing aquifer water quality and does not cause movement of existing groundwater contamination. If effluent is stored underground, the applicant must obtain an APP from ADEQ, in addition to the underground storage permits required from the Department.

7.4.4.4 Well Spacing/Impact Analysis

A.R.S. § 45-598 and the Department's temporary Well Spacing and Well Impact Rules are in place to prevent unreasonable damage to surrounding wells as well as land and water users due to new wells and new withdrawals of groundwater in an AMA. Specifically, these laws require well impact studies to evaluate the potential for new non-exempt wells and new withdrawals to damage land and other water users, particularly existing wells. The Department conducts the impact studies for wells with a maximum discharge of 500 gallons per minute (gpm) or less. For wells with a maximum discharge rate exceeding 500 gpm, the permit applicant must submit a hydrological study of projected water level declines due to the operation of the proposed well. The study must also assess adverse impacts from the migration of poor quality groundwater. The well permit application may be denied if the Department determines that the proposed well would cause an unreasonable and adverse impact on surrounding wells, additional regional land subsidence, or migration of poor quality groundwater.

7.4.4.5 Well Construction and Abandonment Requirements and Licensing of Well Drillers

If wells are not constructed, sealed, or abandoned properly they can act as conduits for contaminant flow from the surface to groundwater or between aquifers. Improperly constructed wells can contribute to groundwater contamination. The Department's rules governing well construction, abandonment, and driller licensing, set forth at A.A.C. R12-15-801, *et. seq.,* are summarized below.

- Minimum well construction and abandonment requirements prevent entry of fluids at and near the surface and minimize the possibilities of migration and inadvertent withdrawal of poor quality groundwater. These requirements also prohibit the use of hazardous materials in the construction of wells.

- Installation, modification, abandonment, or repair of all wells in Arizona must be performed by a driller licensed by the Department. The licensing procedure includes the administration of written examinations to test the applicant's knowledge of state regulations, hydrologic concepts, and well construction principles and practices.

- Disposal site restriction prevents the use of wells as disposal facilities for any material that may pollute groundwater.

- Special standards may be required by the Department if the minimum well construction requirements do not adequately protect the aquifer or other water users.

- Open wells must be capped with a watertight steel plate.

- Except for monitor and piezometer wells, no well shall be drilled within 100 feet of any septic tank system, sewage disposal area, landfill, hazardous waste facility or storage area, or petroleum storage areas and tanks, unless authorized by the Director.

Wells drilled prior to the enactment of the well construction rules (effective March 5, 1984) were not required to be constructed in accordance with minimum well construction standards. If a pre-rule well is replaced or modified, however, the new or modified well must meet the current well construction standards. See A.R.S. §45-594.

7.4.4.6 The Department's Role in the WQARF Program

The Department's involvement in groundwater remediation has been redefined as a result of the Groundwater Task Force, which conducted an extensive series of stakeholder negotiations designed to promote groundwater cleanup and groundwater quality management activities of remedial sites. Involvement in this development process was widespread and representative of a varied group of private and public interests.

7.4.4.6.1 Department Activities in the WQARF Site Cleanup and Management Process

ADEQ's WQARF site cleanup and management process and the Department's role in that process are described in the following discussion.

Site Identification and Characterization

Existing WQARF sites have been identified and are being managed by ADEQ. Additional sites may be identified in the future based on a preliminary investigation by ADEQ to determine the potential risk to public health, welfare, or the environment. The Department will further assist ADEQ in this process by providing resource data which includes well location and pumpage records, water rights information, and any other appropriate data recorded by the Department.

Characterization of sites is important because the nature and extent of contamination must be understood before remedies can be selected and implemented. An important part of site characterization is an evaluation of how contamination impacts current and future groundwater uses. The Department's role may include such activities as site inspections and evaluations, review of investigations, field work such as

well inspection and water quality sampling, identification of potential water management issues, and any other characterization as appropriate. Department computer models may be useful in characterizing groundwater flow patterns.

Site Prioritization

The results of the preliminary investigation will be used by ADEQ for site scoring using a method to be established in rules adopted by the director of environmental quality. The completed preliminary investigation will be used by ADEQ to either make a determination of no further action on a site, or to prepare the site for inclusion on the Site Registry. In this latter case, a Site Registry report is prepared containing a description of the site, with its geographical boundaries indicated, and a score in accordance with the site scoring method to be established in rules and adopted by the ADEQ. The Department will assist ADEQ by sharing pertinent water resource information as described in the previous subsection.

Remedy Selection

ADEQ has established a list of response actions to be considered when managing a site. Based on the potential impact on current and future water uses, a potential remedy must be evaluated and designed. Each remedy is site-specific. The Department will assist in defining potential remedies to ensure that the remedy is consistent with Department management plans and sound groundwater management practices that are publicly acceptable. Ultimately, the Department's level of assistance will vary based on the remedy selected. Possible remedies are discussed below.

- Plume Remediation

Plume remediation, or aquifer restoration, means achieving appropriate water quality standards for groundwater throughout the affected area. Source control and monitoring will likely be essential elements of this strategy. This remedy may be more effective for smaller plumes which can be remedied within reasonable time frames.

- Physical Containment

Physical containment refers to an approach that contains contaminants within defined boundaries. This strategy could consist of plume control and coordination of groundwater pumpage and recharge to ensure that contamination is confined within a defined area. Source control and monitoring are also likely elements of this strategy. Physical containment may be appropriate where potable water supplies are threatened by contaminant migration and where containment is technically feasible, but it may require extensive groundwater management to implement.

- Controlled Migration

This strategy aims to control but not necessarily contain migration of contaminants. Source control and monitoring are likely elements of this strategy. Control of contaminants can include control and/or coordination of pumpage that affects contaminant migration and any other measures taken to control contaminant migration. Controlled migration may be appropriate for larger plumes which cannot be practically remedied or contained.

- Source Control

Source control is reduction of continuing contaminant sources such as soil contamination or areas of high concentrations of volatile organic compounds (VOCs) or other contaminants. Dense non-aqueous phase liquids (DNAPLs), which are contaminants (such as VOCs) of such high concentrations that they are not

dissolved in groundwater but exist as free phase liquids, are an example of contaminant sources. Source control is a remedial action that often results in the highest volume of contaminants removed per unit cost.

This strategy employs controlling the pollutant at the source to ensure that aquifer contamination does not continue on due to uncontrolled contaminant releases. Monitoring is a likely component of this strategy. Source control can include, but is not limited to, the mitigation of sorbed or free phase contaminants, pumpage of groundwater to contain or control significant sources of contaminants, and the removal of contributing contaminant sources.

- Monitoring

The monitoring remedy involves monitoring instead of other remedy options. Monitoring sites for water quality and groundwater levels is important to determine the extent of contamination and the effectiveness of remedial activities. The incorporation of computer groundwater models may be used to predict contaminant movement, to monitor well locations, and to develop contingency plans for more aggressive remedies, if necessary.

- No Action

This alternative consists of taking no action at a site. This strategy is normally included as a baseline condition for comparison purposes, but may be a viable alternative in limited cases. Generally, this alternative would only be chosen for sites that are geographically isolated from populated areas, do not pose a significant threat to water supplies, or would be used for comparative purposes to other sites.

Identification of End Uses

The Department is committed to the beneficial use of groundwater withdrawn and treated at WQARF sites, along with other areas that have degraded groundwater quality, and will assist ADEQ with the identification and facilitation of designated end uses for remedial projects. These end uses should be consistent with those determined for existing sites as well as the development of new end uses to match the intended use.

Implementation and Monitoring

The implementation and monitoring phase of a site activity includes construction, startup, monitoring, operation and maintenance, and any other appropriate activities. The Department will assist ADEQ in this phase through the following activities where appropriate: field work, review of groundwater analyses, appropriate groundwater and assured water supply accounting, and any other appropriate activities.

Site Closure

ADEQ must certify that site goals have been attained in order to discontinue cleanup activities. Department staff assist in evaluation of sites and certification of site closure. The Department assists and may need to identify alternative water sources to replace remediated water when sites are closed.

7.4.4.6.2 Department Policies for WQARF Site Cleanup and Management

In general, site plans should be consistent with the management goal of the AMA in which the site is located. A.R.S. §§ 49-282.06(F); 45-105(B)(4)(c). Therefore, the Department will implement policies during the third management period for the management and cleanup of remedial sites in cooperation with the ADEQ. These policies will ensure that AMA goals are addressed when remedial actions are planned. The Department supports proposed remedial projects when they are appropriate, but believes that remedies

must make sense from a groundwater management perspective. The principles which will be used to formulate these policies are described below.

Water should be used consistent with water allocation concepts in Title 45

This policy requires that entities using water withdrawn pursuant to cleanups, whether under CERCLA, WQARF, RCRA, voluntary, or other sites, possess appropriate authorities for the use of groundwater (such as permits or water rights).

The Department supports source control cleanups to protect water sources

Source control, which controls pollution at its source, can be the most cost effective and practicable approach to cleanups. Many wells have been rendered unsuitable for potable use due to migrating contamination. Source control projects to protect wells that are threatened by contaminant migration are generally supported by the Department. Pollution prevention is also a significant component of mitigating contaminant migration.

Any groundwater withdrawn must be put to reasonable and beneficial use

Reasonable and beneficial use of groundwater withdrawn is a policy that applies to all cleanups. Any withdrawals of 100 acre-feet or less annually may qualify for de minimis status and be exempted from beneficial use requirements, but the Department will evaluate de minimis exemptions from this policy on a case-by-case basis. In the case of leaking UST sites, the Department generally exempts sites that annually pump less than 10 or 15 acre-feet.

Contaminated groundwater represents a resource that will be important

Even if groundwater is contaminated, it represents a resource that can be used for both potable and non-potable uses. Potable uses must meet the state AWQSs and federal Drinking Water Standards which govern public consumption of potable water. ADEQ and the Arizona Department of Health Services intend to develop end use standards for non-potable uses that, if implemented, will make large volumes of groundwater usable again. The Department will cooperate in the development of non-potable end use standards and will develop policies for appropriate end uses based on the new standards.

Containment remedies that involve massive groundwater withdrawals to achieve regional groundwater flow control are generally inappropriate and will not be supported by the Department

In some cases, massive groundwater withdrawals of uncontaminated or only slightly contaminated water may be considered to control migration of contaminant plumes or for other purposes. In general, the Department considers these kinds of proposed remedies to be wasteful of groundwater and not very cost-effective.

7.4.4.6.3 Statutory Mandates for the Department's Involvement in the WQARF Program

The 1997 WQARF reform legislation mandates that the Department implement certain water quality programs and provides for expanded Department involvement in water quality management. New Department programs and responsibilities based on the 1997 WQARF reform legislation include the following:

Remediated Groundwater Incentives

The WQARF reform legislation of 1997 directs the Department to include in the management plans developed pursuant to A.R.S. § 45-566 (the Third Management Plans) provisions to encourage the beneficial use of groundwater that is withdrawn pursuant to approved remedial action projects under CERCLA or Title 49, Arizona Revised Statutes. Laws 1997, Ch. 287, § 51(A).

- Remediated Groundwater Incentive for Conservation Requirement Accounting

In order to encourage the beneficial use of remediated groundwater, the Legislature specifically mandated:

> In determining compliance with applicable conservation requirements adopted pursuant to sections 45-566, 45-567 and 45-568, Arizona Revised Statutes, the department of water resources shall account for groundwater withdrawn pursuant to approved remedial action projects under CERCLA or title 49, Arizona Revised Statutes, consistent with the accounting for surface water.

Laws 1997, Ch. 287, § 51(B).

- Remediated Groundwater Incentive for Assured Water Supply Accounting

In addition, the WQARF reform legislation of 1997 directs the Department to consider specified amounts of groundwater withdrawn pursuant to approved remedial action projects as consistent with the management goal of the active management area from which it is withdrawn for purposes of the Department's AWS Program. Laws 1997, Ch. 287, § 52. The Legislature mandated that:

> For each calendar year until 2025, the use of up to an aggregate of sixty-five thousand acre-feet of groundwater withdrawn within all active management areas pursuant to approved remedial action projects under CERCLA or title 49, Arizona Revised Statutes, shall be considered consistent with the management goal of the active management area.

Laws 1997, Ch. 287, § 52(A).

Once the aggregate volume of 65,000 acre-feet of remediated groundwater use by all users in all active management areas is reached in a year, the use of an additional amount of remediated groundwater is consistent with the management goal of the active management area based on a sliding scale. In the third management period, fifty percent of the total volume withdrawn in excess of the 65,000 acre-feet will be consistent with the management goal. Laws 1997, Ch. 287, § 52(B). By the year 2025, the remediated groundwater incentive for assured water supply accounting decreases to zero.

A municipal provider must apply for a remediated groundwater accounting for an assured water supply determination prior to January 1, 2010. The amount of groundwater determined to be consistent with the management goal cannot exceed the amount that the municipal provider is legally obligated to withdraw or use and does not extend beyond 2025. Laws 1997, Ch. 287, § 52(C).

Annual groundwater withdrawals of 250 acre-feet or less that are withdrawn pursuant to an approved remedial action project shall not be debited against the water provider's assured water supply mined groundwater account and shall not be subject to a replenishment obligation. The water provider must notify the Department of its compliance with the exemption. Annual withdrawals of 250 acre-feet or less of remediated groundwater will not count against the 65,000 acre-feet per year total volume. Laws 1997, Ch. 287, § 52(E).

- Coordination with ADEQ in Evaluating Proposed Remedial Actions

Pursuant to A.R.S. § 45-105(B)(4)(c), the Department is required to actively coordinate and confer with ADEQ in evaluating proposed remedial actions to provide ADEQ with information regarding water resource considerations. The Department will coordinate and confer with ADEQ prior to ADEQ's approval or denial of a proposed remedial action project. Once a remedial action project is approved by ADEQ or the EPA pursuant to CERCLA or Title 49, A.R.S., the Department will account for remediated groundwater in accordance with Laws 1997, Ch. 287, §§ 51 and 52. Among other things, the Department will consider the following factors relating to proposed remedial actions in its recommendations to ADEQ:

- Volume of remediated groundwater to be withdrawn

The Department will encourage remedial actions that use the least amount of groundwater necessary to facilitate a project's remedial goal and will discourage remedial actions that are not prudent and efficient from a groundwater management perspective.

- End uses to which remediated groundwater will be put

The Department will encourage end uses that minimize groundwater withdrawals and that are consistent with the safe-yield goal because they will result in no change in groundwater storage. Where remediated groundwater cannot be practicably or cost-effectively re-injected or recharged, the Department will encourage replacing existing groundwater uses with remediated groundwater and preventing new permanent uses which would not have occurred without the incentive to use remediated groundwater and which would continue to rely on groundwater after the remediated groundwater is no longer available.

While individualized circumstances will be evaluated on a case-by-case basis, generally, the Department's beneficial end use preferences are the following, listed in order from most to least preferred based on the impact on the active management area's management goal and the amount of groundwater in storage:

Neutral to local aquifer

a. Re-inject or recharge in the same local area.
b. Replace existing groundwater uses in the same local area.

Neutral to groundwater basin

c. Re-inject or recharge in the same active management area.
d. Replace existing groundwater uses in the same active management area.

Reduce groundwater in storage

e. Replace existing non-groundwater use in the same active management area.
f. Beneficial uses of water for new purposes.
g. Artificial wetlands or artificial lakes.
h. Dispose to the sewer (unless the resulting effluent is re-injected, recharged or replaces an existing groundwater use).

- Achievement of maximum beneficial use of waters and viability of proposed remedial action

Remedial actions must assure the protection of public health and welfare and the environment; to the extent practicable, provide for the control, management or cleanup of hazardous substances so as to allow the maximum beneficial use of the waters of the state; and be reasonable, necessary, cost-effective and technically feasible. A.R.S. § 49-282.06(A).

- Consistency with Title 45

Groundwater withdrawn pursuant to an approved remedial action must be withdrawn and used consistent with Title 45, Arizona Revised Statutes.

Well Inspection, Modification or Replacement

The Department is required by the 1997 WQARF legislation to develop rules for well inspections. An evaluation of the extent of the cross-contamination problem will be performed by the Department in cooperation with ADEQ and other stakeholders.

Construction of New Wells In and Near WQARF Sites

The 1997 WQARF legislation mandates that the Department ensure that new or replacement wells in areas of known groundwater contamination are constructed in such a manner that cross-contamination does not occur. Department staff will screen Notices of Intent to Drill that are submitted to ensure that wells are properly constructed. The Department will establish policies and procedures to implement this directive, including procedures to effectively communicate with well owners and drillers.

Abandonment of Wells in and Near WQARF Sites

Department staff will review and evaluate Notices of Intent to Abandon to ensure that abandonment of wells is done in accordance with Department rules and that potential for cross-contamination is minimized.

7.5 WATER QUALITY ASSESSMENT

A water quality assessment must be included in management plans pursuant to the Code. The assessment provides an overview of water quality concerns in the Phoenix AMA. The following section discusses goals and objectives of the assessment, water quality of renewable and groundwater supplies, the constituents of concern in the Phoenix AMA and their impact on water management, and specific contamination areas in the Phoenix AMA.

7.5.1 Assessment Goals and Objectives

The primary goal of the Water Quality Assessment is to provide a general evaluation of groundwater and surface water quality conditions in the Phoenix AMA and to identify the interface of water quality concerns with the regional water supply. The impact of water quality on water resource management has become more important in recent years due to such factors as stringent water quality standards, conjunctive use of water supplies, groundwater management at remediation sites, and increasing levels of public concern.

The municipal, agricultural, and industrial sectors have distinctive demand patterns and requirements for water quality. For example, state law prohibits direct use of treated effluent for potable use, but treated effluent is used for turf irrigation, agricultural irrigation, cooling towers, and groundwater recharge. Water that is high in total dissolved solids may be inappropriate for agricultural irrigation but may be usable for some industrial applications. Conversely, water that is high in nitrate could provide a good end use for agriculture, but does not meet potable standards. During the third management period, the Department will evaluate the matching of water quality characteristics with appropriate end uses while ensuring compliance with applicable laws and rules for each end use.

7.5.2 Renewable Water Supplies

Renewable water supplies include CAP water, non-CAP surface water, and effluent. The quality of these waters is discussed in this section.

7.5.2.1 Surface Water Other Than Central Arizona Project Water

Surface water quality in the Phoenix AMA is generally good. Most surface water that is not supplied by the CAP is supplied by the Salt River Project (SRP) which comes from the Salt and Verde Rivers. SRP surface water typically contains total dissolved solids (TDS) levels below 500 mg/l (milligrams per liter). TDS concentrations are generally a good indicator of overall water quality. Other constituent parameters of SRP surface water generally meet applicable water quality standards with appropriate treatment.

7.5.2.2 Central Arizona Project Water

Another surface water supply that augments the water supply of the Phoenix AMA is CAP water which is diverted from the Colorado River in an open canal. With appropriate treatment, the quality of CAP water is acceptable for most uses.

Total dissolved solids concentrations in CAP water vary depending on the location within the CAP canal system. Seasonal data for TDS levels at various mileposts along the CAP aqueduct from 1991 through 1994 were obtained from the CAP. The seasonal data for this period ranged from approximately 450 mg/l (milligrams per liter) to 720 mg/l for the Phoenix milepost. At the Coolidge milepost, TDS concentrations ranged from about 480 mg/l to 700 mg/l. More information about levels of TDS is contained in section 7.5.4.3 of this chapter.

7.5.2.3 Effluent

Effluent is defined by A.R.S. § 45-101(4) as "water that has been collected in a sanitary sewer for subsequent treatment in a facility that is regulated pursuant to A.R.S. §§ 49-361 and 49-362. Such water remains effluent until it acquires the characteristics of groundwater or surface water." Sanitary sewers are comprised of any pipe or other enclosed conduit that carries any waterborne human wastes from residential, commercial, and industrial facilities. A.R.S. § 45-101(8).

Effluent treated at municipal wastewater treatment plants is a significant source of renewable water supply in the Phoenix AMA. Although not suitable for human consumption without advanced treatment, effluent is suitable for turf irrigation, agricultural irrigation, sand and gravel washing, and several other industrial applications. Effluent from the 91st Avenue wastewater treatment facility is used for industrial purposes at the Palo Verde Nuclear Power Generating Station. Wastewater reuse rules are developed by ADEQ that establish parameters for wastewater reuse options.

Wastewater treatment facilities currently discharge effluent into stream channels. The two largest facilities in the Phoenix AMA are the 23rd Avenue and 91st Avenue wastewater treatment facilities. The 23rd Avenue facility discharges effluent into the Roosevelt Irrigation District canal system, while the 91st Avenue facility discharges into the Gila River downstream from its confluence with the Salt River. Segments of the Gila River downstream from wastewater discharges have perennial flows. Wastewater discharges require an NPDES permit to ensure that water quality parameters are being met.

Constructed wetlands may be developed to further enhance the treatment of effluent and pre-treat water prior to recharge or reuse. Vegetation and microbial activity in wetlands as well as filtration of effluent through the vadose zone (soil aquifer treatment) improve the quality of water containing high concentrations of nitrate and organic carbon. Constructed wetlands are occasionally used as a treatment for

lower quality surface waters and agricultural return flows. Wetland projects are also being evaluated as enhanced treatment for effluent discharges to meet potentially more stringent NPDES permit requirements. Wetlands also enhance wildlife habitat and serve as an educational and recreational resource for the community.

7.5.3 Groundwater Supplies

Groundwater is one of the most important sources of water in Arizona. Most of the groundwater in the Phoenix AMA is of acceptable quality for most uses. However, some aquifers have been degraded as a result of contamination.

The introduction of contaminants into aquifer systems degrades groundwater quality and threatens public health and the environment. Contaminants can migrate into areas of potable groundwater due to groundwater pumping or regional groundwater flow patterns. Many areas of the Phoenix AMA are projected to remain dependent on groundwater pumping, thereby potentially causing migration of contaminants. The Department's role in managing potential contaminant migration is through involvement in site-specific and non-site-specific water quality management.

Groundwater that has been degraded has limited beneficial uses due to chemical, biological, or radiological contamination and may have high treatment and delivery costs associated with its use. Despite these limitations, the Department considers poor quality groundwater to be a valuable resource for future water management and encourages appropriate uses of this water supply. Matching the highest beneficial use with poor quality groundwater is an important aspect of water management.

The Central Arizona Groundwater Replenishment District, the Arizona Water Banking Authority, and other entities are actively pursuing recharge of excess CAP water within the Phoenix, Pinal, and Tucson AMAs. The impacts of CAP water recharge on existing groundwater quality are not fully understood at this time. Recognizing that there may be groundwater quality impacts resulting from surface water recharge, the EPA requires states to develop a rule for groundwater under the influence of surface water. ADEQ has proposed a rule (A.A.C. R18-11-405), currently under public review, which would require that groundwater under the direct influence of surface water withdrawn from recharge facilities undergo more extensive treatment than groundwater.

7.5.4 Groundwater Constituents and Their Impacts on Water Quality Management

The management of water resources requires an understanding of how water quality impacts aquifer conditions and potential uses. Drinking water quality regulations are developed to ensure that the intended use will not have harmful impacts on human health. The Department and ADEQ evaluate water quality based on ADEQ's numeric and narrative AWQSs as well as EPA's MCLs and SMCLs, commonly expressed as mg/l or micrograms per liter (µg/l). Appendices 7A and 7B provide a more detailed listing of primary and secondary MCLs for selected volatile organic compounds, pesticides, inorganic metals, radiochemicals, and other selected contaminants.

The following sections briefly overview the impact of selected constituents on groundwater management and public health. ADEQ's Arizona Water Quality Assessment was used as a reference to describe the limitations on uses, present and planned remedial activities, and potential uses for poor quality groundwater for each constituent. The Salt River Project water quality report and information from the Department's own databases were used to describe water quality in the Phoenix AMA.

For each constituent, a corresponding map is provided which displays available water quality data for well locations sampled in the Phoenix AMA since 1990. Well sites that produced test results within acceptable water quality standards are displayed in addition to those well locations which exceeded standards. The

groundwater quality maps developed for the constituents depicted on these maps were the result of an interagency effort between the Department and the ADEQ. An interagency team retrieved and analyzed data from a variety of sources including the Department's Registry of Groundwater Rights and Groundwater Site Inventory databases, the ADEQ Groundwater Quality database, and a number of WQARF site project reports.

Other ADEQ databases, such as the UST and Drinking Water Quality databases, were not used because they either did not have compatible well registration identification numbers from which to compare each agency's well information, or they contained non-point source information which cannot be assigned to a specific location such as a well. Consequently, the groundwater quality maps depicted in this section are a product of the practical information available that is compatible with the Department's well identification system and from which both agencies had a high level of confidence in the data presented. The groundwater quality maps provide a general overview of water quality conditions within the AMA. Other reports which are published by the ADEQ may contain additional data which are not reflected on these maps.

7.5.4.1 Nitrate

Nitrates are salts formed from nitrogen compounds and are one of the most common groundwater contaminants detected in Arizona. Low nitrate concentrations in groundwater may originate from natural sources such as organic acids. Elevated nitrate levels are generally attributed to industrial sources, wastewater treatment plants, septic tanks and leach fields, or agricultural fertilizers.

Water containing high levels of nitrate-nitrogen cannot be delivered as a drinking water supply unless it is equal to or reduced below the MCL of 10 mg/l. Adults can tolerate high levels of nitrate-nitrogen, although water containing more than several hundred mg/l can cause gastrointestinal irritation. Water that contains nitrate in concentrations in excess of the MCL can be harmful to infants. Nitrate may also be harmful to livestock at levels exceeding several thousand mg/l.

Nitrate stimulates plant growth and is typically regarded as a desirable constituent under most agricultural and turf irrigated conditions. For this reason, effluent is often sought as a source of irrigation water. Nitrogen fertilizer application rates may be reduced or eliminated if irrigation water contains elevated nitrate levels.

Figure 7-1 displays nitrate well testing data for locations within the Phoenix AMA. Groundwater with nitrate concentrations in excess of the MCL of 10 mg/l is found throughout the Phoenix metropolitan area. Major nitrate concentrations above the MCL are located in West Phoenix, Buckeye, and near Chandler.

7.5.4.2 Sulfate

Sulfate can occur as a natural inorganic constituent of groundwater which originates from the natural dissolution of minerals in aquifers. Elevated concentrations can result from the leaching of industrial wastes and agricultural fertilizers. High sulfate concentrations are often found in aquifers underlying current or historic agricultural lands, mining areas, and areas of natural mineralization.

The EPA has not established a primary MCL for sulfate although it is currently under review. The secondary MCL for sulfate is 250 mg/l. Figure 7-2 illustrates sulfate conditions in the Phoenix AMA. Elevated sulfate levels above the secondary MCL are prevalent in the West Phoenix area, Buckeye, and the East Salt River Valley Subbasin. Sulfate levels for raw CAP water are typically below the established secondary MCL.

Elevated sulfate concentrations in drinking water supplies can cause problems due to taste and laxative effects and can lead to scale formation in evaporative cooling systems. The diverse nature of industrial water requirements creates specific water quality needs for different industries. Some industries require very low sulfate levels while others can use water with elevated sulfate levels. Additionally, high sulfate concentrations in groundwater do not commonly limit agricultural water use.

7.5.4.3 Total Dissolved Solids

TDS content is a measure of the dissolved minerals present in water and is a general indication of water quality. Components of TDS include inorganic compounds such as calcium, magnesium, sodium, potassium, sulfate, bicarbonate, chloride, and silica. In most areas, the primary components of TDS are derived naturally as groundwater dissolves minerals present in aquifers. TDS concentrations can also be elevated by agriculture, industry, and wastewater treatment facility discharges.

The EPA has established an SMCL of 500 mg/l for TDS, primarily for aesthetic reasons. High TDS concentrations which result in scaling and mineral accumulation have been shown to have an adverse economic impact on water distribution systems and household plumbing and appliances. Though no permanent harmful effects have been observed from drinking high TDS water, some people may find the taste of this water to be less desirable than lower TDS water.

TDS concentrations in the Phoenix AMA are depicted in Figure 7-3. Groundwater within the Phoenix AMA exhibits TDS concentrations of up to 3,000 mg/l in the Buckeye area. Most groundwater in the Phoenix area contains TDS at concentrations of 500-1,000 mg/l, with concentrations decreasing with greater distance from the Phoenix metropolitan area. The highest concentrations are found near the Salt and Gila Rivers and in the West Salt River Valley Subbasin.

The concentration of TDS that limits water use varies widely among industries. A few industries (such as the semiconductor industry) require water so pure that they must treat almost any source water to obtain the necessary quality. Other industries, such as sand and gravel operations, can use water with very high TDS concentrations. The application of high TDS water on turf facilities can cause harmful effects to turf quality and to sprinkler heads if proper management techniques are not followed.

7.5.4.4 Metals

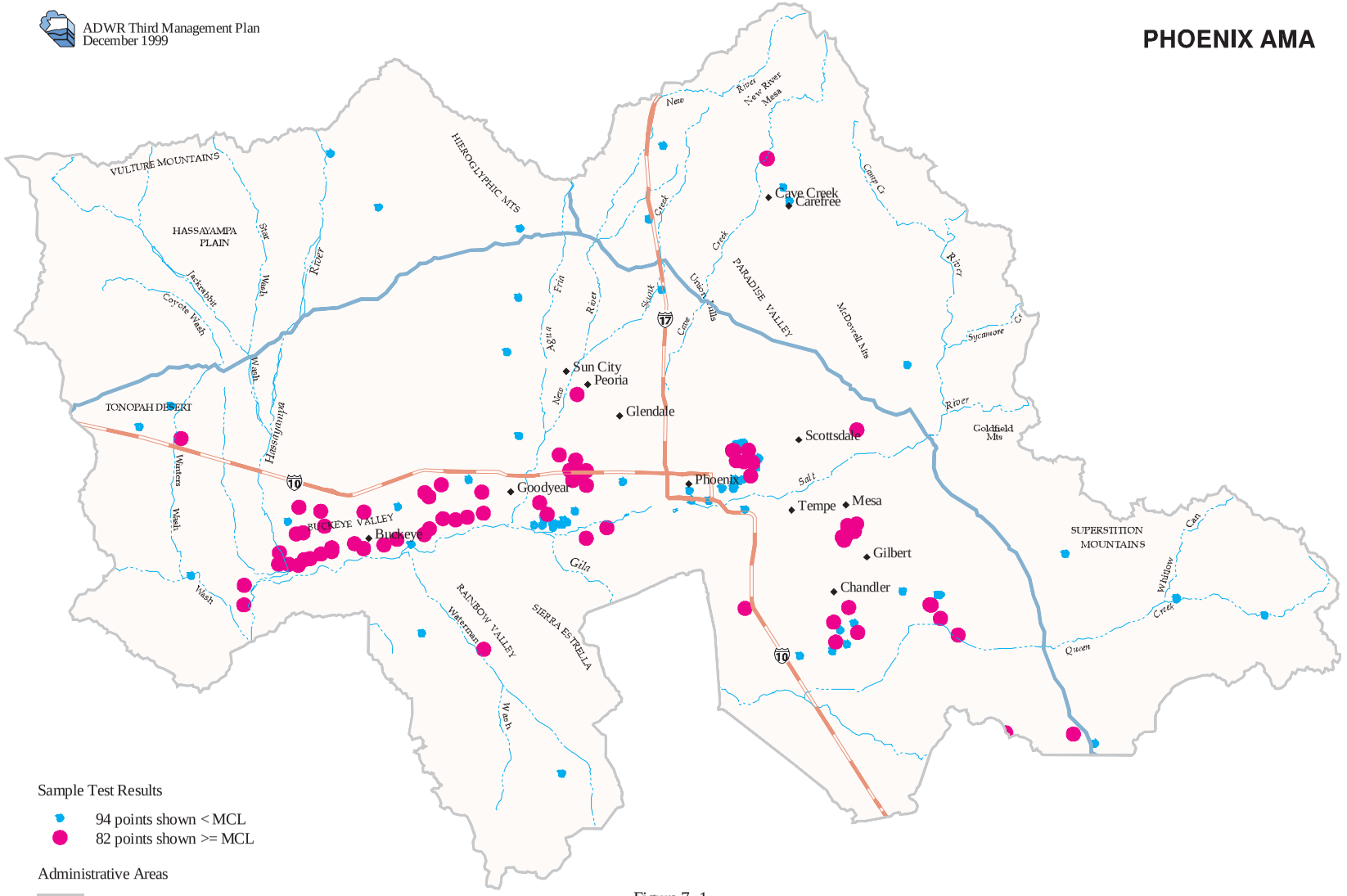
The EPA has established primary MCLs for the following nine metals that occur in drinking water: antimony, arsenic, barium, beryllium, cadmium, chromium, mercury, selenium, and thallium. High concentrations of metals are typically associated with industrial wastes, but certain metals may naturally occur in some aquifers.

Problems with metals are uncommon in the Phoenix AMA, though a few groundwater samples within the Phoenix AMA have exhibited metals concentrations in excess of MCLs. Figure 7-4 displays metal concentrations in the Phoenix AMA.

The health effects associated with exposure to metals vary depending on the constituent and concentrations. Some metals such as selenium and chromium are known to be essential for human nutrition and are beneficial in certain concentrations. Others, such as lead, have no known beneficial effects on human or animal development and are harmful in high concentrations. Limitations imposed on industrial and agricultural water use by high concentrations of metals vary considerably depending on the contaminant present and the associated use.

ADWR Third Management Plan
December 1999

PHOENIX AMA



Sample Test Results

- 94 points shown < MCL
- 82 points shown >= MCL

Administrative Areas

- Phoenix AMA
- Interstate Highways
- Streams
- CAP Aqueduct
- Cities

Figure 7- 1

Water Quality Sample Test Results

Nitrate Nitrogen and Nitrite Plus Nitrate

0 3 6 9 12
Miles

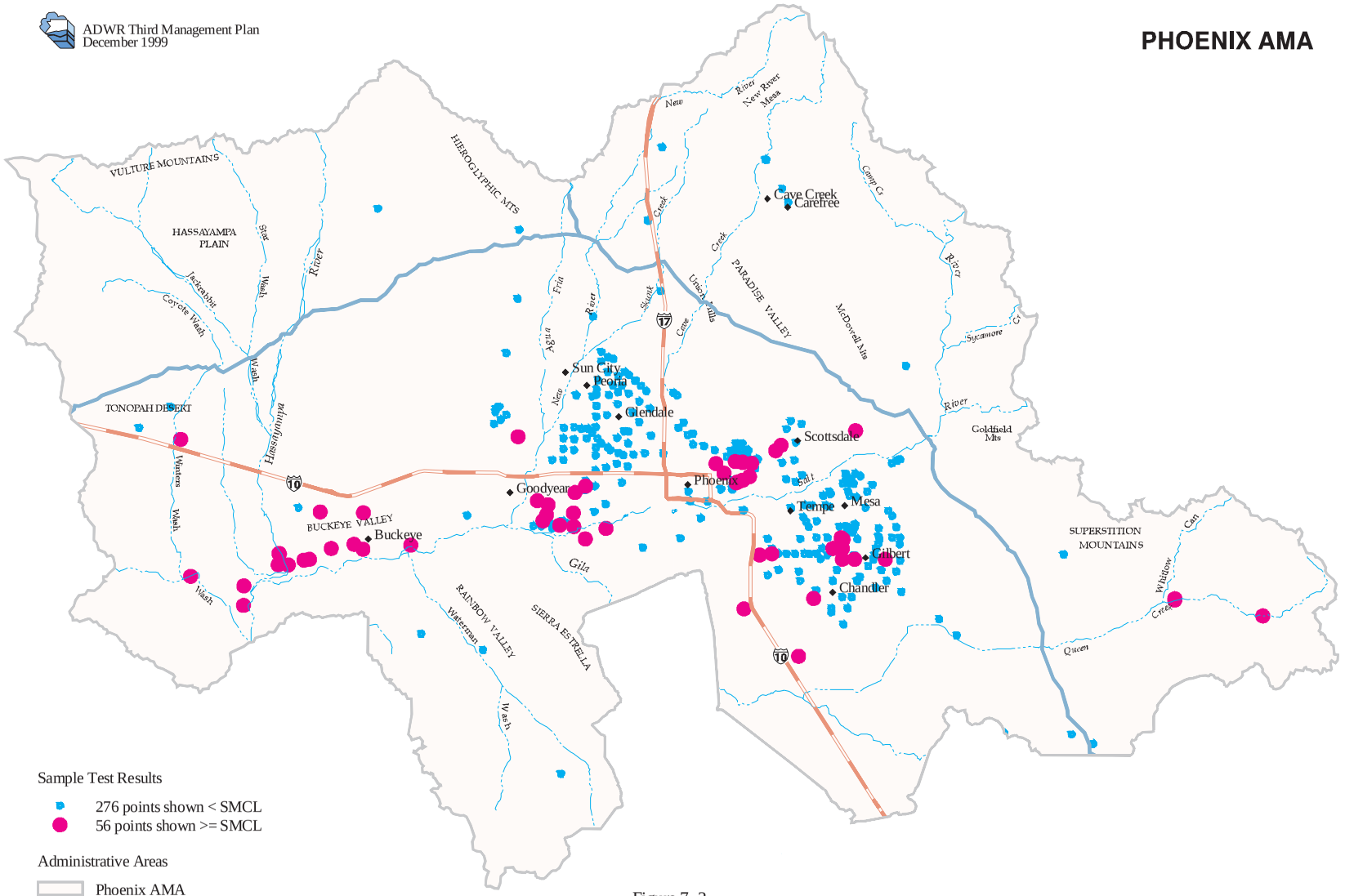
North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality:
Well Locations and Water Quality
Samples since 1990

ADWR Third Management Plan
December 1999

PHOENIX AMA



Sample Test Results
- 276 points shown < SMCL
- 56 points shown >= SMCL

Administrative Areas
- Phoenix AMA
- Interstate Highways
- Streams
- CAP Aqueduct
- Cities

Figure 7- 2

Water Quality Sample Test Results
Sulfate

0 3 6 9 12
Miles

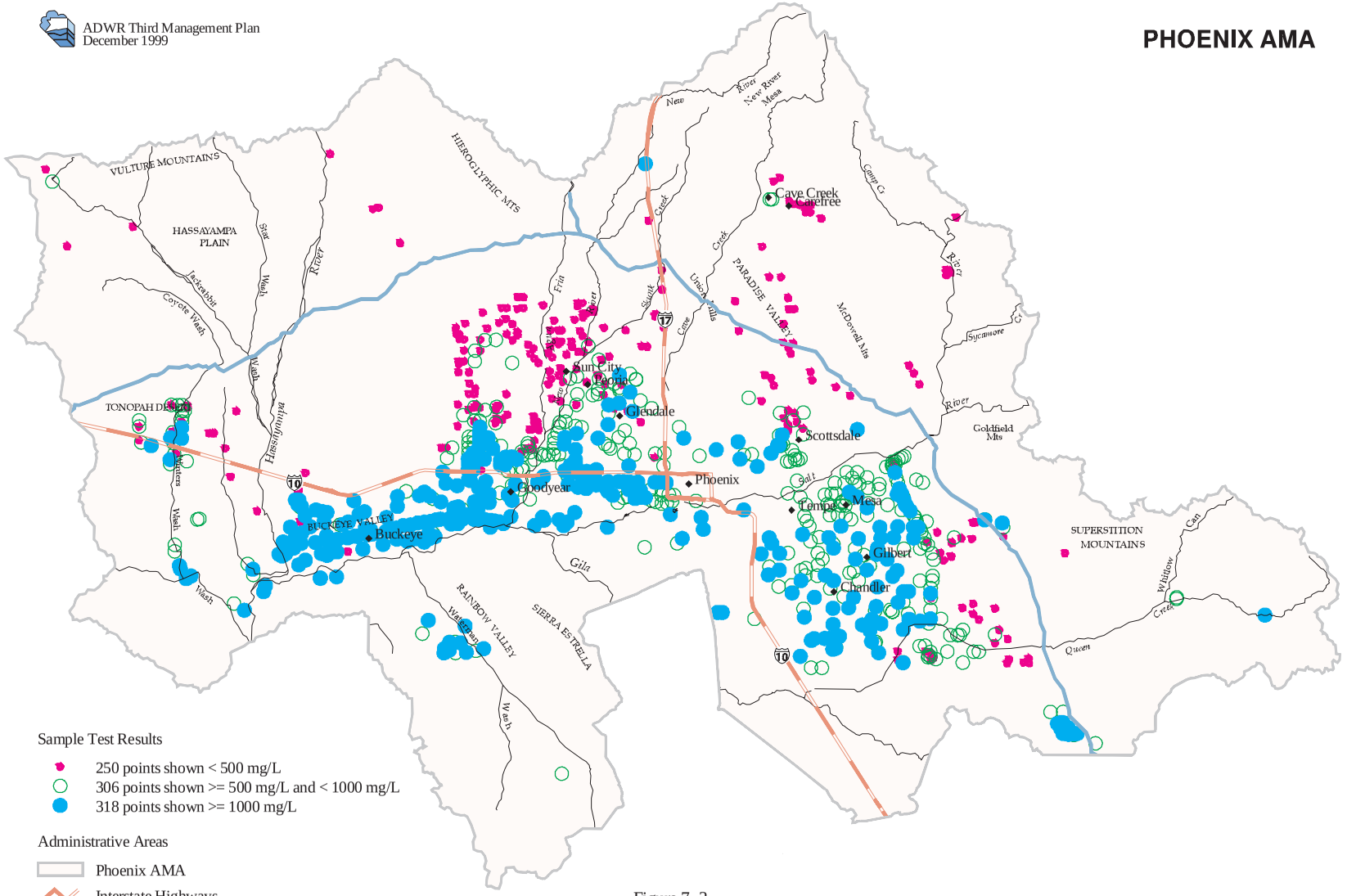
North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality:
Well Locations and Water Quality
Samples since 1990

ADWR Third Management Plan
December 1999

PHOENIX AMA



Sample Test Results

- 250 points shown < 500 mg/L
- 306 points shown >= 500 mg/L and < 1000 mg/L
- 318 points shown >= 1000 mg/L

Administrative Areas

- Phoenix AMA
- Interstate Highways
- Streams
- CAP Aqueduct
- Cities

Figure 7- 3

Water Quality Sample Test Results

Total Dissolved Solids

0 3 6 9 12
Miles

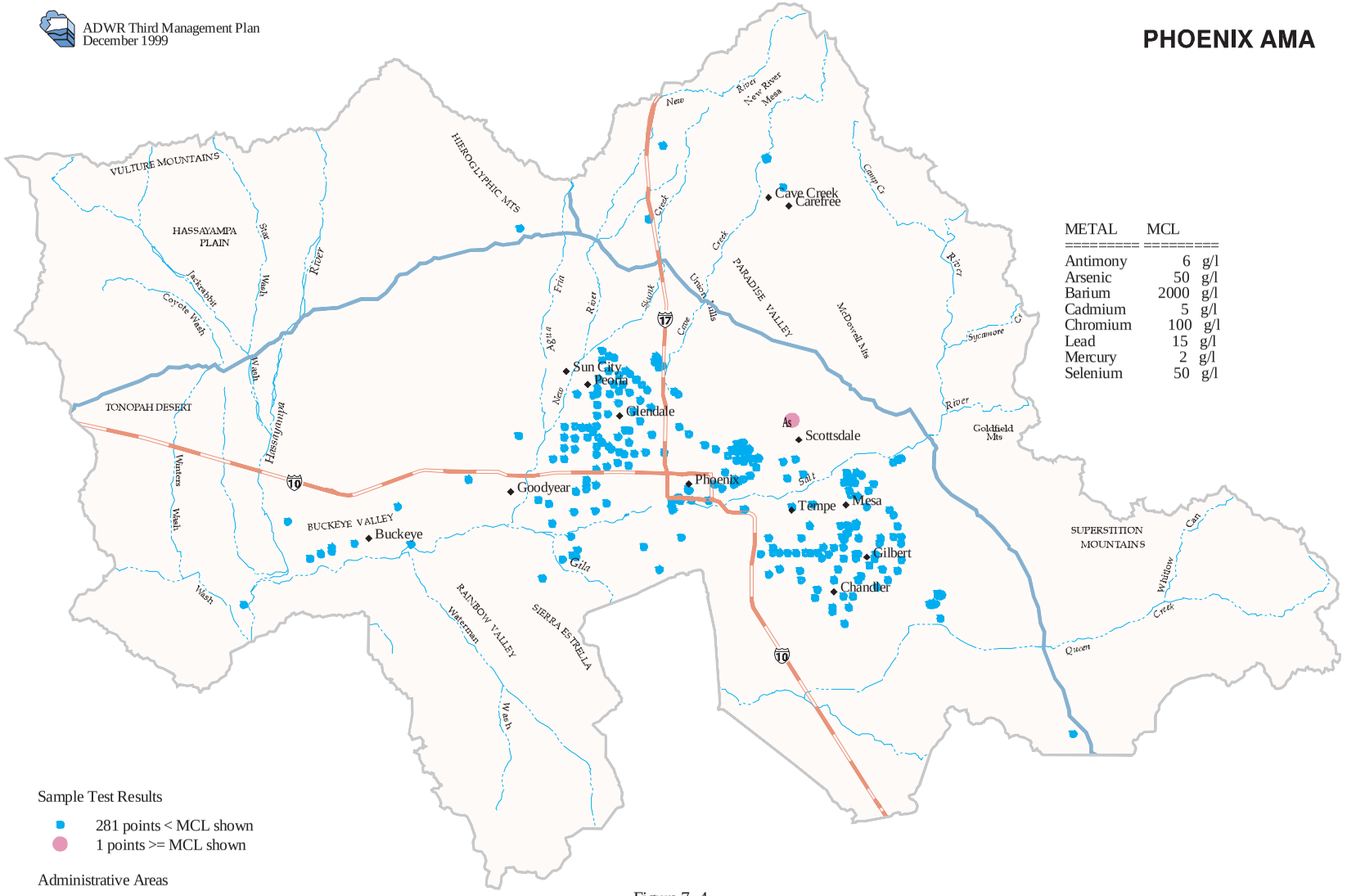
North

ORIGINAL SOURCE

Arizona Department of Water Resources:
GWSI Well Locations
Water Quality Samples since 1990
Calculated from Specific Conductivity

ADWR Third Management Plan
December 1999

PHOENIX AMA



METAL	MCL
Antimony	6 g/l
Arsenic	50 g/l
Barium	2000 g/l
Cadmium	5 g/l
Chromium	100 g/l
Lead	15 g/l
Mercury	2 g/l
Selenium	50 g/l

Sample Test Results

- 281 points < MCL shown
- 1 points >= MCL shown

Administrative Areas

- Phoenix AMA
- Interstate Highways
- Streams
- CAP Aqueduct
- Cities

Figure 7- 4

Water Quality Sample Test Results
Metals

0 3 6 9 12
Miles

North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality:
Well Locations and Water Quality
Samples since 1990

7.5.4.5 Volatile Organic Compounds

VOCs, such as trichloroethylene (TCE) and tetrachloroethylene (PCE), are chemicals that evaporate easily but do not readily dissolve in water. Other VOCs include acetone, vinyl chloride, 1,2-dichloroethane, benzene, 1,1-dichloroethylene, 1,1-dichloroethane, chloroform, toluene, and methylene chloride. VOCs are present in, or are used for the manufacturing of, many substances including degreasers, solvents, plastics, paint, varnish, finish removers, detergent, medicine, and gasoline. When found in groundwater, VOCs are usually associated with industrial areas, landfills, and other sites used for the improper disposal of chemicals.

VOCs are concentrated near WQARF and CERCLA sites in the Phoenix AMA, particularly in central Phoenix, south Scottsdale, north Tempe, near the Phoenix Goodyear Airport, and some other locations. Figure 7-5 displays VOC concentrations within the Phoenix AMA.

Health effects associated with VOCs in drinking water are complex and vary with the types of compounds and concentrations present. Some VOCs such as TCE, are suspected human carcinogens while others have been associated with damage to internal organs. Drinking water supplies which exceed MCLs for VOCs must be treated prior to use.

Potential industrial and agricultural applications of water containing VOCs must be examined on an individual basis.

7.5.4.6 Petroleum Hydrocarbons

This class of contaminants includes non-halogenated hydrocarbons such as benzene, toluene, ethylbenzene, and xylenes, which are ingredients of gasoline and other fuels. Geographical concentrations of these constituents are included as part of the VOC map displayed as Figure 7-5. MCLs have been established for the primary ingredients in gasoline and other fuels. These contaminants can affect groundwater as a result of, among other things, leaking USTs. According to ADEQ, there are over 5,700 leaking UST sites in Arizona. Only a small percentage of these sites are causing groundwater contamination, however. Petroleum hydrocarbons may naturally attenuate over time depending on the physical, chemical, and microbiological conditions in the aquifer.

In Maricopa County, approximately 1,250 open leaking UST facilities were identified out of a total of about 1650 registered open UST facilities. Most of these sites are located within the Phoenix AMA. Some of these leaking USTs have affected groundwater quality. The probable source of contamination at most of these locations is leaking tanks associated with gasoline stations, commercial, and industrial sites. The sites identified have varying degrees of groundwater contamination and are in various stages of remediation. Petroleum hydrocarbon information is not specifically represented on a water quality map in this chapter, although the VOC groundwater quality map encompasses this information indirectly.

7.5.4.7 Pesticides

Pesticides are synthetic organic chemicals which are used as insecticides, rodenticides, and herbicides. Pesticides can be detected in groundwater underlying areas irrigated for citrus. The now banned citrus nematocides ethylene dibromide (EDB) and dibromochloropropane (DBCP) have been detected in groundwater in some areas in the Phoenix AMA, particularly in the West Salt River Valley and the Buckeye area. Figure 7-6 shows pesticide concentrations within the Phoenix AMA. The pesticides EDB and DBCP are the only pesticides which cause major groundwater quality management problems in the Phoenix AMA.

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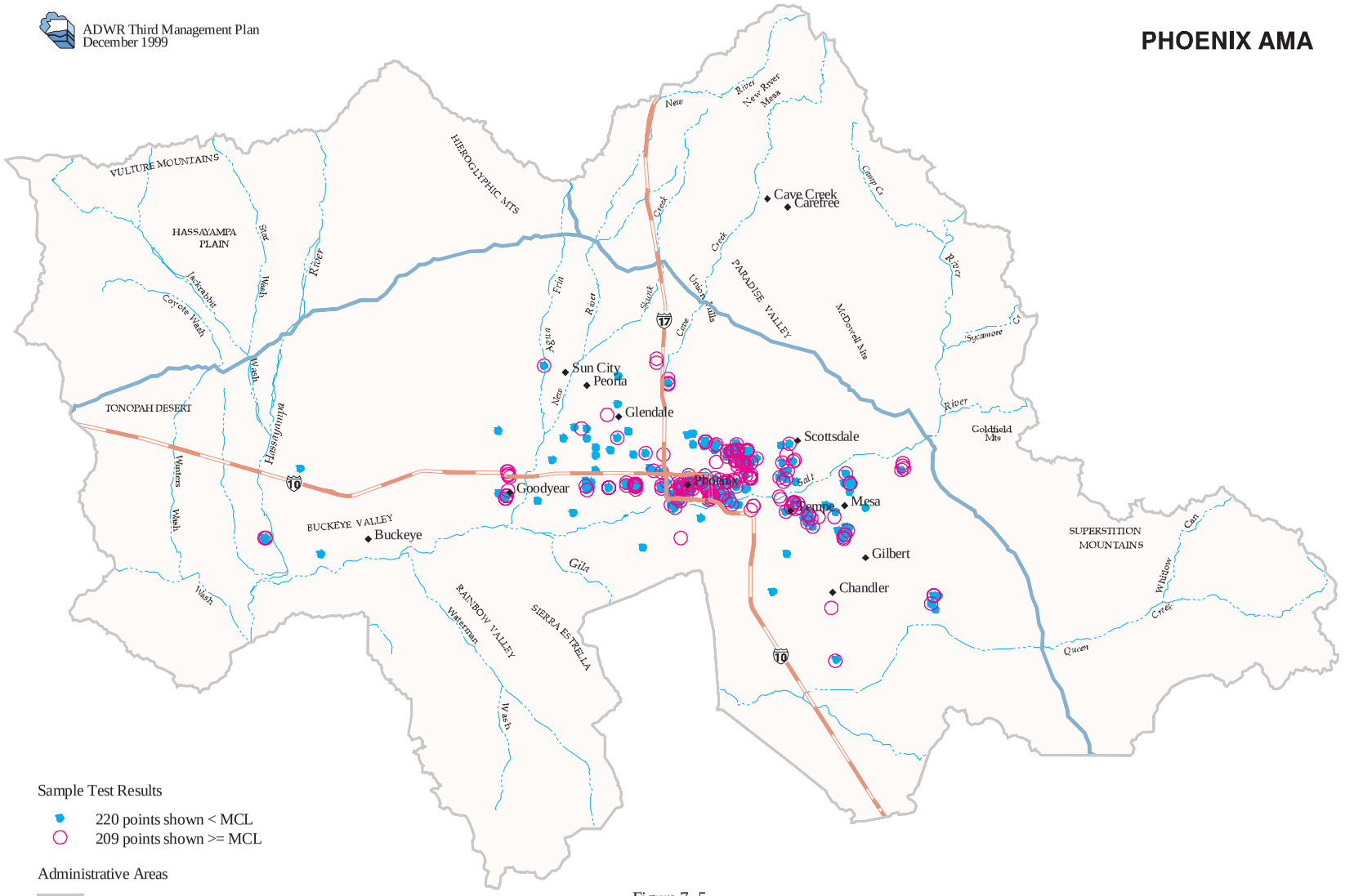
PHOENIX AMA



Sample Test Results

- 220 points shown < MCL
- 209 points shown >= MCL

Administrative Areas

- Phoenix AMA
- Interstate Highways
- CAP Aqueduct
- Streams
- Cities

Figure 7- 5

Water Quality Sample Test Results
Volatile Organic Compounds

0 3 6 9 12
Miles

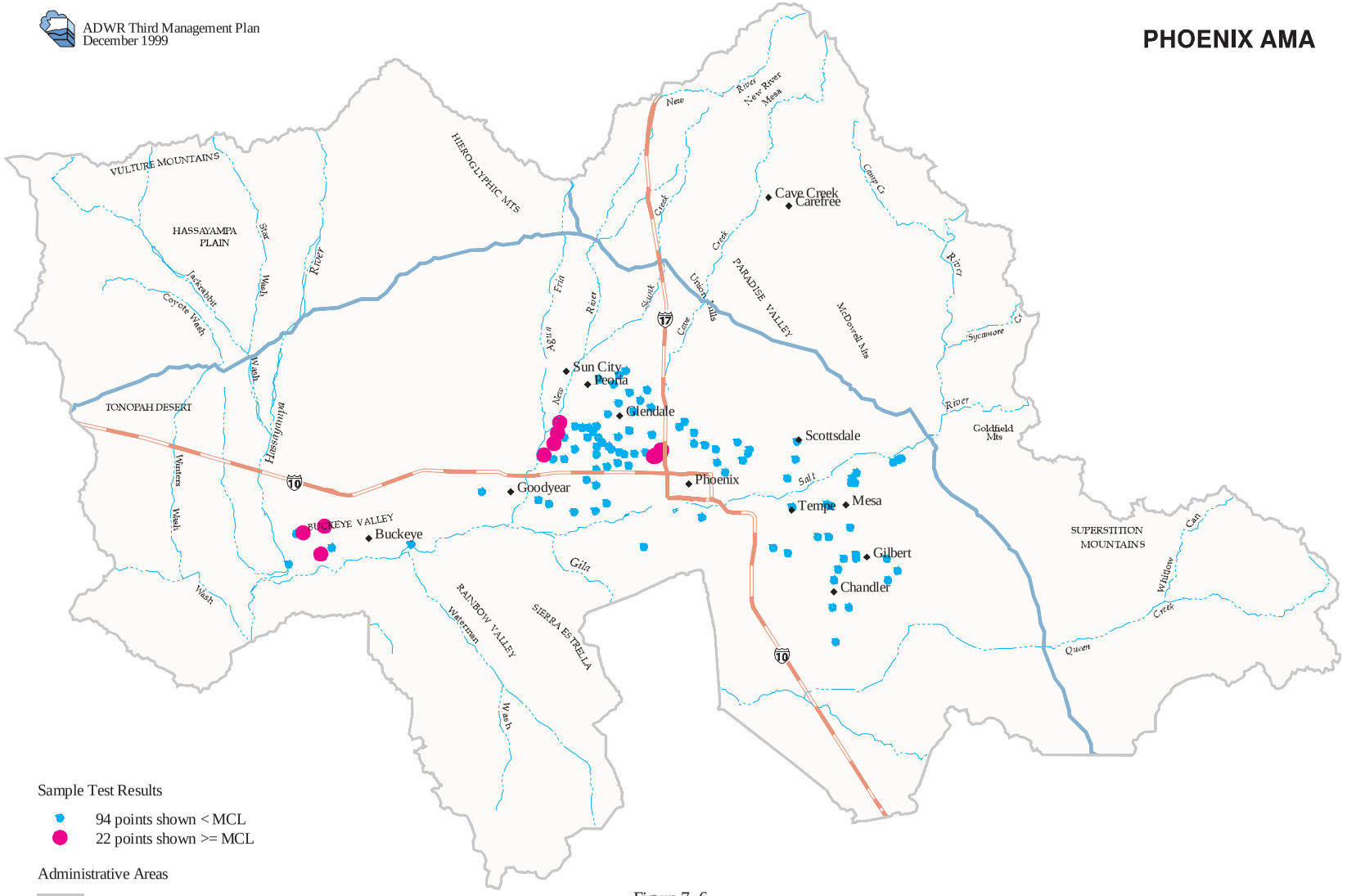
North

ORIGINAL SOURCE

Arizona Department of Water Resources:
Registered Well Locations
Arizona Dept of Environmental Quality:
Water Quality Samples since 1990

ADWR Third Management Plan
December 1999

PHOENIX AMA



Sample Test Results
- 94 points shown < MCL
- 22 points shown >= MCL

Administrative Areas
- Phoenix AMA
- Interstate Highways
- CAP Aqueduct
- Streams
- Cities

Figure 7- 6

Water Quality Sample Test Results
Pesticides

0 3 6 9 12
Miles
North

ORIGINAL SOURCE
Arizona Dept of Environmental Quality:
Well Locations and Water Quality
Samples since 1990

One of the best known pesticides is the chemical compound 1,1,1-trichloro-2,2-bis (p-chlorophenyl)ethane, otherwise known as DDT. DDT is a water-insoluble compound that has a long residual life. DDT was used extensively until it was banned in 1973.

The health effects of pesticide exposure in water are varied and complex, depending on both the pesticide's inert and active ingredients and reaction with substances contained in the water. Drinking water supplies can be affected by pesticide contamination. The presence of pesticides can restrict some industrial water uses such as animal-based industries, because elevated concentrations of pesticides may bioaccumulate (accumulate in living tissue) as they are passed through the food chain. Pesticides that are used for agriculture can also bioaccumulate, thus restricting the use of particular chemicals on edible crops.

7.5.4.8 Fluoride

Fluorides are compounds found in rocks and soil and some industrial waste products. Fluorides are used primarily in manufacturing and as a drinking water additive for the prevention of tooth decay. Fluoride occurs naturally in groundwater, however, its potential for domestic or municipal use depends on the concentration level. Elevated concentrations can cause mottling of teeth and skeletal effects. The EPA primary MCL for fluoride is 4.0 mg/l and the recommended SMCL is 2.0 in order to prevent mottling of teeth.

Concentrations of fluoride in excess of the MCL are found in some areas of the AMA, including east Phoenix, the Hassayampa Subbasin, and other areas. Fluoride concentrations in the Phoenix AMA are shown in Figure 7-7.

7.5.4.9 Radiochemicals

Radioactive elements such as uranium, radon, and radium occur naturally in soil and water at locations throughout Arizona. The federally proposed MCL level for radon is 300 picocuries per liter (pCi/l), but radon in groundwater is not regulated. The EPA is currently collecting data on radon occurrences and conducting a health affects study prior to promulgating a radon standard for drinking water. Inhalation of radon may be harmful when it is released to the air from a contaminated water source. The primary concern of using radon-contaminated water is to ensure that the release of emissions are below air quality standards when processes such as cooling towers, construction aggregate washing and sprinkler irrigation are used.

Due to the lack of available data, groundwater quality maps depicting radiochemical concentrations were not produced for this chapter. Several radioactive elements occur naturally in soil and water. Uranium mining activities which include waste dumps and mine tailings, as well as mine dewatering, can contaminate groundwater with radiochemicals.

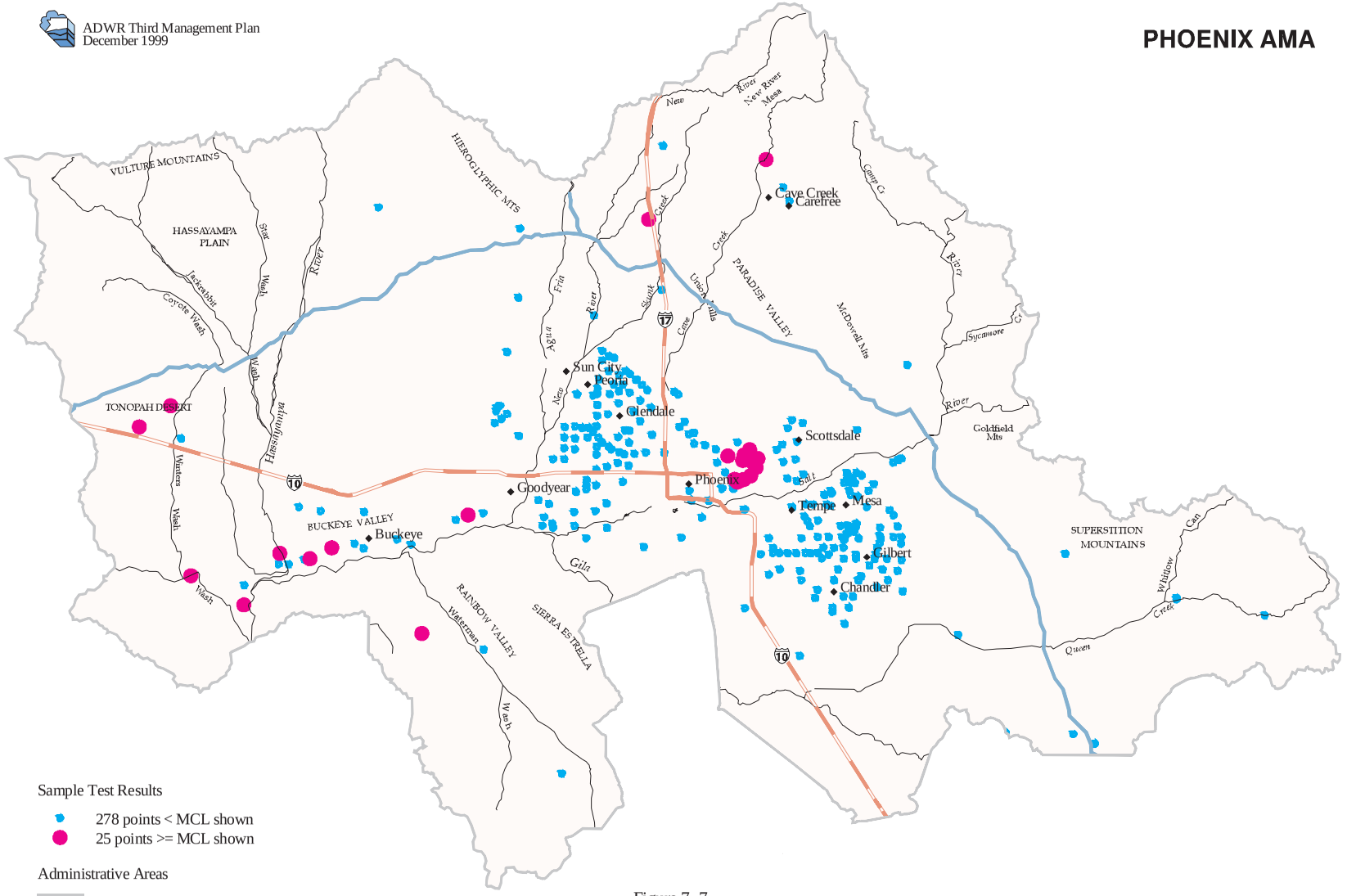
In the Phoenix AMA, naturally occurring contaminants such as radon affect groundwater in some areas which are generally located near hardrock formations.

7.5.5 Specific Contamination Areas

This section contains a description of the specific groundwater contamination areas which have been identified in the Phoenix AMA. Unless otherwise indicated, each of these sites are listed on the WQARF Priority List or the NPL. Figure 7-8 shows existing WQARF, CERCLA, or Department of Defense remedial site boundaries located within the Phoenix AMA. A summary of individual remedial sites in the Phoenix AMA are provided below. The status of each remedial site was obtained from the WQARF Quarterly Report submitted to the state Joint Legislative Budget Committee by the ADEQ for the period of July 1, 1997 through March 31, 1998.

ADWR Third Management Plan
December 1999

PHOENIX AMA



Sample Test Results

- 278 points < MCL shown
- 25 points >= MCL shown

Administrative Areas

- Phoenix AMA
- Interstate Highways
- CAP Aqueduct
- Streams
- Cities

Figure 7- 7

Water Quality Sample Test Results
Fluoride

0 3 6 9 12
Miles

North

ORIGINAL SOURCE

Arizona Dept of Environmental Quality:
Well Locations and Water Quality
Samples since 1990

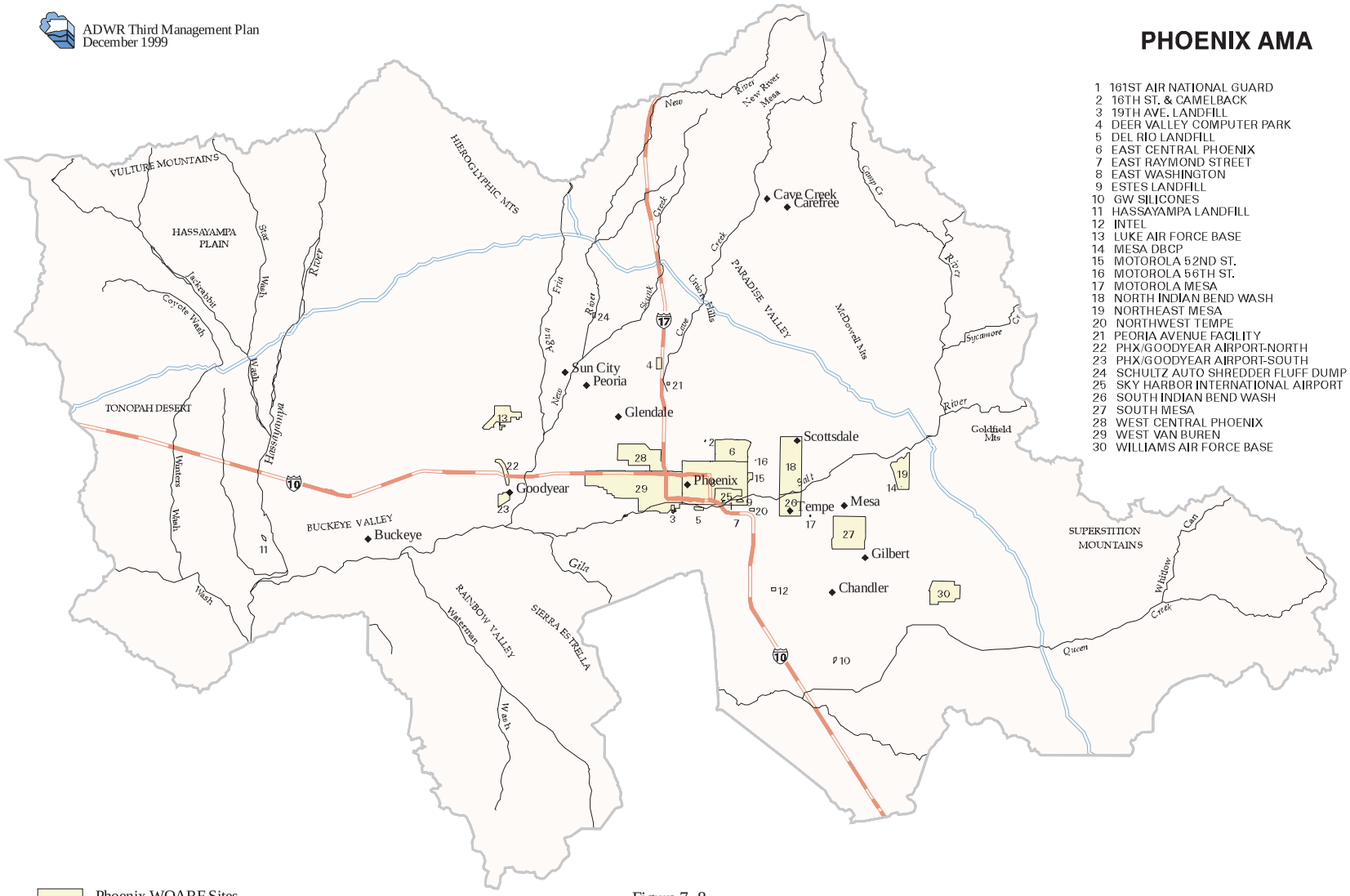


Figure 7- 8

Water Quality Study Areas

ORIGINAL SOURCE

Arizona Dept of Environmental Quality
Geographic Information System

7.5.5.1 Mesa DBCP WQARF Site

This site is located in northeast Mesa and exhibits groundwater contamination from the citrus nematocide DBCP. Concentrations of 0.05-0.93μg/l are present. This project is a treatment facility on one of the wells owned by the City of Mesa. The treatment facility uses carbon beds to absorb the DBCP from the well water. The City is looking to alternatives to reduce operational costs. The well is only in standby service.

7.5.5.2 Northeast Mesa WQARF Site

This site is located in northeast Mesa and exhibits TCE contamination at approximately 64 μg/l in two wells. The extent of contamination is not yet fully defined. The WQARF Site Registry Report and map were completed. The first groundwater sampling round to include all three new monitoring wells was conducted by the ADEQ in February 1998. Wellhead monitoring is planned for the duration of well usage. Additional remedial action may be necessary if monitoring results so indicate.

7.5.5.3 South Mesa WQARF Site

Groundwater at this site contains VOCs. PCE has been found at approximately 40 μg/l. The size of the groundwater contamination plume is not yet fully defined. Wellhead treatment and an additional well are planned. Wellhead treatment is underway as a groundwater cleanup remedy. PCE concentrations in the groundwater have dropped below discharge limitations, thus allowing disconnection of the groundwater treatment system at Baseline Road and Mesa Drive. Quarterly groundwater sampling including eight downtown Mesa areas continues.

7.5.5.4 East Washington WQARF Site

This site is located in east Phoenix and exhibits groundwater contamination from VOCs, particularly TCE, PCE, and DCE. Concentrations are in the 300-600 μg/l range in the northern part of this site. A groundwater data task was completed by an ADEQ contractor in September 1997. A task assignment for Central Phoenix groundwater flow modeling was also initiated in September. Significant work has occurred on the Central Phoenix Groundwater Plume model including sampling of 75 wells, meetings with consultants, and document submittals. The ADEQ is continuing its work to identify potentially responsible parties. Monitoring and investigation is currently ongoing to compile further information to evaluate the site. Plume management, funded by the ADEQ and interested parties, is anticipated to be the planned remedial action.

7.5.5.5 Sky Harbor WQARF Site

Groundwater is contaminated with VOCs at this site near Sky Harbor International Airport in Phoenix. The extent of contamination is not fully defined. The ADEQ is coordinating the groundwater monitoring program of this site as part of the East Washington Area.

7.5.5.6 Estes Landfill WQARF Site

This site is located in Phoenix near Sky Harbor International Airport. Groundwater is contaminated with VOCs, including vinyl chloride, TCE, and DCE. Total VOCs concentrations are as high as 13,057μg/l. Investigations at this site are ongoing. Groundwater in this area has been impacted by VOCs. It appears that a major source of contamination exists in the south-central portion of the Estes Landfill. Quarterly monitoring of groundwater is conducted by the City of Phoenix and the ADEQ. The City completed the remedial investigation and submitted a draft to the ADEQ for review in September 1997. The final remedial investigation and feasibility study (RI/FS) report is expected by March 1999.

7.5.5.7 West Van Buren WQARF Site

This site is located in west Phoenix and is characterized by groundwater contamination by VOCs and metals. Chromium concentrations of 7,000 μg/l and TCE and PCE concentrations in excess of 1,500 μg/l are present. Monthly groundwater elevation data are being collected from approximately 30 wells in the East Washington/West Van Buren site area.

Contracts were awarded for additional investigation activities at the ALSCO site. Drilling of three monitor wells began in March 1998. This site is also encompassed within the Central Phoenix groundwater flow model.

7.5.5.8 East Central Phoenix WQARF Site

This site is located in east Phoenix. Groundwater is contaminated by VOCs, including PCE, TCE, and TCA. PCE concentrations of up to 34,000 μg/l have been detected. The ADEQ installed a soil vapor extraction system as an interim remedy at a dry-cleaning facility to minimize the migration of the PCE contamination from the soils to the groundwater. The system has been temporarily shut down due to negotiations for access to private properties. Soil vapor extraction and groundwater pump and treat are the remedial actions likely to occur at this site. This work will be funded by the ADEQ.

7.5.5.9 West Central Phoenix WQARF Site

This site has been contaminated by VOCs from multiple sources, including PCE in concentrations as high as 95,000 μg/l. The West Osborn Complex Phase II RI/FS Workplan is still being implemented. Groundwater monitoring and water level measurements were collected from all wells. The site is in the process of being split into at least five separate sites which will be placed on the Site Registry after April 1998. Groundwater pump and treat is planned for the final cleanup remedial action.

7.5.5.10 Northwest Tempe WQARF Site

Groundwater at this site, which is located northeast of the Interstate 10/Arizona 143 interchange, exhibits contamination from VOCs, particularly 1,1-DCE. Concentrations of over 60 μg/l have been observed. Investigations to establish contaminant distribution are ongoing. Groundwater pump and treat will be evaluated after sources of contamination are identified.

7.5.5.11 Motorola 52nd Street CERCLA Site

This site is located in east Phoenix and is characterized by groundwater contamination by VOCs, including TCA (up to 5,100 μg/l), TCE, and other contaminants. A partial groundwater remedy has been implemented, and a second remedy is planned. The Operable Unit 1 groundwater pump and treat system is operational. An estimated 550 gallons of contaminated groundwater is being remediated per minute. The Operable Unit 2 remedial design is 30 percent complete.

7.5.5.12 Motorola 56th Street Site

This site is located in east Phoenix near 56th Street and Thomas Road. A plume of contaminated groundwater extends to approximately 42nd Street and Thomas Road. TCE concentrations of up to 1,600 μg/l have been detected. Monitoring efforts are ongoing, with 100 groundwater quality samples taken by the ADEQ from July 1997 through March 1998.

7.5.5.13 Motorola Mesa Site

A groundwater contamination plume has been identified at this site at Broadway Road and Dobson Road in Mesa. Groundwater is contaminated with VOCs, most notably PCE and TCE, in concentrations of up to approximately 45 μg/l. Extraction and treatment of contaminated groundwater has been ongoing since 1984.

7.5.5.14 North Indian Bend Wash CERCLA Site

This site is located in south Scottsdale and exhibits groundwater contamination from VOCs, particularly TCE. Concentrations are generally in the 100-500 μg/l range. A groundwater remedy consisting of treatment of contaminated water and distribution in the Scottsdale municipal system has been implemented. A second remedial action, consisting of a central treatment plant for the Paradise Valley Water Company, was implemented in 1996. Additional groundwater source control projects are being studied and will be implemented in the near future.

7.5.5.15 19th Avenue Landfill CERCLA Site

This site is located in west Phoenix on the Salt River banks. Groundwater contamination above MCLs has been detected for vinyl chloride, TCE, DCE, and PCE. A monitoring program and contingency plan have been implemented for the site.

7.5.5.16 Williams Air Force Base CERCLA Site

This site is located in far southeast Mesa. Jet fuel from underground storage tanks has contaminated groundwater. Although the base closed in 1993, remedial actions continue at the site.

7.5.5.17 Phoenix Goodyear Airport CERCLA Site

This site, which is located in Goodyear, exhibits contamination from VOCs, including TCE, DCE, and methyl ethyl ketone at concentrations over 500 μg/l. This site has been divided into two parts, north and south. Remedial actions at the south part of the site consist of groundwater withdrawals, treatment to remove contaminants, and reinjection. Remedial action at the north site consists of groundwater withdrawals, treatment to remove contaminants, and non-potable use.

7.5.5.18 Hassayampa Landfill CERCLA Site

This site is located near Hassayampa, west of the Phoenix metro area. Groundwater is contaminated with VOCs, including DCE, TCA, Freon, and PCE. Total VOC concentrations are as high as 1,359 μg/l. A groundwater remedy has been implemented at this site.

7.5.5.19 Deer Valley Computer Park Site

This site is located in northwest Phoenix near Thunderbird Road and Interstate 17. Elevated concentrations of VOCs, including TCE (1.5 to 1,250 μg/l), have been detected in groundwater. Remedial actions consist of pumpage, treatment, and re-injection.

7.5.5.20 Honeywell-Peoria Site

This site is located in northwest Phoenix on Peoria Avenue east of Interstate 17. Groundwater contamination from VOCs in the 55 to 59,000 μg/l range has been detected. A groundwater remedy consisting of withdrawal, treatment, and re-injection is projected to be implemented by 1998 or 1999.

7.5.5.21 Great Western Silicones Site

This site is located in south Chandler, east of Interstate 10. Groundwater is contaminated with VOCs, including DCE, PCE, and Freon-113. PCE has been detected at concentrations up to 17.8 μg/l. A groundwater remedy has been implemented. Remediated groundwater is used for landscape and crop irrigation.

7.5.5.22 16th Street and Camelback Site

This site is located in east Phoenix and exhibits groundwater contamination from VOCs. PCE has been detected at 252 μg/l and 1,2-dichloroethane has been detected at 120 μg/l. ADEQ has installed monitoring wells and is planning additional investigations at this site.

7.5.5.23 Glendale Avenue Landfill Site

This site comprises 320 acres and is located just east of the Agua Fria River between Glendale and Northern Avenues. Groundwater in the area has been found to be contaminated with chromium, arsenic, and nitrate. Groundwater is monitored quarterly.

7.5.5.24 Capitol Castings Site

This site is located on south Kyrene Road in Tempe. Groundwater is contaminated above MCLs with VOCs (including 1,1-dichloroethylene and 1,2-dichloroethane), and petroleum hydrocarbons.

7.5.5.25 Del Rio Landfill Site

This site, located near the Salt River and 16th Street in Phoenix, is being voluntarily investigated by the City of Phoenix.

7.6 SUMMARY

Most groundwater supplies in the Phoenix AMA are of acceptable quality for most uses. However, human activity and natural processes have resulted in the degradation of groundwater quality in some areas to the extent that it is unusable for many purposes. The extent and type of contamination varies by location and land use activities. In general, contaminated groundwater has afflicted the upper aquifers throughout a large part of the Phoenix AMA with dissolved solids, nitrates, and other contaminants. Waterlogging down gradient of Phoenix has required drainage pumpage of groundwater with high concentrations of TDS. Pumpage centers that provide potable water can and do influence the migration of poor quality water in many areas of the AMA. The WQARF sites identified in the Phoenix AMA are in varying stages of development, from remedial investigations to actual site cleanup.

As WQARF activities progress, addressing water management issues such as available supply and reuse options will become essential to ensure a long-term water supply of adequate quality. The ability to recognize specific groundwater management requirements for contaminated and degraded aquifer conditions will also become increasingly important as the demands for water increase.

During the first and second management periods, the ADEQ emphasized pump and treat remedies to cleanup poor quality groundwater in aquifers within the AMA. Success was limited, however, due to lengthy periods of litigation which have seriously restricted actual cleanup activities. With the advent of the WQARF reform package of 1997, a new approach emphasizing incentives to cleanup and flexibility in the selection of remedies was developed to improve the likelihood that sites will actually become remediated.

The 1997 WQARF reform legislation creates an incentive for the use of groundwater withdrawn in accordance with approved remedial action projects pursuant to Title 49, Arizona Revised Statutes, or CERCLA. It provides that such groundwater must be accounted for consistent with accounting for surface water for purposes of determining compliance with management plan conservation requirements and that the use of certain volumes of such groundwater is consistent with achievement of the management goal of the AMA until the year 2025. During the third management period, the Department will amend its Assured Water Supply Rules to conform to these provisions. Additionally, permanent rules regarding well spacing and impact will be promulgated by the Department during the third management period. The Department also intends to integrate water quality concerns more fully into its underground water storage programs.

During the third management period, the Department will be committed to enacting and implementing the provisions outlined in this chapter. This commitment will encompass several new provisions and activities summarized below.

- An ongoing groundwater quality assessment in cooperation with ADEQ will assist with the evaluation of existing rules and provisions.

- Integration of groundwater quality management into recharge planning and permitting, and the development of incentives to use remediated groundwater where appropriate.

- Formal permit coordination with ADEQ in order to cooperate on both Title 45 and Title 49 permits. Basin-wide or non-site-specific tracking and coordination of all permits will provide both agencies with a more complete picture of contaminant distribution, groundwater withdrawals, and releases to groundwater and surface water on a basin-scale perspective.

- Evaluation of the need for additional incentives to withdraw and use remediated groundwater within the AMAs throughout the third management period in an effort to match quality with beneficial use. This evaluation will include groundwater that may be contaminated with hazardous, non-hazardous, and naturally occurring substances. Incentives may involve amendments to Arizona Revised Statutes, Title 45, Department rules and policies, or a modification of the management plans.

- The Department and ADEQ will develop and enter into Memorandums of Understanding as necessary to establish, among other things, the division of responsibilities for the implementation of the reformed WQARF program, development of common scopes of work for WQARF sites and other groundwater contamination sites, as well as database development and exchange.

The Department's Water Quality Section, which was established with funding provided by the 1997 WQARF reform legislation, will allow the Department to strengthen its commitment to work closely with ADEQ to resolve groundwater quantity and quality issues. Monies committed by the WQARF reform bill will expedite the cleanup of remedial sites.

Other remedial activities such as those associated with Superfund sites will continue to include the Department's direct involvement. This will ensure that remedial activities meet the Department's water management objectives and are consistent with the AMA's safe-yield goal.

7.7 FUTURE DIRECTIONS

The Department's long range plans for groundwater quality management will focus on two areas: (1) evaluation of groundwater quality issues on a non-site-specific level in order to understand the impact of

groundwater quality issues on water resource management on a broader level and (2) preservation of AMA management goals with emphasis on implementing incentives to use remediated groundwater.

7.7.1 Non-Site-Specific Water Quality Management

Non-site-specific groundwater quality management refers to groundwater quality management activities which may occur in general areas located outside of an identified WQARF or CERCLA boundary.

Significant volumes of groundwater in Arizona have been contaminated or degraded to varying degrees due to human activities. Groundwater contaminated with substances such as nitrate, sulfate, and dissolved solids (major cations and anions) generally result from non-point source pollution and can cause significant service problems for water providers and other water users. For example, groundwater containing high concentrations of TDS can cause scaling problems in cooling towers, is unsuitable for use on some crops, and can cause aesthetic problems in drinking water.

The cessation or decrease of groundwater withdrawals in some areas due to groundwater quality concerns can cause water tables to rise, exposing groundwater to contaminated soils or plume migration to other wells. For example, this condition can exist when soil contaminated by a leaking underground storage tank comes in contact with rising groundwater levels. Contaminated soils associated with landfills may also be inundated by rising water tables. These conditions need to be monitored for impacts on groundwater quality. Ultimately, proper planning will ensure that the impacts of groundwater recharge projects do not contribute to the degradation of aquifer conditions.

To address and mitigate dispersed contamination over large areas, a broader management strategy is needed. Areas which may need more intensive management can include those where public supply wells have been or may be affected by contamination. For instance, areas that are in the vicinity of major population centers or agricultural areas can be affected by contamination, especially if large volumes of groundwater are pumped, creating cones of depression.

The concept of groundwater quality management on a non-site-specific scale (general areas outside of identified site boundaries) will be developed to enhance water management activities in critical areas. The identification of source groundwater quality and the development of area-specific plans to match groundwater quality with the intended use will become an important aspect in the third management period. The Department intends to study the development of area-specific plans that could employ a combination of strategies to evaluate and mitigate the effects of contamination in critical areas. These plans should be developed in coordination with ADEQ and with affected stakeholders. Any contaminant management on a non-site-specific scale will be voluntary and will not affect rights to groundwater, well ownership, delivery responsibilities, or existing permits.

7.7.2 Preservation of AMA Management Goals

The WQARF reform package of 1997 was designed to encourage the remediation of groundwater that has limited or no use due to contamination. Pump and treat groundwater remediation activities are anticipated to increase substantially during the third management period as a result of the remediated groundwater use incentives provided in the WQARF reform package. As a result, previously unavailable sources of groundwater from contaminated areas may be put to considerable use.

Remediated groundwater withdrawals associated with WQARF, CERCLA, Department of Defense, RCRA, and voluntary site cleanups are expected to increase. According to estimates by the ADEQ, significant volumes of poor quality groundwater are projected to be remediated and subsequently withdrawn for beneficial use during the third management period within the Phoenix AMA. Depending on dates of implementation and other factors, estimates for withdrawals of remediated groundwater range

from roughly 75,000 acre-feet to 175,000 acre-feet annually. This estimate may be conservative because remedial activities on known contaminated areas are in different stages of development and due to the potential detection of unknown sites. Other estimates are provided in the Clean Sites West Study available at ADEQ.

In the third management period, the Department will monitor water levels, subsidence, and effects on local water providers at remedial project sites in areas of intensive pumping, which generally are concentrated within the major urban centers of Arizona. While the Department supports the remediation of contaminated groundwater, it also seeks to preserve the management goals of each AMA, of which the most predominant theme is the concept of safe-yield. Water quality management is a lengthy process which will likely continue far beyond the scope of the third management period. Continued remedial activities over the long-term will likely result in considerable volumes of groundwater being pumped, treated, and subsequently used.

The net effect of continued remediated groundwater withdrawals could result in a substantial increase in the overall volume of groundwater put to use within an AMA. Without proper coordination in both water resource and groundwater quality management, these actions could seriously jeopardize the goal of safe-yield by creating new groundwater uses. Remediated groundwater does not represent a renewable water supply. There are limited supplies of poor quality groundwater as well as groundwater of acceptable quality. Consequently, the Department will seek to preserve the intent of the Code and the AMA management goals to protect water resources while cooperating with ADEQ to promote groundwater quality management.

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PHOENIX ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminants in Drinking Water
Inorganics			
Antimony	0.006	Cancer	Fire retardants, ceramics, electronics, fireworks, solder
Arsenic	0.05	Skin, nervous system toxicity	Natural deposits; smelters, glass, electronics waste
Asbestos	7.0 MFL[2]	Cancer	Natural deposits, asbestos cement in water systems
Barium	2.0	Circulatory system effects	Natural deposits, pigments, epoxy sealants, spent coal
Beryllium	0.004	Bone, lung damage	Electrical, aerospace, defense industries
Cadmium	0.005	Kidney effects	Galvanized pipe corrosion; natural deposits, batteries, paints
Chromium (total)	0.1	Liver, kidney, circulatory disorders	Natural deposits; mining, electroplating, pigments
Cyanide (as free cyanide)	0.2	Thyroid, nervous system damage	Electroplating, steel, plastics, mining, fertilizer
Fluoride[3]	4.0	Skeletal and dental fluorosis	Natural deposits, fertilizer, aluminum industries
Mercury	0.002	Kidney, nervous system disorders	Crop runoff; natural deposits; batteries, electrical switches
Nickel	Remanded	Gastrointestinal distress, skin irritation, respiratory congestion	Food, water, metal alloys
Nitrate (as N)	10.0	Methemoglobulinemia	Animal waste, fertilizer, sewage natural deposits, septic tanks
Nitrite (as N)	1.0	Methemoglobulinemia	Same as nitrate; rapidly converted to nitrate
Total nitrate/nitrite	10.0	Methemoglobulinemia	Animal waste, fertilizer, sewage natural deposits, septic tanks
Selenium	0.05	Liver Damage	Natural deposits; mining, smelting, coal/oil combustion
Thallium	0.002	Kidney, liver, brain, intestinal	Electronics, drugs, alloys, glass

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PHOENIX ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminants in Drinking Water
Volatile Organic Chemicals			
Benzene	0.005	Cancer	Some foods; gas, drugs, paint, pesticides, plastic industries
Carbon tetrachloride	0.005	Cancer	Solvents and degradation by-products
ortho-Dichlorobenzene	0.6	Liver, kidney, blood cell damage	Paints, dyes, engine cleaning compounds, chemical wastes
para-Dichlorobenzene	0.075	Cancer	Room and water deodorants, and mothballs
1,2-Dichloroethane	0.005	Cancer	Leaded gasoline, fumigants, paints
1,1-Dichloroethylene	0.007	Cancer	Plastics, dyes, perfumes, paints
cis-1,2-Dichloroethylene	0.07	Liver, kidney, nervous, circulatory	Waste industrial extraction solvents
trans-1,2-Dichloroethylene	0.1	Liver, kidney, nervous, circulatory	Waste industrial extraction solvents
Dichloromethane	0.005	Cancer	Paint stripper, metal degreaser, propellant, extraction
1,2-Dichloropropane	0.005	Liver, kidney effects; cancer	Soil fumigant; waste industrial solvents
Ethylbenzene	0.7	Liver, kidney, nervous system	Gasoline; insecticides; chemical manufacturing wastes
Monochlorobenzene	0.1	Nervous system and liver effects	Waste solvent from metal degreasing process
Styrene	0.1	Liver, nervous system damage	Plastics, rubber, resin, drug industries; landfill leachate
Tetrachloroethylene	0.005	Cancer	Improper disposal of dry cleaning and other solvents
Toluene	1.0	Liver, kidney, nervous, circulatory	Manufacturing and solvent operations, gasoline additive
1,2,4-Trichlorobenzene	0.07	Liver, kidney damage	Herbicide production, dye carrier
1,1,1-Trichloroethane	0.2	Liver, nervous system effects	Adhesives, aerosols, textiles, paints, inks, metal degreasers
1,1,2-Trichloroethane	0.005	Kidney, liver, nervous system	Solvent in rubber, other organic products; chemical production wastes

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PHOENIX ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminants in Drinking Water
Trichloroethlylene	0.005	Cancer	Textiles, adhesives, and metal degreasers
Vinly chloride	0.002	Cancer	May leach from PVC pipe; formed by solvent breakdown
Xylenes (total)	10.0	Liver, kidney, nervous system	By-product of gasoline refining; paints, inks, detergents
Synthetic Organic Chemicals			
Alachlor	0.002	Cancer	Runoff from herbicides applied to crops
Atrazine	0.003	Mammary gland tumors	Runoff from herbicides used on crops and non-cropland
Benzo(a)pyrene	0.0002	Cancer	Fossil fuels, burning organic matter, coal tar coatings, volcanics
Carbofuran	0.04	Nervous, reproductive system effects	Soil fumigant; some area restrictions apply
Chlordane	0.002	Cancer	Leaching from soil treatment for termites
2,4-D	0.07	Liver and kidney damage	Runoff from herbicides applied to crops, rangelands, and lawns
Dalapon	0.2	Liver and kidney effects	Herbicide on orchards, crops, lawns, road/railways
Dibromochloropropane	0.0002	Cancer	soil fumigant
Di(2-ethylhexyl)adipate	0.4	Decreased body weight	Synthetic rubber, food packaging, cosmetics
Di(2-ethylhexyl)phthalate	0.006	Cancer	PVC and other plastics
Dinoseb	0.007	Thyroid, reproductive organ damage	Runoff of herbicide from crop and non-crop applications
Diquat	0.02	Liver, kidney, eye effects	Runoff of herbicide on land and aquatic weeds
Endothall	0.1	Liver, kidney, gastrointestinal	Herbicide on crops, land/aquatic weeds; rapidly degraded
Endrin	0.002	Liver, kidney, heart damage	Pesticide on insects, rodents, birds; restricted since 1980

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PHOENIX ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminants in Drinking Water
Ethylene dibromide	0.00005	Cancer	Leaded gasoline additives; leaching of soil fumigant
Glyphosate	0.7	Liver, kidney damage	Herbicide on grasses, weeds, brush
Heptachlor	0.0004	Cancer	Leaching of insecticide for termites and very few crops
Heptachlor epoxide	0.0002	Cancer	Biodegradation of heptachlor
Hexachlorobenzene	0.001	Cancer	Pesticide production waste by-product
Hexachlorocyclopentadiene	0.05	Kidney, stomach damage	Pesticide production intermediate
Lindane	0.0002	Liver, kidney, nervous, immune circulatory	Insecticide on cattle, lumber, gardens; restricted in 1983
Methoxychlor	0.04	Growth, liver, kidney, nerve effects	Insecticide for fruits, vegetables, alfalfa, livestock, pets
Oxamyl (Vydate)	0.2	Kidney damage	Insecticide on apples, potatoes, tomatoes
Pentachlorophenol	0.001	Cancer, liver, kidney effects	Wood preservatives, herbicide, cooling tower wastes
Picloram	0.5	Kidney, liver damage	Herbicide on grass sod, some crops, aquatic algae
Polychlorinated biphenyls	0.0005	Cancer	Coolant oils from electrical transformers; plasticizers
Simazine	0.004	Cancer	Herbicide on grass sod, some crops, aquatic algae
2,3,7,8-TCDD (Dioxin)	3×10^{-8}	Cancer	Chemical production by-product; impurity in herbicides
Toxaphene	0.003	Cancer	Insecticide on cattle, cotton, soybeans; canceled in 1982
2,4,5-TP (Silvex)	0.05	Liver and kidney damage	Herbicide on crops, right-of-way, golf courses; canceled in 1983

APPENDIX 7A
DRINKING WATER STANDARDS AND HEALTH EFFECTS
PHOENIX ACTIVE MANAGEMENT AREA

Contaminants	Primary MCL (mg/l)[1]	Potential Health Effects from Ingestion of Water	Sources of Contaminants in Drinking Water
Radionuclides			
Combined Radium-226 and Radium-228	5 pCi/l[4]	Bone Cancer	Natural deposits
Gross Alpha[5]	15 pCi/l	Cancer	Decay or radionuclides in natural deposits
Gross beta	4 mrem/yr[6]	Cancer	Decay of radionuclides in natural and man-made deposits
Radon-222 (Proposed)	300 pCi/l	Cancer	Natural sources
Uranium (Proposed)	20 µg/l[7]	Cancer	Natural sources
Microbiology			
Giardia lamblia	TT[8]	Gastroenteric disease	Human and animal fecal waste
Legionella	TT	Legionnaire's disease	Indigenous to natural waters; can grow in water heating systems
Standard Plate Count	TT	Indicates water quality, effectiveness of treatment	
Total Coliform	[9]	Indicates gastroenteric pathogens	Human and animal fecal waste
Turbidity	[9]	Interferes with disinfection, filtration	Soil runoff
Viruses	TT	Gastroenteric disease	Human and animal fecal waste
Total Trihalomethanes	0.1	Cancer	Drinking water chlorination by-products

[1] mg/l = milligrams per liter (all MCLs are in mg/l unless otherwise indicated)
[2] "MFL" means million fibers per liter greater than ten microns
[3] The MCL for fluoride applies to community water systems only
[4] pCi/l = picocuries per liter (30pCi/l is equivalent to 20 µg/l)
[5] Gross particle activity, including Radium-226 but excluding Radon and Uranium
[6] mrem/yr = millirem per year, see ADEQ, Drinking Water Rules source (1) for more information
[7] µg/l = micrograms per liter
[8] Treatment Technology (refer to source (1) for more information)
[9] Refer to source (1) for more information

Sources: Arizona Department of Environmental Quality, Arizona Drinking Water Rules, April 28, 1995
United States Environmental Protection Agency, Office of Water 4304, EPA 822-B-96-002, October 1996
United States Environmental Protection Agency, National Primary Drinking Water Regulations, Appendix A: National Primary Drinking Water Standards (Modified 1/14/98)

APPENDIX 7B
SECONDARY DRINKING WATER STANDARDS[1]
PHOENIX ACTIVE MANAGEMENT AREA

Contaminants	SMCLs (mg/l)[2]
Aluminum	0.05 to 0.2
Chloride	250
Color	15 color units
Copper	1.0
Corrosivity	non-corrosive
Fluoride	2.0
Foaming agents	0.5
Iron	0.3
Manganese	0.05
Odor	3 threshold odor numbers
pH	6.5 - 8.5
Silver	0.1
Sulfate	250
Total dissolved solids	500
Zinc	5

[1] Secondary Drinking Water Standards are unenforceable federal guidelines regarding taste, odor, color and certain other non-aesthetic effects of drinking water. States may adopt their own enforceable regulations governing these concerns.

[2] Secondary Maximum Contaminant Levels (SMCLs) units are in milligrams per liter (mg/l) unless otherwise indicated.

Source: United States Environment Protection Agency, Office of Water 4304, EPA 822-B-96-002, October 1996

CHAPTER

8

Augmentation and Recharge Program

8.1 INTRODUCTION

The purpose of the Augmentation and Recharge Program is to encourage the development, delivery, use, and storage of renewable water supplies now and in the future. The Augmentation and Recharge Program, in combination with conservation program efforts, is intended to support achievement of the safe-yield management goal for the Phoenix Active Management Area (AMA). Increasing the use of renewable supplies, particularly Central Arizona Project (CAP) water and effluent, to replace groundwater mining is a key component of achieving safe-yield.

For purposes of this chapter, "augmentation" means increasing the availability and use of renewable water supplies such as CAP and effluent in lieu of groundwater. "Recharge" means storage of water supplies for future use pursuant to the Underground Water Storage, Savings and Replenishment Act.

Although safe-yield remains the Phoenix AMA groundwater management goal, the objectives of the Augmentation and Recharge Program in the third management period reflect an increased awareness and improved understanding of the importance of water management on a smaller scale. An AMA-wide "paper balance" between supply and demand for groundwater does not address local concerns regarding groundwater level declines and subsidence, waterlogging, physical availability problems, and poor groundwater quality, because it allows for substantially variable water level conditions in the AMA. The Third Management Plan incorporates a new focus on water management by taking these site-specific or "critical areas" into consideration, and looks for solutions to the problems where possible.

Conservation activities will continue to play an important role in achieving safe-yield by ensuring the efficient use of the finite groundwater resources of the AMA. However, the augmentation and recharge of renewable water resources will be the principal mechanism by which the AMA can meet its safe-yield and subregional goals. Through its Third Management Plan Augmentation and Recharge Program, the Arizona Department of Water Resources (Department) will use the authorities available to facilitate and encourage the development, efficient use, and recharge of renewable water supplies for the AMA, especially in critical areas.

The state's Recharge Program, authorized under the Underground Water Storage, Savings and Replenishment Act (Arizona Revised Statutes, Title 45, Chapter 3.1), is an important tool in the Third Management Plan Augmentation Program. While the development and direct use of renewable water supplies is an important component of the Augmentation Program during the third management period, the Recharge Program provides a cost-effective means of storing water that is currently available to the AMA but that has no direct use. Additionally, the Recharge Program can be an effective tool in helping to mitigate problems associated with critical areas, depending where storage and recovery occur.

One of the most important factors that will shape the Augmentation Program for the third management period is the unique opportunity to bring excess CAP water into the AMA and store it underground for future use. A substantial supply of CAP water is physically available to augment the AMA's water supply during the third management period, but will be fully utilized at some point in the future. Therefore, taking advantage of this supply and storing it now while it is currently available is an opportunity that must be encouraged to the fullest extent possible. The Arizona Water Banking Authority (AWBA) provides the means to purchase and store CAP water that is not currently economically feasible for direct use, and that would otherwise remain along the Colorado River. Furthermore, the AWBA statutes specify that some of this water may be used "to fulfill the water management objectives" of the Groundwater Code (Code). Taking advantage of this opportunity now while excess supplies are available will be a significant component of the Augmentation Program for the third management period to meet safe-yield and to alleviate some of the problems in critical areas.

While the Department will work with the AWBA to augment the AMA's water supplies for water management purposes, the Department recognizes that the principal responsibility for developing additional water supplies remains with the region's water users. Local water users have invested millions of dollars in the treatment facilities necessary to put CAP water to direct use. Additional investments have been made in treating effluent to high quality standards. Still additional investments have been committed or used to construct storage facilities for both CAP water and effluent so that water supplies not currently put to direct use can be stored for use in the future. The Department will continue to work with the local community during the third management period to encourage these activities and to facilitate them where possible. The Department has limited authority to address water management and augmentation issues that face the AMA. The current scope of the Department's authorities and activities in augmentation and recharge includes the following:

- Statutory roles. The director of the Department is statutorily designated as the representative of the State of Arizona in Colorado River and interstate water issues; advisor to the Secretary of the Interior (Secretary) in allocating water among users; coordinator of Arizona's review and comments on water development proposals by the United States Army Corps of Engineers, Secretary, and Secretary of Agriculture; chairperson of the AWBA; and manager of the state's water rights to ensure achievement of water management objectives.

- Regulatory and permitting authority. The Department's regulatory and permitting authority regarding use of water rights and development of underground storage and recovery projects ensures that these uses of water are consistent with water management objectives.

- Regulatory incentives. Regulatory incentives established in the agricultural, municipal, and industrial conservation programs (chapters 4, 5, and 6, respectively) and the Department's Assured Water Supply Rules (AWS Rules) facilitate the implementation of augmentation activities by water users.

- Staff support to the Arizona Water Banking Authority and the Arizona Water Protection Fund. The Department's staff assists the AWBA and the Arizona Water Protection Fund (AWPF) Commission in carrying out their mandates. Both entities are operated in close coordination with Departmental activities.

- Technical and planning assistance. The Department provides technical assistance by reviewing and providing input on proposals for water augmentation and recharge projects, planning and feasibility studies, project operations, and data interpretation.

- Data management and public information. The Department's responsibility for accumulation and dissemination of water use and water supply data provides the information necessary to develop water management plans, implement augmentation projects, conduct research related to increasing available water supplies, and identify areas requiring additional water management.

- Coordination and facilitation of efforts. The coordination and facilitation of augmentation and recharge activities, particularly between jurisdictions and multiple regulatory agencies, are an important component of the Department's statewide and regional water planning responsibilities.

- Financial assistance. The augmentation and conservation assistance fund, as well as specifically budgeted appropriations, provide financial assistance to entities implementing augmentation projects or studies that contribute to achieving the AMA management goal or resolving regional water management issues.

The Department is mindful that, in these early years of CAP water importation, water appears to be plentiful. Indeed, the Phoenix AMA is fortunate to have renewable water resources available to meet the growing demand of its water users. It must be recognized, however, that the CAP represents the last significant new supply of water for the Phoenix AMA for the foreseeable future. It must be used wisely so that the greatest possible use can be made of this and all our water resources. Wasteful uses of water, which will not be sustainable as water becomes scarce in the AMA, should be discouraged. The need to encourage the efficient use of renewable water resources will also shape the Augmentation Program for the third management period.

The remainder of this chapter will more fully describe these considerations and will explain the Augmentation Program for the Phoenix AMA for the third management period in the order listed below:

- An assessment of the groundwater supplies in the AMA
- An assessment of the renewable water supplies that are available to augment the AMA's water supplies
- An assessment of the Augmentation Program in the Second Management Plan
- An assessment of water management issues facing the Phoenix AMA
- The Third Management Plan Augmentation Program goals and objectives
- The Third Management Plan Augmentation and Recharge Program
- Future directions

8.2 PHYSICAL ASSESSMENT OF THE ACTIVE MANAGEMENT AREA

Attaining the safe-yield goal will not necessarily eliminate water supply problems facing the Phoenix AMA water users. Different localities within the AMA have very diverse water supply problems, including groundwater declines and other physical availability problems, subsidence and earth fissuring, poor groundwater quality, and waterlogging. These varied physical conditions and resulting impacts to AMA residents demonstrate a need to develop a subregional management strategy during the third management period.

8.2.1 Groundwater Overdraft

In 1995, groundwater use in the Phoenix AMA was 946,052 acre-feet. This amount is 41 percent of the total demand for water in the AMA. In the same year, "safe-yield recharge" was estimated to be approximately 586,033 acre-feet. Therefore, in 1995, approximately 360,019 acre-feet more water was withdrawn from the AMA's aquifers than returned. Thus, the Phoenix AMA has been using groundwater at more than one and one-half times the rate of aquifer replenishment. (See Table 11-12.)

Projections, based on current use scenario demands, by the Department indicate that the AMA's overdraft will increase to 471,085 acre-feet by 2025. Simultaneously, however, the AMA's population is projected to almost double, from 2.55 million in 1995 to 4.48 million in 2025. The dependability of our water supplies will be crucial as the population grows. (See Table 11-12.)

8.2.2 Local Areas of Drawdown

Groundwater conditions have changed dramatically in the Salt River Valley since 1900 due to an increase in agricultural pumping as described in Chapter 2. As a result, the five areas within the Phoenix AMA have or are experiencing significant drawdown of local water tables. (1) The West Salt River Valley (West SRV), including the areas of Luke Air Force Base, El Mirage, Surprise, and Sun City/Sun City West has experienced water level declines between 300-350 feet. (2) The northeast Phoenix and north Scottsdale water table has declined approximately 300 feet. (3) An area along the Mesa-Apache Junction border has experienced water level declines of more than 350 feet. (4) The Queen Creek area near the San Tan Mountains has had declines up to 400 feet. (5) The Carefree Subbasin has experienced water level

declines exceeding 10-12 feet per year due to growth and development since the 1960s (see Chapter 2, Figure 2-4).

Since 1992, the AMA has seen some improvements in water table elevations valley-wide in the range of 20-120 feet. These improvements are likely due to incidental recharge and artificial recharge, a decline in agricultural pumping, an increase in in-lieu water use, and higher than average stream bed recharge due to precipitation. Certain localized areas dependent on groundwater pumping, however, continue to experience declining water tables (see Figure 8-1).

8.2.2.1 Projected Water Level Trends

While excessive historic groundwater level declines are associated with current problems in regions of the AMA, it is also the rate at which the declines are projected to occur that can increase the cost and reliability of future groundwater supplies. Exacerbating these problems are the regulatory authorities that allow groundwater mining by residual pumpers to continue. This section summarizes the decline projections in the AMA and frames the regulatory problems that contribute to these projections.

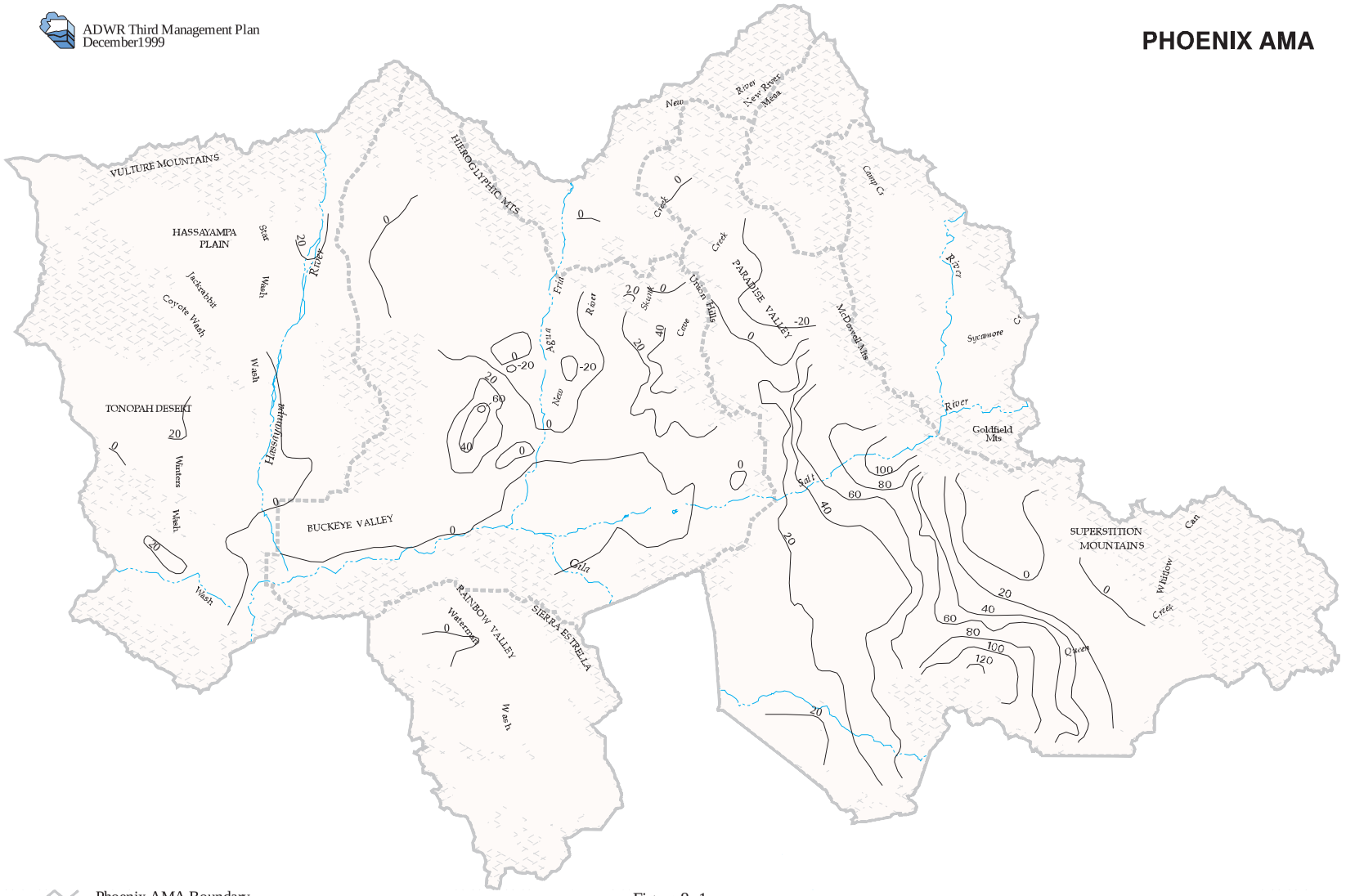
The Department, through its regional groundwater flow model of the Salt River Valley, has projected water level trends into the future based on extensive data gathered from municipalities, irrigation districts, and water companies, and annual water use data collected by the Department. The model projects maximum decline rates to the year 2025 of up to eight feet per year within the West SRV, particularly in the Sun City West area. Decline rates for other areas in the West SRV, including Surprise, El Mirage, Peoria, Youngtown, and a portion of Glendale, are projected to be a maximum of seven feet per year, and projected decline rates in the extreme north Scottsdale area are up to eight feet per year. While these projections to the year 2025 are significant, they do not account for designated providers depleting their respective groundwater allowance accounts beyond 2025, which will further impact the decline rate.

Future trends in water level declines relate to the withdrawal authorities established in the Code as well as groundwater use allocations under the AWS Rules. Existing water right allocations (irrigation grandfathered rights, Type 1, and Type 2 non-irrigation grandfathered rights) and withdrawal permit volumes alone exceed natural and incidental recharge by a factor of about 2.9 in the Phoenix AMA. Although state law mandates no new land be brought into agricultural production in the AMA, agricultural groundwater use may increase if more of the acreage associated with existing water rights is farmed. Industrial water users may acquire new groundwater withdrawal permits (e.g., General Industrial Use permits), may obtain Type 1 non-irrigation grandfathered rights through the conversion of agricultural rights, and may obtain, through purchase or lease, currently unused non-irrigation grandfathered rights to pump groundwater.

Of the agricultural, industrial, and municipal sectors, only new municipal use is legally required to utilize renewable supplies through acquisition of an assured water supply designation or Certificate of Assured Water Supply (Certificate of AWS) for the future. Because all new subdivisions must demonstrate the use of renewable supplies (through direct use or storage and recovery) or join the Central Arizona Groundwater Replenishment District (CAGRD) so that their groundwater pumping will be replenished, most municipal water use will gradually transition to renewable supplies. The transition is an important strategy in reducing the long-term reliance on groundwater. However, it does not reduce the fact that a significant amount of groundwater will be allowed to be pumped under the Assured Water Supply Program (AWS Program), which will further affect groundwater levels and the rates of decline in the AMA. Even at safe-yield, the water levels could be hundreds of feet lower than at present (to a maximum of 1,000 feet below land surface for pumping by designated providers, or lower for non-designated providers and other groundwater users outside of designated service areas).

ADWR Third Management Plan
December1999

PHOENIX AMA



Phoenix AMA Boundary
Water Elevation Change Isolines (Feet)
- 20 Water Level Decline
20 Water Level Rise
Hardrock
River
Grounwater Subbasins

Figure 8- 1

Water Elevation Change
1992 - 1998

0 3 6 9 12
Miles
North

ORIGINAL SOURCE
Arizona Department of Water Resources
Hydrology Division

Therefore, assuming that conservation opportunities are limited, water supply augmentation, retirement of existing rights, and management of new uses are needed to mitigate the groundwater overdraft. These measures could also address severe trends in groundwater level declines in certain parts of the AMA, which could lead to the further potential for degrading water quality, increased pumping costs, and subsidence.

8.2.3 Subsidence and Earth Fissures

As described in Chapter 2, subsidence and earth fissures are occurring in three areas of the AMA (see Figure 8-2). The most notable area is near Luke Air Force Base, where over 18 feet of subsidence reversed the gradient of the Dysart drain and reduced its carrying capacity from 1,000 cubic feet per second to 300 cubic feet per second (Hoff, 1998). Costs were incurred associated with flooding, as well as the repair of various water, wastewater, storm water infrastructures, and hospital and housing facilities. Additional costs to repair, design, and make improvements to the Dysart drain, including, but not limited to, replacing bridges, excavating a new drainage channel, and replacing concrete channel lining to account for additional subsidence until the year 2035 have cost taxpayers approximately $22 million (Wachter, 1997).

Eliminating the withdrawal of groundwater is the only way to prevent subsidence from occurring. However subsidence can continue for years after groundwater pumping has stopped in subsidence-prone areas (Slaff, 1993). Compounding the potential for damage in the AMA is the fact that rapid urbanization is now occurring in many areas where significant future subsidence and earth fissuring is anticipated and groundwater level declines as much as 700 to 800 feet are projected. These areas include Apache Junction, the northwest Salt River Valley Subbasin, Queen Creek, and east Mesa, in addition to currently urbanized areas like Paradise Valley where earth fissuring has already occurred.

Supporting the use of renewable supplies to replace groundwater pumping and increasing underground storage of those supplies (especially at groundwater savings facilities) in areas where future subsidence and earth fissures are predicted will be a strategy to consider in addressing this very serious water management objective in the third management period.

8.2.4 Areas Lacking Physical Supplies

The communities of Carefree, Cave Creek, and Apache Junction have undergone, or are projected to undergo, extensive growth. All groundwater in these areas has been fully pledged for existing and committed demand under the AWS Program and the communities are now limited in their ability to grow unless non-groundwater supplies are acquired. Other areas in the AMA may become problematic in the future as well, such as in Scottsdale and Peoria.

The problems associated with areas having fully committed supplies relates to one of the guiding principles described in Chapter 1. Ensuring reliable amounts of good quality water at a reasonable price is more difficult as water levels decline, groundwater pumping costs increase, and water quality worsens. Adverse impacts on both water quality and economic development in these areas as a result of limited supplies must be avoided to the greatest extent possible. Greater use of renewable supplies instead of groundwater pumping should be encouraged where possible.

8.2.5 Waterlogged and Shallow Groundwater Areas

In contrast to the areas of the AMA experiencing a physical shortage of groundwater, the area of the West SRV in the vicinity of the Buckeye Irrigation Company, the St. Johns Irrigation District, and the Arlington Canal Company is experiencing extremely shallow depths to groundwater, as has been described in Chapter 2, section 2.3.10.

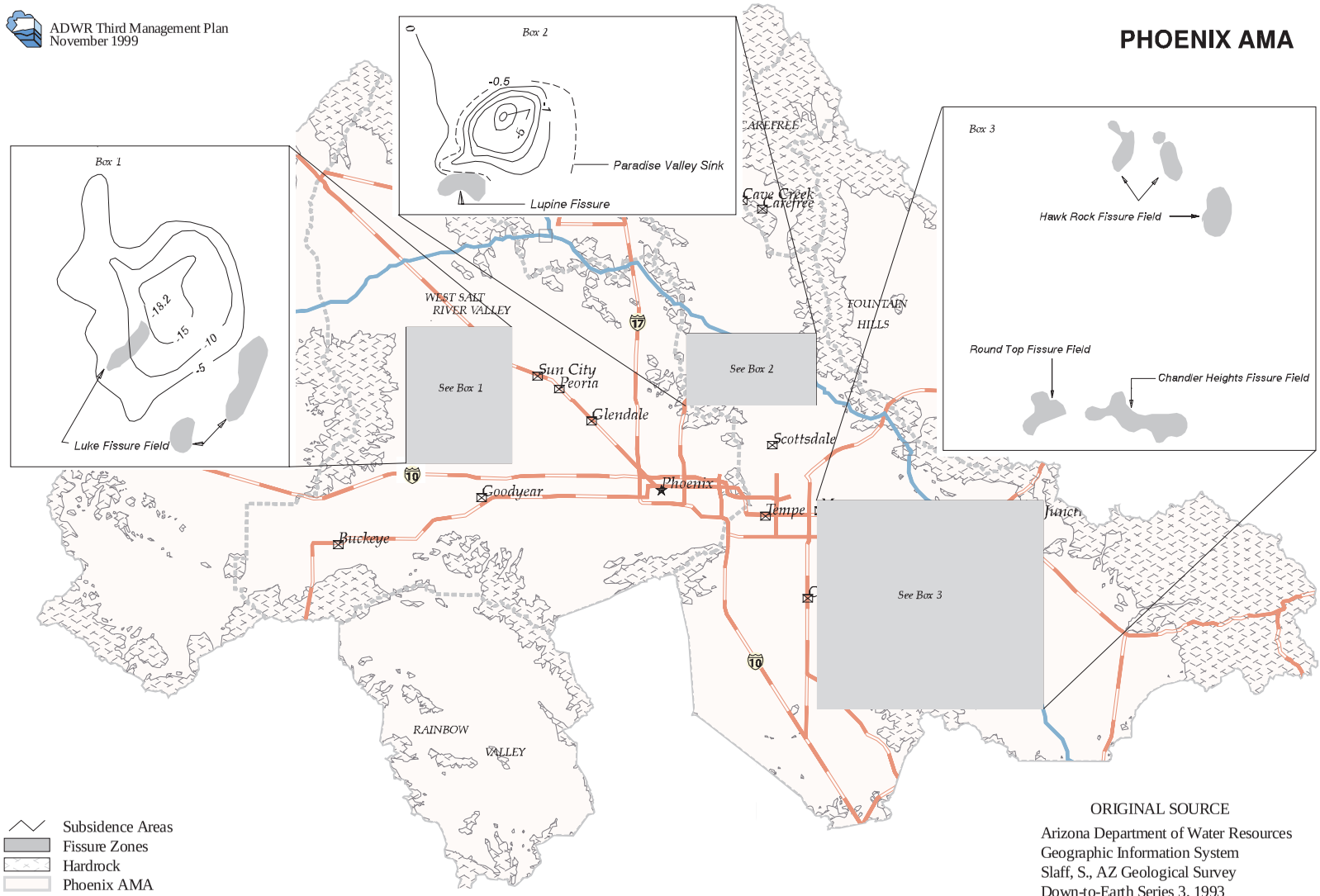


Figure 8- 2

Subsidence and Earth Fissure Zones

ORIGINAL SOURCE

Arizona Department of Water Resources
Geographic Information System
Slaff, S., AZ Geological Survey
Down-to-Earth Series 3, 1993
US Geological Survey
Open-File Report 94-532
Harris, R. C., A Reconnaissance of
Earth Fissures Near Apache Junction
Chandler Heights, and Southern Picacho
Basin, OFR 94-11

Waterlogging has occurred in this area as far back as 1927, when the construction of a nine-mile drainage system was first required (Halpenny, 1984). Since that time, dedicated drainage wells have been operating to remove nuisance groundwater where it is then conveyed to the Gila River via the drainage channels (Montgomery, 1988).

In addition to this area of the West SRV, small localized areas having high water levels in other parts of the AMA, such as in central Phoenix, have needed emergency temporary dewatering to make the desired use of commercial property feasible.

Between 1969 and 1986, drainage pumping totaled 270,775 acre-feet (Montgomery, 1988). This averages approximately 15,000 acre-feet per year. Between 1990 and 1995, drainage and temporary dewatering due to shallow water level conditions exceeded 71,000 acre-feet and averaged approximately 12,000 acre-feet per year. Most of these supplies were not put to direct beneficial use.

8.2.6 Summary

The physical assessment of the Phoenix AMA emphasizes that overdraft of the AMA's aquifers is projected to increase between now and 2025, and shows the severity of local groundwater conditions in several areas of the AMA. At least five localized areas of the AMA, which include areas of the West SRV, north Phoenix and north Scottsdale, Carefree, eastern Mesa, western Apache Junction, and Queen Creek, have experienced significant drawdown of their water tables. In a number of these areas, drawdown is projected to continue at a high rate. A number of these areas have also experienced physical damage to the land surface and infrastructure from subsidence related to the dropping water tables. In some areas of the AMA, physical groundwater supplies for assured water supply purposes are fully pledged. In contrast, areas of the West SRV are experiencing difficulties caused by waterlogging and shallow groundwater. In designing and implementing the AMA's Augmentation and Recharge Program to achieve safe-yield, the Department is considering ways in which the program can also begin to address these localized water management concerns.

8.3 RENEWABLE WATER SUPPLIES ASSESSMENT

The Phoenix AMA has been favored geographically with renewable surface water resources. The confluences in the AMA of the Salt, Verde, Agua Fria, and Gila Rivers have provided the AMA with regular sources of water from the rain and snowfall in the mountains north and east of the desert valley.

Recently, the completion of the CAP has made a significant volume of the state's 2.8 million acre-foot per year allocation of Colorado River water physically available to central Arizona and the Phoenix AMA. This additional renewable supply will play a key role in meeting the future water needs of the AMA, especially while excess CAP water is available through the third management period.

Effluent is the third, and ever increasing supply of renewable resources available to the AMA. Putting more effluent to use will allow the AMA to use its groundwater, surface water, and CAP water multiple times, making those supplies more valuable.

These supplies of renewable water, particularly the unfulfilled potential of CAP water and effluent, can address the AMA's over-dependence on finite groundwater resources and are described herein. To the extent these supplies are not currently being put to direct use but are being stored underground is also described in this chapter in the recharge inventory (section 8.3.4).

8.3.1 Central Arizona Project Water

CAP water has been available to the Phoenix AMA since 1985. Although Colorado River water delivered through the CAP canal has already augmented the AMA's water supplies, the CAP has not yet achieved its full potential benefit in the AMA.

Most of the CAP's water has already been allocated among three user groups–Indian communities, the non-Indian agricultural sector, and the municipal and industrial sectors. Table 8-1 shows the CAP allocations among water providers and Indian Communities. Table 8-2 shows the CAP allocations to irrigation districts in the Phoenix AMA. In the Phoenix AMA, a volume of more than 312,000 acre-feet per year has been allocated among the municipal and industrial sectors. An additional volume of 262,200 acre-feet per year has been allocated among Indian communities for both municipal and agricultural use. This amount includes 173,100 acre-feet per year allocated to the Gila River Indian Community, which has lands both in the Phoenix AMA and the Pinal AMA. Additional Indian settlements have resulted in rights to CAP water by the Fort McDowell Indian Community and the Salt River Pima-Maricopa Indian Community (SRPMIC). The Fort McDowell settlement includes 18,233 acre-feet of CAP water that may be leased for up to 100 years off-reservation within Pima, Pinal, and Maricopa Counties. Of that amount, 4,300 acre-feet has already been leased to the City of Phoenix. The SRPMIC settlement agreement provided for a 99-year lease to Phoenix AMA cities (commencing in the year 2000) of its 13,300 acre-feet CAP allocation. The Ak-Chin Indian Settlement allows for the lease of its 75,000 acre-foot entitlement to users within the Phoenix, Tucson, or Pinal AMAs, of which 10,000 acre-feet has been leased to the Del Webb Corporation in the Phoenix AMA. Additionally, the San Carlos Apache Tribe may lease its 64,135 acre-foot entitlement of CAP water to users in Pima, Maricopa, and Pinal Counties. Finally, the Yavapai-Prescott Indian Tribe was authorized to market its 500 acre-foot CAP allocation to the City of Scottsdale.

Agricultural CAP use was relatively small in the early 1990s, ranging from a high of over 72,000 acre-feet in 1990 to a low of 5,480 acre-feet in 1993. Therefore, the Central Arizona Water Conservation District (CAWCD), the managing entity of the CAP canal, established an incentive pricing program for non-Indian agricultural CAP water, beginning in 1994 and ending in 2011, to encourage greater direct use of these supplies. This restructuring program was established primarily to deal with the inability of the irrigation districts in the Pinal and Phoenix AMAs to meet their obligations to CAWCD under their CAP subcontracts. In exchange for waiving their entitlement to CAP water under their subcontracts, the irrigation districts would receive excess and surplus CAP water. The program, called "target pricing," created three pools of agricultural supplies to be available to the Phoenix, Pinal, and Tucson AMAs. Pools 1 and 2 each contain a total of 200,000 acre-feet, whereas the amount in Pool 3 is not capped. Pool 1 was made available to each district that executed a CAP subcontract prior to October 1, 1993. Pool 2 water was made available to non-Indian irrigation subcontractors who relinquished part or all of their original entitlement between October 7, 1993 and January 1, 1994. The Phoenix AMA pool water allocations are also shown in Table 8-2. Pool 3 water consists of agricultural water remaining after sales of Pools 1 and 2 and is available to agricultural entities otherwise eligible to receive CAP water service at a price equal to pumping energy costs plus a capital charge.

The benefits of target pricing are twofold. First, CAWCD and the Department require the irrigation districts to use the low cost pool water prior to taking any in-lieu water if the district is a groundwater savings facility (GSF). This benefits water management efforts by ensuring that a portion of the agricultural water demand is met with CAP water and not with groundwater– groundwater that is either pumped today or the future pumping of long-term storage credits. Second, no interest is due on the total federal repayment obligation of the CAP canal for water supplied to agricultural lands. Therefore, the more CAP water, including Pool water, used on agricultural lands, the less the overall repayment debt becomes.

TABLE 8-1
CENTRAL ARIZONA PROJECT ALLOCATIONS, 1998
PHOENIX ACTIVE MANAGEMENT AREA

Subcontracts	Allocation (acre-feet)
Municipal and Industrial Subcontracts	
Arizona Water Company - Apache Junction	6,000
Arizona Water Company - White Tanks	968
City of Avondale	4,746
Berneil Water Co.	200
Brooke Water L.L.C.	3,932
Town of Buckeye	25
Carefree Water Company	400
Cave Creek Water Company	1,600
City of Chandler	3,668
Chandler Heights Citrus Irrigation District	315
Chaparral City Water Company	6,978
Citizens Utilities - Agua Fria Division	1,439
Citizens Utilities - Sun City Water Co.	16,215
Town of Gilbert	7,235
City of Glendale	14,183
City of Goodyear	3,381
Litchfield Park Service Company	5,580
Maricopa County Parks and Recreation Department	665
City of Mesa	34,888
New River Utility Company	1,885
Paradise Valley Water Company	3,231
City of Peoria	18,709
City of Phoenix	113,914
Phoenix Memorial Park	84
Queen Creek Water Co.	348
Rio Verde Utilities, Incorporated	812
San Tan Irrigation District	236
City of Scottsdale	45,297
Sunrise Water Company	944
City of Surprise	7,373
City of Tempe	4,315
Water Utilities Community Facilities District	2,919
Water Utility of Greater Buckeye	43
Water Utility of Greater Tonopah	64
West End Water Company	157
SUBTOTAL	**312,749**
Indian Subcontracts	
Ak-Chin	58,300
Fort McDowell	4,300
Gila River Indian Community	173,100
Salt River Pima-Maricopa Indian Community	13,300
Yavapai-Prescott	500
San Carlos Apache	12,700
SUBTOTAL	262,200

Source: CAP, 1998

[1] The original CAP allocation per the CAP Record of Decision was 58,300 acre-feet. The Ak-Chin Settlement Act allocated an additional 50,000 acre-feet of priority 3 water from the Yuma Mesa Division to the Ak-Chin Indian Community. The San Carlos Apache Settlement Act reallocated 33,300 acre-feet of the original CAP allocation for the Ak-Chin to the San Carlos Apache Tribe.

For 1998, costs of Pools 1, 2, and 3 were set at $31, $21, and $43 per acre-foot, respectively. The price of Pools 1 and 2 increases $1.00 per acre-foot annually and the price of Pool 3 will be determined annually.

TABLE 8-2
CENTRAL ARIZONA PROJECT ALLOCATIONS TO IRRIGATION DISTRICTS
PHOENIX ACTIVE MANAGEMENT AREA

I.D.	Original Allocation[1] (%)	Pool 1 Allocation[2] (%)	Pool 1 Supply (AF/YR)	Pool 2 Allocation[3] (%)	Pool 2 Supply (AF/YR)	Total Supply[4] (AF/YR)
CHCID	.28	.38	765	.52	1,037	**1,802**
Tonopah I.D.	1.98	1.11	2,217	1.50	3,005	**5,222**
San Tan I.D.	.77	.93	1,869	1.27	2,533	**4,402**
Queen Creek I.D.	4.83	6.65	13,113	8.88	17,770	**30,883**
New Magma I.D.	4.34	8.68	17,358	11.76	23,523	**40,881**
RWCD	5.98	7.60	15,205	0.00	0	**15,205**
TOTAL			**50,527**		**47,868**	**98,395**

Sources: CAP, 1994; CAP, 1998
I.D. = Irrigation District
CHCID = Chandler Heights Citrus Irrigation District
RWCD = Roosevelt Water Conservation District
[1] Allocation through 1993.
[2] Allocation from 1994 to 2011.
[3] Allocation from 1994 to 2003
[4] Pool 1 supply plus Pool 2 supply.

Table 8-3 summarizes the total amount of CAP water delivered to the Phoenix AMA through the second management period. These deliveries include CAP water delivered for direct use by agricultural, municipal, and industrial users and for recharge at both underground storage facilities (USFs) and GSFs.

TABLE 8-3
TOTAL CENTRAL ARIZONA PROJECT DELIVERIES (ACRE-FEET) 1990-1997
PHOENIX ACTIVE MANAGEMENT AREA

1990	1991	1992	1993	1994	1995	1996	1997
229,305	109,242	200,495	254,726	341,354	409,222	511,307	677,042

Source: CAP Annual Operations Summaries, 1990-1997

Table 8-4 compares the direct use of CAP water for the three water use sectors for the years 1990-1995. The volumes do not include CAP stored in the Phoenix AMA nor do they include contracts for direct delivery by non-regulated customers (i.e., golf courses that are not served by a city or that do not hold withdrawal authorities, etc.)

TABLE 8-4
SECTOR CENTRAL ARIZONA PROJECT USE COMPARISON (ACRE-FEET) 1990-1995
PHOENIX ACTIVE MANAGEMENT AREA

Sector	1990	1991	1992	1993	1994	1995
Agricultural	72,480	26,967	10,102	5,480	142,124	121,238
Municipal	150,827	74,187	92,223	111,476	143,419	151,791
Industrial	395	204	163	311	903	1,530
TOTAL	**223,702**	**101,358**	**102,488**	**117,267**	**286,446**	**274,559**

Although direct use of CAP water is expected to continue to increase during the third management period, full direct use of all CAP water available to the AMA is not expected, primarily due to the lack of infrastructure needed to directly deliver CAP water to the subcontractors. Adding to the unused supply, occasional declarations by the Secretary that surplus conditions exist on the Colorado River may, in some years, increase the amount of Colorado River water available to the state. Unused entitlement (either surplus supplies or subcontracted water that is not ordered and used, known as excess supplies) can be contracted on an annual basis to other users. This provides an opportunity for the AWBA, the CAGRD, and users who would like to order CAP water in excess of their contract to acquire CAP water. Figure 8-3 illustrates the projected excess supplies of CAP water, the mainstream Colorado River supply, and the CAP supply used. The unused entitlement is a temporary resource because, as the Colorado River becomes more heavily utilized, less excess water will be available. Therefore, a significant opportunity exists through the third management period to import into the AMA any CAP water that is available, and not used directly, for underground storage and future use.

Through 1996, many cities, towns, private water companies, and other entities had stored more than 500,000 acre-feet of CAP water for future use, as shown in Figure 8-5. In 1997, its first year of storage, the AWBA stored an additional 164,000 acre-feet of CAP water. These activities will continue to augment the AMA's water supplies during the third management period. As will be discussed later in this chapter, the powers and duties of the AWBA can be of particular use in addressing the AMA's augmentation needs and water management objectives through the storage of CAP water.

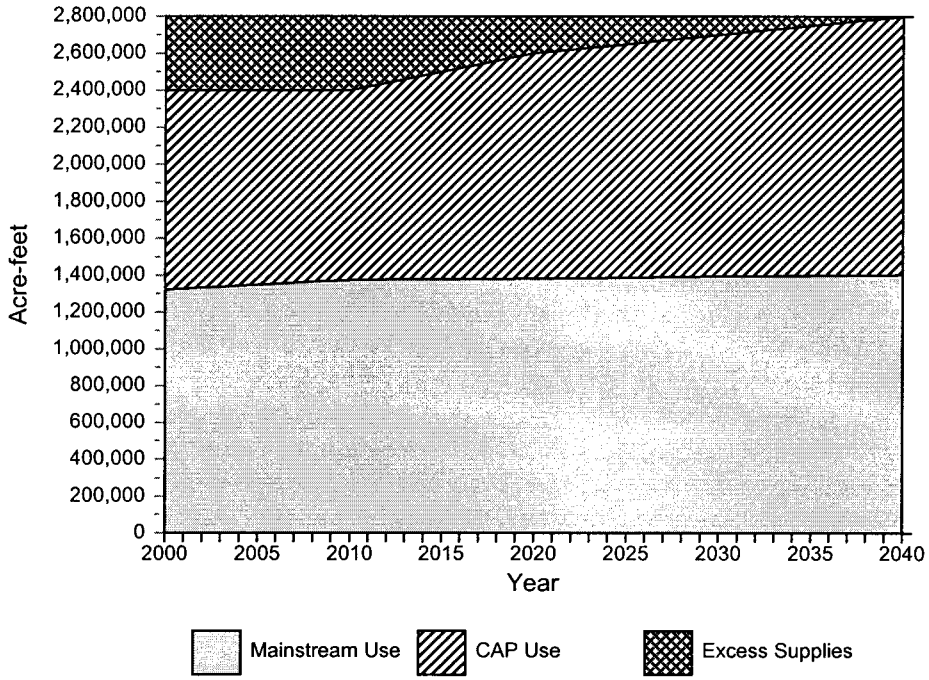
8.3.2 Effluent

Phoenix AMA cities, towns, and water companies have spent millions of dollars in investments to construct wastewater treatment plants and recharge facilities to use and store treated effluent in their service areas over the last decade. Although effluent use has increased during the second management period, the production of treated effluent has also increased with the population growth. Once the excess CAP water is gone, effluent will be our only available and increasing renewable future supply. Although direct human consumption of treated effluent is not expected during the third management period, the potential for greater use of effluent for other direct non-potable uses remains, as well as indirect potable uses through storage and recovery. Storage of effluent underground can improve its quality while preserving it in the AMA for future use. Direct use of effluent and its storage and recovery recycles our water supplies. When effluent is captured and reused, the original source water gets used more than once, and may cycle through the system multiple times prior to its full consumption. This increases the value of effluent as a resource in the Phoenix AMA.

Total effluent generated in the AMA is estimated to be 286,000 acre-feet per year. This figure is based on the 1995 AMA population of 2.5 million multiplied by an average 100 gallons of effluent produced per person per day. By the end of the third management period in 2010, over 374,000 acre-feet of effluent will

be generated per year based on a population of 1,395,725. The single largest use of effluent is 53,000 acre-feet per year used at the Palo Verde Nuclear Generating Station, followed by 30,000 acre-feet per year delivered to Roosevelt Irrigation District, and 30,000 acre-feet per year delivered to Buckeye Water Conservation and Drainage District.

FIGURE 8-3
PROJECTED EXCESS COLORADO RIVER SUPPLIES 2000-2040
STATE OF ARIZONA



The major single source of treated effluent is the 91st Avenue Wastewater Treatment Plant (WWTP). This facility has a capacity of 161.75 million gallons per day (MGD) with an expansion to 184 MGD planned, and has produced an average of approximately 142 MGD, or 159,060 acre-feet, of effluent per year since 1989. Currently all but approximately 53,000 acre-feet (used by Palo Verde Nuclear Generating station) is discharged to the Salt River downstream of the wastewater treatment plant. Natural recharge of the effluent occurs downstream of the treatment plant, which is also downstream from the majority of users in the Phoenix AMA. This discharge has created a riparian area that provides many benefits; however, much of this natural recharge contributes to the Buckeye waterlogged area, and approximately 53,000 acre-feet of the discharged effluent exits the AMA downstream of the 91st Avenue WWTP annually.

During the second management period, many alternatives to discharging effluent from the 91st Avenue WWTP to the Salt River were explored. The two alternatives remaining for the effluent under consideration are: (1) discharge to the Tres Rios constructed wetland and (2) recharge of the effluent into the groundwater aquifer alongside the Agua Fria River (Kinshella, 1998). Both alternatives together have the potential to provide many water management benefits to the AMA.

As shown in Table 8-5, many cities, towns, and private water utilities have constructed wastewater treatment plants within their service areas because they recognize the value of having a reliable water resource that will continue to grow, and remain within each city's control. It is likely that additional facilities will be needed to treat increased amounts of wastewater as the population grows. Placement of

these additional treatment facilities in areas where the effluent can be used within the AMA to offset groundwater use will be crucial to meeting the future water needs of the AMA.

TABLE 8-5
WASTEWATER TREATMENT PLANTS
PHOENIX ACTIVE MANAGEMENT AREA

Treatment Plant	Capacity (MGD)	Average Production (MGD)	Use of Effluent
Apache Junction	2.14	0.49	Stream Discharge
Avondale	3.50	1.80	Stream Discharge
Buckeye	0.60	0.29	Stream Discharge, Agricultural Use
Carefree/Boulders	0.16	0.11	Golf Course Irrigation
Cave Creek WWTP	0.27	0.05	Golf Course Irrigation
Chandler/Ocotillo WWTP	10.00	7.50	Recharge, Turf Irrigation, Cooling Water
Chandler/Lone Butte WWTP	10.00	7.50	Agricultural Irrigation
Sunshine Mobile Home Park	0.10	N/A	Landscape Irrigation
El Mirage WWTP	0.75	0.37	Golf Course Irrigation
Fountain Hills Sanitary District WWTP	1.20	1.19	Turf Irrigation, Fountain
Gilbert WWTP	7.00	5.15	Recharge, Turf Irrigation
Glendale/Arrowhead Ranch WRP	2.50	1.65	Lakes, Discharge to 91st Ave WWTP
Goodyear/157th Avenue	3.00	1.40	Recharge
Goodyear/Estrella	0.20	0.10	Stream Discharge, Proposed Golf Course Irrigation
Goodyear/Loral Defense System	0.45	0.11	Stream Discharge
Luke Air Force Base	1.20	0.55	Stream Discharge, Golf Course and Park Irrigation
Paradise Valley/Indian Bend Wash WRP	0.75	N/A	Flows to 91st and 23rd Avenue WWTPs
Peoria Beardsley WWTP	3.00	0.30	Recharge, Proposed Future Recreation or Irrigation
Mesa/Williams Air Force Base	1.00	0.23	Turf Irrigation

TABLE 8-5
WASTEWATER TREATMENT PLANTS
PHOENIX ACTIVE MANAGEMENT AREA

Treatment Plant	Capacity (MGD)	Average Production (MGD)	Use of Effluent
Mesa/Southeast WRP	4.00	1.97	Turf Irrigation
Mesa/Northwest WRP	8.00	3.60	Recharge, Stream Discharge
Phoenix/91st Avenue WWTP	161.75	142.00	Stream Discharge, Agricultural Irrigation, Palo Verde Nuclear Generating Station
Phoenix/23rd Avenue WWTP	63.00	60.00	Agricultural Irrigation, Stream Discharge
Queen Creek/Rancho Del Rey WWTP	0.02	N/A	N/A
Arizona Boys Ranch	0.02	0.01	Discharge to Leach Fields
Scottsdale/Gainey Ranch	1.70	1.00	Turf Irrigation
Scottsdale/Troon Village	0.40	0.13	Turf Irrigation
Scottsdale/Desert Mountain	0.06	N/A	Turf Irrigation
Scottsdale/Taliesin West	0.02	0.02	Landscape Irrigation
Scottsdale Water Campus	6.00	4.00	Turf Irrigation, Recharge
Sun City West (Citizens)	3.14	2.08	Recharge
Surprise/Litchfield Road WWTP	0.40	0.14	Turf Irrigation
South Surprise WWTP	3.20	1.20	Recharge, Agriculture, Irrigation
Tempe/Kyrene	3.00	1.06	Recharge, Turf Irrigation
Tolleson	17.50	9.30	Palo Verde Nuclear Generating Station

N/A = information not obtained
WWTP = Wastewater treatment plant
WRP = Wastewater reclamation plant
MGD = million gallons per day

Water exchanges have contributed to the increased direct use of effluent in the Phoenix AMA. The 1992 Water Exchange Act laid the legal framework for water exchanges, which has provided opportunities to manage renewable water supplies, including effluent, more efficiently. A three-way exchange between the City of Phoenix, Roosevelt Irrigation District, and the Salt River Project (SRP) has resulted in putting 30,000 acre-feet per year of effluent from the 23rd Avenue WWTP to beneficial use.

Four factors limit the ability to directly use all of the effluent generated in the Phoenix AMA. First, the quality of the effluent is insufficient to directly introduce it into potable water supply systems. Direct use, therefore, is limited to agricultural irrigation, turf watering, and some industrial applications. Second, users of effluent for agricultural irrigation and turf watering purposes have high summer and low winter water demands. However, effluent generation is directly related to indoor water consumption and tends to be higher in the winter months due to winter season visitors. Third, the effluent supply will exceed the demand for effluent for these purposes over time. Fourth, infrastructure is lacking to treat and deliver all the effluent supplies for direct use.

Groundwater recharge allows effluent to be stored during low demand periods and later recovered during high demand periods. Recharge also allows the possibility of indirect potable use of effluent through recovery wells. As of August 1998, there were nine full-scale USFs permitted to store over 33,000 acre-feet of effluent on an annual basis in the Phoenix AMA. Through 1996, a volume of over 47,000 acre-feet of effluent had been stored. See Appendix 8A for a listing of all storage facilities in the Phoenix AMA as of August 1998.

8.3.3 Surface Water

Surface water resources in the Phoenix AMA have historically met and continue to meet a large proportion of the demand for the municipal and agricultural sectors in the AMA. In 1995, use of water from the Salt, Verde, and Agua Fria River watersheds met 40 percent of the demand, over 889,000 acre-feet of water, in the AMA. Surface water supplies are not typically underutilized in the Phoenix AMA because they are an economical source, they are available in most years, and the demand of municipal and agricultural users is in close proximity to the surface water canals.

Salt River Project (SRP) facilities have a maximum reservoir storage capacity of over 2 million acre-feet of Salt and Verde River water. The amount of SRP surface water delivered each year depends on the amount of surface water in storage each year. When reservoirs are low, SRP supplements its surface water deliveries with groundwater to meet customer demand. SRP surface water use is based on decreed and appropriative water rights, and is available only to water users on SRP lands.

Many providers with rights to surface water utilize USFs and recovery wells to manage their surface water supplies. Appropriable surface water generally must be recovered within the same month it is stored. If stored and recovered in this manner, referred to as annual storage and recovery, it is considered a direct use of the supply. Through 1996, approximately 9,000 acre-feet of Salt and Verde River was put to use through annual storage and recovery activity.

8.3.3.1 Plan 6 Water

Plan 6 refers to the development of reservoir facilities for storing CAP water. Plan 6 included construction of New Waddell Dam on the Agua Fria River, modifications to Roosevelt Dam, and the proposed construction of Cliff Dam on the Verde River. The plans to construct Cliff Dam were halted in 1987 due to environmental concerns; however, Phoenix area cities were ensured by the Arizona Congressional Delegation and the Secretary that they would receive water supplies necessary to replace the additional resources that would have been provided by Cliff Dam. This was provided through the assignment of the Hohokam Irrigation and Drainage District agricultural subcontract to the cities in exchange for the payment of private and federal debts related to the district's distribution system.

Plan 6 water provides opportunities for additional surface water resources from the Agua Fria River and the Salt River to augment supplies in the AMA. Waddell Dam on the Agua Fria River was replaced by New Waddell Dam which has an increased storage capacity. The original dam and reservoir stored up to 150,000 acre-feet while the new dam and reservoir store up to 800,000 acre-feet (Maricopa Association of

Governments, 1993). Not only has this increased capacity allowed Colorado River water to be delivered into central Arizona for storage throughout the year (which was not possible previously), it resulted in additional appropriative rights to CAWCD of up to 698,800 acre-feet of Agua Fria River water captured by the increased storage capacity. The Maricopa Water District (MWD) retained the historical appropriative and storage rights associated with the original Waddell Dam.

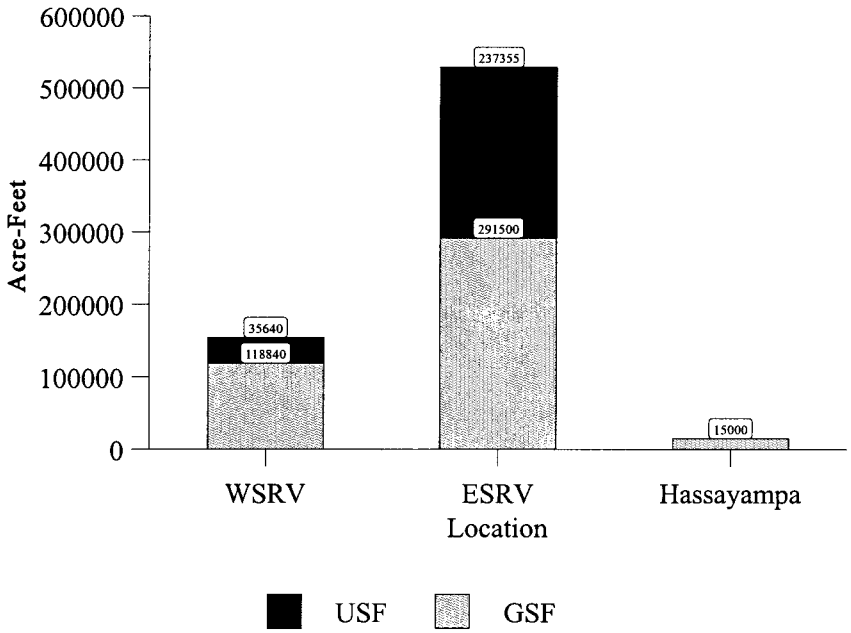
Plan 6 also included modifications to Roosevelt Dam on the Salt River. These modifications increased storage capacity in the reservoir by approximately 255,100 acre-feet, not including flood control space. The appropriative rights to the additional surface water captured by the modified dam were obtained for municipal use by the cities of Chandler, Glendale, Mesa, Phoenix, Scottsdale, and Tempe, who contributed funding toward the construction of the dam modifications. Unlike Salt and Verde River water, this Plan 6 water supply may be used off SRP member lands or recharged underground for long-term storage.

8.3.4 Recharge Inventory

Additional above-ground reservoirs to store renewable supplies are not planned for the foreseeable future; therefore, the greatest potential for increasing storage of these supplies in the AMA is in the development and full use of additional underground storage and savings facilities. Recharge facilities will play an important role in storing currently unused renewable water supplies for future use. Storing water in specific locations to prevent further declines and land subsidence, and also to protect water quality, as described in Chapter 7, are also important water management strategies for the third management period. The locations of current facilities and the siting of future storage facilities with respect to critical areas in the AMA play an important role in water management efforts.

The volume of water currently permitted to be stored at USFs and GSFs in the Phoenix AMA through the second management period exceeds 698,000 acre-feet per year. Figure 8-4 shows the total annual

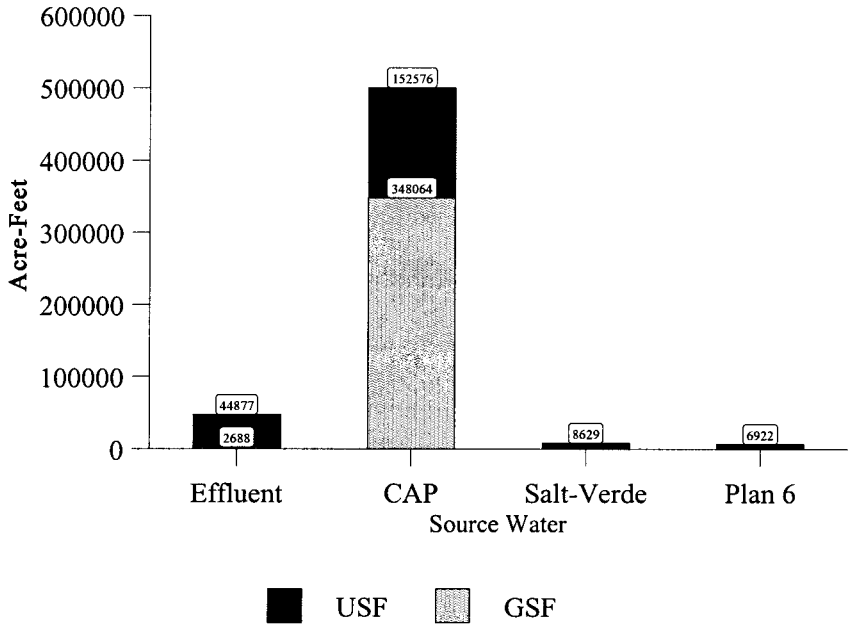
FIGURE 8-4
PERMITTED STORAGE VOLUMES
PHOENIX ACTIVE MANAGEMENT AREA



permitted volumes of facilities in the AMA for each subbasin, through 1996. While the potential storage capacity has grown in both the East and West Salt River Valley Subbasins, the discrepancy among the subbasins in terms of current permitted storage capacity is evident. It should be noted that the Carefree Subbasin, which has been identified previously with physical availability problems, has no storage facilities. Appendix 8A lists all the permitted storage facilities in the Phoenix AMA through the first quarter of 1998.

Figure 8-5 shows over 563,000 acre-feet of underground water storage that has occurred in the AMA through 1996. (These amounts are approximate and do not equate to recovery rights because evaporation, system losses, and other deductions from storage volumes have not been subtracted from these amounts.) The amounts also do not reflect the minimal amount of recovery that has occurred to date– less than 10,000 acre-feet, or approximately 1 percent of total storage.

FIGURE 8-5
TOTAL STORAGE VOLUMES THROUGH 1996
PHOENIX ACTIVE MANAGEMENT AREA



The location of permitted and proposed facilities, as of 1998, is shown on the map in Figure 8-6.

8.4 ASSESSMENT OF THE SECOND MANAGEMENT PLAN AUGMENTATION PROGRAM

The Code did not require the Department to include a water supply augmentation program in the Phoenix AMA's First Management Plan. However, the Code did require the Department to include such a program, including incentives for artificial groundwater recharge, in the Second Management Plan for each AMA. A.R.S. § 45-565(A)(6).

The Augmentation and Reuse Program in the Second Management Plan identified a number of augmentation measures designed to encourage and facilitate the augmentation of the AMA's water

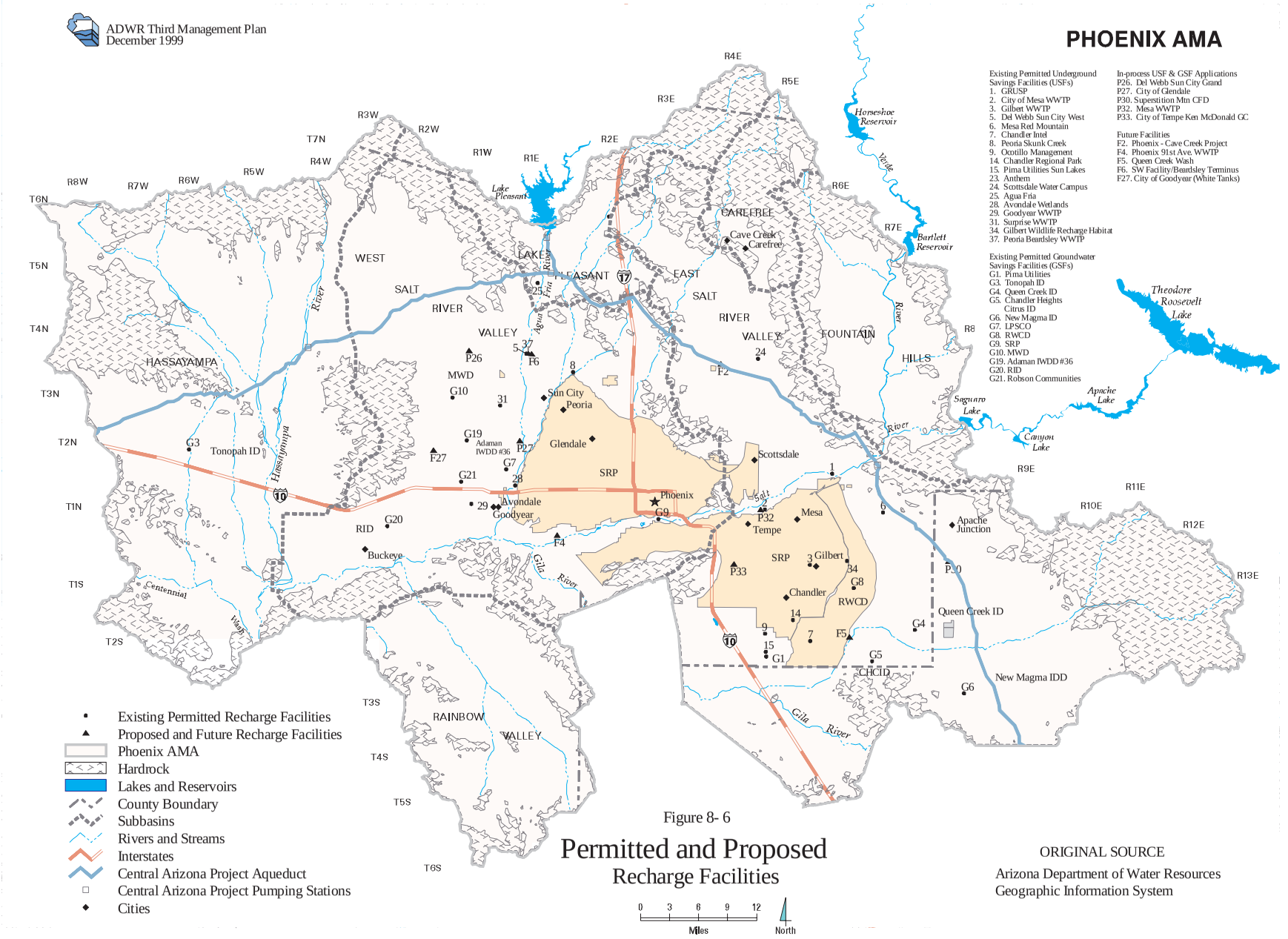


Figure 8- 6

Permitted and Proposed Recharge Facilities

ORIGINAL SOURCE

Arizona Department of Water Resources
Geographic Information System

supplies. They included watershed management, weather modification, water transfers, storm water runoff utilization, effluent reuse, maximizing the use of CAP and Plan 6 water, and underground water storage. During the second management period, some of the measures identified in the Second Management Plan were implemented. These few measures focused on increasing the use of renewable water supplies within the AMA and are discussed below.

The augmentation measures that were the most feasible for implementation were underground water storage, maximizing the use of CAP and Plan 6 water, and effluent reuse. In addition, provisions established in the First and Second Management Plan conservation programs for the agricultural, municipal, and industrial sectors; the Code; and the AWS Program provided incentives for water users to implement augmentation and reuse measures. In particular, the AWS Program provided the most direct regulatory requirements for using alternative water supplies for new municipal growth within an AMA. The measures not implemented will continue to be evaluated as future water augmentation alternatives.

8.4.1 Second Management Plan Program Goals and Objectives

The Second Management Plan Augmentation and Reuse Program goal was to develop additional water supplies and to increase the use of renewable water supplies in the Phoenix AMA for the purpose of attaining safe-yield. The program encouraged full utilization of CAP water and effluent to preserve groundwater for future uses in the AMA. To maximize the use of these water supplies, the program included provisions to incorporate recharge into plans for water supply development.

Six objectives were identified for the Second Management Plan Augmentation and Reuse Program. They were: (1) maximize the use of CAP allocations within the AMA; (2) utilize the CAP delivery system to the fullest extent possible to deliver "surplus" Colorado River water and other waters to the AMA; (3) maximize recharge of developed water supplies, including effluent, for the water that cannot be used directly; (4) generate additional water supplies within the state to maximize the benefit to the AMA of interregional water transfers and exchanges; (5) resolve technical, institutional, legal, and environmental constraints that inhibit the development and beneficial use of alternative water supplies; and (6) research and identify augmentation measures for future implementation.

8.4.2 Second Management Plan Program Implementation

The Second Management Plan Augmentation and Reuse Program included five main elements designed to assist water users in developing new water supplies to meet the objectives identified above: (1) regulatory incentives; (2) technical assistance; (3) coordination and facilitation of efforts; (4) resolution of legal and institutional barriers; and (5) implementation of the augmentation and conservation assistance fund. The Second Management Plan recognized that while the Department may provide incentives and coordination efforts, the principal responsibility for developing water supplies remains with the region's water users. Each element of the Second Management Plan Augmentation and Reuse Program is discussed below.

8.4.2.1 Second Management Plan Regulatory Incentives

Provisions established in the conservation programs of the Second Management Plan provided regulatory incentives for water users in the Phoenix AMA to augment their supplies, especially by encouraging the direct use of effluent. The overall effectiveness of these regulatory incentives, discussed in previous chapters of this management plan, has been limited. The principal reason for this lack of effectiveness is that the incentives have little or no impact on water cost or availability, which are the main factors in determining whether renewable supplies will be used instead of groundwater. Availability is especially critical in the case of effluent use. In older, developed areas of the Valley, only water users in close proximity to wastewater treatment plants are able to receive effluent for direct use because of limited existing distribution systems and the high cost of expanding these systems. The benefit of these incentives

did not offset higher water costs associated with converting to renewable supplies. However, providers serving newer growth areas in the AMA are incorporating more sophisticated effluent distribution systems from local plants to end users, and are storing and recovering effluent to take advantage of the incentives.

8.4.2.2 Technical Assistance Through the Second Management Plan

The Second Management Plan stated that the Department would support augmentation project construction, planning, and research activities during the second management period.

The Department provided technical assistance to water users by assessing the need for developing augmentation projects and determining their feasibility. Department staff also assisted with study, design, data collection, data analysis, and information dissemination.

Arizona's Legislature enacted House Bill 2239 in 1994, which authorized a water resources study for the West SRV to examine the state of the water resources and to facilitate long range water planning. The Department worked closely with Western Maricopa Coalition's Water Resources Committee and secured additional technical and financial assistance from the Bureau of Reclamation to complete the study using the Department's existing hydrologic flow model. The study included an inventory of available water resources, plans for the incorporation of CAP water, a range of water supply and demand scenarios, and an examination of potential recharge projects. All of this was done in coordination with area water users.

Additionally, the Department developed the hydrologic model for the East and West Salt River Valleys. This model has been a useful tool within the Department and with the regulated community in projecting water level trends associated with various groundwater pumping scenarios. The primary users of this information have been consultants representing various water providers, irrigation districts, and Indian communities. Requests for model data sets became so numerous that the Department has made them available through the Internet.

8.4.2.3 Coordination and Facilitation of Efforts During the Second Management Plan

Because cooperative efforts among government agencies, water users, and other groups allow the development of larger, more effective augmentation projects and studies, the Second Management Plan stated that the Department would work with organizations to coordinate and facilitate augmentation activities.

In 1992-93, the Department staffed extensive studies on the underutilization of CAP water in the state for the Governor's CAP Advisory Committee. These studies facilitated the establishment of incentive pricing of agricultural CAP water by CAWCD and the passage of legislation to address the underutilization problem.

Since passage of the Underground Storage and Recovery Act in 1986, the Department and the AMA have worked closely with water users to issue over 33 USF and over 68 water storage permits. This level of facilitation is critical, especially for storage facility permits, since applicants are required to submit substantial, often detailed information that must be reviewed by the Department.

In addition, in the early and mid-1990's, the Department coordinated a multi-agency research effort known as the Arizona Atmospheric Modification Program to assess the technical feasibility of using weather modification in the Verde River watershed to increase water supplies. The study confirmed that it is possible to accurately predict both the amount and distribution of precipitation resulting from cloud seeding.

8.4.2.4 Resolution of Institutional and Legal Barriers During the Second Management Plan

The Second Management Plan stated that the Department would work with interested parties in the AMAs and around the state to draft rules and to propose legislation that would resolve legal and institutional problems in developing large scale augmentation projects. This element of the Second Management Plan Augmentation Program may have been one of the most successful during the second management period. The following sections describe rules, legislation, and programs that have resulted from the efforts of the Department, water users, and other interested parties.

8.4.2.4.1 Assured and Adequate Water Supply Rules

In February 1995, the Department adopted new rules for its Assured and Adequate Water Supply Program, which requires new subdivisions to use renewable supplies and provides a critical incentive for underground storage of unused supplies for future use.

8.4.2.4.2 Central Arizona Groundwater Replenishment District

The establishment of a replenishment entity in the AMA is closely tied to the AWS Program. In 1993, the Legislature authorized CAWCD to undertake replenishment activities that allow municipal providers and new subdivisions who wish to obtain Designations of Assured Water Supply (Designation of AWS) or a Certificate of AWS to become members of the CAWCD replenishment authority, known as the CAGRD. By joining the CAGRD and pledging to finance the replenishment of groundwater used in excess of the amount allowed by the AWS Rules, members can use groundwater for new development and legally meet the assured water supply provisions, which requires that projected water use of new development be consistent with the achievement of the AMA's management goal.

8.4.2.4.3 Groundwater Transportation Act

Passage of the 1991 Groundwater Transportation Act severely restricted the ability of municipal water providers to transfer groundwater from rural basins to AMAs. In general, the Groundwater Transportation Act of 1991 restricts the transport of groundwater from rural groundwater basins to initial AMAs, which includes the Phoenix AMA. A.R.S. §§ 45-551, *et seq.* The act, however, contains several exceptions that allow transportation of limited amounts of groundwater to the Phoenix AMA from groundwater basins outside the AMA. Thus, under the Act, and under very limited circumstances, groundwater could be imported into the AMA from a number of locations. These locations include the McMullen Valley Groundwater Basin, the Butler Valley Groundwater Basin, the Harquahala Irrigation Non-Expansion Area, and the Pinal AMA. Although the Act in general prohibits groundwater transfers, it does specifically identify which water supplies are available to augment the Phoenix AMA supplies.

8.4.2.4.4 Water Exchange Act

Passage of the 1992 Water Exchange Act establishes a legal mechanism to allow water-for-water trades between two or more parties. A.R.S. §§ 45-1001, *et seq.* Exchanges allow for improved management of limited water supplies. Water exchanges can reduce the cost of water deliveries and allow the quality of water to be matched with the requirements of the user. Entities in the Phoenix AMA have engaged in water exchanges to satisfy Indian water settlements, to overcome distribution system limitations, and to obtain less expensive sources of water.

8.4.2.4.5 Underground Water Storage, Savings and Replenishment Act

In the late 1980s and early 1990s, the Legislature enacted a series of underground water storage programs. The first of these programs established a legal mechanism to physically store water underground and to

later recover that water. Later enactments allow for unused renewable water supplies to be provided to groundwater users in lieu of groundwater. This program has had the result of providing affordable CAP water to farmers and saving groundwater that would otherwise have been pumped. In 1994, the Underground Water Storage, Savings and Replenishment Act repealed these previous enactments and consolidated all of the storage programs into a unified program. A.R.S. §§ 45-801.01, *et seq*. The result has been a more unified permitting system, a unified accounting system for all water stored, and readily assignable storage credits accrued under the program.

8.4.2.4.6 State Demonstration Program

One of the recharge programs enacted in the early 1990s and included in the Underground Water Storage, Savings and Replenishment Act is the State Demonstration Program. This program collected funds through an ad valorem tax assessed in Maricopa and Pima Counties. These funds were then made available to CAWCD to construct and operate recharge facilities. Although funding for the program was discontinued after 1995, the funds collected have been used by CAWCD to store water at the Granite Reef Underground Storage Project. The remaining funds collected from Maricopa County are being used to construct additional storage facilities in the Phoenix AMA.

8.4.2.4.7 Arizona Water Banking Authority

Arizona does not currently use its full 2.8 million acre foot per year share of Colorado River water established under *Arizona vs. California*, 373 U.S. 546 (1963). Any of Arizona's apportionment not diverted from the mainstream by Arizona is available for use in California or Nevada. The AWBA was established in 1996 as a means to increase the utilization of Arizona's Colorado River apportionment and to store unused Colorado River water to meet Arizona's future water supply needs. As Arizona directly uses more of its Colorado River apportionment, the amount of excess CAP water available to the AWBA for storage is expected to decrease.

The objectives of the AWBA include: (1) protecting municipal and industrial (M&I) users of CAP water from shortages or disruptions of the CAP system; (2) assisting in meeting the management objectives of the state's Code; (3) assisting in the settlement of Indian water rights claims; (4) exchanging water to assist Arizona's Colorado River communities; and (5) exploring opportunities for interstate water banking with Nevada and California. Although the AWBA has been working closely with the AMAs to identify storage opportunities that would also help support water management objectives of each AMA, some recharge projects ideally located to meet some of these AWBA objectives may not optimally assist the AMAs in meeting their specific water management goals, for example, hydrologically feasible sites located outside of the AMA.

Annual funding for the AWBA comes from four sources: (1) an ad valorem property tax of four cents per $100 assessed valuation in the three-county CAP service area; (2) a groundwater withdrawal fee of $2.50 per acre-foot in the Tucson, Phoenix, and Pinal AMAs; (3) general fund appropriations; and (4) the proceeds of interstate banking activities. The ad valorem tax collected for the AWBA in Maricopa County is estimated to be $6.1 million in 1998. The 1997 groundwater withdrawal fee (collected in 1998) should generate $2.2 million. General fund money projected to be used for storage in the Phoenix AMA in 1998 is $235,000. Based on the $8.5 million that are currently available, the total recharge capacity that could be utilized by the AWBA in the Phoenix AMA is estimated at 121,000 to 170,000 acre-feet per year, based on water costs of $70 to $50 per acre-foot, respectively, which may be optimistic for the long-term. In 1998, the AWBA actually stored over 117,000 acre-feet of water.

The AWBA, under certain conditions, is authorized to enter into interstate banking agreements with entities in Nevada and California. Under these agreements, the out-of-state entity would finance the storage of Colorado River water in Arizona. Later, when that entity needed additional water supplies, the

AWBA would provide for the recovery of the previously stored water. The recovered water would be used in place of diverting Arizona's full mainstream Colorado River apportionment. The additional water left on the mainstream would be made available to the participating out-of-state entity. To the extent interstate water is stored in the Phoenix AMA, the AMA would receive a short-term benefit of additional water supplies imported into the AMA in advance, perhaps by decades, of when those supplies would be needed for direct use by the out-of-state entity.

The Phoenix AMA's specific recommendations to the AWBA regarding siting of storage facilities and contributions to water management appear in section 8.7.1.

8.4.2.4.8 Governor's Central Arizona Project Advisory Committee Recommendations

As the CAP moved into its final phases of construction in the early 1990s, concern over a variety of issues related to the project led to the formation of the Governor's CAP Advisory Committee, which was staffed by the Department. The Committee issued a number of recommendations which led to legislative changes. One significant change was the date at which municipalities with CAP contracts were required to establish Designations of AWS. The date was moved up from January 1, 2001 to January 1, 1998. To address some of the environmental issues associated with the CAP, the Arizona Water Protection Fund (AWPF) was established in 1994. This fund, partially financed by CAP water users outside of the three-county CAWCD service area, is administered by a commission and issues grants to water users for implementing projects to protect the state's rivers and streams, including the use of excess CAP water for riparian enhancement.

8.4.2.4.9 Indian Water Rights Settlements

In the Phoenix AMA, the Fort McDowell and the SRPMIC water claims have been settled. The Fort McDowell settlement resulted in annual rights provided to the Fort McDowell community of 35,950 acre-feet of water from the Verde River and the CAP. This amount includes 18,233 acre-feet of CAP which may be leased for up to 100 years off-reservation within Pima, Pinal, and Maricopa Counties. The SRPMIC settlement agreement provided 122,400 acre-feet of Salt and Verde River supplies, groundwater, and CAP water to the community. The agreement requires the SRPMIC to achieve safe-yield at the same time as the Phoenix AMA. In addition, the agreement provides for a 99-year lease (commencing in the year 2000) of its 13,300 acre-feet CAP allocation to Phoenix AMA cities.

8.4.2.4.10 Other Resolutions

Outside the legislative arena, other issues associated with increasing the use of CAP water are being addressed. The CAWCD has established numerous pricing policies intended to encourage both the direct use and the storage of CAP water. The non-Indian agricultural water pricing policy has already been discussed in section 8.3.1.

Toward the end of the second management period, CAWCD and the United States federal government were engaged in litigation over issues involving the Master Repayment Contract for the CAP, as well as other issues. Resolution of these issues, either through a negotiated or litigated means, will likely bring more certainty of the cost and availability of CAP water to all of the project's users.

8.4.2.5 The Second Management Plan Augmentation and Conservation Assistance Fund

The Phoenix Active Management Area Augmentation Grant Program has been an effective and popular complement to the regulatory functions of the AMA. The program facilitates development of technologies and dissemination of information to assist water users in their attempt to attain the goal of safe-yield by 2025.

The Augmentation Grant Program and its associated Conservation Assistance Grant Program have been financed by fees on groundwater withdrawals in the AMA. Through 1996, $1.75 of the $2.75 per acre-foot withdrawal fee was dedicated to the two grant funds. However, this funding has been reduced beginning in 1998 with the fees collected for groundwater pumped in 1997. Beginning in 1997, and through 2016, a minimum of $.25 per acre-foot, not to exceed $.50 per acre-foot, of the withdrawal fees collected will go to the Augmentation and Conservation Assistance Fund; the remainder will be used to augment AMA water supplies through AWBA activities.

The Department has been collecting funds for the Augmentation Grants Program since 1990 and for the Conservation Assistance Grants Program since 1991. Through 1997, a total of $9.6 million has been collected for both programs. Of that amount, the director has contracted for augmentation grants totaling approximately $2.6 million. Augmentation grants to date have financed augmentation planning, research projects, feasibility studies, demonstration projects, pilot recharge facilities, water treatment and reuse projects, and construction of full-scale recharge facilities. More discussion on augmentation and conservation assistance funding is found in Chapter 9, section 9.4.1.

8.4.3 Summary of Program Effectiveness

Overall, the implementation of the Second Management Plan Augmentation and Reuse Program for the Phoenix AMA has been effective. The Department has taken a lead role in facilitating and coordinating augmentation activities and in resolving many of the institutional and legal barriers to such activities. The Phoenix AMA has provided significant technical and financial assistance to entities seeking to implement augmentation projects during the Second Management Period. Program elements that focused on developing new supplies, like weather modification and watershed management, were determined not to be feasible augmentation alternatives during the Second Management Period.

The primary objectives identified for the Second Management Plan Augmentation and Reuse Program have generally been met. Effluent treatment plants have been constructed to treat wastewater from the growing areas of the AMA. The number of recharge facilities to store these supplies has grown in response to the need for non-groundwater supplies pursuant to the AWS Rules. Direct use and storage of CAP water within the Phoenix AMA has increased, although not to the full extent projected in the Second Management Plan. However, due to the storage activities of the AWBA, the CAP delivery system is close to being used to the fullest extent possible as the second management period ends.

8.5 PHOENIX ACTIVE MANAGEMENT AREA AUGMENTATION ISSUES

The physical assessment section of this chapter identifies several water management problems existing in the AMA. Even with positive strides made in renewable supply use and other water management efforts through the Second Management Plan, several augmentation issues still need to be addressed through the third management period and beyond.

First, although new municipal growth is expected to transition to renewable supplies as discussed in section 8.2.2.1, other pumping is expected to continue. Existing grandfathered rights (irrigation grandfathered rights, Type 1 and Type 2 non-irrigation rights) and withdrawal permits exceed total incidental recharge and natural recharge. No legal requirement exists for these withdrawals to diminish over time. In addition, Type 2 non-irrigation rights can be relocated anywhere in the AMA, including areas experiencing serious water table declines or areas where the groundwater supplies have been fully committed under the AWS Program. Furthermore, in most areas of the AMA, the cost of producing groundwater is lower than alternative water supplies; thus, it will remain the economic choice for many water users in the AMA.

Second, the review of the renewable water supplies available to the AMA establishes that excess renewable water supplies are available and should be stored now. CAP water and effluent, which are not currently fully utilized for direct use, are the supplies that are available for this purpose. Because CAP water is not projected to be fully and directly used in the next 40 years, a limited window of opportunity exists to store unused CAP water for the future.

The physical assessment of the AMA has also established that an augmentation program, particularly one that employs recharge as a means to store excess water for future use, must be implemented to provide the most benefit to the AMA. While certain areas of the AMA are experiencing serious water level declines and could be aided by local recharge, other areas of the AMA that are waterlogged or require dewatering would be inappropriate sites for recharge. Therefore, the third issue for the Third Management Plan is to consider developing a critical management area strategy during the management period. The AWBA and the CAGRD are tools to assist with this effort and with meeting other water management objectives. This chapter has also discussed areas of the AMA where local groundwater supplies have been fully committed for assured water supply purposes (thereby preventing growth in the area without additional renewable supplies) and where substantial groundwater declines have resulted in subsidence. Not only will the Third Management Plan attempt to encourage storage facilities in these areas in coordination with local partnerships, but will continue to provide storage and recovery criteria that help to maximize the benefits and reduce the negative impacts to the AMA.

Storage facilities are the primary tools used to augment the groundwater supplies of the Phoenix AMA. Evolution of the Recharge Program in the last decade has resulted in a change to the concept of an underground storage facility. Initially, facilities were constructed for the sole purpose of storing water supplies that could not be used directly, for recovery and use in the future. The first permitted facilities were constructed as multiple shallow spreading basins to allow for wet and dry cycles, which increased infiltration rates and stored renewable supplies at high efficiency rates. These were typically constructed in undeveloped areas, such as in the Salt River bed, near wastewater treatment plants, and in locations where aesthetics were not particularly an issue. Over the last ten years, however, increased growth and land prices in the AMA have caused many entities to design USFs that also incorporate recreation, wildlife habitat, educational opportunities, aesthetics, and economic development aspects not found in the typical recharge facility design. The fourth issue is that, while multipurpose facilities may provide a greater benefit versus cost than do traditional single purpose facilities, the effectiveness of multipurpose facilities in meeting water management goals and objectives depends on their achievement of their principal purpose– water storage.

In summary, an augmentation program established to assist the AMA in reaching its goal of safe-yield must be designed to consider local water issues. Recharge, particularly when recovery will occur away from the area of impact of storage, should be discouraged in areas where high water tables are problematic. However, recharge should be encouraged at the highest efficiency possible, facilitated in areas where water tables are low, and located where groundwater supplies are already fully committed. Additional protection of local water supplies, in conjunction with a local area commitment to help, may be needed in areas experiencing local supply problems.

8.6 THIRD MANAGEMENT PLAN AUGMENTATION PROGRAM GOALS AND OBJECTIVES

This Augmentation and Recharge Program Chapter has thus far highlighted the physical groundwater supply problems experienced in various locations throughout the AMA, the underutilization of available renewable water supplies, the successes and shortcomings of the Augmentation Program for the second management period in the AMA, and the water management challenges facing the AMA as the third management period approaches. The Department has developed the goals and objectives of the Augmentation and Recharge Program for the third management period based upon these AMA

considerations. The Augmentation and Recharge Program for the third management period is intended to move the Phoenix AMA toward its goal of safe-yield and to begin to address sensitive areas by emphasizing the following objectives:

To maximize the use of renewable supplies, the Department will:

- Provide renewable supply use incentives for each water use sector to encourage the development of infrastructure necessary for full and direct utilization of CAP and effluent supplies throughout the AMA.
- Evaluate new and more effective renewable resource use incentives or programs to increase the direct use of renewable supplies.

To maximize the storage of renewable supplies, the Department will:

- Coordinate the storage of water with the AWBA to fulfill the water management objectives of the state.
- Provide technical and financial assistance to water users to develop storage facilities.
- Encourage the storage of renewable supplies in areas that will contribute to the groundwater supplies relied upon for future use.
- Encourage maximum efficiency for all storage facilities.

To address local water supply problems, the Department will:

- Develop a critical management area strategy through local/ state partnerships that encourages the reduction of groundwater pumping and replenishment of those resources in areas which are currently experiencing or are projected to experience water supply problems, including cones of depression, subsidence, and/or earth fissures.
- Develop a critical management area strategy through local/ state partnerships that discourages underground storage in areas experiencing problems caused by high water tables.
- Protect groundwater supplies in areas lacking physical availability to meet current and committed demand.
- Encourage extinguishment of credits by the AWBA in critical areas.
- Evaluate the need for establishing a purchase and retirement program for groundwater rights in the AMA, and evaluate possible incentives to retire existing groundwater rights.
- Develop a program to put shallow groundwater to beneficial use.
- Improve the information available on groundwater availability and land subsidence through the continued development of monitoring programs to facilitate effective implementation of water augmentation and recharge plans.
- Encourage the reduction and replenishment of mined groundwater pumped by residual pumpers.

Additional Augmentation and Recharge Program objectives to assist with meeting the AMA goals are:

- Identify and assess the feasibility of potential future water supply augmentation measures.
- Integrate groundwater replenishment, water banking, assured water supply, recharge, and related activities to facilitate achievement of groundwater management objectives.
- Develop well spacing rules that protect existing well owners from excessive drawdown and limit damage, such as subsidence, caused by additional withdrawals.

8.7 THE THIRD MANAGEMENT PLAN AUGMENTATION AND RECHARGE PROGRAM

The Department is required to include in the Third Management Plan "a program for additional augmentation of the water supply of the active management area, if feasible, including incentives for

artificial groundwater recharge." A.R.S. § 45-566(A)(6). "Augmentation" in this context is statutorily defined to mean "to supplement the water supply of an active management area and may include the importation of water into the active management area, storage of water or storage of water pursuant to chapter 3.1 of this title." A.R.S. § 45-561(2). As described in the introduction, the Department must remain consistent with this statute, but for purposes of this chapter, a finer distinction has been drawn: *augmentation* means increasing the availability and use of renewable supplies such as CAP and effluent in lieu of groundwater and *recharge* means storage of water pursuant to Title 45, Chapter 3.1, the Underground Water Storage, Savings and Replenishment Act. The Augmentation Program therefore includes provisions for maximizing the use of renewable supplies and for storage of renewable water.

The Third Management Plan includes a number of other provisions related to augmenting the AMA's water supplies. A.R.S. § 45-566(A). Paragraph 9 of that subsection provides that the Third Management Plan may include a plan for the purchase and retirement of grandfathered rights beginning no earlier than January 1, 2006. Paragraph 13, subsections (a) through (c), requires that the plan include recommendations to the AWBA regarding:

(a) Whether additional water storage in the active management area would help to achieve the management goal for the active management area.
(b) Where additional water storage in the active management area would be most useful to achieve the management goal for the active management area.
(c) Whether the extinguishment of long-term storage credits accrued or to be accrued by the AWBA would help to achieve the management goal for the active management area.

The Augmentation and Recharge Program for the third management period in this chapter addresses all of these required elements of A.R.S. § 45-566(A).

The principal responsibility for developing water supplies and for storing that water for future uses lies with the area's water users. The Department's responsibility under A.R.S. § 45-566(A) is to design an augmentation program that encourages and facilitates the efforts of those water users. The program should particularly encourage augmentation and storage of water where groundwater supplies are limited. The Augmentation Program, however, must also allow the Department to use the authorities granted by the Legislature to prevent unreasonable harm to third parties and to not aggravate existing local water supply problems.

The Third Management Plan Recharge Program derives from A.R.S. § 45-801.01, *et seq.*, the Underground Water Storage, Savings and Replenishment Act, which details the statutory requirements for storing and recovering water within an AMA. The key statutory provisions for storage facilities relate to hydrologic feasibility, A.R.S. § 45-811.01(C)(2); protection from unreasonable harm to land and other water users, A.R.S. § 45-811.01(C)(3); and avoidance of water quality impacts, A.R.S. § 45-811.01(C)(5). Although this Act contains requirements for water storage and for recovery, it also includes requirements linking storage and recovery to the management plan goals. The provision that affects non-recoverable storage is found in A.R.S. § 45-833.01(A), with a special requirement that non-recoverable water storage must be consistent with the AMA's Augmentation Program. The provisions that affect recovery are found in A.R.S. § 45-834.01; it includes a requirement for consistency with the management plan in the case of recovery outside the area of impact where the water is stored. A.R.S. § 45-834.01(A)(2)(b).

The Department has developed the Augmentation and Recharge Program for the Third Management Plan based on the statutory authorities and tools available to address the goals and objectives identified in the previous section. The program components will be presented in the order listed.

- Recommendations to the AWBA (section 8.7.1)
- Underground Water Storage, Savings, and Replenishment Program (section 8.7.2)

- Regulatory Incentives (section 8.7.3)
- Purchase and Retirement of Grandfathered Rights (section 8.7.4)
- Technical Assistance, Coordination, and Facilitation of Efforts (section 8.7.5)
- Financial Assistance (section 8.7.6)
- Resolution of Legal and Institutional Barriers (section 8.7.7)

8.7.1 Recommendations to the Arizona Water Banking Authority

As previously described, the AWBA was created in 1996 for the purpose of importing and storing unutilized CAP water in Arizona. One of the stated purposes of the legislation is to "store water brought into this state through the central arizona project to fulfill the water management objectives of this state set forth in chapter 2 of this title." A.R.S. § 45-2401(F)(3). The AWBA is also required to coordinate with the director, who serves as chair of the AWBA Commission, in the "storage of water and distribution and extinguishment of long-term storage credits . . . in accordance with the water management objectives set forth in chapter 2 of this title [the Code]." A.R.S. § 45-2423(A)(3).

The Code requires the Third Management Plan to include recommendations to the AWBA on whether additional storage in the AMA helps to achieve the goals of the AMA, where the storage would be most useful, and whether the extinguishment of credits would assist in achieving the goals. Therefore, the Department provides the following recommendations to the AWBA for water storage in the AMA.

8.7.1.1 Advice to the Arizona Water Banking Authority on the Additional Storage Needs in the Active Management Area

Funding has been made available to the AWBA for fulfilling the state's water management objectives. The Legislature has given the AWBA a variety of funding mechanisms, each tied to specific purposes for which the AWBA was created. Groundwater withdrawal fees collected pursuant to A.R.S. § 45-611 in the Phoenix AMA must be used for the benefit of the Phoenix AMA. A.R.S. § 45-2457(B)(6). The long-term storage credits earned with these funds may be used for Indian water rights settlements or for fulfilling the state's water management objectives. These funds may be used to store water for future use or to extinguish credits. A.R.S. § 45-2457(B)(6).

Long-term storage credits accrued with general fund appropriations may be used by the AWBA only as follows: (1) to make water available to M&I water users of Colorado River water in this state that are outside the CAWCD service area, and to CAWCD for the purpose of meeting the demands of its municipal and industrial subcontractors (both are limited to situations when there are water shortages and require reimbursement); (2) to implement Indian water rights settlements; and (3) to fulfill the water management objectives of the Code. A.R.S. § 45-2457(B)(2-4).

In addition, credits accrued with ad valorem taxes may only be used to benefit the county in which the funds were collected. The Authority is also required to transfer the credits to CAWCD to meet the demands of CAWCD's municipal and industrial subcontractors during times of shortage. A.R.S. § 45-2457(B)(7). Finally, credits accrued with monies paid by California or Nevada agencies pursuant to the interstate banking provisions must be associated with a plan for forbearance from taking Colorado River water in the future. A.R.S. § 45-2472(A).

Thus, the Legislature has established and funded a valuable tool for achieving the AMA's water management goals. The mechanism is in place to bring water into the state and to store it specifically for the purpose of achieving safe-yield. Making use of this tool while unused CAP water is still available must be one of the highest priorities of the Augmentation and Recharge Program during the third management period.

Although achieving the state's water management objectives is only one of the AWBA's responsibilities, all of its storage activities in the AMA will augment the water supplies. Any or all of the water stored by the AWBA for its other purposes may be stored in areas of the AMA experiencing physical shortages of groundwater and recovered from areas that have more plentiful underground reserves. It is recommended that, as a part of the Augmentation and Recharge Program, the AWBA work with the Department to ensure that the AWBA storage in the Phoenix AMA serves as many water management objectives as possible, within the purposes for which the AWBA was created.

8.7.1.2 Advice to the Arizona Water Banking Authority on the Location of Water Storage in the Active Management Area

When the AWBA prepared its storage facility inventory for the Phoenix AMA pursuant to A.R.S. § 45-2452, it consulted with the Department to determine whether storage by the AWBA at each facility listed in the facility inventory promoted groundwater management objectives. It was determined that adequate storage capacity existed within the AMA in excess of the AWBA's needs for the following ten years. At the time the AWBA made this determination for the Phoenix AMA, it was recognized that the Department was still examining potential water storage sites that would be beneficial in fulfilling the water management objectives of the state. The AWBA storage facility inventory found that the AWBA would reconsider this finding of adequate storage facilities after additional planning studies were conducted by the Phoenix AMA (AWBA, 1997). Further, the AWBA is required to update and evaluate its facility inventory at least every five years.

While the Department continues to examine the issue of where storage facilities could best be located within the Phoenix AMA to fulfill the state's water management objectives, it is apparent that storage at the existing facilities do not fully address the groundwater management objectives for the Phoenix AMA. Most of the storage facilities in the AMA, including USFs and GSFs, are located in the East Salt River Valley (East SRV). These facilities are located where CAP water and SRP surface water supplies are already accessible through existing distribution systems. Consequently, groundwater is no longer the sole, or even primary, source of supply in much of this region, and groundwater levels are fairly stable in many areas.

Those regions of the AMA that rely predominantly on groundwater have groundwater levels that are declining and need additional storage facilities. The physical assessment section of this chapter emphasized five areas of the AMA where water level declines were or are projected to be particularly significant. Those areas are:

- West SRV encompassing Luke Air Force Base, El Mirage, Surprise, and Sun City/Sun City West
- Carefree Subbasin
- North Phoenix and Scottsdale
- Region between Mesa and Apache Junction
- Queen Creek area near the San Tan Mountains

Based on the physical assessment, the Department recommends that the AWBA consider storage in both the East and West Salt River Valley Subbasins. When planning efforts are completed, and as new facilities are permitted in the AMA, additional recommendations will be provided to the AWBA regarding where storage would provide the most benefit. It is further recommended that, as new storage locations are identified, the AWBA update its facilities inventory accordingly.

8.7.1.3 Advice to Arizona Water Banking Authority on Water Storage and Storage Credit Extinguishment

The physical assessment of groundwater supplies earlier in this chapter establishes that groundwater overdraft is projected to continue past 2025. Water storage and long-term storage credit extinguishment could eliminate, or at least greatly reduce, overdraft and allow the AMA to achieve its safe-yield goal.

During the third management period, the Department will undertake annual studies to project the extent to which overdraft is expected to continue beyond 2025. The Department recommends that AWBA create a bank of credits reserved for the purpose of achieving and maintaining safe-yield in the AMA. The Department recommends that the AWBA use groundwater withdrawal fees to reserve a minimum of 32,000 acre-feet of storage credits per year for extinguishment to fulfill the state's water management objectives. The Department may adjust that recommendation upon further studies of projected groundwater overdraft.

For the second part of this program, the Department recommends that the AWBA, in concert with the Department, develop a process to quantify and locate where credit extinguishment should occur for water management purposes, and to offset groundwater overdraft that occurs in 2025 or beyond.

8.7.2 Underground Water Storage, Savings, and Replenishment Program

The expense and environmental concerns associated with constructing large surface water storage reservoirs, like those found on the Salt, Verde, and Agua Fria Rivers, supports underground water storage as an increasingly important tool for the storage of renewable water supplies for future use in the Phoenix AMA. Underground storage provides an additional benefit of restoring or preserving groundwater in areas where groundwater levels have declined. The Underground Water Storage, Savings, and Replenishment (UWS) Program is, therefore, an important component of the Augmentation and Recharge Program.

As has already been reviewed, Arizona's UWS Program provides regulations under which water may be stored and rights to recover that water may be accrued. The statutes and policies of the UWS or "recharge" program, when read together, can be seen to establish a number of objectives. These include:

- To protect the general economy and welfare of the state by encouraging the use of renewable water supplies, especially Colorado River water, instead of groundwater, through a flexible and effective regulatory program for the underground storage, savings, and replenishment of water;
- To allow for the efficient and cost-effective management of water supplies by allowing the use of storage facilities for filtration and distribution of surface water instead of constructing surface water treatment plants and pipeline distribution systems;
- To further the conjunctive management of the water resources of this state to reduce the overdraft and achieve the management goals of the AMAs;
- To store water underground for seasonal peak demand and for use during years of shortage; and
- To augment the water supply for future growth and development.

Since its inception in 1986, the Recharge Program has become increasingly flexible over time with regard to storage and recovery locations and the number and types of programs available. With the increased flexibility has come an increased complexity and the potential for recharge projects to aggravate, as well as mitigate, local water problems. High water tables, low water tables, water quality, physical availability, and third party impacts are all problems that can be affected positively or negatively by recharge facilities. Thus, the regulation of the program to maximize benefits and minimize harm is crucial to an effective program.

The following sections describe: (1) a brief overview of the UWS programs, (2) the definition of a storage facility, and (3) the storage and recovery location criteria that determine whether a recharge project is considered "consistent with the management plan and achievement of the management goal" of the AMA.

8.7.2.1 Overview of the Underground Water Storage, Savings, and Replenishment Program

Persons who want to undertake recharge activities are required to obtain permits from the Department. There are three types of permits: (1) storage facility permits, which may be constructed underground storage facility (USF) permits, managed USF permits, or groundwater savings facility (GSF) permits; (2) water storage permits; and (3) recovery well permits.

8.7.2.1.1 Storage Facility Permits

Storage facility permits allow the holder to construct, develop, and operate a storage facility. If storage is to occur at a facility that will use constructed basins or wells to add water to an aquifer, a constructed USF permit is required. If the storage will utilize the natural channel of a river or stream to add water to an aquifer, a managed USF permit is required. At a GSF, a groundwater user who would otherwise have pumped groundwater is provided an alternative supply of water by a water storer. The alternative supply is then used in lieu of the groundwater, thus preserving the groundwater.

8.7.2.1.2 Water Storage Permits

Water storage permits authorize the holder to store water at an affiliated storage facility. Rights to recover water under the UWS Program always accrue to the holder of the water storage permit, unless the water stored through the water storage permit is designated as non-recoverable.

8.7.2.1.3 Recovery Well Permits

Recovery well permits allow the holder to recover water stored pursuant to the UWS Program. The storer of the water may always recover the water stored within the area of impact of water storage, which is defined "as projected on the land surface, the area where the stored water has migrated or is stored." A.R.S. § 45-802.01(2). Under a number of conditions, some of which are discussed in detail later in this chapter, recovery may also occur outside the area of impact. Theoretically, if these conditions are met, storage could occur anywhere within the AMA. Under no circumstance, however, can water be recovered in the AMA if it was stored outside the AMA.

8.7.2.1.4 Key Program Components

The UWS Program has a number of key components. Rights to recover water may be exercised annually or over the long-term. Almost any water can be recovered within the same year in which it was stored. If a number of conditions are met, stored water will be credited to a long-term storage account allowing the account holder to recover the water at any point in the future. The conditions greatly assist the achievement of water management goals by preventing an entity from storing water and earning long-term storage credits if the water could be put to direct use. The statutes define what source water cannot be put to direct use and therefore, what may be eligible as long-term storage credits. In general, if an entity stores effluent it is determined that, until 2025, it cannot reasonably be put to direct use, and is therefore eligible to be stored as long-term storage credits. Additionally, CAP water is considered water that cannot be put to direct use if the storer is not simultaneously mining groundwater. A.R.S. § 45-802.01(21). In other words, if the storer continues to mine groundwater, then stored CAP water may only result in credits if the entity stores an additional amount of CAP water to offset the groundwater pumping. (A designated provider who pumps groundwater from its groundwater allowance account is not considered to be mining groundwater.) The obvious intent for this provision is to encourage direct use of CAP water. It should be

reemphasized that while water storage may not be eligible to accrue long-term storage credits, the water stored is eligible to be recovered on an annual basis, and is treated as a direct use for all intents and purposes.

No time limit exists on the right to recover long-term storage credits. Long-term storage credits may be assigned to another person if that person could meet the same provisions for earning credits as did the storer. In addition, once the water is recovered, it retains the same legal characteristics it had before storage. For example, if CAP water is stored, the recovered water may be used in any legal manner that CAP water can be used, even if the recovery occurs outside the area of impact of the stored water.

The UWS Program is also the mechanism by which the CAGRD replenishes water on behalf of its members. The CAGRD may store water and accrue long-term storage credits or obtain credits already accrued. At the CAGRD's request, the Department will transfer credits from CAGRD's long-term storage account to its replenishment account, termed a "conservation district account" by statute, to offset the CAGRD replenishment obligations. A.R.S. § 45-859.01. Once the credits are transferred to the replenishment account, they may not be recovered, assigned, or moved back to the long-term storage account.

8.7.2.2 Underground Water Storage, Savings, and Replenishment Program Issues

Arizona law generally prohibits artificial "bodies of water" constructed for landscape, scenic, or recreational purposes. However, one of the exceptions to this prohibition is if the body of water is "unsealed and an integral part of an underground storage facility." A.R.S. § 45-132(B)(6). One issue the Department considers carefully when permitting storage facilities is whether they are legitimate storage facilities that will meet the goals and intents of the program, including those facilities that "further the conjunctive management of the water resources of this state to reduce the overdraft and achieve the management goals of the AMAs," as stated in section 8.7.3.

With regard to USFs, A.R.S. § 45-815.01 specifically lists water systems that are categorically excluded as USFs. These include aqueducts, irrigation canals, and other man-made water conveyance systems. In addition, incidental recharge from any agricultural, municipal, mining, or industrial use is precluded from qualifying for a USF permit. Bodies of water, as defined in statute, do not qualify for USF permits unless they "have been designed, constructed or altered so that water storage is a principal purpose of the body of water." A.R.S. § 45-815.01(1). Thus, the law does allow for a body of water to be both a USF and a recreational lake. However, the Department guards against attempts by applicants to avoid the prohibition on recreational lakes by labeling a body of water a USF when its principal purpose is not underground storage. Thus, if the purpose of the facility is primarily recreational or aesthetic, it does not qualify as a USF. However, if the facility meets the goals, intents, and requirements of the USF Program while serving other uses as well, it may qualify for a USF permit.

Usually, the efficiency of a USF is related to its purpose. If a permit applicant's primary intent is to store water, achieving high efficiency at the facility is an important goal for the applicant. If the applicant's intent is to achieve multiple purposes, or if storage is not a primary purpose, efficiency is less important to the applicant.

Efficiency at USF's, however, is always a concern to the Department. As the AMA becomes more reliant on renewable supplies to meet a growing demand, as is required under the AWS Rules, efficiency of all surface water and groundwater use will be necessary. This program will serve to encourage efficient uses of water, and every effort will be made in the future to retain the integrity of the program and its intents and goals through maximizing the efficiency of recharge at permitted facilities. The Department examines projected efficiency of a USF as part of its review to determine whether a project is hydrologically feasible, which must be established before a USF permit will be issued. A.R.S. § 45-811.01(C)(2). The less

efficient a proposed project is, the more the Department will examine it to determine if it is a legitimate USF. The Department will consider a number of factors when evaluating a facility for efficiency as a component of hydrologic feasibility, including the following:

- Whether the facility has the *potential* to store water, and the quantity of that potential storage
- Whether the facility is designed, constructed, or altered so that water storage is a principal purpose
- Whether other regulatory agencies impart conflicting standards to a facility (e.g., Arizona Department of Environmental Quality containment standards in a treatment wetland)
- Whether and how the facility will be maintained (e.g., wet-dry cycles, scraping, etc.) to ensure and/or enhance infiltration
- If a facility serves multiple purposes, whether the purposes other than recharge would not be legal or regulated without being associated with a recharge facility
- Whether potential water storers at the facility are subject to conservation requirements and lost and unaccounted for water limits under the management plan

The Department is also concerned about potential abuses in GSF permits. The statutes clearly state that not every instance where groundwater use is replaced with a renewable water resource qualifies for a GSF permit. Only where the use of the renewable resource would not have occurred without the operation of the GSF and only where there is no other reasonably available alternative source should a GSF be permitted. A.R.S. § 45- 812.01(B).

While the groundwater savings program is an important tool in achieving the water management objectives by increasing the uses of Colorado River water and effluent and preserving groundwater supplies, it must be emphasized that 95 percent of the groundwater saved today will be pumped in the future through the use of long-term storage credits. The groundwater savings program is, in effect, a deferred groundwater pumping program and should not be confused with the conversion of an existing groundwater use to a renewable resource, which would provide a permanent savings of groundwater and a direct contribution to the achievement of safe-yield. For these reasons, the Department will not issue a GSF permit or storage credits unless a legitimate "groundwater savings" will occur or has occurred.

8.7.2.3 Storage and Recovery Siting Criteria

The benefits to water management through the Recharge Program depends on where the water is stored and recovered. Non-recoverable water storage is discussed in the next section.

For storage and recovery, unless stored water is recovered by the storer within the area of impact, the recovery is only allowed "if the director determines that recovery at the proposed location is consistent with the management plan and achievement of the management goal for the active management area." A.R.S. § 45-834.01(A). Recovery of stored water *within* the area of impact of the stored water is always considered consistent with the management plan.

Although the statute ties recovery outside the area of impact to the consistency requirements of the plan, the locations of storage and recovery of water are inherently linked. Both must be considered when determining whether the future recovery meets the consistency requirements and management goals of the AMA. Outside the area of impact, it cannot be determined whether recovery is consistent with water management objectives of the AMA unless the storage location is also considered. Water management benefits to the AMA would depend greatly on whether water recovered from an existing well was stored in a remote area of the AMA or in a large pumping center of the AMA. Therefore, the criteria to determine whether the recovery location is consistent with the management plan and goal for the AMA must also consider where water was stored.

The locations of storage and recovery are important factors in addressing local and regional supply problems, particularly in critical areas, and in attempting to balance the supplies in the AMAs during the third management period. For example, the future water supplies of the AMA may be diminished if water storage occurs in a remote location having no foreseeable future demand for the stored water and if recovery occurs outside the area of impact of storage. In this instance, the stored water would, in effect, be wasted if there was not a projected use of the aquifer either by existing groundwater users or through recovery. In addition, recovery outside the area of impact of water storage could aggravate problems if the area of recovery was experiencing rapidly dropping groundwater levels or if groundwater supplies were already fully committed under the AWS Program. On the other hand, if storage occurs in an area experiencing high water levels and recovery occurs away from the area of impact, the water storage will contribute to those high water levels. If dewatering is required as a *direct* result of water storage or savings, either the storage facility's operational plan should be adjusted to minimize impacts or the storer may not be issued credits.

The Second Management Plan siting criteria provided no protection of groundwater supplies already committed under the AWS Program. However, the new Third Management Plan criteria protect groundwater supplies already committed for an assured water supply from an entity who wishes to recover water *outside* the area of impact.

The Third Management Plan criteria also link future use benefits to determinations under the AWS Program. If storage occurs in an area that has a committed and projected demand through a Designation or Certificate of AWS, then it is deemed to contribute to groundwater supplies that will be used in the future. If the storage does not meet this criteria, such as if it were located in a remote area with no committed or projected demands per a Designation or Certificate of AWS, it must be determined by the director to otherwise be beneficial to the AMA if recovery is to occur outside the area of impact of storage. Permitted storage facilities to date, listed in Appendix 8A, are all in locations that provide benefits to the AMA. If a storage facility is found not to meet the criteria, it will be indicated as such in the permit as a notice to potential water storers that future recovery may only be allowed inside the area of impact until such time that there is a demand for groundwater in the area of impact of the storage.

Recovery from within the area of impact is not required to meet management plan consistency requirements. Recovery may occur *outside* the area of impact of the storage only if the director determines that the recovery location is consistent with the management plan. A.R.S. § 45-834.01(A). Therefore, recovery must continue to be consistent with management plan criteria, even after the recovery well permit has been issued. Thus, previously permitted recovery wells are subject to the criteria of the Third Management Plan and future management plans.

8-101. Storage and Recovery Siting Criteria

During the third management period, for the purposes of A.R.S. § 45-834.01(A)(2)(b), recovery of stored water at a location is consistent with the management plan and achievement of the management goal for the active management area:

A. *If recovery will occur within the area of impact, regardless of whether the recovery well permit applicant was the storer of the water; or*

B. *If recovery will occur outside of the area of impact, all of the following three criteria are met:*

1. The water storage that resulted in the right to recover water:

a. Is contributing to groundwater supplies that are accessible to current groundwater users or that have been committed to establish a Designation, Certificate, or Analysis

of Assured Water Supply pursuant to A.R.S. § 45-576 or rules adopted thereunder so long as the areas in which water is stored are not experiencing problems associated with shallow depth to water; or

b. Is a component of a remedial action project under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) or Title 49, Arizona Revised Statutes, and the director has determined that the remedial action will contribute to the objectives of this chapter or the achievement of the management goal for the active management area; or

c. Is otherwise determined by the director to have contributed to the objectives of this chapter or the achievement of the management goal for the active management area.

2. Either:

a. At the time of the application, the maximum projected depth to water at the location of the recovery well after 100 years does not exceed the general 100-year depth-to-static water level for the AMA specified by A.A.C. R12-15-703 after considering: (1) the maximum proposed withdrawals from the recovery well; (2) withdrawals for current, committed, and projected demands associated with determinations made under A.R.S. § 45-576 that are reliant on the water which the recovery well will withdraw; and (3) withdrawals for other current or projected demands that are reliant on the water which the recovery well will withdraw; or

b. The recovery will be undertaken within the applicant's service area and the applicant is a municipal provider designated as having an assured water supply.

3. The recovery well is:

a. Located in an area experiencing an average annual rate of decline that is less than 4.0 feet per year; or

b. A component of a remedial action project under CERCLA or Title 49, Arizona Revised Statutes, and the director has determined that the remedial action will contribute to the objectives of this chapter or the achievement of the management goal for the active management area; or

c. Likely to contribute to the water management objectives of the geographic area in which the well is located, as determined by the director.

8.7.2.4 Criteria for Storage of Non-Recoverable Water

Pursuant to A.R.S. § 45-833.01(A), "the director may designate a water storage permit as storing non-recoverable water. If the water storage occurs within an active management area, the water storage permit may be designated in this manner only if the storage is consistent with the active management area's augmentation program." The director may make this designation only upon application by a proposed water storer.

Only in few instances has this designation been applicable. In the second management period, non-recoverable storage occurred in association with certain augmentation grants that included storage of water to test the hydrologic feasibility of a recharge site. The Department has not allowed augmentation grant money to be used to purchase water supplies for storage and recovery for a grantee. Therefore, water

stored in association with certain grants has been designated as non-recoverable. Under the Third Management Plan, non-recoverable water storage may also occur as a result of an enforcement action associated with non-compliance of conservation requirements.

Water that is stored under a permit with this designation may not be recovered on an annual basis, may not be credited to a long-term storage account, and may not be used for replenishment purposes associated with the CAGRD. The same considerations discussed in the preceding section that shaped the criteria for recovery location have shaped the criteria for siting non-recoverable storage.

8-201. Criteria for Storage of Non-Recoverable Water

During the third management period, water storage that is designated as non-recoverable is consistent with the AMA's Augmentation Program if one of the following criterion is met:

The water storage:

1. *Is contributing to groundwater supplies that are accessible to current groundwater users or that have been committed to establish a Designation, Certificate, or Analysis of Assured Water Supply pursuant to A.R.S. § 45-576 or rules adopted thereunder so long as the areas in which water is stored are not experiencing problems associated with shallow depth to water; or*

2. *Is a component of a remedial action project under CERCLA or Title 49, Arizona Revised Statutes, and the director has determined that the remedial action will contribute to the objectives of this chapter or the achievement of the management goal for the active management area; or*

3. *Is otherwise determined by the director to contribute to the objectives of this chapter or the achievement of the management goal for the active management area.*

8.7.3. Regulatory Incentives

Provisions established in the Agricultural, Municipal, and Industrial Conservation Programs of this management plan provide incentives for water users to utilize renewable resources. The inclusion of renewable supply incentives is somewhat controversial due to the perception that encouraging the use of a renewable supply may result in an inefficient use of the supply. The program to increase the use of renewable water supplies should not be perceived as an alternative to conservation.

Arizona is not currently using its full Colorado River apportionment directly, and some municipal entities do not have enough annual demand or the infrastructure with which to deliver their allotments directly. However, these conditions are likely to change in the next 10 to 15 years, due primarily to the provisions of the AWS Rules. The Code (particularly through the assured water supply provisions) and the management plans require a long-term perspective on supply and demand. In the long term, efficient use of all water supplies will be necessary. The distinctions that are now being made among sources of water, including incentives that allow increased use of certain renewable sources, may seem ill-advised in hindsight. In fact, shortages are anticipated on the Colorado River system 35 out of the next 100 years. It would be inappropriate not to build a conservation ethic into the structure of the Phoenix AMA communities, even as they move towards the use of renewable supplies.

Some uses of water can be identified as "structural" and others as "discretionary." Structural uses are part of the base water use requirement; for example, once a swimming pool is built, it is likely to be filled with water. However, the decision to overseed a lawn or a golf course in a particular year is discretionary, or

non-structural. As incentives were designed for inclusion in this plan, the Department emphasized that increased utilization of renewable supplies should be for non-structural purposes, so that the use can be scaled back if available renewable supplies become scarce. Although it is unlikely, a renewable supply shortage may occur during the third management period. Therefore, promoting efficient use of all supplies now in anticipation of future shortages is responsible water management.

Achievement of the water management goals over the long term is only possible in the context of diligent, long-term conservation efforts and increased utilization of renewable supplies. The debate is not between conservation and augmentation, but rather, whether the concept of "efficient use" can be integrated into the regulatory system and the community ethic. Matching the resources to the most appropriate demand will require more sophisticated management, including conjunctive management of groundwater and surface water, than has been the norm in Arizona in the past. It is difficult to design incentives that are administratively workable without causing equity problems and weakening the conservation message which is crucial in protecting our resources for the future.

Table 8-6 lists the Third Management Plan incentives to use alternative supplies. Some of these incentives were established in the Second Management Plan. Because many of these incentives encourage use of alternative supplies at the expense of conservation, the incentives may need to be scaled back in the future to achieve safe-yield.

Although the need to include specialized incentives to address subregional conditions has been identified, the only regulatory tool to date for addressing localized areas of decline is the limitation on recovery of recharged water if it is recovered outside the area of hydrologic impact. The compliance approach described in Table 8-6 may result in encouraging recharge in specific locations to address local hydrologic concerns.

8.7.4 Purchase And Retirement of Grandfathered Rights

The Code specifies that the Third Management Plan may include a program for the purchase and retirement of grandfathered rights by the Department not to begin earlier than January 1, 2006. A.R.S. § 45-566(A)(9). An annual groundwater fee of up to $2.00 per acre-foot can be collected for the purchase and retirement of grandfathered rights beginning in 2006, although the fee cannot be levied until the management plan contains a program for such purposes. A.R.S. § 45-611(C)(4). The possibility of the Department developing such a program is being considered for inclusion in the Third Management Plan beginning in 2006. If the plan were to be modified to include such a program, it would provide the Phoenix AMA with another method for reducing groundwater overdraft and helping to achieve the management goal. The purpose of this section is to analyze those issues that need to be considered in determining the feasibility of developing and implementing a grandfathered right purchase and retirement program in the AMA.

The focus of this analysis is on the purchase and retirement of lands associated with irrigation grandfathered rights (IGFRs). Agricultural use is diminishing with the growth and development of our communities, and therefore, a purchase and retirement program will simply affect the rate at which agricultural water use is reduced. Although a purchase and retirement program could also legally include Type 1 and Type 2 non-irrigation grandfathered rights, these rights may be more expensive to retire. Purchase and retirement of these rights could possibly be offset by increases in General Industrial Use permits, thereby defeating the objective of reducing groundwater demand. At a minimum, the program should be limited to: (1) those IGFRs that use groundwater exclusively, and (2) do not lie in the path of urban development. In addition, IGFRs that would be targeted for purchase and retirement should be required to meet one or more of the following secondary criteria: high water duties, high percentage of annual groundwater use (if not exclusively groundwater), history of high consumptive use crops, history of high land utilization rates, and located in areas historically exhibiting high groundwater decline rates.

TABLE 8-6
RENEWABLE WATER SUPPLY UTILIZATION INCENTIVES
PHOENIX ACTIVE MANAGEMENT AREA

Municipal
Delivery of effluent by a municipal water provider does not count against the gallons per capita per day (GPCD) requirement, unless effluent is recharged in one location and recovered outside the area of impact. This is an incentive for municipal providers to invest in reclaimed water systems (Chapter 5, section 5.8). CAP water delivered by a municipal provider to a non-residential water user is excluded from the provider's total GPCD requirements for up to ten years if it is shown that the delivery will expedite the development of infrastructure to deliver reclaimed effluent to the user in the future (Chapter 5, section 5.8). The Alternative Conservation Program removes the non-residential portion of the GPCD requirement for providers who limit their groundwater use to the highest annual use between 1980-1989, utilize renewable supplies for their remaining demand, and implement specific conservation measures for non-residential customers. This program also includes an incentive to extinguish existing grandfathered rights to groundwater (Chapter 5, section 5.7.1.3.1). The Non-Per-Capita Program removes the GPCD rate as a regulatory tool entirely in exchange for implementation of specified conservation programs. A "best management practices" approach is designed to achieve the same level of efficiency as the GPCD, but the point of compliance is implementation of the programs, not the level of water use. To qualify, water providers must phase out groundwater use, or have a Designation of AWS (Chapter 5, section 5.7.1.2.3).
Industrial
Turf Effluent use is discounted when calculating compliance with the annual allotment for each facility. For the Third Management Plan, the incentive has been increased to a 40 percent discount (the Second Management Plan discount was a maximum of 20 percent) (Chapter 6, section 6.3.5.3). If 100 percent of the water used at a facility in a year is from a non-groundwater source, no compliance is required with the annual allotment for that year.
Cooling Towers Cooling towers that beneficially reuse 100 percent of their blowdown water are exempt from meeting the blowdown concentration requirements (Chapter 6, section 6-602.B.1). Cooling towers that convert to at least 50 percent effluent are exempt from the blowdown concentration requirements for one full year. If it is shown that they cannot meet the requirements, amended blowdown concentration levels may be applied (new incentive in the Third Management Plan) (Chapter 6, section 6-602.B.3).
Electric Power Electric power generating facilities are given a full year with no blowdown concentration requirements if they convert to at least 50 percent effluent. If it is shown that they cannot meet the requirements, amended blowdown concentration levels may be applied (new incentive in the Third Management Plan) (Chapter 6, section 6-505).

TABLE 8-6
RENEWABLE WATER SUPPLY UTILIZATION INCENTIVES
PHOENIX ACTIVE MANAGEMENT AREA

Dairies The reuse of dairy wastewater by a grandfathered groundwater right holder is not counted toward compliance with the dairy's maximum annual water allotment (Chapter 6, section 6-703).
Agricultural
Pursuant to A.R.S. § 45-467, effluent use cannot contribute to a farm exceeding its allotment in any year. In determining whether a farm exceeds its maximum annual groundwater allotment for a year, total water use, including groundwater, effluent, and surface water, is counted. Any effluent used that year is subtracted from the amount of groundwater that otherwise would have exceeded the farm's allotment.

8.7.4.1 Potential Groundwater Savings Under Purchase and Retirement

To analyze the potential groundwater savings that could be realized from an IGFR purchase and retirement program in the Phoenix AMA, an estimate was first made of the total withdrawal fees that could be collected by the Department in 2006 assuming: (1) use of a $2.00 per acre-foot withdrawal fee for purchase and retirement, and (2) groundwater and in-lieu water use by the IGFRs equivalent to the AMA's average annual groundwater and in-lieu water use from 1990 through 1996. An estimate was next made of the amount of farmland that could be purchased by the Department assuming: (1) use of all collected fees, and (2) a purchase cost for farmland equivalent to the representative 1996-97 price for an acre of farmland in those areas of the AMA that best meet the proposed minimum program criteria. The groundwater savings were then estimated by assuming: (1) a historic groundwater use for the retired farmland equivalent to the annual groundwater use per acre for those IGFRs in the AMA that grow high consumptive use crops and have high land utilization rates, and (2) a benefit period for the groundwater savings, beginning in 2006 or in the year in which the land was purchased, and lasting through the end of the fifth management period in 2025. These assumptions were used to calculate the potential groundwater savings that could be realized from a purchase and retirement program implemented for 1, 5, 10, 15, and 20 years. A program implemented for 5 years, for example, would mean that purchase and retirement fees would be collected for only 5 years (2006-2010) and used to purchase and retire irrigation grandfathered rights. However, the groundwater saved from such a short term program would continue each year beyond the program's duration. These savings and associated costs are shown in Table 8-7.

As shown in Table 8-7, assuming the same amount of purchase and retirement fees are collected each year from 2006 to 2010, the potential groundwater savings until 2025 would be 10,404 acre-feet per year on average (or a total of 208,080 acre-feet), and the purchase costs would be $41.66 per acre-foot. These costs assume a one-time purchase of the land in the year the funds were collected, with groundwater savings accruing annually through the year 2025. It should be noted that this cost reflects only the Department's cost for purchasing farmland and assumes that 578 acres of farmland would be purchased each year using $1,734,078 of withdrawal fees collected during that year. The 2,312 acre-feet of groundwater savings resulting from the purchase would continue to accrue on an annual basis from the year of purchase through 2025. Adding the accrued groundwater savings from each year's purchase of farmland results in total groundwater savings of 208,080 acre-feet by 2025. The total costs from 2006 to 2010 for purchasing the farmland equal $8,670,390 or (1,734,078 x 5). Therefore, the average cost of groundwater savings is $41.66 per acre-foot (or $8,670,390 ÷ 208,080 acre-feet).

It is unlikely that the Department would terminate a purchase and retirement program at the end of the third management period. A more realistic assumption is that the program would continue through the fourth and fifth management periods. Assuming no change in the price for farmland, the potential groundwater savings for a 20-year purchase and retirement program are estimated to average 24,276 acre-feet per year, with purchase costs averaging $71.43 (or $34,681,560 ÷ 485,520 acre-feet). Should agricultural land prices double, however, the average annual groundwater savings after 20 years would only be 12,138 acre-feet and the resulting costs would be $142 per acre-foot.

TABLE 8-7
POTENTIAL GROUNDWATER SAVINGS AND ASSOCIATED IMPACTS[1]
IRRIGATION GRANDFATHERED RIGHT PURCHASE AND RETIREMENT PROGRAM
PHOENIX ACTIVE MANAGEMENT AREA

Program Duration (Years)	Total Purchase and Retirement Fees Collected[1] ($)	Total Farmland Purchased and Retired[2] (Acres)	Total Groundwater Savings[3] Through 2025 (Acre-Feet)	Average Groundwater Savings[4] (Acre-feet per year)	Cost of Groundwater Savings[5] ($/Acre-Foot)
2006 (1)	$1,734,078	578	46,240	2,312	$37.50
2006-2010 (5)	$8,670,390	2,890	208,080	10,404	$41.66
2006-2015 (10)	$17,340,780	5,780	358,360	17,918	$48.39
2006-2020 (15)	$26,011,170	8,670	450,840	22,542	$57.69
2006-2025 (20)	$34,681,560	11,560	485,520	24,276	$71.43

[1] Assumes a purchase and retirement fee of $2.00 per acre-foot and 867,039 acre-feet of groundwater pumping and in-lieu water use in the Phoenix AMA annually.
[2] Assumes use of all of the fees collected and land purchase costs of $3,000 per acre annually.
[3] Assumes previous use of groundwater on farmland was 4.0 acre-feet per acre and groundwater savings accruing annually through 2025. Assumes a benefit period from the year in which farmland was purchased and retired to 2025.
[4] Annual savings equals total benefit divided by 20 years.
[5] Reflects land purchase costs only.

It should also be noted that the potential groundwater savings assume that the retired farmland would not be offset by inactive farmland being brought back into production in another location in the AMA. A "rebound effect" such as this is possible in the Phoenix AMA because much fallow farmland already exists.

8.7.4.2 Land Management and Maintenance Issues

Before a purchase and retirement program could be developed and implemented in the Phoenix AMA, land management and maintenance issues would need to be addressed. These issues include, but are not limited to, the following:

- Funding for staff and other resources needed to manage the retired farmland
- Liability claims
- Impacts of removing the land from the county and local property tax base
- Control of noxious weeds and dust on the land

8.7.4.3 Future Directions for Purchase and Retirement Program

For the Phoenix AMA to meet its management goal, as quantified in this management plan, an IGFR purchase and retirement program could have limited success in reducing the excess overdraft, especially if the program included the purchase of the land associated with the IGFR. However, the program does not necessarily have to include the purchase of the land. Instead, another option may be to purchase and retire the grandfathered rights only, but not the land. If the Department decides to modify the Third Management Plan to include such a program in the AMA, the rebound effect and land management and maintenance issues need to be fully addressed before the program is implemented.

8.7.5 Technical Assistance, Coordination, and Facilitation

The Department will continue to support augmentation project construction, planning, and research activities during the third management period. Technical assistance will be provided to entities in assessing the need for augmentation projects (especially in critical areas), determining project feasibility, and reviewing project impacts. Department staff will participate on oversight committees, provide data, and review planning and feasibility study reports. To facilitate research projects, the Department will assist entities by conducting research activities, assisting in study design, providing data, reviewing results, and disseminating information.

Many augmentation activities during the third management period will require the participation of water users, government agencies, and a variety of interest groups. Cooperative efforts among the participants will allow the development of more effective projects and studies. The Department will work with organizations to coordinate and facilitate augmentation activities. Examples of these activities include: (1) developing a critical management area strategy, (2) reviewing the second plan of operation for the CAGRD and facilities plan for the AWBA, (3) promoting the efficient use of the CAP delivery system, (4) facilitating Indian water rights settlements and leases, (5) further assessing the feasibility of other augmentation measures, and (6) working with organizations such as the West Valley Central Arizona Project Subcontractors (WESTCAPS) and other local groups to find solutions to water management problems.

8.7.5.1 Critical Area Strategy Planning

As described in Chapter 2 and summarized in the physical assessment section of this chapter, certain areas within the AMA are experiencing water management problems that are more serious than in other portions of the AMA. Two areas in the AMA, the northwest portion of the West SRV Subbasin and the Carefree Subbasin, need particular attention. These areas could continue to experience severe water management problems even if safe yield is achieved on an AMA-wide basis unless a more localized approach to water management is implemented.

Without an increased water management emphasis in these areas, existing problems such as drawdown, subsidence, earth fissures, etc., are anticipated to become worse. Therefore, the Phoenix AMA will place more emphasis on these areas through the third management period to develop a strategy to address these problems.

In conjunction with critical area strategy planning, many things can be done to help reduce future subsidence, earth fissuring, and associated damage in critical areas. One of the most important steps which

must be taken is to create an awareness among groundwater users, land developers, urban planners, and regulatory agencies about the potential problems which may be caused by future subsidence. One step which has been taken to promote this needed awareness is the formation of an internal Department subsidence group which will examine various subsidence issues and make recommendations concerning future rule modifications, regulatory approaches, and public education. Externally, the Department, the Arizona Geological Survey, the United States Geological Survey, and the intergovernmental Steering Committee on Land Subsidence and Earth Fissures will play an important role in providing education, information, and recommendations on subsidence-related issues.

Other planning efforts may include: (1) developing local/state partnerships, (2) identifying stakeholders, (3) identifying problems, (4) identifying groundwater pumping issues, (5) conducting hydrogeologic investigations as necessary, (6) examining new legislation and or local ordinances to remove barriers to problem mitigation, (7) providing recommendations for the AWBA regarding storage locations, (8) developing programs, and (9) creating incentives that contribute to a solution.

8.7.5.2 West Valley Central Arizona Project Subcontractors

A coalition of west valley water providers has been formed to establish a coordinated water resources planning effort to determine how renewable resources may be used to accommodate future urbanization. This coalition, known as WESTCAPS, is conducting a study to develop regional water strategies to optimize the efficient use of CAP allocations in the West SRV.

The Department is providing WESTCAPS with technical and planning assistance. In addition, financial support has been provided from the conservation assistance and augmentation grants fund.

8.7.5.3 Salt River Valley Model

The Department has developed a regional groundwater flow model of the Salt River Valley to provide an analytical tool capable of quantifying the effects of various groundwater management and conservation scenarios on the groundwater supplies within the study area. This model is currently used in the analysis of applications for Certificates and Designations of AWS within the Phoenix AMA.

This model provides a cumulative source of hydrologic and geologic data for the Phoenix AMA and is intended for use by interested parties and as a framework for other models in the Salt River Valley. The model may be restructured in the future to incorporate water quality data, data regarding seasonal hydrologic stresses, a subsidence package, new water level data, and improved geologic data.

8.7.5.4 Gravity Surveys, Subsidence Monitoring, and Development of a Predictive Model

The Department is conducting a gravity survey and subsidence monitoring program in the Phoenix, Tucson, and Pinal AMAs to provide data that can be used to evaluate water level trends, groundwater storage changes, aquifer system compaction, and land subsidence conditions. The results of these analyses will then aid the Department in formulating future groundwater management policies. Gravity surveys can provide accurate information regarding changes in aquifer storage. Land subsidence monitoring provides a means to detect ongoing and potential future damage to the land surface. It is proposed that data gathered through this program will enhance the existing information on subsidence and determine if subsidence has occurred in other areas of the Phoenix AMA. The Department will make this information available to the public and will be available to discuss and present the results with local advisory groups or committees that have an interest in the topic.

In addition to the subsidence monitoring, the Department will also develop a subsidence predictive modeling component that will be used in conjunction with the Hydrology Division's Salt River Valley

Groundwater Flow Model. This tool will be used for educational and planning purposes and for estimating the level of subsidence likely to occur, if any, under various groundwater withdrawal scenarios. In particular, this information will be useful in determining whether the depth-to-water limitations under A.A.C. R12-15-703 will contribute to additional subsidence in certain areas of the AMA. For the Phoenix AMA, A.A.C. R12-15-703 prohibits pumping below 1,000 feet below land surface. Therefore, if the modeling scenarios were to show that water levels at 1,000 feet below land surface caused additional subsidence in areas which resulted in substantial unreasonable harm, then it may provide the evidence that a depth-to-water limitation under the AWS Rules should be reevaluated.

8.7.6 Financial Assistance

The Department's Augmentation Assistance Program is described fully in Chapter 9. This program provides funding for augmentation, reuse, and recharge projects to enhance the region's water supply through grants, contracts, and intergovernmental agreements.

8.7.7 Resolution of Legal and Institutional Barriers

The Department will continue to work with interested parties in the AMAs and around the state to draft rules and propose legislation that will resolve legal and institutional barriers to augmentation activities. Among the barriers are difficulties with the recharge permitting process and conflicting objectives of various regulatory programs. Some problems the Department can address with its existing resources, tools, and authorities, such as revising the well spacing and impact rules. The Department can also indirectly influence progress in some areas through support of legislation. For some issues, new or revised statutory authorities may be necessary.

8.7.7.1 Colorado River Issues

The Colorado River is a very important source of water for the State of Arizona, both for the agricultural interests and towns along its banks and for the central valleys of the state served by the CAP. The supply is managed by a series of reservoirs controlled by the Secretary through the United States Bureau of Reclamation (USBR). In Arizona, the two principal reservoirs are Lake Powell (Glen Canyon Dam) and Lake Mead (Hoover Dam).

In 1964, the United States Supreme Court issued a final decree in the case of Arizona v. California, 376 U.S. 340 (1964), granting Arizona permanent rights to 2.8 million acre-feet of mainstream Colorado River water for use within the state, to the extent that the water was available within the system. The Court also provided the division of the water in years of surplus and shortage. In 1968, Congress passed the Colorado River Basin Project Act, which authorized the construction of the CAP and also altered the priority system on the mainstream. The Act directed the Secretary to adopt operating plans for the Colorado River system, including criteria for determining surplus and shortage conditions, and to operate the system in years of shortage so that California would receive its full entitlement of 4.4 million acre-feet before any water was available to the CAP. This latter political compromise, which was necessary to gain approval of the CAP over the objections of California, has effectively made the CAP the last priority water right among the states of the Lower Division in the Colorado River basin.

In 1983, once the CAP was under construction, the Secretary completed the National Environmental Policy Act analysis of the allocation of CAP water by publishing the Record of Decision in the federal register. This final determination made initial allocations of CAP water and provided guidelines for future allocations. It also included criteria for reducing CAP deliveries in years of shortage on the Colorado River. Thus, there are two separate shortage criteria that govern deliveries through the CAP–the shortage criteria and priorities on the river system and the shortage criteria and priorities within the CAP.

The Department is the state successor to the Arizona Interstate Stream Commission, and has been granted authority to represent the state in all matters concerning the rights to waters of interstate streams, most notably the Colorado River. In this role, the Department has the responsibility of monitoring the Secretary's operation of the Colorado River system, and of working with the USBR to insure that the system is operated in a manner consistent with Arizona's interests. In recent years, this has become a greater challenge as increasing demand on the system has forced the Secretary to make difficult choices on a variety of issues ranging from the development of surplus and shortage criteria to formal consultation with the United States Fish and Wildlife Service (USFWS) on the needs of endangered species under the Endangered Species Act.

The Department has been active in all of these decision-making processes. Primarily, these have involved interstate negotiations to resolve the competing demands on the river. Arizona has finally reached a point where it is using most, if not all, of its 2.8 million acre-feet entitlement. This use prevents the Secretary from delivering Arizona's unused water to California, which has occurred every year since the 1964 decree. The California demand is approximately 5.3 million acre-feet per year, with no indication of a meaningful plan for reduction yet announced. Nevada is also rapidly approaching full utilization of its .3 million acre-feet apportionment and is actively looking for new sources of water on the river. The Secretary may attempt to meet all demands on the river without requiring California to curtail its use to 4.4 million acre-feet (its full entitlement) by "borrowing" from the system by declaring surplus conditions. This borrowing impacts Arizona because of the low priority of the CAP. If the reservoirs are drawn down to accommodate excess demand, shortages may occur earlier, and they may be more severe than if the demand were limited.

The Department has spent considerable effort modeling the river system and working with the USBR to develop surplus and shortage criteria that would base surplus declarations on excess supply, rather than excess demand. This would result in a series of small shortages on the system, rather than a few very large shortages. This strategy would protect the M&I users of the CAP in most years by not exceeding the cushion of shortage protection created by non-Indian agricultural CAP contractors, who would be required to forego their right to use CAP water before any M&I shortage occurs. Also, the Department has been active in negotiating with the Secretary on resolving ambiguities and conflicts over the priorities within the CAP system, particularly those shortage decisions between M&I users and Indian contractors. While hydrologic predictions do not indicate shortages on the river system for many years to come, significant historical analysis shows that such shortages are almost a certainty. The Department is very interested in settling shortage criteria and correcting ambiguous or conflicting regulations before any shortage occurs.

The Endangered Species Act has become a much greater component of water management and planning in recent years. This is particularly true on the Colorado River because the entire system is managed by the federal government. Each federal agency has the duty to consult with the USFWS over any federal action that may affect endangered species or habitat, and the USFWS has the authority to require reasonable and prudent alternatives and remedial measures as a condition to continued federal action. Because Colorado River operations are so important to Arizona, the Department became a founder of a group of state agencies and utilities dedicated to finding a cooperative solution to the restrictions of the Endangered Species Act. This group, known as the Lower Colorado River Multi Species Conservation Plan Steering Committee, is actively planning a long-term habitat conservation plan and programmatic consultation program with USBR and the USFWS. This plan is designed to accommodate current water and power production on the river while protecting and enhancing habitat for all species determined to be threatened by river operations. By supporting this program, the Department hopes to avoid any alteration of the water delivery system which would negatively impact Arizona's water supply.

8.8 ADDITIONAL WATER MANAGEMENT TOOLS

Beyond the third management plan programs, the following sections describe other management tools that assist water users in achieving water management objectives.

8.8.1 Assured Water Supply Rules

The Assured and Adequate Water Supply Rules are a primary tool in achieving the AMA's management goals and ensuring sufficient water supplies for new development. This program provides the largest impetus for water providers to develop Augmentation and Recharge Programs through the need to have a safe, secure water supply to meet demands for 100 years. To be consistent with the Rules, water providers or developers either acquire renewable supplies for direct use or underground storage to meet future demand, or they join the CAGRD who will replenish the aquifer with renewable supplies on their behalf to replace groundwater that is pumped to meet their demand.

8.8.2 Water Exchanges

Water exchanges are water-for-water trades between two or more parties that improve the management of limited water supplies. Water exchanges can reduce the cost of water deliveries and allow the quality of water to be matched with the requirements of the user. Entities in the Phoenix AMA have engaged in water exchanges to satisfy Indian water settlements, to overcome distribution system limitations, and to obtain cheaper sources of water. Water exchanges are governed by A.R.S. §§ 45-1001, *et seq.*

8.8.3 Well Spacing Rules

The Code states that the director shall adopt rules governing well locations (A.R.S. § 45-598(A)) and may adopt rules governing pumping patterns (A.R.S. § 45-601) to minimize damage to adjacent land and water users. The Department is currently evaluating existing draft well spacing and well impact rules pursuant to the criteria specified by A.A.C. R12-15-830; however, the Department also is considering new rules. New rules in this area could better address the statutory requirements of protection, including criteria with which potential subsidence-related impacts and damage may be quantitatively evaluated. New rules could also assist in the goals of this Augmentation Program by allowing greater scrutiny of localized aquifer conditions.

8.8.4 Indian Water Rights Settlements

Settlement of long-standing disputes over the water rights claims by Indian communities in the state would assist water management by providing certainty over the legal rights to water of both tribal and non-Indian entities. The Department participates in and encourages settlement discussions, offering technical assistance and ensuring that state water laws and policies are considered by the parties. To help in settlement discussions, the state has created the Office of Indian Water Rights Settlement Facilitation. The parties may utilize the facilitator for information, facilitation, and mediation purposes.

8.8.5 Water Protection Fund Grants

Legislation establishing the AWPF Commission was passed in 1994. The purpose of the AWPF is to provide grant monies to water users for implementing projects to protect or restore the state's rivers and streams, including the purchase of CAP water or effluent for riparian enhancement. The Legislature appropriated $4 million for the AWPF from the state general fund in 1994, $6 million in 1995, $1.6 million in 1996, $5 million in 1997, and $1.6 million in 1998.

AWPF grants could impact future augmentation activities in the Phoenix AMA by providing funds to develop riparian enhancement projects which would utilize excess CAP water or effluent. While the amount of incidental recharge occurring due to these activities would increase, new or enhanced riparian areas also create an additional demand for water supplies.

8.9 FUTURE DIRECTIONS

Many issues must be addressed in order to achieve safe-yield and the other objectives discussed in this chapter. There is a growing recognition that the regulatory and non-regulatory tools available may not be sufficient to meet the AMA water management objectives. As has been discussed, numerous factors affect water use patterns, many of which are not affected by the Department's programs. Although some Code provisions are directly linked to achievement of the management goal, water management tools could be improved in many ways.

Critical area management strategies need to be formulated during the third management period to attempt to move beyond the AMA-wide goal and address water management problems in specific geographic areas of the AMA. The critical area strategy program will focus on problems associated with groundwater pumping, such as large cones of depression, subsidence, earth fissures, reduction in aquifer storage capacity, and the reduced physical availability of supplies. In addition, developing programs that promote the beneficial use of groundwater from waterlogged areas to replace groundwater pumped elsewhere serves multiple purposes. These efforts will require partnerships with entities from the areas in question who are willing to make necessary changes and support more stringent requirements to improve groundwater conditions.

It may be necessary to reexamine the AWS Rules provision that deems groundwater up to 1,000 feet below the land surface to be physically available. Allowing groundwater levels to fall this low will exacerbate subsidence and earth fissures, water quality problems, and problems with well productivity. Results from the subsidence monitoring and gravity survey conducted by the Department and its subsequent incorporation into the groundwater flow model will provide information that can be used to amend the Rules if changes are warranted.

Further examination of the purchase and retirement of IGFRs will be conducted. Issues such as whether the current withdrawal fee would be sufficient to successfully carry out this program and whether the Department will consider the purchase and retirement of the lands associated with the rights will be evaluated.

The Third Management Plan storage and recovery criteria relating to the decline rate remained consistent with the Second Management Plan. However, further evaluation will be conducted in the third management period to determine whether more stringent criteria is warranted, especially in relation to developing a critical management strategy.

Through the third management period, continued evaluation of meeting water management objectives through AWBA activities will be conducted, including researching where water storage and credit extinguishment could provide the most benefit to the AMA.

REFERENCES

AWBA, 1997. Storage Facility Inventory. p. 11.

CAP Agricultural Water Supply Available Under Restructured Plan, Revised January 17, 1994.

CAP Annual Operations Summaries, 1990-1997.

CAP Subcontracting Status Report, March 20, 1998.

Halpenny, L.C., 1984. Waterlogging within the Buckeye Water Conservation and Drainage District, Buckeye Valley, Arizona. p. 3-1.

Hoff, T.M., 1998. Maricopa County Flood Control District. Letter to S. Ehlers.

Kinshella, P., 1997. City of Phoenix. Personal Communication.

Larson, M.K. and Pewe, T.L., 1986. *Origin of Land Subsidence and Earth Fissuring, Northeast Phoenix*, Arizona. Bulletin of the Association of Engineering Geologists, Vol. XXIII, No. 2, pp.139-165.

Maricopa Association of Governments, 1993. 208 Water Quality Management Plan. p. 3-5.

Montgomery, E.L. and Desert Agricultural and Technology Systems, Inc., 1988. *Study of Waterlogging Problems in the West Salt River and Hassayampa Sub-basins of the Phoenix Active Management Area*. Desert Agricultural and Technology Systems, Inc.

Pewe, T.L., 1990. *Land subsidence and earth-fissure formation caused by groundwater withdrawal in Arizona; A review*, in Higgins, C. G., and Coates, D.R., eds., Groundwater geomorphology; *The role of subsurface water in Earth-surface processes and landforms; Boulder, Colorado.* Geological Society of America Special Paper 252, pp.219-233.

Schumann, H.H., 1992. *Land subsidence and earth-fissure hazards near Luke Air Force Base, Arizona.* 18 USGS Subsidence Interest Group Conference, Edwards AFB, Antelope Valley, Nov. 18-19, 1992; Abstracts and Summary.

Slaff, S., 1993. Land Subsidence and Earth Fissures in Arizona. Arizona Geological Survey Down-To-Earth Series 3, 24 p.

Wachter, J., 1997. Luke Air Force Base Memorandum for CES/CEVC.

APPENDIX 8A
PERMITTED STORAGE FACILITIES FROM MAY 1988 THROUGH MARCH 1998
PHOENIX ACTIVE MANAGEMENT AREA

Facility	Type	Pilot/ Full-Scale	Source	Annual Volume (AF)	Subbasin Location	*Total Stored (AF)
Surprise/South WWTP	USF	Pilot	effluent	313	West SRV	61
Surprise/South WWTP	USF	Full-scale	effluent	3,584	West SRV	0
Goodyear WWTP	USF	Pilot	effluent	3,360	West SRV	0
Chandler/Regional Park	USF	Pilot	effluent	250	East SRV	0
Chandler/Regional Park	USF	Full-scale	effluent	5,600	East SRV	0
Chandler/Intel	USF	Full-scale	effluent	3,100	East SRV	0
Del E. Webb/ Sun City West	USF	Full-scale	effluent	3,042	West SRV	5,775
Peoria/Beardsley	USF	Full-scale	effluent	2,470	West SRV	0
Ocotillo	USF	Full-scale	effluent	2,500	East SRV	3,476
Gilbert	USF	Full-scale	effluent	3,314	East SRV	14,530
Pima Utilities	USF	Full-scale	effluent	628	East SRV	0
Mesa Northwest Wastewater Reclamation Plant	USF	Full-scale	effluent	8,963	East SRV	21,034
Goodyear/ White Tanks	USF	Pilot	CAP	120	West SRV	0
Surprise/McMicken	USF	Pilot	CAP	2,000	West SRV	200
Scottsdale/ East Pima	USF	Pilot	CAP	5,000	East SRV	246
Scottsdale /Water Campus	USF	Pilot	CAP	5,000	East SRV	1,481
Avondale	USF	Pilot	CAP, Salt &Verde	10,000	West SRV	0
Del Webb Home Construction/ Sun City Grand	USF	Pilot	Surface water from MWD	150	West SRV	0
Tempe /Kyrene	USF	Pilot	CAP, effluent	1,000	East SRV	113
Peoria/ Skunk Creek	USF	Pilot	CAP, Salt & Verde	10,000	West SRV	0
Phoenix /Injection	USF	Full-scale	CAP	600	West SRV	305

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PERMITTED STORAGE FACILITIES FROM MAY 1988 THROUGH MARCH 1998
PHOENIX ACTIVE MANAGEMENT AREA

Facility	Type	Pilot/ Full-Scale	Source	Annual Volume (AF)	Subbasin Location	*Total Stored (AF)
Mesa/ Red Mountain	USF	Full-scale	CAP	2,000	East SRV	0
Granite Reef Underground Storage Project	USF	Full-scale	CAP, Salt & Verde, Plan 6	200,000	East SRV	165,782
Litchfield Park Service Company/ Sun Cor Farms	GSF	N/A	effluent	840	West SRV	679
San Tan Irrigation District	GSF	N/A	CAP	5,000	East SRV	7,660
Salt River Project	GSF	N/A	CAP	200,000	East SRV& West SRV	49,422
Pima Utilities/ Sun Lakes	GSF	N/A	effluent	1,500	East SRV	2,008
Queen Creek Irrigation District	GSF	N/A	CAP	28,000	East SRV	57,357
Chandler Heights Citrus Irrigation District	GSF	N/A	CAP	3,000	East SRV	3,662
Roosevelt Water Conservation District	GSF	N/A	CAP, effluent	100,000	East SRV	58,996
Maricopa Water District	GSF	N/A	CAP	18,000	West SRV	0
Tonopah Irrigation District	GSF	N/A	CAP	15,000	Hassayampa	29,032
New Magma Irrigation District	GSF	N/A	CAP	54,000	East SRV	141,935
TOTAL				**698,334**		**563,754**

* Total water stored through 1996.
WWTP = Wastewater Treatment Plant
MWD = Maricopa Water District
AF = acre-feet
CAP = Central Arizona Project
East SRV = East Salt River Valley
West SRV = West Salt River Valley
USF = Underground Storage Facility
GSF = Groundwater Savings Facility
N/A = Not applicable

APPENDIX 8B
DECLINE RATE METHODOLOGY

In evaluating an application for a proposed recovery well permit, the Department considers many factors in determining consistency with the average water level decline rate siting criteria. The time frame for which the average is calculated may vary based on data availability and the hydrologic characteristics of the area. Major trends in precipitation, water supply utilization over time, hydrogeologic data, and the modeling of projected impacts may be factors in evaluating this rate. Other considerations may also be appropriate depending on the location of the proposed recovery well.

Typically, the Department examines the historic static water level data for the period of record for wells located in the section in which the proposed recovery well is located and in the adjacent eight sections. The specific area examined depends on the availability and quality of water level data and the hydrogeology of the area. Bedrock outcrops, large pumping centers, and other features may affect the determination of pertinent data. Generally, wells that are screened in the aquifer of concern and are regularly monitored using consistent methods for static water level data are good reference points (such as the Department's statewide monitoring or index wells). The Department examines the well hydrographs (graphs of static water levels over time), and evaluates the slope of the curve for the period of interest. The slope indicates whether the static water level in the monitoring well has risen or fallen over time. A horizontal line on the hydrograph indicates that water levels remained stable over time. The Department identifies what activities may have caused the groundwater changes over time to see whether the activity still exists or has been reduced, eliminated, or increased over time.

This approach provides more flexibility and protection of the groundwater resource than would be provided by a simplistic evaluation of decline rates calculated for all water level data within a set radius and during the entire period of record. For example, if a recovery well is proposed for an area which historically had a rapid decline in groundwater levels due to activities that no longer exist (e.g., retirement of agriculture after heavy agricultural use in the 1940s and 1950s), and if the proposed area is not at high risk for subsidence, the proposed recovery well might be deemed consistent with the average decline rate criteria by looking at the period of time after the historic change in use. Similarly, if water levels in the vicinity of the proposed recovery well were stable for decades but a relatively new use caused rapid rates of decline, the proposed recovery well may be deemed inconsistent with the criteria.

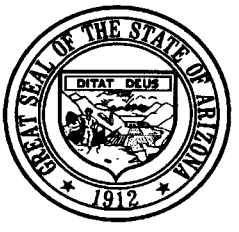
The Department's groundwater models may be used to project future water levels and decline rates on a regional basis. Modeling may assist the permittee in evaluating recovery options. Where there are sufficient data, a model may give an indication of how long recovery within a region may remain permitted based on the current average decline rate criteria.

The most current procedures for establishing the average groundwater level decline rate in the vicinity of a proposed recovery well will be published in the Department's Recovery Well Application Packet.

CHAPTER

9

Water Management Assistance Program



9.1 INTRODUCTION

The Arizona Department of Water Resources' Water Management Assistance Program (WMAP) is intended to provide financial and technical resources and to assist in the development and implementation of conservation programs, augmentation programs, and programs designed to monitor hydrologic conditions and assess water availability in the Active Management Area (AMA). Program resources will be focused on projects with the highest probability of contributing to the goal of safe-yield. This program is funded through a portion of the groundwater withdrawal fee paid annually by those who withdraw groundwater in the AMA.

Conservation assistance may take the form of financial assistance to water users proposing to undertake conservation programs or planning and technical support designed to increase water use efficiency across the AMA. Conservation assistance will continue to serve as a balance to enforcement actions related to conservation requirements during the third management period. Augmentation assistance may take the form of financial assistance to water users, providing them the means to study, design, and construct renewable resource facilities. Assistance may also take the form of planning and technical assistance designed to develop AMA-wide and local area management strategies. Monitoring activities include providing staff assistance and funds for water availability and subsidence monitoring studies.

The Arizona Department of Water Resources (Department) administers this program through the awarding of contracts to water users, universities, consultants, and other eligible persons, and through the provision of planning and technical assistance to water users. The Department also provides legal, financial, and administrative support to the contracts program.

In this chapter, the following topics are discussed in the order listed:

- Statutory Provisions
- The Department's Role in the Water Management Assistance Program
- Second Management Plan Program Summary and Assessment
- Third Management Plan Program Goals and Objectives
- Future Program Directions

9.2 STATUTORY PROVISIONS

9.2.1 Program Authorization and Funding

The Groundwater Code (Code) requires that the Third Management Plan include a program for "additional augmentation of the water supply of the active management area, if feasible, including incentives for artificial groundwater recharge," and a program for "conservation assistance to water users within the active management area." A.R.S. § 45-566(A)(6) and A.R.S. § 45-566(A)(8). Funding for these programs comes primarily from groundwater withdrawal fees levied and collected pursuant to A.R.S. § 45-611(C).

9.2.2 Withdrawal Fees

An annual groundwater withdrawal fee is levied and collected from each person withdrawing groundwater in an AMA from a non-exempt well. Withdrawal fees are authorized by the Code and are assessed on a per acre-foot basis of groundwater withdrawn and beneficially used. A.R.S. § 45-611(A)(2). Pursuant to A.R.S. § 45-614, by October 1 of each year, the director of the Department must set the groundwater

withdrawal fee for the following calendar year. For purposes of this WMAP, the Code sets a withdrawal fee cap of $2.00 per acre-foot of water withdrawn. The Code instructs that these fees be used to provide financial assistance for augmentation of the water supply, conservation assistance to water users, and for monitoring and assessing water availability within the AMA. The monitoring and assessment provision was added to the Code through a 1996 amendment.

The creation of the Arizona Water Banking Authority (AWBA) in 1996 signaled a dramatic shift in the funding levels for the WMAP. Beginning with the 1997 groundwater withdrawal fees (collected in 1998 to be used for the 1998 grant cycle), the first $2.50 per acre-foot of the established withdrawal fee is assigned to the AWBA to fund, in part, its activities. Under 1997 fee levels of $2.75 per acre-foot in the Phoenix AMA, $2.50 per acre-foot goes to the AWBA and $.25 per acre-foot is collected to support the WMAP. At average pumping levels of 900,000 acre-feet at $.25 per acre-foot, the WMAP will collect $225,000 annually. This is in contrast to pre-AWBA levels of approximately $1,400,000 collected annually for the WMAP. The director is authorized under A.R.S § 45-611(C)(2) to set that portion of the annual groundwater withdrawal fee used for conservation and augmentation assistance, and water availability monitoring at a maximum of $.50 per acre-foot. These conditions are statutorily set through the year 2016.

Total available funding for the program will vary from year to year depending on the amount of groundwater withdrawn and on any carry-over of unspent conservation assistance, augmentation, and monitoring monies from previous years.

Each AMA has a five-member Groundwater Users Advisory Council (GUAC) appointed by the governor to represent various sectors of the regulated water community. The GUAC makes recommendations to the director regarding how the fees should be set within the statutory limits. Withdrawal fees are collected annually with the Groundwater Withdrawal and Use Reports.

The Department began collecting withdrawal fees for this program for the 1990 calendar year. The assessment in the first year was to initiate the augmentation assistance program adopted as part of the Second Management Plan. In 1991, the Second Management Plan was modified to include a conservation assistance program, which also became eligible for funding.

Table 9-1 shows the total groundwater pumped, annual groundwater withdrawal fees, and total fees collected for the program from 1990 through 1997 in the Phoenix AMA.

9.3 THE DEPARTMENT'S ROLE IN WATER MANAGEMENT ASSISTANCE PROGRAM

The Department's role in the WMAP is to direct the program by identifying areas in need of technical or financial assistance, establishing assistance priorities, soliciting and reviewing applications, developing contractual arrangements with grantees, providing administrative and logistical support to contractors, reviewing contract deliverables, monitoring contract progress, and providing access to contract results.

9.3.1 Annual Assistance Priorities

In an effort to apply available funding and technical assistance to the most important projects, the AMA identifies annual program priorities. With assistance from members of the water-using community and the GUAC, high priority project categories are identified. Any applications for funding in these categories receive preference during the application review and selection process. The 1998 grant cycle incorporated for the first time a "must fund" category. The premise for this category was the determination that there were certain projects, due to their high priority, that would be carried out with financial support from this program or with technical assistance from the Department, regardless of whether an application was submitted. A more detailed discussion of annual priorities is found in section 9.4.4.1.1.

TABLE 9-1
GROUNDWATER WITHDRAWAL FEES COLLECTED FOR WATER MANAGEMENT ASSISTANCE PROGRAM PHOENIX ACTIVE MANAGEMENT AREA

Year	Groundwater Pumped (acre-feet)	Withdrawal Fee[1] (per acre-foot)	Money Collected[1]
1990	1,113,121	$1.00	$1,113,121
1991	915,900	$1.25	$1,144,876
1992	787,314	$1.60	$1,259,702
1993	927,467	$1.60	$1,483,947
1994	830,087	$1.75	$1,452,652
1995	774,655	$1.75	$1,355,646
1996	922,427	$1.75	$1,614,248
1997	914,286[2]	$ .25	$228,572[2]
Average	898,157	—	—

[1] Withdrawal Fees and Money Collected reflect only that portion of the groundwater withdrawal fee established to support the Water Management Assistance Program. Total withdrawal fees through 1997 have been greater than Table 9-1 fees, since the first one dollar per acre-foot of the annual withdrawal fee was established for general Department administrative purposes.

[2] Estimate (actual pumpage and fees not determined as of 5/20/98)

9.3.2 Application and Review Process

Water users from an extensive mailing list receive notice that the annual grant application process has begun. The notice identifies funding categories, priorities, application review criteria, application submittal and review schedules, and funding levels. Once applications are received, AMA staff conduct their review. AMA staff also provide logistical and technical support to the GUAC during their concurrent review. Generally, an initial screening of applications is conducted by the GUAC. Applications most consistent with the established funding priorities are retained for further consideration. Those applications making the "first cut" are invited to make a presentation to the GUAC. Subsequent to the presentations and application reviews, the GUAC selects which applications should receive funding and forwards their recommendations to the Department director. The director then makes the final determination as to which applications will be offered a contract.

9.3.3 Department of Water Resources' Directed Projects

Conservation, augmentation, and monitoring projects and proposals can be initiated at any time by the Department after receiving input from the GUAC or a public or private entity. The GUAC and Department staff analyze such proposals for consistency with the AMA's conservation, augmentation, and monitoring objectives and the applicable review criteria and make a recommendation to the director. To qualify for funding in this category, a clear and convincing demonstration must be made regarding why the proposal should be funded in advance of the next scheduled grant application cycle.

9.3.4 Contract Development

Each applicant receiving a favorable determination from the director is required to enter into a contractual agreement with the Department. The contract is prepared by Department staff, consistent with the applicant's proposal and scope development, and describes what is to be accomplished by the applicant for which reimbursement will occur.

9.3.5 Contract Monitoring and Support

Department staff track the progress of each contractor. Contract products are reviewed for consistency with contract requirements. Intermediate contract deliverables and review provisions are followed. Department staff authorize and issue payments, modify contracts as needed, and provide other legal and administrative support.

9.3.6 Clearinghouse

Each AMA acts as an information repository for all conservation, augmentation, and monitoring information generated from the contracts they administer. In addition to any information transfers or product dissemination requested in the contracts, the Department makes all information or products generated by contracts available to the public upon request.

The Department's Web site also serves as an information clearinghouse and the primary public venue for dissemination of current information on the assistance programs. Information gained through Department-sponsored programs, which are deemed to be regionally, statewide, and/or nationally transferable, will be placed on the Department's Web site and updated regularly. A future activity includes linking the Department's Web site to other pertinent Web sites. This will assist users in finding water conservation, water supply, and augmentation information from other sources.

A centralized clearinghouse could include a library of conservation and augmentation literature, detailed information on grants and contracts previously funded, and could provide information on centralized water conservation outreach activities.

9.4 SECOND MANAGEMENT PLAN PROGRAM SUMMARY AND ASSESSMENT

The fees collected during the second management period were used to fund conservation and augmentation grants, as well as to fund program administrative support staff in the Phoenix AMA. Typically, the Department advertised the availability of funds for grants each year, evaluated the grant proposals received, and awarded funds to projects that best met the program objectives.

From the beginning of this program in 1991 through the 1998 grant cycle, 91 grants have been awarded in the Phoenix AMA at a total funding amount of $6.5 million. Appendix 9 lists all grants awarded during the tenure of this program.

9.4.1 Conservation Assistance Program

The Second Management Plan identified four conservation categories to be the focus of the program:

- Information and Education
- Agricultural Users Program
- Municipal Users Program
- Industrial Users Program

The Second Management Plan required that a minimum of one conservation project be funded in each category during the second management period. Through the 1998 grant cycle, the Phoenix AMA had funded 62 conservation projects totaling $3,823,232. The number of grants in each of the conservation assistance funding categories and the funding amounts are listed in Table 9-2.

TABLE 9-2
CONSERVATION ASSISTANCE GRANTS AWARDED
PHOENIX ACTIVE MANAGEMENT AREA

Category	Number of Grants	Funding Totals
Information and Education	22	$454,090
Agricultural Users	10	1,282,965
Municipal Users	26	1,846,883
Industrial Users	4	239,294
Totals	62	**$3,823,232**

The types of projects funded included:

- Conservation Research and Planning - Eighteen grants totaling $993,746 were awarded to analyze water use activities (such as water use within single family homes, evaporative cooler use, and outdoor misting systems), develop innovative conservation practices and programs, and evaluate the effectiveness of conservation programs.

- Conservation Program Development and Implementation - Eight grants were awarded in this category, totaling $397,931. These grant programs focused primarily on plumbing retrofit programs for senior citizens and low income neighborhoods.

- Xeriscape™ Demonstration Gardens/Design Guides - Five grants totaling $739,500 were awarded in this category. The objective in this category was to display low water use plants in a highly visible public setting to encourage others to plant low water use landscapes and to provide low water use landscape design guides to single family homeowners to encourage more water efficient residential landscapes.

- Agricultural Conservation and Crop Water Use Studies - Nine grants totaling $1,237,965 were awarded. On-site water management assistance was provided on farms in the East and West Salt River Valley Subbasins, and research on the consumptive use of cotton was conducted.

- Information and Education - Twenty-two grants totaling $454,090 were awarded in this category. Teaching and training various segments of the water-using community were the primary activities in this category. Workshops, training sessions, school curriculum, information dissemination, and displays and promotions were utilized to educate water users and students on conservation.

9.4.2 Augmentation Assistance Program

The Second Management Plan identified two broad funding categories for augmentation grants. Category I included construction and implementation projects designed to directly increase water supplies or water storage. Demonstration and pilot augmentation (recharge) projects fell into this category. Category II included planning, research, and feasibility studies. This category included studies of new technology, selection of future project sites, and resolution of technical and institutional barriers to augmentation and

recharge. In addition to these two categories, the Second Management Plan originally contained restrictions on the amount of augmentation money that could be spent in each category. A 1996 modification to the Second Management Plan eliminated all such categories and restrictions and now allows the GUAC to recommend any level of funding for either studies or construction projects.

Through the 1997 grant cycle, the Phoenix AMA has funded 29 augmentation projects totaling approximately $2,647,000. The number of augmentation grants and the types of grants are described below:

- Augmentation Research and Planning - Three grants totaling $273,600 were funded in this category.

- Recharge Research, Demonstration, and Construction - Fifteen grants totaling $1,081,537 were awarded in this category. Various research projects regarding recharge technology, hydrologic feasibility of recharge sites, and recharge demonstration projects were the focus in this category. Central Arizona Project water and effluent recharge projects were studied and constructed with assistance from this fund.

- Water Quality Enhancement and Reuse - Eleven grants were awarded in this category for a total of $1,291,977. Research on constructed wetlands designed to treat effluent, effluent reuse, and greywater use were the primary focus in this category.

9.4.3 Monitoring and Assessing Water Availability Program

Statutory authorization making monitoring and water availability assessments fundable under this program was given in 1996. Projects that may be funded in this new category include water measurement, aquifer and geohydrologic studies, land subsidence monitoring, and aquifer compaction studies. Projects in this category are not required to follow the previously described grant funding process. The Department may requisition funds from the withdrawal fee account if, in the opinion of the Department, such a project is critical to the needs of the agency. Funding of up to $200,000 has been encumbered to develop a Phoenix AMA land subsidence monitoring network. The Pinal and Tucson AMAs have also contributed funding for the monitoring program to be included in those areas.

9.4.4 Second Management Plan Program Assessment

The WMAP has been in operation for seven years. As previously described, many projects in several categories have been funded under this program. This section will generally assess the accomplishments of the program and the assessment will be used to reaffirm or reshape the program, as necessary, for the third management period. This general program assessment was conducted for the following reasons:

- During the third management period, the program will experience a 70 to 86 percent reduction in funding due to the creation of the AWBA. This significant reduction in funding levels demanded an assessment of the program direction.

- The recognition that the AMA is not making as much progress as anticipated toward achieving safe-yield will cause a reevaluation of all programs, including the WMAP.

- Much time and money have been invested in this program. With that investment, it is good policy to determine what has been successful to provide direction for future program efforts.

9.4.4.1 Goal and Objectives Attainment

The goal of the WMAP during the second management period was to assist water users or others in achieving the conservation requirements of the management plan and in developing augmentation and recharge projects to maximize the use of renewable resources. This was to be achieved by: (1) identifying and carrying out high priority projects, (2) providing funds for the development of such programs, (3) acting as a central source of information, and (4) increasing public awareness of the importance of water conservation and renewable resource development.

9.4.4.1.1 Priority Projects

As previously described, the AMA establishes annual funding priorities based on consultation with the GUAC and other members of the water-using community. Applications for funding under these priority categories receive stronger consideration in the review and selection process. Conservation assistance and augmentation assistance compete equally for funding. During the first four years of this program, funding priorities were not set. Any application that met the Second Management Plan review criteria had an equal opportunity for funding. Beginning with the 1995 grant cycle, the Department began considering priorities when awarding grants. Table 9-3 identifies the annual program priorities.

Applications were received and contracts were awarded in many of the priority categories for the past three years. Many conservation assistance grants have directly assisted users in achieving their conservation requirements. Direct application of improved on-field agricultural water management techniques, residential plumbing retrofits, industrial conservation programs, and public housing and multifamily housing retrofits have all taken place, with varying levels of savings estimated. Numerous conservation research, planning, and demonstration projects have been completed that have led to full-scale implementation of conservation programs. In most cases, savings determinations are difficult to obtain and the long-term implications are unknown. Certain priority offerings received little or no applicant interest.

9.4.4.1.2 Providing Funds

The Department has made all funds collected for this program available for award; however, a small percentage of total funds collected is used by the Department to provide legal and administrative support to the program. Although all funds collected have been made available, all funding has not been awarded. In most years, the amount of funding available has exceeded the amount requested by applicants receiving GUAC recommendation. As a result, the program has established an "unencumbered balance." Given the existence of the unencumbered balance and the dramatic reduction in funding for this program due to the AWBA, the Department will develop a strategy for the third management period that integrates the lesser annual funding levels with the unencumbered balance. The Department will also consider a funding cycle strategy that may operate on "less than an annual cycle." This combination should allow the Department to retain the program and assist the AMA in moving toward safe-yield.

9.4.4.1.3 Central Source of Information

Many research documents, feasibility studies, and program implementation reports have been submitted to the Department. In addition to serving the needs of the contractors, this information is available to any interested water user. The Department is developing a Web site to serve as a central information repository and clearinghouse.

TABLE 9-3
ANNUAL PROGRAM PRIORITIES
PHOENIX ACTIVE MANAGEMENT AREA

1991 - 1994	Open categories/no priorities
1995	Innovative agriculture scheduling technologies
	Promotion of low water use landscaping
	Conservation potential for commercial, industrial, and multifamily residential water users
	Conservation assistance for small municipal providers
	Feasibility studies for recharge
	Feasibility studies for effluent use
1996	Regional planning for renewable water supply development
	Assistance to agricultural users to increase use of renewable water
	Regional recharge plan
	Irrigation district distribution system efficiency improvement
	Junior High water resources curriculum
	Point-of-purchase water conservation promotion.
1997	Funded continuation of existing projects only
1998	Do-it-yourself low water use landscape guide
	Critical area strategy development
	Front-loading clothes washer rebate/promotion
	Golf course water use–edge effect, slope, salinity
Other Priorities	Conservation advertising campaign Urban irrigation system scheduling Greywater use - obstacles Irrigation district efficiency improvements

9.4.4.1.4 Increasing Public Awareness

Through the education grants workshops, training sessions, school curriculum, information dissemination, and various promotions offered in this program, the public was made aware of the need for conservation and renewable resource development.

9.4.4.2 Summary Assessment

Overall, the WMAP has been successful in contributing to water use efficiency and the development of renewable supplies. Most grantees performed well and Department and AMA staff did a commendable

job of managing this program. Areas requiring additional attention during the third management period are:

- In many instances, the priorities established did not result in good project submittals.
- Significant difficulties were experienced with certain contractors with respect to schedules, deliverables, and other contractual difficulties.
- Significant reductions in funding (beginning in the 1998 grant cycle) need to be analyzed to determine how the WMAP will be impacted.

9.5 THIRD MANAGEMENT PERIOD PROGRAM GOALS AND OBJECTIVES

The Phoenix AMA conservation and augmentation funds supported many programs and contracts during the second management period. As incoming funds decline, the AMA will need to further focus its resources on areas that provide the most benefit to the AMA.

During the third management period, the Department, with input from the GUAC, may take a more active role in directing how funds are utilized. This may include a list of projects that need to be funded through a Request for Proposals mechanism, in addition to the current grant-based approach. Assessment of program effectiveness and transferability of information are particularly important as the monies available for assistance decline.

9.5.1 Conservation Assistance Program Goal

The goal of the Conservation Assistance Program is to assist water users or other eligible persons within the Phoenix AMA in achieving the conservation requirements of the current management plan. The Department will meet this goal by working toward the following program objectives:

- Identify high priority funding areas, in consultation with the GUAC and the water-using community, and administer priority programs.
- Provide funds for the development of such conservation assistance programs for agricultural, municipal, and industrial water users and for information and education on water conservation.
- Act as a central source for information on water conservation.
- Increase public awareness of the importance of water conservation.

9.5.2 Augmentation Assistance Program Goal

The goal of the Augmentation Assistance Program is to assist water users or other eligible persons within the Phoenix AMA in developing augmentation and recharge projects to maximize the use of renewable sources of water such as Central Arizona Project, other surface water, and effluent. The Department will meet this goal by working toward the following program objectives:

- Identify high priority funding areas, in consultation with the GUAC and the water-using community, and administer priority programs.
- Provide funds for the planning, design, and construction of such augmentation and recharge projects.
- Act as a central source for information on augmentation and recharge.
- Increase public awareness of the importance of augmenting the AMA's groundwater supplies.

9.5.3 Monitoring and Assessing Water Availability

The goal of this program is to assist in identifying, establishing, and implementing programs that monitor and assess the hydrologic conditions and the potential impacts of continued groundwater pumping and water level declines.

9.6 ALLOCATION OF PROGRAM FUNDS

The AMA makes initial recommendations to the GUAC on fund allocation based on the need to implement particular programs for the benefit of the AMA. The GUAC in turn provides the Department with recommendations on how the WMAP fund will be allocated among the three program categories (conservation assistance, augmentation assistance, and monitoring activities).

9.6.1 Fund Categories

Conservation and augmentation assistance and monitoring activities must be targeted based on program goals and objectives and AMA priorities. The following types of assistance could be provided through grants, professional contracts, or direct staff assistance.

- Planning, research, and feasibility studies
- Demonstration and pilot projects
- Technical assistance
- Information and education materials
- Conservation devices and technology
- Testing and monitoring
- Construction of augmentation facilities
- Monitoring equipment
- Monitoring and assessment activities

9.6.2 Project Selection

The decision-making process in selecting a project for funding must allow for a great deal of flexibility. During the third management period, changes may occur in water use patterns, technological advances, social values, institutional constraints, and the economic viability of conservation or efficiency measures. Due to this potential for change, it is impractical at this time to determine the type of projects that merit funding. The second management period project selection process has proven to be flexible, as well as politically and publicly responsive. This has been accomplished by involving the full participation of the GUAC. The GUAC's regularly scheduled meetings provide an excellent forum for public review and comment on projects and proposals. This process will be continued during the third management period.

Projects other than grants can be initiated at any time by the Department after receiving input from the GUAC or a public or private entity. The GUAC and Department staff will analyze such proposals for consistency with the AMA's conservation, augmentation, and monitoring objectives and the evaluation criteria, as applicable, and make a recommendation to the director. A clear and convincing demonstration regarding why the proposal should not wait for the next grant cycle will be required.

If the Department determines that grant funds will be available in a given funding cycle, it will provide notice to water users and other interested parties of the procedures for soliciting grant project proposals. Proposals are solicited for all three grant categories (conservation assistance, augmentation assistance, and monitoring and water availability studies). The Department may also submit its own projects for consideration. The priorities that will be used by the GUAC and the director in selecting projects to be funded will be determined prior to commencing the project solicitation process. Applicants may be invited

to give a presentation for the GUAC and to address any concerns or issues that need clarification. Using the evaluation criteria set forth below, the proposals will be reviewed by AMA staff, the GUAC, and outside reviewers as appropriate. The GUAC will then recommend projects for funding to the director. If the GUAC recommends a project proposed by the Department, the GUAC may also recommend whether the project should be implemented by the Department or another entity based on an evaluation of efficiency, effectiveness, and short-term and long-term benefits to the AMA. The GUAC may choose to give special preference to priority projects and may declare a "must fund" project which would receive first consideration for funding. These priorities may change from year to year. The director will then consider the GUAC and AMA staff recommendations and determine which projects should be funded.

9.6.2.1 Selection Criteria

Each application will be evaluated according to the criteria established by the Department in consultation with the GUAC. Evaluation criteria shall include, but are not limited to:

1. Compatibility of the project with the Department's policies and programs and the management goal of the Phoenix AMA.

2. Compliance of the project with applicable federal, state, and local laws and regulations.

3. Cost-effectiveness of the project. Ability to combine the project with proposed or ongoing projects resulting in cost and human resource savings. Ability of the project proponent to obtain matching funds for the project. Extent to which the applicant is contributing to the cost of the project (e.g., in-kind or cash). Predicted water demand reduction–extent and duration of reduction relative to project costs.

4. Extent to which the type of project is applicable to other users, other sectors, and other AMAs. Demonstrated sector commitment to participate in the project. For example, if the proposal is written to serve a particular sector such as agriculture, it must have been developed or supported by the agricultural interests it addresses.

5. Likelihood of community support for the project. Significance of the project's potential economic, environmental, and social impacts.

6. Extent to which the type of project has previously been proven feasible and effective, or extent to which implementation of the project will provide information on feasibility and effectiveness, if not previously proven.

7. Demonstrated need–is it likely the project would not be implemented without water management assistance funding?

8. Ability to monitor demand reductions during and after implementation of the project. Ability to produce documented comparisons of pre-project and post-project water savings, scientific data collection and reporting methods, or pre-program and post-program surveys to verify project results.

9. Capabilities of project proponents to successfully implement project. Applicant has experience and past success with similar projects. Past performance of project proponent with regard to implementing grant projects.

10. Effectiveness of proposal–includes factors such as a clear statement of purpose, goals, methodology, and list of deliverables (data collection, interim and final reports, etc.). Contains

background on current and historic water use, if applicable. The proposal is innovative and includes sufficiently researched budget information to determine if the requested funding is warranted (e.g., salary costs and benefits, retrofit device costs, equipment purchases, and supplies).

11. Timely, efficient development of alternative renewable water supplies. Potential to contribute to regional or critical area water management solutions.

12. Likelihood of developing transferable information or technology.

The Department will coordinate with other Arizona agencies and organizations possessing water management authority, such as the Arizona Department of Environmental Quality, through a review and comment process to ensure that these agencies and organizations are aware of the proposed project and are allowed time to assess any impacts of the proposed project.

9.7 FUTURE PROGRAM DIRECTION

The future of the WMAP will be influenced and shaped by many considerations. The next ten years will be crucial years in the Department's effort to achieve the management plan goal of safe-yield. Key considerations in the structure of the third management period program will be:

- Reduced program funding
- Program goals and objectives
- Program priorities

9.7.1 Reduced Program Funding

As described in section 9.2.2, the existence of the AWBA will dramatically reduce the amounts of program funding available to the Phoenix AMA. This is occurring at a time when there is a growing need by AMA water users to develop and expand water conservation and augmentation programs. In light of this situation, it is important that full consideration be given to maximizing withdrawal fees within current legislative limits and to the strategic use of current unencumbered program fund balances. A combination of annual withdrawal fees and some percentage of the unencumbered balance will be used annually to sustain this needed program throughout the third management period. The level of funding and the combination of funding resources should be tied to agency planning and program development needs, necessary levels of agency administrative support, and funding priorities. The possibility of future legislative authorizations to increase the groundwater withdrawal fee should also be considered.

The Department will continue to participate in financial or in-kind partnerships with other agencies, municipalities, businesses, and utilities to allow the Department to continue to promote conservation, augmentation, and monitoring activities with fewer available funds. The Department may also need to look to other sources of funding, such as special legislatively funded studies and projects. The AMA may need to reevaluate the level of assistance it has provided in the past and focus primarily on providing seed money for projects or target funds to demonstration or feasibility projects which may be lower cost. The AMA could also direct funds toward a very limited number of priority projects and defer grant disbursal in some years in order to build up sufficient funds to support key projects.

9.7.2 Relationship of Assistance Programs to AMA Program Goals and Planning Efforts

As the Department continues its efforts to facilitate increased utilization of renewable water supplies in concert with water conservation, funds could be allocated to promote the goals and objectives of its regulatory programs. The "Future Directions" sections of chapters 4, 5, 6, 7, 8, and 12 identify specific

needs that could be addressed with assistance funds. These research and assistance needs are summarized in this section.

The municipal, agricultural, and industrial programs all demonstrate the need for assistance in expanding the utilization of renewable water supplies and for funds for continued conservation assistance and education as described below.

- Municipal program needs include the evaluation of effectiveness of conservation programs and funding of programs that result in significant long-term savings. This may involve focusing funds on conservation research or evaluation projects as well as implementation programs. Urban landscape design, private water company participation, and a water issue awareness campaign are important areas.

- Agricultural program needs include irrigation water management assistance to farmers, installation of efficient irrigation systems, and infrastructure to convey renewable supplies to farms. Other agricultural needs identified were the need to monitor crop and water use patterns and to evaluate the impact of market conditions and regulatory programs on farming operations.

- Industrial needs include developing opportunities and planning assistance for renewable supply use. For turf-related facilities, research involving evaluation of the application rate and of new irrigation technologies is needed. For cooling towers, further research on the impact of effluent and Central Arizona Project water on cooling tower operation, the use of blowdown water for irrigation, and further investigation of cooling tower maintenance technologies is needed.

- Monitoring and assessment activities must be expanded to understand the contributions of the water-using sectors to reaching safe-yield. It is also important to develop strategies to reach the goal of safe-yield in the context of the hydrologic conditions in the AMA. It is necessary to understand groundwater movement, volumes, locations of groundwater recharge and depletions, and the location and movement of poor quality water to develop a hydrologic model to understand the long-term policies necessary to reach safe-yield. Monitoring and assessment activities are also critical to developing water management strategies that take localized water conditions into account.

As each of these programs will be designed to address AMA-wide water management issues, each can also be considered for assistance as critical area strategies are developed.

APPENDIX 9
PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Agriculture Conservation and Crop Water Use Studies			
Irrigation Water Conservation and Water Use Study IGA92-7956 CA93PHA15 CA93PHA16 CA95PHA02 CA96PHA28 CA96PHA29 CA97PHA02 CA98PHA29 1992, 1993, 1995, 1996, 1997, 1998	Central Arizona Water Conservation Management Program (WCMP) - East Maricopa, Agua Fria-New River and Buckeye-Roosevelt Natural Resources Conservation Districts (NRCD)	The WCMP provides services to assist both farmers and urban irrigation users with improving the efficiency of their irrigation programs. The original program funded in 1992 was specifically confined to the West Valley area. In 1993, the WCMP expanded their service area to cover the entire East and West Valley.	 $187,665 $121,191 $168,880 $88,228 $41,567 $191,262 $154,426 $167,121
Upland Cotton Feasibility and Water Use Study CA95PHA16 1995	University of Arizona	This grant funded a study of several short season cotton varieties. The objective of the study was to determine the quality and feasibility of each variety of cotton while making a comparison of consumptive water use for short season cotton versus long season cotton.	 $117,625
Total Category Funding			**$1,237,965**

APPENDIX 9
PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Augmentation Research and Planning			
Future Use of Central Arizona Project Water in Sun City - Study AUG98PH04 1998	Sun City Home Owners Association	This grant will provide funding for a study which will determine the appropriate future use of Central Arizona Project (CAP) water in the Sun City area; and to organize an education program to communicate the future need for CAP water and the plans to make effective use of it.	$48,600
Shallow Groundwater Management Strategies - Feasibility Study AUG98PH05 1998	City of Chandler	A feasibility study which will seek to develop strategies to manage rising, shallow, poor quality groundwater resulting from natural recharge, return flows and artificial recharge. An emphasis will be on reuse of the shallow groundwater.	$75,000
WESTCAPS / City of Glendale AUG96PH13 1996	WESTCAPS and City of Glendale	The purpose of this grant is to provide partial funding for the creation of a Water Resources Director position to coordinate planning efforts of the West Valley Central Arizona Project Subcontractors' Coalition (WESTCAPS). The director's primary duty shall be to establish and implement a regional planning process to identify, develop, evaluate and recommend courses of action to facilitate the use of CAP water in the West Valley.	$150,000
Total Category Funding			**$273,600**

APPENDIX 9
PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Conservation Program Development and Implementation			
Industrial and Commercial Retrofit Incentive Program CA95PHM18 1995	City of Tempe	The City of Tempe requested funding to develop and implement a financial incentive program to encourage industrial and commercial water users to implement water conservation measures. The intent of the grant was to provide financial rebates for projects that anticipated a water savings of fifteen percent or more of the total water used at the facility.	$100,000
Neighbors Helping Neighbors Program CA94PHM18 CA95PHM27 CA96PHM50 1994, 1995, 1996	Phoenix Revitalization Corporation and Labor's Community Service Agency	The goals of this program were threefold: (1) to promote and assist residents in achieving water conservation in geographic areas with historic high water consumption, economic hardship and a high level of criminal activity; (2) to provide a catalyst and vehicle for neighborhood self-help; and (3) to provide job training and employment opportunities for local residents, particularly youths at risk for gang involvement.	$45,000 $78,100 $48,541
Public Housing Retrofit Program CA94PHM46 1994	City of Peoria	The City of Peoria conducted a water conservation plumbing/retrofit program for 150 public housing units. Department funding was used to partially fund the fixtures used in the retrofit kits.	$4,000
Seniors Helping Seniors Program CA92PHM14 CA95PHM25 CA97PHM05 1992, 1995, 1997	Arizona Department of Commerce Energy Office	The Seniors Helping Seniors Program is a retrofit program for senior residents conducted by seniors. The program provides both energy and water conservation education for senior residents and provides a degree of social service if necessary.	$40,000 $37,500 $44,790
Total Category Funding			**$397,931**

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PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Conservation Research and Planning			
ACC Institutional Constraint Resolution CA94PHM21 1994	Megecon	This grant funded a detailed investigation into the nature of the institutional constraints between the Department and the Arizona Corporation Commission and possible solutions. The Grantee identified many issues related to water conservation program cost recovery and provided an analysis and recommendations for resolution of the issues.	$30,000
Drip System Failures and Impacts CA95PHI19 1995	University of Arizona	The purpose of this grant is to: (1) investigate the causes of drip system failures in the Phoenix area and determine their horticultural and economic ramifications; (2) develop guidelines and techniques for design, installation, maintenance and operation for drip irrigation based upon findings from interviews, site inspections, laboratory analysis and literature review; and (3) promote the guidelines through educational materials such as demonstration models, booklets and workshops.	$117,969
Evaluation of Non-Per Capita Conservation Programs CA94PHM24 1994	University of Arizona	This grant was to assist municipal water providers in the Phoenix AMA in the measurement of water savings from existing conservation measures, determine key implementation factors and evaluate the potential savings of proposed conservation programs.	$19,000
Evaluation of Water Conservation Measures CA94PHM40 CA96PHM40 1994, 1996	Arizona State University Morrison Institute	This grant provided the groundwork for a systematic evaluation of conservation measures employed by water providers throughout the Phoenix AMA in order to meet the mandates of the 1980 Groundwater Management Act. A reference material/literature search and an assessment of residential water conservation efforts within the Phoenix AMA was provided. A second phase funded in 1996 is to develop a quantitative model which can be used by water providers for evaluating the costs and benefits of conservation measures.	$29,600 $62,000

APPENDIX 9
PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Evaporative Cooler Water Use in the City of Phoenix CA92PHM03 CA93PHM04 1992, 1993	University of Arizona	A study to determine the average volume of water used by evaporative coolers with and without bleed-off systems; the percentage of the volume of water used by the cooler as a portion of total household water use; and the ability of typical residential water meters to record the true volume of water utilized by coolers.	 $40,000 $20,000
Irrigation Requirements for Ground Covers CA94PHM29 CA94PHM29B 1994	Boyce Thompson Arboretum	The purpose of these grants was two-fold: (1) to identify new ground covers with potential use in low and middle elevation landscapes of Arizona; and (2) to quantify water use requirements for both new and currently used ground covers.	 $11,558
Minimum Irrigation Requirements for Trees CA93PHM06 1993	University of Arizona	This study identified the minimum irrigation requirements for three tree species common to urban landscapes in the Phoenix AMA, developed irrigation schedules for landscape professionals and homeowners and provided guidelines based on research. Two detailed brochures were produced.	 $57,358

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PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Multifamily Exterior-Interior Water Use Efficiency Evaluation CA95PHM12 CA97PHM01 1995, 1997	City of Mesa	The Grantee conducted a comprehensive study of two multifamily sites (one a high water use site and the other a low water use site) and identified water demand strategies that could improve the efficiency of each site's water use. The Grantee compiled background information; recommended two study sites; developed and conducted a demographic, water use and conservation knowledge survey; conducted a series of interior and exterior water use audits to identify water demand systems at each apartment complex; led a workshop for the participants of the study and provided recommended actions for each site along with a cost benefit analysis. Phase 2 (CA97PHM01) involves the implementation of site specific water management strategies (retrofits, landscape conversion and education) that were discovered in Phase I (CA95PHM12).	 $96,100 $186,470
Outdoor Misting System Efficiency CA95PHM09 1995	University of Arizona	The purpose of this grant was to investigate water usage and efficiency of outdoor misting systems and disseminate findings to the public.	 $18,797

APPENDIX 9
PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Residential End Use Study CA96PHM18 1996	Arizona Municipal Water Users Association (AMWUA)	The primary goals of this study were to measure where water is being used in a residential setting, create a comprehensive database about those uses and provide a resource to evaluate the penetration and effectiveness of existing conservation measures. This study employs portable data loggers and sensors fitted to the water meter at each monitored household. When coupled with basic survey information from each household, the data logging will reveal the variation in water use for each purpose according to factors such as fixture age, volume and frequency of use, household size, age of home, lot size, landscape type, and socio-economic factors. The regional database created will be combined with other study sites throughout North America to create a nationwide statistical water use model which will be able to predict water use for various end uses.	$70,600
Reuse of Industrial Process Water Study CA96PHI03 1996	City of Chandler	The focus of this project is to study the cost and type of treatment necessary to recycle industrial process water and assess the feasibility of its use in industrial and commercial cooling towers and on landscaping.	$50,000
Software for Design of Sloping Border Irrigation Systems CA94PHA20 1994	US Water Conservation Laboratory USDA/ARS	This grant developed a software program which aids in the design of sloping border irrigation systems with tailwater runoff.	$45,000
Tolerance Levels of Grass Varieties to Long-Term Effluent Use CA98PHI21 1998	University of Arizona	This project will determine tolerance levels of modern bermuda grass and perennial rye grass varieties (35 varieties of each grass) to long-term effluent use. The grasses will be grown inside a greenhouse hydroponics system developed by the University of Arizona. The grasses will be grown in a synthetic effluent which matches that of Phoenix effluent.	$22,098

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PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Turf Edge Effect Study CA98PHI15 1998	University of Arizona	This project will use microlysimeters and meteorological monitoring to determine: (1) how much turf evapotranspiration (ET) is increased at the interface between turfed and surrounding desert landscapes (the "edge effect"); and (2) how this enhancement of ET changes with distance from the turf/desert interface.	$67,196
Water Use Restrictions Through Model Ordinances CA95PHM04 1995	City of Surprise	The purpose of this grant is to develop model water conservation ordinances and guidelines for use by the City of Surprise as it develops its water distribution system and service as a water provider.	$50,000
Total Category Funding			**$993,746**

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PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Information and Education			
AZMET Turf and Crop ET Data Collection and Dissemination CA94PHI22 CA97PHM04 CA98PHI28 1994, 1997, 1998	University of Arizona	Grant funds were used to install AZMET (Arizona Meteorological Network) monitoring stations throughout the Phoenix AMA. The stations provide real-time data on water requirements for turf via E-Mail, FAX and the Internet and is particularly useful for large industrial turf customers (primarily golf courses). The stations also provide the data for lawn watering guides for the general public.	$10,400 $6,000 $8,710
Computer Tracking System and Education Program CA93PHE10 1993	City of El Mirage	This grant funded an upgrade to the City's computer system that allows it to more effectively track the water use of its citizens. Included in the grant are funds to develop a program to educate employees and citizens about the importance of water conservation.	$20,000
Conservation Public Awareness Program CA95PHM20 1995	Desert Botanical Garden	This grant funded efforts by the Desert Botanical Garden to increase public awareness of water conservation measures through its Center for Desert Living, which serves as the Garden's principle exhibit on the ornamental use of desert plants, desert horticulture and water and energy conservation strategies.	$50,945
HydroSmarts Water Conservation Program CA98PHM25 1998	Kid's View Communica-tions Corp.	Expansion of an existing Tucson AMA project. The HydroSmarts Water Conservation Program is a creative and interactive program designed to educate young readers about water issues. The HydroSmarts feature is incorporated in the Bear Essentials News for Kids, a newspaper for school children ages 6 - 13. This grant provides funding for Kid's View to expand the program to the Phoenix area.	$69,350

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PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Indoor Water Management Workshop CA92PHE10 CA93PHE13 1992, 1993	Alfred's Plumbing	Mr. Alfred Eichenger conducted workshops pertaining to indoor water management and indoor plumbing fixtures. CA92PHE10 required Mr. Eichenger to conduct 24 workshops demonstrating installation and operation of low-flow plumbing fixtures to high school students. CA93PHE13 demonstrated the same concepts to homeowners.	 $13,000 $13,000
Plant of the Month and Promotional Education CA95PHM13 CA96PHM04 CA97PHM03 1995, 1996, 1997	Arizona Nursery Association	Three grants were awarded to the Arizona Nursery Association for the development of an education program for nursery personnel, a plant of the month program and a video which was developed and will be available at nurseries in kiosks to assist in the education and promotion of low water use plants to the public. The 1997 grant was provided to further advertise plant of the month fliers and the video through radio station announcements.	 $50,750 $27,300 $30,000
Plumbing Fixture Workshop CA93PHE14 1993	Alfred's Plumbing	Mr. Eichenger taught indoor water management and installation and operation of low-flow indoor plumbing fixtures to junior high school students at five different schools.	 $4,825
Student Scholarships CA93PHE08 CA94PHM47 CA95PHM03 CA96PHM12 CA98PHM27 1993, 1994, 1995, 1996, 1998	Natural Resource Conservation Workshop for Arizona Youth (NRCWAY)	Grant money was used to cover the tuition of several high school students to the NRCWAY workshop, which is held for one week each year. Topics covered in the annual workshop are ecology, geology, hydrology, anthropology and forestry. The Department also supported this effort by supplying volunteer instructors.	 $3,150 $3,975 $4,680 $4,680 $4,125

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PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Teacher / Student Education Program and Booklet CA96PHM20 1996	Duncan Farms	Grant funds were used to design and construct a maze to instruct children about water conservation. Funds were also used to develop and publish 2,000 water conservation education booklets for teachers and 30,000 water conservation children's activity sheets.	$12,000
Technical Water Conservation Training for Industrial / Commercial CA94PHI02 CA95PHM33 1994, 1995	Arizona Municipal Water Users Association (AMWUA)	These grants funded workshops specifically geared to assist commercial and institutional facility managers with performing water audits of their facilities.	$6,200 $51,000
Water Conservation Curriculum for Junior High Schools CA92PHE08 1992	Arizona Municipal Water Users Association (AMWUA)	AMWUA developed a junior high school water conservation curriculum.	$35,000
Xeriscape™ Brochure CA93PHE11 1993	Arizona Municipal Water Users Association (AMWUA)	AMWUA created and distributed a Xeriscape™ brochure. It provided colorful pictures of Xeriscape™ landscaping options that were exceptionally well presented and provided names for all the plants portrayed.	$25,000
Total Category Funding			**$454,090**

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Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Recharge Facilities			
Cave Creek Water Reclamation Plant - Wetlands and Recharge Project AUG98PH03 1998	City of Phoenix	This project will design and construct a system of unlined wetlands and recharge basins in an urban area to further treat and recharge effluent generated at the Cave Creek Water Reclamation Plant. The recharge project will be designed to utilize high quality reclaimed water for recreation, habitat enhancement and augmentation of critical water resources by allowing recharge and aquifer storage.	$50,000
Recharge by Injection in Chandler AUG94PH26 INJECTION WELLS AT THE CHANDLER TREATMENT FACILITY AUG95PH06 1994, 1995	City of Chandler	This grant partially funded the construction, equipping and testing of a pilot injection well constructed in 1995 for the Chandler Effluent Treatment and Recharge Facility which will recharge 3,100 acre-feet of effluent per year at full-scale. A second phase of Recharge by Injection in Chandler (AUG94PH26), provided funding for the construction and monitoring of three injection wells which will serve to inject reverse osmosis treated effluent into the aquifer.	$50,000 $150,000
Total Category Funding			**$200,000**

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PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Recharge Study / Demonstration Projects			
Central Arizona Project and Effluent Study AUG94PH08B 1994	City of Surprise	This study conducted research on the recharge capabilities of two spreading basin sites in the City of Surprise -- an effluent site at the waste water treatment plant and a Central Arizona Project site at McMicken Dam. This grant demonstrated that recharge at both sites would be hydrologically feasible for a large-scale project and enabled the City to begin the design and permitting processes needed for full-scale recharge facilities.	$105,500
Feasibility of Cap Recharge in Goodyear AUG95PH08 CAP RECHARGE IN GOODYEAR AUG96PH08 1995, 1996	City of Goodyear	In AUG95PH08, the City of Goodyear studied the feasibility of recharging Central Arizona Project (CAP) water in the West Valley. Part of the study investigated the feasibility of transporting CAP water from the Beardsley Canal. The grant provided funding for a study of recharge alternatives and establishment of a direct delivery system through the Beardsley Canal by which the City's CAP allotment can be transported without expensive new infrastructure. The purpose of AUG96PH08 was to develop a detailed technical and hydrological study for the recharge of 120 acre-feet of CAP water delivered through the Beardsley Canal.	$22,311 $117,689
High Quality Recharge Study AUG94PH24 1994	Arizona State University	This project is studying the interactions of soil minerals with reverse osmosis-treated water, micro-filtered water, CAP water and specific blends of these waters to determine whether contaminants might be released in the vadose zone from these potentially corrosive source waters during groundwater recharge.	$56,797
Optimal Operation And Maintenance Techniques For Recharge Basins in Fine Grained Soils AUG98PH06 1998	City of Surprise	This grant provides funding for pilot recharge testing that will systematically evaluate the various methods of operation and maintenance and the effect those techniques have on the long-term sustainability of infiltration rates. This grant springboards from a previous grant that conducted pilot recharge testing and evaluation of design criteria for the City's effluent recharge facility.	$200,000

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Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Queen Creek Study AUG94PH13 1994	City of Mesa	This grant provided funding for the completion of a hydrologic feasibility study for storing water underground at the proposed Queen Creek Wash Underground Storage and Recovery Project. The study concluded that approximately 10,000 acre-feet of water can be recharged in the Queen Creek wash based on the size and conditions of the proposed recharge project site.	$21,000
Recharge and Reuse of Treated Effluent - Goodyear AUG95PH09 1995	City of Goodyear	The purpose of this grant is to develop a master plan for reuse and recharge of up to 21.00 million gallons per day of treated effluent produced at the Goodyear Wastewater Treatment Plant. The Reuse/Recharge Master Plan will develop the infrastructure to utilize the effluent for both direct use within the community and for recharge of the regional aquifer.	$75,330
Recharge Mounding Prevention Study AUG95PH10 1995	University of Arizona	This grant is developing a systematic general method to improve the operation of percolation recharge systems to avoid groundwater mounding problems. The project proposed to develop a methodology for determining the optimal infiltration application cycles and protective well pumping rates to maximize the overall economically feasible recharge rate.	$65,283
Soil Aquifer Treatment Optimization Study AUG94PH20 1994	Arizona State University	A study with the intent to develop a methodology for determining the optimal operation of soil aquifer treatment (SAT) systems to maximize infiltration under different constraints. The results may be used by engineers, agencies and consultants involved in the planning, operation and design of SAT systems.	$57,659

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PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Vadose Zone Demonstration AUG94PH18 1994	Town of Gilbert	The purpose of this ongoing project is to test the feasibility of recharging reclaimed wastewater into vadose zone injection wells (VZIW) in the vicinity of Gilbert's wastewater treatment plant. Once the VZIW is installed, the well performance will be monitored for a sufficient time to determine its suitability as compared to the infiltration spreading basins.	$51,500
Waddel Dam Recharge Study AUG94PH04 1994	Arizona State University	The purpose of this grant was to test the feasibility of recharging the aquifer with CAP water in the Agua Fria River basin downstream of Lake Pleasant, to develop a recharge plan and to enhance riparian wildlife habitat along the river below Lake Pleasant.	$30,910
Well Maintenance Technology For Tertiary Effluent AUG95PH16 1995	Arizona State University	This grant sought to determine if wells can be used to recharge effluent directly into water supply aquifers. All recharge systems utilizing effluent are susceptible to clogging over time as a result of biomass accumulation and physical filtration of suspended solids. The effectiveness of several disinfection schemes to control this clogging were to be investigated, as well as the ability of the aquifer to break down potentially hazardous disinfection by-products.	$77,558
Total Category Funding			**$881,537**

APPENDIX 9
PHOENIX ACTIVE MANAGEMENT AREA GRANTS

Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Water Quality Enhancement and Reuse			
Avondale Wetlands Study AUG96PH03 1996	Arizona State University	ASU, in collaboration with the City of Avondale, is studying the City's nitrate treatment wetland-recharge demonstration project that will ultimately utilize 35,000 acre-feet of water annually, including 5,000 acre-feet of Central Arizona Project water. The wetland is needed to treat Salt River Project canal water which often exceeds the maximum contaminant level for nitrate.	$212,000
Central Arizona Project Groundwater Treatment Facility AUG95PH07 1995	City of Goodyear	The purpose of this grant was to provide assistance in developing a pilot study to identify design criteria for a treatment plant capable of treating both surface and groundwater in the same facility. This study will determine the feasibility of treating CAP water and high TDS groundwater in a conventional water treatment plant.	$124,800
Dairy Wastewater Treatment with Constructed Wetlands AUG94PH19 AUG97PH02 1994, 1997	University of Arizona	This project involves the construction of an experimental wetland facility to treat wastewater generated by a valley dairy operation. It will be used to assess the ability of this technology to produce water suitable for recharge and/or reuse in an environmentally sound manner. AUG97PH02 is a continuation and enhancement of AUG94PH19. It will increase, by 15 months, the length of time for operating and monitoring the performance of the wetlands, and the reuse and recharge components of the project.	$392,180 $159,138
Establish Wetlands Nursery for Avondale Wetlands AUG94PH28 1994	City of Avondale	The City of Avondale established a wetlands plant nursery as part of a future wetland treatment and recharge system (AUG96PH03). The goal of the nursery project was to observe and monitor indigenous growth and treatment characteristics provided by native plants transplanted from the Avondale Wastewater Treatment Plant discharge area, as well as give the Grantee the opportunity to raise its own plant material for the wetlands project.	$10,000

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Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Greywater Reuse and Impacts on Plants CA94PHM38 1994	Desert Botanical Garden	The purpose of this ongoing grant is to determine the effect of greywater on the growth and performance of selected ornamental desert plant species. The project is using greywater generated by the occupants of the Desert House which is located at the Desert Botanical Garden in Phoenix.	$59,025
Iron Induced Aquifer Treatment to Improve Water Quality AUG95PH15 1995	Arizona State University	This grant funded a study to determine if elemental iron is effective in dechlorinating certain organo-chlorine compounds under laboratory conditions. Organo-chlorine compounds are significant groundwater contaminants and, if successful, the use of elemental iron to degrade these contaminants may offer a more cost-effective method than is currently available to treat groundwater contaminated by these compounds.	$24,470
Mobile Water Treatment/Recharge Center AUG94PH30 1994	Arizona State University	The purpose of this grant was to develop a cost-effective portable system for filtering and improving the quality of raw water (such as runoff from the Salt and Verde rivers and CAP water) which could then be used for recharge.	$88,364
Study to Supply High Quality Water to the Town of Buckeye AUG96PH18 1996	Town of Buckeye	The purpose of this grant was to aid in the development of a water supply strategy for the Town of Buckeye that reduces the Town's dependence on poor quality groundwater and reduces the cost of water to residents of the Town. The study was to identify sources which would be renewable, adequate to provide for future growth, of acceptable quality and available at a reasonable price.	$31,500
Tres Rios Constructed Wetlands Study AUG94PH03 AUG97PH01 1994, 1997	City of Phoenix	An ongoing study to test the capability of constructed wetlands to upgrade the present quality of treated sewage effluent of the 91st Avenue Wastewater Treatment Plant to levels that will satisfy expected National Pollutant Discharge Elimination (NPDES) Permit requirements. AUG97PH01 is a continuation of AUG94PH03 and will partially fund additional studies of the constructed wetlands.	$150,000 $40,500
Total Category Funding			**$1,291,977**

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Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Xeriscape™ Demonstration Gardens / Design Guides			
Botanical Walk at Superstition Springs CA94PHM23 1994	City of Mesa	A project designed to enhance the Botanical Walk at Superstition Springs Mall. A four-color low-water use plant brochure was designed and printed with a portion of the grant funds, which listed characteristics of plants found in each of three desert regions. Entrance monument signs, desert region signs and plant identification signs were designed, created and installed. A maintenance manual was also developed.	$15,000
Boyce Thompson Arboretum/ Interpretive Signs CA94PHM27 1994	Boyce Thompson Arboretum	Interpretive signs were created for inclusion into a demonstration garden of low-water use plants. The signs targeted important water conservation concepts and explained the functionality of low-water use plants. Topics depicted included water efficient landscapes, water harvesting, concentration of salts in water and soils and designing water efficient gardens.	$20,000
Do-it-yourself Xeriscape™ Design Guide and Demonstration Area CA98PHM01 CA98PHM02 CA98PHM03 1998	Human Productivity Center and Arizona Municipal Water Users Association	A collaboration of efforts between the public and private sectors to develop and distribute Xeriscape™ design guides to new home buyers and existing homeowners in the Phoenix AMA. Instructional Xeriscape™ design booklets will be prepared along with customized landscape templates, primarily for new single-family home buyers. Step-by-step procedures will be addressed for landscape and irrigation system design and installation. Long-term maintenance information will be provided. Xeriscape™ landscapes will be installed and maintained as public demonstration areas and educational workshops will be a component of the overall project.	$680,000

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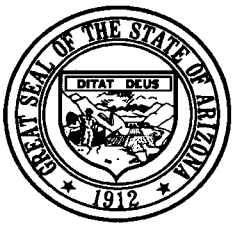
Grant Title Grant Number Year(s) Funded	Grantee	Description	Funding Amount
Master Gardeners/ Trail Guide and Sign Construction CA94PHM25 1994	Arizona Master Gardeners, Inc.	The Master Gardener Program, working in conjunction with the Maricopa County Extension Office, created signs and a Trail Guide pamphlet for use at a demonstration garden and interpretive trail designed to illustrate efficient water use techniques for the Sonoran Desert. The site is located at the Maricopa County Extension Office.	$4,500
Xeriscape™ Demonstration Garden CA94PHM30 1994	City of Tempe	A Xeriscape™ demonstration garden was created in Tempe at the Tempe Women's Club Park. Plants and signs were installed in an area that had already been in use as a storm water retention basin.	$20,000
Total Category Funding			**$739,500**
Total Funding for All Categories			**$6,470,232**

CHAPTER

10

Plan Implementation



10.1 INTRODUCTION

This chapter describes the process the Arizona Department of Water Resources (Department) will follow when implementing, determining compliance with, and enforcing compliance with the Third Management Plan requirements. These plan elements will be carried out in accordance with the Department's overall regulatory approach, which is described in the preface to Section II, Regulatory Programs. The following topics are discussed in the order listed:

- Notice of Conservation Requirement - Compliance Dates
- Variance and Administrative Review Process
- Plan Modification Procedures
- Groundwater Use Reporting Requirements
- Monitoring and Audit Procedures
- Compliance Approach

10.2 NOTICE OF CONSERVATION REQUIREMENTS - COMPLIANCE DATES

Within 30 days of adoption of the Third Management Plan, the Department will mail written notice of the irrigation water duties and conservation requirements established in the plan to the persons required to comply with the requirements. A.R.S. § 45-566(B). The written notice will set forth the final irrigation water duty or conservation requirement that will become effective on January 1, 2010, and any intermediate water duties or conservation requirements that must be complied with prior to that time. Two years before the compliance date for an intermediate water duty or conservation requirement established in the Third Management Plan, the Department will give additional written notice of the requirement to the person required to comply. A.R.S. § 45-566(B).

A person who receives notice of an irrigation water duty or conservation requirement established in the Third Management Plan must begin complying with the requirement by the date specified in the notice, unless the person applies for and is granted a variance, as explained in section 10.3. A.R.S. § 45-566(C). The person must continue complying with the requirement until the effective date of any substitute water duty or conservation requirement established in the Third or Fourth Management Plans. If a person receives notice of a Third Management Plan water duty or conservation requirement that replaces a water duty or conservation requirement established for the person in the Second Management Plan, the person must continue complying with the Second Management Plan water duty or conservation requirement until the effective date of the Third Management Plan requirement.

The director may give written notice of a conservation requirement at any time to a person with a right to withdraw, distribute, or use groundwater that was not in existence when the management plan was adopted. The person given written notice must comply with the conservation requirement not later than the compliance date specified in the notice, unless the person applies for and is granted a variance. A.R.S. § 45-571.01(B) and (C).

10.3 VARIANCE AND ADMINISTRATIVE REVIEW PROCESS

Upon receipt of a notice of Third Management Plan irrigation water duty or conservation requirement, a person may apply for a variance from or seek administrative review of the water duty or conservation requirement. In general, a variance gives a person additional time to comply with a water duty or

conservation requirement, while an administrative review can result in an adjustment to the requirement for that management period. Each of these processes is described below.

10.3.1 Variance

If a person requires additional time to comply with a new irrigation water duty or conservation requirement, the person may apply for a variance. An application for a variance must be filed within 90 days of the date of the notice of the water conservation requirement given two years prior to the compliance date for the requirement. A.R.S. § 45-574(A). The director may grant a variance for up to five years upon a showing that "compelling economic circumstances" will prevent the person from complying with the new water duty or conservation requirement by the compliance date specified in the notice. A person granted a variance must continue complying with any existing water duty or conservation requirement during the variance period, unless the director establishes a schedule of intermediate water duties or conservation requirements to be reached at specified intervals during the variance period. A.R.S. § 45-574(C).

10.3.2 Administrative Review

If a person believes that an error or omission was made in calculating the person's water duty or conservation requirement, an administrative review of the irrigation water duty or conservation requirement may be requested by the person. If granted, an administrative review can result in a permanent adjustment to the water duty or conservation requirement. An application for administrative review must be filed within 90 days of the date of the notice of the water duty or conservation requirement given within 30 days of adoption of the management plan, if the application is based on circumstances in existence as of the date of the notice. A.R.S. § 45-575(A).

At any time during the third management period, a person may seek administrative review of the person's water duty or conservation requirement based on a claim that "extraordinary circumstances not in existence as of the date of notice that was given thirty days after adoption of the management plan" justify revision of the water duty or conservation requirement. The director may revise the water duty or conservation requirement based on clear and convincing evidence that extraordinary circumstances not in existence as of the date of notice make it unreasonable to require compliance with the water duty or conservation requirement. A.R.S. § 45-575(B).

In determining whether extraordinary circumstances exist that render a water duty or conservation requirement unreasonable, the director will consider, among other things, whether actual conditions that came into existence after the date of notice are significantly different from those conditions in effect at the date of notice.

Examples of extraordinary circumstances may include: an increase in average lot size within a municipal provider's service area that substantially exceeds the average lot size the Department used in developing the provider's per capita conservation requirements; changes in water quality that necessitate altering water application rates for irrigation grandfathered rights; changes in technology or economics that are significantly different from the Department's projections or assumptions; and changes in federal, state, and local laws and regulations that prevent compliance with water duties or conservation requirements.

Additionally, a municipal provider that is subject to the Non-Per Capita Conservation Program (NPCCP) may seek administrative review of a conservation requirement, other than a conservation requirement for an individual user, only if the municipal provider claims at any time that "significant circumstances that did not exist when the municipal provider's application for the NPCCP was approved by the director" justify the modification. The director may modify the conservation requirement upon clear and convincing

evidence that significant circumstances that did not exist when the application was approved by the director make it unreasonable to require compliance. A.R.S. § 45-575(C).

10.4 PLAN MODIFICATION PROCEDURES

At any time after the Third Management Plan is adopted, the plan may be modified pursuant to the same public hearing and comment procedures required for adoption of the plan. A.R.S. § 45-572(A). Further, the director may modify an irrigation water duty or conservation requirement established in the plan "only if the director determines that extraordinary circumstances, errors, or mistakes justify the modification." A.R.S. § 45-572(A).

Within 30 days of a modification of an irrigation water duty or conservation requirement, the Department must give written notice of the modification to the person required to comply with the modified requirement. The person may request a variance from or an administrative review of the modified water duty or conservation requirement within 90 days of the date of the notice. A.R.S. § 45-572(B) and (C).

10.5 GROUNDWATER USE REPORTING REQUIREMENTS

The Groundwater Code (Code) contains a number of provisions that enable the Department to acquire needed information on water use. This information is used to evaluate compliance with the Code and Department rules, permits, and management plans. The water use monitoring and reporting requirements, which are summarized below, are also designed to provide water users with the data needed to assess their progress in attaining conservation requirements.

10.5.1 Water Measurement

The Code requires persons withdrawing groundwater from non-exempt wells in Active Management Areas (AMA) to use water measuring devices approved by the director. A.R.S. § 45-604. However, some small irrigation and non-irrigation users are exempt from the measuring device requirements. The Department has adopted rules requiring the use of an approved device, or a combination of devices and methods, for measuring rates and volumes of groundwater withdrawals for the calculation of the total annual volume of groundwater withdrawn. A.A.C. R12-15-901, *et seq.* Persons subject to the measuring device requirements must maintain the accuracy of the device within specific standards.

10.5.2 Records and Annual Reports

The Code requires most persons who own or lease a right to withdraw, receive, or use groundwater to file an Annual Water Withdrawal and Use Report with the director for each right they hold. All persons required to file annual reports must maintain current and accurate records of water withdrawn, delivered, received, and used. A.R.S. § 45-632.

Persons withdrawing groundwater from exempt wells and most non-irrigation customers of cities, towns, private water companies, and irrigation districts are exempt from record keeping and reporting requirements. Persons receiving water pursuant to a grandfathered right or a groundwater withdrawal permit and persons assigned and noticed of individual user requirements must meet the record keeping and reporting requirements, although certain small right holders are exempted from those provisions.

10.6 MONITORING AND AUDIT PROCEDURES

The Department has the authority to determine compliance with Code, management plan, and rule requirements. This authority is described below.

10.6.1 Measuring Devices

The Department monitors compliance with the measuring device requirements, as required by A.A.C. R12-15-901, *et seq.,* through review of Annual Water Withdrawal and Use Reports and field investigations. Before field visits, the Department generally contacts well owners to ask for their cooperation and presence during the inspection. Standardized procedures and equipment are used to test the accuracy of measuring devices. The Department checks a significant percentage of the wells in the Phoenix AMA for accuracy each year.

10.6.2 Irrigation Acreage and Water Use Monitoring

The Department monitors irrigated acreage and irrigation water use in the Phoenix AMA using annual reports, crop records, energy use records, aerial photography, and satellite-based remote sensing data. These procedures are also used both to determine the accuracy of annual water use reports and to detect illegal irrigation. The Department investigates any potential discrepancies or violations identified using these methods.

10.6.3 Annual Report Reviews and Audits

The Department reviews all annual water withdrawal and use reports. This is the Department's primary means for determining compliance with conservation requirements, measuring requirements, and groundwater rights limitations.

Each year, the Department conducts official audits of a significant number of annual reports to check the accuracy of the reports and to verify suspected problems. An audit is a detailed review by Department staff of a person's water use records. Each person audited is requested to attend the audit. Audits ensure overall compliance with the Code and the management plan for the Phoenix AMA.

10.6.4 Inspections

The Code allows the Department to enter property where facilities are located that are used for the withdrawal, transportation, or use of groundwater. This authority allows the Department to inspect facilities and lands subject to Code provisions and obtain data or access to records relating to the withdrawal, use, or transportation of groundwater. A.R.S. § 45-633.

The Department is generally required to give persons reasonable notice of inspections or investigations unless entry is sought solely to inspect a measuring device. Notice is not required in the rare cases in which there is reason to believe that notice would impede enforcement efforts.

10.7 COMPLIANCE APPROACH

The Department has developed a compliance program approach that includes education, assistance, and flexibility.

10.7.1 Education and Assistance

The Department informs water users of their conservation and reporting requirements as described in section 10.2 of this chapter. The Department also educates water users by explaining how the requirements were derived and how the user can achieve those requirements. This is done through advisory committees, detailed program descriptions contained in reports and issue papers, public presentations, the publication of this management plan, and individual meetings with interested users.

Annual flexibility account balance statements are sent to all affected users allowing them to monitor their compliance status. Irrigation grandfathered right holders who have exceeded the debit limits of their flex accounts, or who are close to exceeding them are notified of their status and given the opportunity to reduce water usage or purchase flexibility account credits to avoid an enforcement action. However, irrigation grandfathered right holders regulated under the Historic Cropping Program may not purchase flex credits.

Financial and technical assistance is available to water users to assist them in meeting their conservation requirements. This assistance is more fully described in Chapter 9.

10.7.2 Determination of Compliance

The mandatory conservation programs in the Third Management Plan are designed to achieve reductions in groundwater withdrawals and use. Consequently, the persons given notice of water duties and conservation requirements established in the plan are required to comply with those water duties and conservation requirements only in those years in which they withdraw, distribute, or receive groundwater. The following two sections describe how the Department determines compliance with conservation requirements when groundwater is used.

10.7.2.1 Maximum Annual Water Allotments and Gallons Per Capita Per Day Requirements

The Third Management Plan establishes maximum annual water allotments for farms, turf-related facilities, dairies, and cattle feedlots. Municipal providers regulated under the Total GPCD Program and the Alternative Conservation Program are required to comply with gallons per capita per day (GPCD) requirements. These requirements are similar to maximum annual water allotments in that they limit the amount of water that may be used during a year to a predetermined amount. A person's compliance with a maximum annual water allotment or GPCD requirement is generally determined by comparing the total amount of water used by the person during the year with the amount of water allowed by the allotment or GPCD requirement. However, the use of water in excess of the allotment or GPCD requirement during a year does not necessarily mean that the person is out of compliance for the year. To account for weather variations and other factors that may result in the use of more water in some years than others, the Department determines compliance either through the operation of a flexibility account or through a three-year averaging method, depending on the type of use.

Flexibility accounts are used to determine compliance for municipal providers subject to GPCD requirements, turf-related facilities, and farms. The total water use reported by the user for the year is compared with the amount of water the user was entitled to use during the year. Generally, if the total amount of water used during the year is less than the allotment for the year, the flexibility account is credited with the difference. If the water use exceeds the allotment, the flexibility account is debited with the difference. A user is out of compliance with its allotment or GPCD requirement in any year in which its flexibility account is debited with an amount of water that causes the account balance to exceed the maximum negative balance allowed for the use.

For dairies and cattle feedlots subject to maximum annual water allotments, compliance is determined through a three-year averaging method. Under this method, the user will be in compliance with its allotment for any year in which its water use exceeds its allotment if the total amount of water used during that year and the previous two years does not exceed the sum of allotments for those three years.

If a farm, turf-related facility, or municipal provider uses water during a year in an amount which causes its flexibility account to exceed its maximum negative account balance, or if a dairy or cattle feedlot uses water during a three-year period in an amount which exceeds the sum of the allotments for those three years, a violation occurs, but only to the extent of the groundwater included in excess. The Department

determines the amount of groundwater in the excess by the previously described process known as "stacking."

Under the stacking process, water from all sources used by a person during a year, with certain exceptions, is counted when comparing the person's water use to the maximum annual water allotment or GPCD requirement. However, groundwater is counted last. The process of counting groundwater last is called stacking because the groundwater is added to, or stacked on top of, the non-groundwater sources. Because groundwater use is counted last, the amount of any water used by a person in excess of its allotment or GPCD requirement will be comprised, at least partially, of groundwater.

10.7.2.2 Specific Conservation Measures

Municipal providers regulated under the Non-Per Capita Conservation Program are required to comply with specific conservation measures instead of GPCD requirements. The following industrial users are required to comply with conservation measures specific to their type of use instead of maximum annual water allotments: dairies regulated under the Best Management Practices Program, sand and gravel facilities, electrical power plants, large-scale cooling facilities, and new large landscape users. For these municipal providers and industrial users, compliance will be determined by ascertaining whether they implemented their specific conservation measures in the manner required by the management plan rather than by comparing their water use to a volumetric allotment. They are out of compliance if they fail to implement the conservation measures in the required manner.

All industrial users, including those subject to maximum annual water allotments, are required to comply with the conservation measures established for All Industrial Users in section 6-202 of Chapter 6. These conservation requirements include general requirements to avoid waste and make efforts to recycle water. They also include more specific requirements relating to low water use landscaping, landscaping and water features in publicly-owned rights of way, single pass heating and cooling, and low flow plumbing fixtures. In addition to these requirements, section 6-1002 of Chapter 6 requires that all new large industrial users submit a water conservation plan to the director.

10.7.3 The Enforcement Process

When the Department's monitoring program identifies a potential violation or when third party complaints are received about the activities of another user, an investigation is conducted to obtain the facts.

An investigation may involve a field inspection by Department staff or an audit at the Department's office after notice to the potential violator. The Department may request that the individual produce relevant records for the inspection or audit. Based on the investigation, the Department will determine whether there has been a violation, and if so, what course of action to take.

Where the violation is minor, and does not require corrective action, the Department may bring the compliance action to a close with an advisory letter upon discontinuance of the violation. For more serious violations where there is reason to believe a person is violating or has violated a statute, permit, rule, or management plan provision, enforcement action will be taken by the Department.

During the first and second management periods, the Department took a non-traditional approach to enforcement. Given the recent introduction of the Code and management plans, a high level of tolerance was employed. Fines were set at low levels and probationary provisions and advisory notices were widely used. In most instances, for unintentional violations of management plan requirements such as GPCD limits and maximum turf or farm allotments, the Department deferred any monetary penalties. Instead, it allowed the violator to develop or expand conservation measures designed to help the violator reduce water use. The Department felt that the long-term benefits of a properly designed and implemented conservation

program, tightly structured and closely monitored, would exceed the benefits of a traditional monetary penalty program.

In each instance of a management plan violation, the violator was given the following options:

- Contest the enforcement action by requesting a hearing,
- Pay a predetermined monetary penalty, generally based on the amount of groundwater used in excess of the requirement, or
- Negotiate a mitigation program with the Department designed to develop or expand conservation programs intended to assist the violator in achieving future compliance.

The results of this enforcement strategy have been mixed. Some mitigation programs developed under this approach have been successful in increasing water use efficiency, while others have been less effective. In most cases, significant and sometimes disproportionate amounts of time and resources have been invested by both the violators and the Department.

The Third Management Plan approach to enforcement will continue to exercise tolerance and flexibility, but on a more limited scale. The arguments of "newness and complexity" will be less compelling in this management period. Previous violations will be considered in determining the appropriate compliance approach. In addition, the Department may consider new compliance approaches during the management period for Code and management plan violations. One possible provision would employ a groundwater replenishment option. This may involve storage of renewable water designated as non-recoverable, as defined by A.R.S. § 45-833.01, in a volume that would compensate for the excess groundwater pumpage. A related approach may allow the purchase and extinguishment of long-term storage credits to compensate for a violation. The result of these approaches is a penalty that atones for a violation and results in a positive water resource activity. If a water user anticipates a violation and informs the Department of this expectation before they receive a notice of non-compliance, the director may consider their voluntary disclosure to be a mitigating factor in determining the appropriate enforcement action.

The Department may consider a more aggressive level of compensation for certain violations as part of its forthcoming "critical area strategy."

Additional enforcement mechanisms are generally reserved for violators not amenable to the previously mentioned mechanisms. They include contested hearings, cease and desist orders, and civil penalties of up to $10,000 per day for violations directly related to illegal withdrawals, transportation, or use of groundwater. A.R.S. §§ 45-634 and 45-635.

Extremely serious cases may also be referred for criminal prosecution if persons knowingly violate or refuse to comply with the Code or with a permit, rule, or order issued or adopted under the Code.

SECTION

III

Future Conditions and Directions

Chapter 11 Water Budgets and Projections

Chapter 12 Future Directions

Preface

Sections I and II have described water resource conditions within the Phoenix Active Management Area (AMA) and the regulatory programs designed to cause efficient use of groundwater and increasing amounts of renewable water supplies to be used. The Arizona Department of Water Resources' (Department) regulatory program for the third management period described in Section II represents the midpoint in our overall management strategy to implement water management programs which ultimately will lead to the achievement of the AMA's management goal by the year 2025.

This section, Section III, describes projected future conditions within the Phoenix AMA, as well as the directions the Department proposes to take in developing water management programs during the third management period.

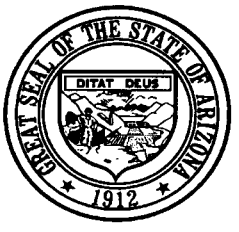
Alternative future water supply and demand conditions are described in Chapter 11. The Department's supply and demand conditions, also known as "water budgets," are designed to illustrate a range of supply and demand possibilities for consideration as we develop our management programs. Both Phoenix AMA scenarios exhibit significant overdraft conditions; one more severe than the other. Chapter 11 projects continued overdraft scenarios even under optimistic conditions, indicating that mid-course changes in direction may be necessary if we are to achieve safe-yield by 2025.

Chapter 12 describes some options for the future, looking towards ultimately achieving the AMA management goal through increasingly stringent requirements for the conservation of groundwater along with the augmentation of water supplies. Chapter 12 summarizes existing water management problems, identifies the obstacles to safe-yield, and describes the actions the Department expects to take to remove these obstacles during the Third Management Period and beyond.

CHAPTER

11

Water Budgets and Projections



11.1 INTRODUCTION

The Arizona Department of Water Resources (Department) uses detailed water budgets to estimate total Active Management Area (AMA) water demand and supply. In this manner, the Phoenix AMA can evaluate the current imbalance or overdraft of groundwater to meet current demand in the AMA and the effectiveness various water management decisions have toward achieving the AMA goal of safe-yield of groundwater by the year 2025. After consideration of various possible future water management scenarios, the Phoenix AMA has developed water budgets for two scenarios of future water supply and demand through 2025. One scenario projects a continuation of the level of water use efficiency in the AMA in 1995 through the year 2025. The second scenario projects the effects of the Third Management Plan in improving water use efficiency. The projection scenarios are distinct future paths designed to assess the effectiveness of conservation requirements and augmentation efforts for the third management period and to reveal what will be needed in the fourth and fifth management periods to achieve the AMA's safe-yield goal.

11.2 WATER BUDGET SCENARIOS

The two water demand and supply projection scenarios are prepared based on many assumptions. In each scenario, only the assumptions that are key to fulfilling the objectives are varied; most assumptions remain the same for both of the scenarios. The following assumptions remain constant:

- Water demand for 1995 is the baseline for all projections.

- Water use rates for purposes such as residential landscape watering and agricultural crop watering are influenced by annual weather variation. To account for this, 1991 water use rates were used in the budget scenarios. The Department compared 1991 water use rates with long-term data and found that 1991 resembles long-term average annual weather conditions and water use rates more than any other recent year.

- Surface water availability can vary greatly from year to year. It is impossible to make long-term projections of surface water available year to year in the future with much accuracy. Historic long-term annual average surface water availability is the basis for future annual surface water availability in the water budget scenarios.

- Projections of population and urbanization of agricultural land are key factors for determining changes in agricultural, municipal, and industrial water use. As urbanization occurs, less land is available for agriculture. The 1995 AMA population estimate is based on municipal water service area population estimates developed by the Maricopa Association of Governments (MAG) for the Department. Population and land use projections for five year increments from the year 2000 through 2025 in the AMA are derived from 1993 Arizona Department of Economic Security projections for Maricopa and Pinal Counties. The population of the AMA is projected to grow from 2,549,931 in 1995 to 4,482,876 in 2025.

- Although urbanization of agricultural land caused by population growth will reduce non-Indian cropped acres through 2025, Indian communities are projected to considerably increase their cropped acres. Total cropped acres in the AMA (both on Indian and non-Indian lands) are projected to increase from approximately 200,000 acres in 1995 to approximately 227,000 acres in 2025.

- Natural system effects (recharge and underflow) are constant from year to year.

- Rates (but not volumes) of incidental recharge from agricultural, municipal, industrial, and other uses are constant from year to year.

- The volume of artificial recharge tallied in water budget scenarios in any given year is equal to: (1) the volume of recharge credits projected to be recovered in that year and (2) the quantity of artificial recharge that is considered a "cut to the aquifer" or the quantity stored that is ineligible for future recovery. Artificial recharge does not appear in the budget if it results in the accumulation of long-term storage credits which are not recovered by 2025.

- In the event of a water exchange, the water supply offered for exchange by the giving party is attributed to meet the demand of that party. For example, when a party exchanges groundwater for effluent, it is assumed for the water budget scenarios that the party used groundwater to meet its demand.

The two water budget scenarios are referred to as the Current Use Scenario and the Meet TMP Scenario for the remainder of the chapter. The objectives and key demand and supply assumptions are distinct for each scenario.

11.2.1 Current Use Scenario

This scenario measures groundwater overdraft in the AMA if current water use and supply utilization practices continue. This projection scenario assumes that water use efficiencies through the year 2025 by agricultural, municipal, and industrial users will remain at current levels. For example, it is assumed that the average household will be no more efficient in its water use in the year 2025 as it is today. Supply assumptions vary for the municipal, agricultural, and industrial sectors. Municipal supplies are prioritized based on compliance with Assured Water Supply Rules (non-Indian) or current sources (Indian). Agricultural supplies are prioritized based on source costs (non-Indian) or likely supplies available (Indian). Industrial supplies are largely groundwater and are projected to remain as such.

11.2.2 Meet TMP Scenario

This scenario measures groundwater overdraft if agricultural, municipal, and industrial users improve water use efficiency to meet Second Management Plan water use conservation requirements for each sector (chapters 4, 5, and 6, respectively) from 1995 to 2002, Third Management Plan conservation requirements from 2002 to 2010, and continue at this level of efficiency from 2011 to 2025. This scenario is designed to measure the effectiveness of the Third Management Plan conservation requirements toward meeting the safe-yield goal. Supplies are prioritized in the same manner as the Current Use Scenario.

11.3 OVERVIEW OF SECTOR DEMAND

Water use to meet demand in the Phoenix AMA is divided into municipal, agricultural, industrial, and riparian uses for analysis. Water supplies and uses are shown in Table 11-1 along with the percent of total water used by each sector in 1995 (more detailed information regarding current water use in the AMA is found in Chapter 3). Water use by the Indian communities within the AMA is not managed by the Department but is included in the AMA water budget scenarios. Water use figures for Indian communities are estimated for 1995 based on water rights settlement reports and hydrologic surveys.

TABLE 11-1
WATER USE SECTORS
PHOENIX ACTIVE MANAGEMENT AREA

Sector	Demand Characteristics	Supplier of Water / Legal Authority	1995 Volume / Percent of AMA Water Use
Municipal	- Non-residential industrial, commercial and institutional uses and residential uses - Urban irrigation served by large untreated water providers. - Effluent use at Palo Verde Nuclear Generating Station	- Cities and towns, private water companies, Indian communities, exempt wells - Large untreated water providers - 91st Avenue Wastewater Treatment Plant	869,962 acre-feet 37%
Agricultural	- Cultivation including Indian and non-Indian demand	Irrigation Grandfathered Groundwater Rights, irrigation districts and Indian community water rights	1,333,885 acre-feet 57%
Industrial	- Industrial, commercial and institutional uses served pursuant to a groundwater right or permit	Type I or Type II non-irrigation grandfathered groundwater rights; and groundwater withdrawal permits	83,088 acre-feet 4%
Riparian	- Riparian areas located along perennial areas of rivers and streams	N/A	48,000 acre-feet 2%

11.3.1 Municipal Demand

Total AMA municipal demand is composed of:

- Residential demand (household interior and exterior demand) and non-residential demand (commercial, industrial, and institutional uses) served by municipal water providers
- Residential and non-residential demand served within the Indian communities
- Urban flood irrigation served by large untreated water providers
- Lost and unaccounted for water from municipal provider and large untreated provider water systems

More information regarding municipal water use characteristics may be found in Chapters 3 and 5.

11.3.1.1 Municipal Demand Served by Municipal Water Providers and Indian Communities

Municipal demand served by municipal water providers and Indian communities is composed of residential and non-residential water uses and lost and unaccounted for water. Residential use constitutes interior and exterior use at single family and multifamily homes and apartments. Interior residential water

use can vary with the number and efficiency of fixtures and appliances, water use practices, and the number of persons in a household. Exterior residential water use is dependent upon the type of landscaping at the residence, the type of irrigation system used and irrigation practices employed, and lot size. Non-residential use includes industrial, commercial, and institutional water uses served by municipal water providers and includes such uses as industrial processing, cooling, and landscaping. Since non-residential uses reflect the full range of economic activity in the AMA, the variables affecting water use can differ considerably from facility to facility. Lost and unaccounted for water results from leaking pipes, unmetered hydrant use, and other losses when water is conveyed in a municipal provider's water distribution system. The two water budget scenarios differ with respect to the degree of anticipated improvements in water use efficiency by new and existing residential and non-residential water uses served by municipal water providers as measured by gallons per capita per day (GPCD) water use.

To calculate non-Indian municipal provider water demand for each scenario, the AMA was divided into water planning areas. Water planning area boundaries usually correspond to municipal water provider boundaries and the supply source for the area (e.g., Gilbert outside of Salt River Project (SRP), Gilbert within SRP). MAG population projections for the AMA were disaggregated by water planning area and multiplied by a GPCD rate for that planning area. The AMA GPCD calculation shown in Table 11-2 is an average of the GPCD rates of each water planning area weighted by population. Different rates of population growth projected for each of the water planning areas will affect the AMA-wide average GPCD.

TABLE 11-2
ASSUMPTIONS FOR MUNICIPAL WATER DEMAND
SERVED BY MUNICIPAL PROVIDERS AND INDIAN COMMUNITIES
PHOENIX ACTIVE MANAGEMENT AREA

Factors	Projections			
	1995	2005	2015	2025
Population	2,549,931	3,016,643	3,704,394	4,482,876
Indian Reservation	12,053	12,520	13,004	14,457
Off Indian Reservation	2,537,878	3,004,123	3,691,390	4,468,419
GPCD - Current Use Scenario				
Indian	517	517	517	504
Non-Indian	238	235	234	232
GPCD - Meet TMP Scenario				
Indian	517	517	517	504
Non-Indian	238	219	212	207

GPCD = gallons per capita per day

Indian municipal water use is not subject to the AMA's conservation requirements, so the assumptions are the same for both scenarios. To calculate Indian municipal water demand, the latest published water settlement technical reports, hydrology reports, and population data were used. A GPCD rate for 1995 was estimated for each community based on this data. The estimated GPCD rate was then multiplied by population projections for the Phoenix AMA portion of the Gila River Indian Community and the Salt River Pima-Maricopa Indian Community to project water use for these communities. Because no population projections are available for the Fort McDowell Indian Community, municipal water demand is held constant from current estimated levels throughout the projection period. Differing population growth rates projected for each community explains the fluctuations over time in the weighted average GPCD rate for all Indian communities shown in Table 11-2.

The estimated 1995 GPCD rate for Indian communities seems extraordinarily high. Since many community households do not water elaborate landscaping, a major component of residential water use, GPCD rates were anticipated to be lower than the non-Indian average. Non-residential uses being developed within the Indian communities such as casinos, recreation facilities, and large retail developments with high water use characteristics spread across a small population base could also account for an unusually high per capita use rate. Lack of reliable data makes refining the projections difficult. However, since Indian municipal water demand accounts for less than 1 percent of total AMA water demand, the high degree of uncertainty associated with the projections will not greatly effect the water budget demand and groundwater overdraft calculations.

11.3.1.2 Urban Irrigation Demand Served by Large Untreated Water Providers

The number of landscaped acres irrigated, the irrigation requirements of the landscaping, and how water is applied to the landscaping (flood irrigation, sprinklers, etc.) are the primary factors influencing water demand for urban irrigation. The two water budget scenarios differ in how efficiently water is used to irrigate turfgrass. System inefficiencies, the practice of flood irrigation, and/or misguided or uninformed water management decisions by homeowners force more water to be applied to turfgrass than what it requires. The closer the amount of water applied to turfgrass comes to the actual consumptive use requirements, the less water is lost or wasted through inefficiency.

Large untreated providers are required by the Third Management Plan to limit deliveries for urban irrigation to 4.0 acre-feet per gross acre per year. Gross acres include acreage that is not landscaped and irrigated, such as buildings and driveways. Based on data submitted by large untreated providers on their 1995 annual water use reports, the current application rate is less than 4.0 acre-feet per gross acre. For this reason, the application rate per gross acre will not change and will remain the same for both scenarios (see Table 11-3). Irrigated acreage is assumed to be 60 percent of gross acreage and have a consumptive use rate of 3.6 acre-feet per acre. The remaining applied water is assumed to incidentally recharge the aquifer.

TABLE 11-3
ASSUMPTIONS FOR URBAN IRRIGATION WATER DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Factors	Projections			
	1995	2005	2015	2025
Irrigated Acres	29,741	30,833	33,355	36,066
Gross Acres	45,755	47,435	51,315	55,487
Application Rate (acre-feet/gross acre)	3.1	3.1	3.1	3.1

The Department consulted with large untreated providers to determine whether the provider would pursue new urban irrigation within their district. For both scenarios, new urban irrigation is projected for two large untreated providers - Roosevelt Water Conservation District (RWCD) and Maricopa Water District (MWD) - at a rate matching their projected population growth. As a result, urban irrigation acres are projected to increase by over 6,000 acres by 2025 (Table 11-3).

11.3.2 Agricultural Water Demand

Agricultural water demand is composed of Indian and non-Indian lands that are cultivated. Agricultural water use is a function of the total acreage which can legally be irrigated, the acreage of land actually cropped, the mix of crops planted, the efficiency of water use, the average consumptive use of crops, and

any lost and unaccounted for water. More information on current and historic agricultural water use characteristics can be found in Chapters 3 and 4.

Both water budget scenarios assume rapid growth of the Phoenix metropolitan area will cause some non-Indian farmland to be urbanized and converted to non-agricultural uses, resulting in cropped acres declining from 161,797 acres in 1995 to 133,131 acres by 2025. The 1993 MAG land use projections were used to determine the number of cropped acres that are urbanized on a district by district basis. Where lands are urbanized, irrigation rights are likely to be inactivated and/or converted to Type 1 non-irrigation rights.

The underlying premise for the assumption that non-Indian cropped acres will decline rests with the price structure of water, not demand for crops. Lands which are in the path of new development and undergo the most urbanization - within the irrigation districts of SRP, MWD, and RWCD - have abundant surface water supplies and usually the lowest water costs per acre. Outlying irrigation districts that are removed from urbanization pressures are more heavily reliant on groundwater, which, with the possible exception of the Buckeye Water Conservation and Drainage District, have higher water costs than surface water districts. As a result, it is projected that no cropped acres will be established in the outlying areas to replace acres lost to urbanization closer to the Phoenix metropolitan area.

By contrast, cropped acres within the Indian communities are projected to increase through 2025 due to the agricultural development plans of the communities. Both scenarios assume that cropped acres on the Salt River Pima-Maricopa and Fort McDowell Indian Communities will grow by approximately 10 percent per year. The Gila River Indian Community is projected to aggressively increase farm acreage. The community's cropped acres are assumed to grow to nearly 76,000 acres in the Phoenix AMA portion of the Gila River Indian Community by 2025.

Different plants have different water needs. In 1995, the most common plants cropped in the AMA were cotton, wheat, and alfalfa. The future crop mix in the AMA is difficult to predict because federal subsidies and worldwide market conditions may change and these factors play a large part in determining the type of crops planted in the AMA. Future planting of crops with higher or lower consumptive use requirements than what is planted today would have significant effects on total agricultural water use. Because it is very difficult to predict long-term changes in crop mix in the AMA, future consumptive use requirements for both scenarios are assumed to remain constant with the 1995 weighted average consumptive use requirement for each irrigation district.

The water budget scenarios differ in how efficiently water is used to irrigate crops. System inefficiencies force more water to be applied to crops than what is needed. The closer the amount of water that can be applied to irrigated crops is to consumptive use requirements, the less water is lost or wasted through inefficiency. Table 11-4 illustrates the different assumptions regarding consumptive use of crops and efficiency for each of the water budget scenarios.

The weighted average consumptive use requirement for non-Indian lands is estimated to be approximately 3.8 acre-feet per acre. This figure is derived from the analysis of consumptive use requirements developed for the Second Management Plan. The weighted average consumptive use requirement for Indian lands is estimated to be approximately 3.6 to 3.7 acre-feet per acre. This figure is derived from estimates made within the latest published water settlement technical reports and hydrology reports.

Actual water use efficiencies by agricultural users are not reported to the Department annually. For the Current Use Scenario, non-Indian efficiencies were estimated by calculating weighted average efficiencies from Second Management Plan initial conservation requirements for areas of similar farming conditions. For the Meet TMP Scenario, non-Indian projections are based on meeting efficiencies found in the standard conservation requirements for agricultural users in Chapter 4. It is further assumed for this

scenario that no agricultural users would enter the Historic Cropping Program (see Chapter 4). Indian agricultural water users are expected to steadily improve efficiencies through 2025.

Lost water results from seepage from canals and laterals and other losses when water is conveyed to agricultural lands. The two water budget scenarios include lost water reported to the Department.

TABLE 11-4
ASSUMPTIONS FOR AGRICULTURAL WATER DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Factors	Projections			
	1995	2005	2015	2025
Non-Indian Irrigation				
Cropped Acres, Both Scenarios	161,797	155,184	146,258	133,114
Consumptive Use, Both Scenarios (acre-feet/acre)	3.8	3.8	3.8	3.8
Irrigation Efficiency (%)				
Current Use Scenario	67	64	64	63
Meet TMP Scenario	80	80	80	80
Indian Irrigation				
Cropped Acres, Both Scenarios	37,956	63,748	82,248	93,575
Consumptive Use, Both Scenarios (acre-feet/acre)	3.6	3.7	3.7	3.7
Irrigation Efficiency (%)				
Both Scenarios	63	68	71	74

11.3.3 Industrial Water Demand

Industrial demand includes all users who pump or receive groundwater pursuant to non-irrigation grandfathered rights and withdrawal permits and may include any industrial, commercial, or institutional use. The largest water use within industrial demand is turf-related facilities, followed by dairies, sand and gravel operations, electrical power plants, feedlots, and large cooling towers (see Chapter 6).

Factors that influence water use vary with the type of industrial user. For turf-related facilities, the number of acres, the type of landscaping, and type and efficiency of landscape watering systems are principal factors. The number of lactating cattle, the number of milkings per day, and cooling practices are key factors affecting water use by dairies. Sand and gravel water use is driven by the quantity and quality of washed material and how much water is reused in the washing process. Cooling tower capacity and the frequency of water reused in the towers are the principal aspects of water use at electrical power plants and other facilities. Details of industrial water use may be found in Chapters 3 and 6.

Common assumptions of all water budget scenarios are the following:

- Turf-related facilities will grow approximately the same rate as population by 2025. Approximately 25 percent of new turf-related facilities from 1995 to 2025 will be industrial users (as opposed to facilities served by a municipal water provider whose water use is counted within

municipal water demand). Water use for the Meet TMP Scenario is based on adjusting current water use rates to reflect all turf-related facilities in compliance with the Second and Third Management Plan conservation requirements.

- Sand and gravel operations and other industrial uses will grow commensurate with population.

- Reflecting past trends, feedlot water use will steadily decline, while dairy water use will steadily increase. For dairies, water use for the Meet TMP Scenario is based on adjusting current water use rates to reflect all turf-related facilities in compliance with the Second and Third Management Plan conservation requirements.

- Electrical power plants will remain unchanged from 1985 to 1995 average annual water use. Future additional power demand is projected to be met by sources outside the AMA.

TABLE 11-5
ASSUMPTIONS FOR INDUSTRIAL WATER DEMAND
PHOENIX ACTIVE MANAGEMENT AREA

Factors	Projections			
	1995	2005	2015	2025
Turf-Related Facilities				
Number of Industrial Facilities:				
Both Scenarios	110	130	152	177
Water Use (acre-feet):				
Current Use Scenario	49,227	57,451	66,795	77,294
Meet TMP Scenario	49,227	53,814	62,082	71,370
Dairies				
Number of Dairies:				
Both Scenarios	86	108	133	161
Water Use (acre-feet):				
Current Use Scenario	8,423	10,598	13,017	15,756
Meet TMP Scenario	8,423	9,807	12,045	14,579
Sand and Gravel Water Use (acre-feet)	8,278	10,416	12,793	15,485
Electric Power Water Use (acre-feet)	3,832	3,524	3,524	3,524
Feedlot Water Use (acre-feet)	809	788	768	748
Other Industrial Water Use (acre-feet)	12,519	15,752	19,348	23,418

11.3.4 Riparian Water Demand

In addition to agricultural, municipal, and industrial uses, evapotranspiration from vegetation growing along water courses contributes to water demand in the AMA. Riparian growth along the Salt and Gila Rivers is sustained in areas where the depth to groundwater is less than 20 to 30 feet below land surface and downstream from effluent releases into riverbeds from wastewater treatment plants. Most riparian growth in the AMA is located downstream from the 91st Avenue Wastewater Treatment Plant (WWTP) in Phoenix. Recent calibrations of a groundwater flow model for the Salt River Valley by the Department's Hydrology Division estimate 48,000 acre-feet per year of water is used by riparian growth in the AMA.

11.4 OVERVIEW OF SECTOR SUPPLIES

As described in detail in Chapter 2, municipal, agricultural, and industrial water demand in the AMA is met by four principal supplies:

- Surface water from rivers or their tributaries within the AMA, predominately the Salt, Verde, Gila, and Agua Fria Rivers, that is collected behind dams in regulatory storage reservoirs for use throughout the year;
- Colorado River water imported into the AMA by way of the Central Arizona Project (CAP);
- Effluent or water derived from human waste that is treated to sufficient quality so that it may be reused for certain uses; and
- Groundwater withdrawn from the six groundwater subbasins that make up the Phoenix AMA.

The Groundwater Code's (Code) goal of safe-yield of groundwater by the year 2025 for the Phoenix AMA necessitates prudent municipal, agricultural, and industrial water use efficiency coupled with maximum use of non-groundwater sources to achieve the goal.

Water is a physical resource and, as such, can be tracked and understood in purely physical terms. However, water management is becoming increasingly tied to legal accounting mechanisms for water. To maintain consistency with legal water accounting, groundwater overdraft projected in this chapter reflects legal water accounting rather than strict hydrological conditions. Using legal mechanisms for groundwater overdraft calculations addresses needs such as accounting for short and long-term storage of artificially recharged water and subsidizing the cost of renewable supplies, especially CAP, for non-potable purposes. For example, if effluent is stored at an Underground Storage Facility (USF), it is credited to the storer for future recovery. When recovery of the stored effluent occurs, the water is physically pumped from the ground, but legally it is considered effluent and is accounted for as such in the water budgets. Likewise, if an irrigation district is designated a Groundwater Savings Facility (GSF), the delivery of CAP water to substitute for groundwater pumping by the district is credited to the storer. The actual delivery and use of the supply is legally considered groundwater; future recovery of accrued credits will be considered CAP water. For further details, see Chapter 8.

11.4.1 Surface Water Other Than Central Arizona Project Water

In 1995, 1,004,593 acre-feet of surface water was used in the Phoenix AMA. Surface water availability, however, has been highly variable from year to year. Periods of drought have sharply reduced the volume of surface water within regulatory storage reservoirs. By contrast, in very wet years there has been insufficient storage capacity and it has been necessary to release spillwater from storage reservoirs. Projections for surface water availability in the water budget scenarios are based on historic long-term annual average diversions of each major surface water supply. Annual surface water availability for the Salt/Verde, Gila, and Agua Fria Rivers assumed in the water budget scenarios is found in Table 11-6.

Salt/Verde River water availability is based upon analyses done by SRP for the Department and the Bureau of Reclamation for determining municipal water provider consistency with the Assured Water Supply Rules (AWS Rules). In SRP's 1995 model run, total median water available at Granite Reef Diversion Dam was projected to be 833,000 acre-feet in the year 2040 (Keane, Emelity, and Anderson, 1996). However, this model run was completed prior to the raising of Roosevelt Dam and the resulting additional permanent storage capacity made available on the Salt/Verde system (see Chapter 2). An additional model run by SRP in 1997 projected an average annual yield of 73,800 acre-feet for New Conservation Space at Roosevelt Dam, for a total of 906,800 acre-feet available on the Salt/Verde River system.

TABLE 11-6
ASSUMPTIONS OF SURFACE WATER AVAILABILITY THROUGH 2025
PHOENIX ACTIVE MANAGEMENT AREA

Major River System	Annual Availability (acre-feet per year)
Salt/Verde Rivers	906,800
Gila River	68,170 increasing to 92,963
Agua Fria River	32,308

Gila River supply availability is the Phoenix AMA portion of the median amount of acre-feet diverted to the Pima Agency (Indian portion) of the San Carlos Indian Irrigation Project (SCIIP). Anticipated lining of the SCIIP canal system is expected to raise the amount of Gila River water available for use within the AMA by 2025. Agua Fria River supply availability is based on the maximum quantity reported by MWD to the Department.

In addition to Salt, Verde, Gila, and Agua Fria River water, very small quantities of other surface water supplies from Cave Creek, Queen Creek, and the Colorado River (that is not a part of CAP) are also included in the AMA water budget projections.

11.4.2 Central Arizona Project

An estimated 409,222 acre-feet of CAP water was delivered by the Central Arizona Water Conservation District (CAWCD) in the AMA in 1995 (CAWCD, 1996). This total includes direct use by municipal water providers, industrial users, and irrigation districts. It also includes water delivered to irrigation districts designated as groundwater saving facilities and legally accounted for as groundwater or CAP water stored in USFs for future recovery (see Chapter 8).

CAP water was originally allocated by the CAWCD to municipal and industrial users as well as agricultural users. However, when CAP water was finally available to users, the cost proved prohibitively expensive for most irrigation districts. By 1995, most agricultural irrigation districts had relinquished their CAP allocation subcontracts. In response, the CAWCD "pooled" this water and now offers it to users at a subsidized price. Pool 1 water is available to all agricultural entities who originally signed a subcontract. Pool 2 water is also available to those who waived certain subcontract rights. Pool 3 water is offered to any agricultural customer available who wants more than their allocated share of Pool 1 and Pool 2 water. For the water budget scenarios, it is assumed that Pool 1 water will continue to be offered through 2025, Pool 2 water will expire in 2003, and Pool 3 water will expire in 2011 (CAWCD, 1993).

CAP water has been allocated to the Indian communities within the AMA and is included in the scenarios. In recent years, several municipal water providers have worked to bolster their CAP allocations by acquiring or leasing unused allocations from outside the AMA. In addition, CAP allocations held by Indian communities may be leased by private developers or municipal water providers to serve future non-Indian municipal demand. For example, the lease of Indian CAP water to a non-Indian party (e.g., the lease of a portion of the Ak-Chin Indian Community's CAP right to Del Webb Corporation) is also included in the water budget scenarios.

Because future acquisitions or leasing arrangements are difficult to predict, it is assumed in both budget scenarios that municipal and industrial users with a municipal and industrial (M&I) allocation of CAP water will not acquire or lease any additional allocations of CAP water after 1998, either from Indian interests or from other M&I users throughout the state. However, future increases in municipal water use

may cause the CAGRD to choose to lease CAP water to fulfill any obligations under the AWS Rules to replenish groundwater use by municipal users.

M&I users in the AMA have also used "excess" CAP water, or CAP water that has been allocated but remained unused in a given year, either by direct use or by storage at a GSF. The amount of "excess" water available in any year is dependent upon whether allocations remain unused throughout the state or whether a surplus is declared on the Colorado River. Given the difficulties in projecting future available "excess" CAP water, deliveries to the AMA of 677,000 acre-feet of CAP water for non-Indian uses is assumed throughout the entire projection period. This figure is based on actual deliveries to the AMA by the CAWCD in 1997 (CAP, 1998). It includes use based on M&I allocations (which total 312,749 acre-feet in 1998), "pooled" water made available to agricultural users, and "excess" water which is either directly used or artificially recharged.

Due either to a lack of existing or planned infrastructure necessary for direct use of CAP water, some M&I CAP allocations held by municipal providers are assumed to remain unutilized for direct uses. Such remaining CAP water is projected to be artificially recharged by municipal water providers for long-term storage credits.

11.4.3 Effluent

Effluent reuse within the Phoenix AMA continues to increase for all three sectors. The availability of effluent is calculated assuming 100 gallons of effluent are produced per person per day. Based on this assumption, an estimated 286,000 acre-feet of effluent was produced within the Phoenix AMA in 1995. Most of the effluent is produced at the 91st Avenue WWTP, of which 177,300 acre-feet per year of effluent is contracted to be piped from the plant to the Palo Verde Nuclear Generating Station (although 60,000 is approximately the maximum the facility has received as of 1998) and another 30,000 acre-feet is contracted to the Buckeye Water Conservation and Drainage District to irrigate crops (Maricopa Association of Governments, 1993). Through a water exchange agreement with the City of Phoenix, the Roosevelt Irrigation District is entitled to use up to 30,000 acre-feet of effluent per year, although Phoenix actually gets credited with the effluent use in their accounting (see Water Exchanges, A.R.S. § 45-1001, *et seq.*). Much of the remaining effluent from this plant recharges the aquifer or flows out of the AMA. Approximately 7,000 acre-feet of effluent from Chandler's Lone Butte WWTP is used to irrigate crops within the Gila River Indian Community. Much of the remaining direct use of effluent consists primarily of landscape watering by municipally served facilities and industrial users.

Based on the population projections for the AMA, approximately 502,000 acre-feet of effluent will be produced by 2025, an increase of 216,000 acre-feet from 1995. It is anticipated that the AWS Rules will cause municipal water providers to take greater advantage of effluent as a renewable supply and build future regional wastewater treatment plants in proximity to new development. These plants will allow municipal water providers to either use the effluent directly or artificially recharge it for long-term storage credits. Table 11-7 shows projections for total effluent production; the amount of effluent directly used by municipal, agricultural, and industrial users; the amount artificially recharged; the amount of natural recharge; and the amount remaining unused (discharge into riverbeds that either flows out of the AMA or is lost before recharging the aquifer).

Municipal water providers generally report little, if any, direct use of effluent to the Department. Projections of direct use of effluent by municipal water providers in the scenarios are probably conservative. In addition, the Department lacks data on effluent that may be released from wastewater treatment plants and not put to beneficial use. For these reasons, projections of artificial recharge are likely high and represent the maximum amount that may be artificially recharged in a given year.

TABLE 11-7
PROJECTED EFFLUENT USE THROUGH 2025
PHOENIX ACTIVE MANAGEMENT AREA

Type of Effluent Use	Projections (acre-feet)		
	2005	2015	2025
Direct Use			
Current Use Scenario	146,063	157,244	162,740
Meet TMP Scenario	144,709	159,170	159,446
Palo Verde Nuclear Generating Station	48,899	48,899	48,899
Maximum Artificial Recharge			
Current Use Scenario	102,771	168,629	250,334
Meet TMP Scenario	104,125	166,703	253,628
Incidental Recharge	46,000	46,000	46,000
Losses	43,073	43,073	43,073
TOTAL	337,907	414,945	502,147

11.4.4 Groundwater

In 1995, 946,052 acre-feet of groundwater was either withdrawn or received in lieu of pumping by municipal, agricultural, and industrial users in the AMA. For the water budget scenarios, it is assumed that users will be able to continue to annually pump groundwater up to the limits of their groundwater withdrawal authorities or what is allowable under AWS Rules. For both budget scenarios, significant quantities of unused allotments remain for both agricultural and industrial users throughout the projection period. Although provisions in the Code allow the Department to purchase and retire groundwater rights beginning in 2006, it is not included in the projection scenarios and does not act as a limiting factor for future groundwater pumping.

In 1997, the Legislature enacted legislation significantly revising the Water Quality Assurance Revolving Fund (WQARF) Program to provide incentives for the use of poor quality groundwater to facilitate the remediation of contaminated groundwater. The WQARF legislation provides that when determining compliance with management plan conservation requirements, the Department shall account for groundwater withdrawn pursuant to approved remedial action projects under the Comprehensive Environmental Response, Compensation and Liability Act or Title 49, Arizona Revised Statutes, consistent with the accounting for surface water. Laws 1997, Ch. 287, § 51(B). This legislation also provides that when determining the amount of allowable groundwater a provider may withdraw in accordance with the AWS Rules the Department shall account for groundwater withdrawn pursuant to approved remedial action projects, up to predetermined amounts, as consistent with the management goal of the AMA.

It is estimated as much as 175,000 acre-feet of poor quality groundwater could be remediated per year in the Phoenix AMA. However, given ongoing negotiations in this area, it is difficult to predict. For both scenarios, it is estimated that approximately 75,000 acre-feet per year will be remediated, based on known remedial action plans.

11.5 SUPPLY ASSUMPTIONS BY WATER USE SECTOR

The supply assumptions in the budget projections that are made for the municipal, agricultural, and industrial sectors reflect current water use patterns, the effects of complying with AWS Rules, water pricing, and the legal authority to source waters. Specific assumptions are listed below.

11.5.1 Municipal Water Supplies

Supply assumptions for non-Indian municipal water use, Indian municipal water use, and urban irrigation are distinct from one another in the water budget scenarios. Each component of municipal water use is listed separately below.

11.5.1.1 Supplies for Non-Indian Municipal Water Use

For all scenarios, the cities of Avondale, Chandler, Glendale, Goodyear, Mesa, Peoria, Phoenix, Scottsdale, Surprise, Tempe, the Town of Gilbert, Apache Junction Water Facilities District (formerly Consolidated Water Utilities of Apache Junction), and Chaparral City Water Company (Fountain Hills) are assumed to be designated under the AWS Rules. All other new non-Indian demand is anticipated to be met by Certificates of Assured Water Supply (Certificates of AWS) where applicable (see Chapter 5).

To meet water demand supplied by municipal water providers, supplies were prioritized based on a combination of the cost of supply sources, the availability of supplies to individual providers, and the likelihood or feasibility of using different supply sources for both scenarios. The Department made a preliminary determination of supply source priorities within each water planning area of the AMA (see section 11.3.1.1 for additional discussion of water planning areas). Municipal providers were asked to comment upon the priorities, and any resulting feedback was incorporated into the budget scenarios. The general order of priorities is as follows:

- SRP (to meet on-project demand only)
- Incidental recharge groundwater credit (AWS Rules)
- Other renewable supplies
- CAP water
- Direct use of effluent
- (A) accumulated recharge credits (designated providers under AWS Rules) or
  (B) a minimum CAGRD requirement (Certificates of AWS under AWS Rules)
- Allowable groundwater (AWS Rules)
- Mined groundwater obligated to be replenished with the CAGRD (AWS Rules)

The ranking of priorities was changed if feedback called for otherwise or if different water sources are available to the provider than what is listed above.

11.5.1.2 Supplies for Indian Municipal Water Use

In 1995, municipal and industrial water use on all three Indian communities was met by a combination of groundwater and surface water. Due to the lack of surface water treatment facilities, existing and new demand is projected to be met completely by groundwater for the Gila River and Salt River Pima-Maricopa Indian Communities and by surface water for the Fort McDowell Indian Community for both scenarios.

11.5.1.3 Supplies for Urban Irrigation

All demand as of 1995 is projected to be served by the same supplies delivered by untreated providers in 1995, which was a mix of groundwater, surface water, and CAP water, through 2025. Because surface water supplies of large untreated providers are fully committed to existing urban irrigation and other sector demands, any additional demand projected for urban irrigation above the 1995 level will be met by groundwater.

11.5.2 Agricultural Water Supplies

Supply assumptions for non-Indian and Indian agriculture differ in methodology and are discussed separately below.

11.5.2.1 Supplies for Non-Indian Agriculture

In both scenarios, cheaper water sources are assumed to rank higher in priority. Non-groundwater sources will be used prior to using groundwater, if available to an irrigation district. Irrigation grandfathered right holders outside of irrigation districts are assumed to pump groundwater. Right holders within irrigation districts that have a surface water supply other than CAP water are assumed to use surface water first and then move to in-lieu groundwater (in certain cases) or groundwater to meet demand. Right holders within irrigation districts that do not have a surface water supply other than CAP water are assumed to use CAP water first (Pool 1, Pool 2, and Pool 3), then move to using in-lieu groundwater, and finally to using groundwater.

11.5.2.2 Supplies for Indian Agriculture

The Salt River Pima-Maricopa Indian Community is assumed to continue its current supply mix of groundwater and surface water through 2000, after which it is assumed the community will reduce groundwater use and increase surface water use in accordance with its water rights settlement. The Fort McDowell Indian Community is assumed to use Verde River water for agricultural water demand throughout the projection period (this is consistent with the water rights settlement for the community). The Gila River Indian Community is anticipated to greatly increase use of CAP water to meet demand. Remaining demand not met by CAP water is projected to be met by Gila River water for lands within the SCIIP, SRP tailwater, effluent, and groundwater, in order of priority.

11.5.3 Industrial Water Supplies

All future industrial demand is projected to be served by the same supplies in the same proportion used in 1995. These include predominantly groundwater supplies but also include some surface water served by irrigation districts, "excess" CAP water not used by municipal and industrial users that hold a CAP allocation, and effluent from non-municipal sources.

11.6 CALCULATION OF GROUNDWATER OVERDRAFT

For the water budget scenarios, annual groundwater overdraft is calculated by subtracting recharge to the aquifer and other allowances from groundwater use created by municipal, agricultural, industrial, and riparian water demand outlined in section 11.3 above. If groundwater demand exceeds recharge, there is overdraft.

The calculation of groundwater overdraft requires the following subtractions from groundwater demand:

- Net natural system effects, such as groundwater underflow and natural recharge

- Incidental recharge of the aquifer caused by municipal, agricultural, and industrial water use
- AWS Rules, allowable groundwater
- AWS Rules, groundwater pumped with a replenishment obligation
- Benefits to the aquifer required by artificial recharge rules
- Benefits to the aquifer caused by the Arizona Water Banking Authority (AWBA)

These considerations are discussed below.

11.6.1 Net Natural System Effects

Net natural system effects are defined as the net naturally occurring additions to groundwater storage. Components of net natural recharge include mountain front recharge and ephemeral stream recharge. Also affecting groundwater storage is the net effect of groundwater underflow (groundwater inflow minus groundwater outflow). Net natural system effects in the AMA are estimated to contribute 24,100 acre-feet of water per year to the aquifer. Estimates of net natural system effect volumes have been revised since the Second Management Plan based on recent calibrations of components used in a groundwater flow model for the Salt River Valley in the AMA and other data. Components of net natural system effects are shown in Table 11-8.

TABLE 11-8
COMPONENTS OF NET NATURAL SYSTEM EFFECTS
PHOENIX ACTIVE MANAGEMENT AREA

Elements of Net Natural System Effects	Acre-Feet (AF)
Mountain Front Recharge	21,500 AF
Stream Channel Recharge	19,400 AF
Groundwater Inflow	11,800 AF
Groundwater Outflow	(28,600) AF
Total Net Natural System Effects	**24,100 AF**

Precipitation is the main source of water replenishing the aquifers as natural recharge. Mountain front recharge occurs in channels at the margins of mountain ranges, mainly the Superstition and McDowell Mountains. Mountain front recharge in the AMA is estimated at 21,500 acre-feet per year. Groundwater conditions in the Phoenix AMA may also be greatly affected by intermittent but occasionally large surface water flows (stream channel recharge) from the Salt, Gila, and Agua Fria River drainages and to a much lesser extent by intermittent, smaller flows from Cave Creek, Skunk Creek, New River, and Queen Creek. Surface water flows recharge the groundwater system as water infiltrates through the stream channel sediments to the underlying aquifers. Stream channel recharge on the Salt/Verde and Gila River systems, although historically and potentially very large in some years, is highly irregular and not reliable, occurring only when there is insufficient capacity to store water upstream. For this reason, median annual recharge, as opposed to mean annual recharge which may be skewed by flood events, is used in the budget scenarios. Because these estimates do not include the raising of Roosevelt Dam in the mid-1990s, which significantly increases the flood control capacity of the SRP, the long-term historic averages for stream channel recharge may be overestimated for future conditions.

Groundwater inflow to the Phoenix AMA occurs as groundwater flows north out of the Pinal AMA and into the Phoenix AMA near Florence and Sacaton into the East Salt River Valley Subbasin. Groundwater exits the Phoenix AMA from the Rainbow Valley Subbasin near Waterman Wash and the Maricopa-

Stanfield area and flows into the Pinal AMA. Groundwater inflow minus groundwater outflow yields a net groundwater loss of 16,800 acre-feet from the AMA.

Changes in the quantity of groundwater pumping and where pumping will occur may alter groundwater flow patterns in the AMA. However, the effect of future changes is hard to predict. Although groundwater underflow may change in the future, net natural system effects are held constant throughout the projection period.

11.6.2 Incidental Recharge

Incidental recharge is the amount of water which percolates down to the water table after it is used. In the Phoenix AMA, the volume of incidental recharge is largely dependent upon municipal and industrial demand and the quantity and efficiency of water applications to irrigated land. The percentage rate of incidental recharge for all sectors by scenario is shown in Table 11-9. Because the Meet TMP Scenario assumes that the conservation requirements will cause users to be more water efficient in certain instances, such as agricultural production, a lower volume of water is incidentally recharged as compared to the Current Use Scenario.

Other incidental recharge can occur in the AMA besides what is shown in Table 11-9. Incidental recharge from effluent flows released by the 91st Avenue WWTP into the Salt and Gila Rivers is projected to be 46,000 acre-feet annually (Table 11-7). The numerous irrigation district canals that crisscross portions of the AMA have seepage. It is projected that 85,000 acre-feet of water will be lost from the canals and seep into the aquifers annually.

TABLE 11-9
INCIDENTAL RECHARGE ASSUMPTIONS USED IN WATER BUDGET SCENARIOS
PHOENIX ACTIVE MANAGEMENT AREA

Rate Applied to Source of Recharge		Source of Incidental Recharge
Current Use Scenario	**Meet TMP Scenario**	
		Municipal demand:
4%	4%	• Municipal demand served by municipal water providers and Indian communities
24%	24%	• Urban irrigation
		Agricultural Demand
26%	15%	• Non-Indian agriculture
30% dropping to 21%	30% dropping to 21%	• Indian agriculture (sliding rate reflects efficiency improvements through 2025)
		Industrial Demand:
12%	12%	• Turf-related facilities and sand and gravel operations
0%	0%	• Dairies, feedlots, power plants
4%	4%	• Other industrial demand

11.6.3 Assured Water Supply Rules and Allowable Groundwater

The AWS Rules require consistency with the AMA's groundwater management goal of safe-yield. To that end, the AWS Rules in the Phoenix AMA limit the expansion of groundwater pumping in the municipal

water use sector by shifting municipal users in growing areas to renewable supplies. The AWS Rules limit the amount of groundwater that designated providers and new developments coming under Certificates of AWS may use to meet the consistency with goal criteria for a 100-year supply. Because this quantity of groundwater or "allowable groundwater" has been found to be consistent with the management goal of safe-yield, it is subtracted from overdraft calculations for the water budget scenarios (see Chapter 5).

11.6.4 Assured Water Supply Rules and Replenishment Obligation

AWS Rules also require a designated provider or certificate holder that exceeds its allowable mined groundwater to replenish the aquifer with artificial recharge for the excess groundwater mined by contracting with the CAGRD for this purpose. In the water budget scenarios, groundwater mined in excess of allowable groundwater for new development has been assumed to be replenished as required by the AWS Rules. Thus, the net effect of this use is not considered a contributor to overdraft in the overdraft calculations for the water budget scenarios (see Chapter 5).

11.6.5 Artificial Recharge Cut to the Aquifer

CAP water, unappropriated surface water, or effluent may be artificially recharged into the aquifer to augment existing groundwater supplies for future use (see Chapter 8). When water is artificially recharged for use in later years, long-term storage credits accrue to the party storing water at an USF or deferring groundwater use at a GSF. In most instances of artificial recharge of CAP and unappropriated surface water, credits are limited to 95 percent of the water recharged. The remaining 5 percent is considered a "cut to the aquifer" and may not be recovered for use in the future.

Table 11-10 shows projections of the number of artificial recharge credits that will be earned through 2025 for each water budget scenario. Artificial recharge at GSFs is assumed to be equal to non-Indian agricultural demand met by in-lieu groundwater (section 11.5.2.1). Artificial recharge at USFs is assumed to be limited to CAP, effluent or other surface water supplies still available for use after projected demand has been met by either direct use of the supply or by in-lieu groundwater.

TABLE 11-10
PROJECTIONS OF MAXIMUM ARTIFICIAL RECHARGE
PHOENIX ACTIVE MANAGEMENT AREA

Scenario	Projections (acre-feet)		
	2005	2015	2025
Current Use Scenario			
Cap	463,830	432,604	399,016
Effluent	102,771	168,629	250,334
Surface	42,967	37,360	33,277
Meet TMP Scenario			
Cap	474,740	448,586	414,648
Effluent	104,125	166,703	253,628
Surface	42,228	36,557	33,277

Changes in supply availability and the quantity of direct use greatly affect supply availability for artificial recharge. The availability of CAP water to the AMA is especially uncertain (section 11.4.2) and direct use of effluent may be underestimated (section 11.4.3). The figures shown in Table 11-10 represent the maximum quantities projected to be artificially recharged.

In the water budget scenarios, the amount of artificial recharge that is a cut to the aquifer in a projection year is calculated based on the total artificial recharge of CAP water and unappropriated surface water projected to occur in that year. Because the cut to the aquifer cannot be used in the future, it is subtracted from total groundwater use when calculating overdraft in the water budget scenarios. All other artificial recharge is projected to be reserved for future use and is not used in overdraft calculations unless credits are recovered to meet demand.

11.6.6 Artificial Recharge by the Arizona Water Banking Authority

The AWBA is authorized to purchase unused Colorado River Water, bring the supply into central Arizona through the CAP aqueduct, and store it in existing aquifers for drought protection, enhanced water management, and other purposes. As a result, the AWBA will be a participant in CAP recharge projects in the AMA. A portion of the CAP recharge credits accumulated by the AWBA through these recharge activities are anticipated to be extinguished, preventing them from being recovered in the future. The CAP water recharged under these conditions becomes a permanent addition to the groundwater supply in the aquifer and is subtracted from total groundwater use when calculating groundwater overdraft. The volume of CAP recharge credits which will be extinguished by the AWBA has been projected based on estimating annual groundwater withdrawal fees which will be collected before 2017 (the current estimated date for cessation of AWBA activities) and assuming that the cost to recharge water into the aquifer is $70 per acre-foot. The projected volume of extinguished credits varies with water budget scenarios since the volume of groundwater withdrawal varies between scenarios (Table 11-11).

TABLE 11-11
PROJECTED EXTINGUISHMENT OF CAP RECHARGE CREDITS
BY THE ARIZONA WATER BANKING AUTHORITY
PHOENIX ACTIVE MANAGEMENT AREA

Scenario	Projections (acre-feet)			
	1995	2005	2015	2025
Current Use	0	31,168	33,433	0
Meet Third Management Plan	0	24,148	25,904	0

11.7 WATER BUDGET SCENARIOS

Tables 11-12 and 11-13 present the results of the Current Use Scenario and Meet TMP Scenario from 1995 through 2025 in ten year intervals. When the demand and supply assumptions for each sector are brought together into water budgets, it is apparent that both scenarios reveal continuing overdraft through the year 2025. Details of each scenario are described below.

11.7.1 Current Use Scenario

If no additional water use efficiencies are gained in the next 30 years, projected overdraft will increase from over 360,000 acre-feet in 1995 to over 471,000 by the year 2025. Overall demand will rise from over 2.3 million acre-feet in 1995 to over 2.9 million acre-feet by 2025, an increase of over 25 percent. Currently, the majority of water is used by the agricultural sector. By 2025, however, rapid population growth coupled with little change in water use by the agricultural sector result in changing the relative size of the two largest water use sectors, with agricultural water use falling to 46 percent of AMA water use and municipal water use increasing to 47 percent. Non-Indian municipal water will exceed non-Indian agricultural water use by 2010. The proportion of water used by the industrial sector is projected to change minimally through 2025.

Groundwater withdrawals are projected to initially drop through 2000 as municipal water providers convert to renewable water supplies to meet AWS Rules. However, this trend is short-lived as total water demand increases, and groundwater use in the AMA is projected to exceed 1995 levels from 2005 through 2025. Groundwater meets 41 percent of AMA water demand in 1995; this will not change by 2025. Most renewable supplies are expected to be artificially recharged for long-term storage credits and do not appear in the water budgets unless recovered for direct use.

11.7.1.1 Municipal Sector

As rapid population growth occurs in the AMA, the municipal sector's water use will increase dramatically, growing over 60 percent to nearly 1.4 million acre-feet by 2025. Most of the total municipal water use and most new demand is attributable to non-Indian residential and non-residential growth. Water use for urban irrigation and Indian municipal uses are projected to grow much more slowly. Overall, the municipal sector will become the largest water using sector in the AMA, growing from 37 percent of total AMA water use in 1995 to 47 percent by 2025.

Despite the growth in water use, adherence to AWS Rules is projected to initially cause a decline in groundwater use by the municipal sector as providers switch to renewable supplies. By 2015, however, groundwater use will rise to above the 1995 level. Although some of this rise is attributable to increased use of groundwater for urban irrigation and Indian municipal uses, most of the increase is due to an increase in groundwater use by the non-Indian municipal sector. Some of this groundwater is allowed under AWS Rules. Therefore it is deemed consistent with the management goal of the AMA and is subtracted from groundwater overdraft calculations for this reason. The municipal sector's proportion of the AMA's groundwater use initially falls from 27 percent in 1995 to 21 percent in 2005. However, because the sector's water use grows so rapidly, the proportion rises back up to 27 percent by 2025.

11.7.1.2 Agricultural Sector

Agricultural water demand is anticipated to rise through 2015, from 1.33 million acre-feet to 1.40 million acre-feet, then slowly fall through 2025 to 1.36 million acre-feet. The rise is solely attributable to an initially sharp increase in cropped acres and hence water demand on Indian lands. Indian water demand increases rapidly throughout the projection period. As the Indian communities approach the limit of developed acreage, growth in water demand slows later in the projection period. By contrast, non-Indian demand is projected to steadily decline throughout the period as urbanization overtakes agricultural land in the path of development.

Non-Indian groundwater use is projected to show little change annually over the 30-year projection period. This is largely due to a sharp increase in the use of in-lieu groundwater to replace Pool 1, 2, or 3 CAP water. Groundwater pumping, by contrast, is expected to steadily decline throughout the projection period. Although high levels of incidental recharge occur due to agricultural uses, non-Indian agriculture is projected to continue to use more groundwater than what is incidentally recharged into the aquifer from agricultural uses.

With the exception of the Gila River Indian Community, Indian agriculture is projected to be almost completely reliant on renewable supplies. However, because of rapid growth in agricultural acreage on the Gila River Community through 2020, total groundwater use steadily rises through 2020, then levels off.

Despite a proportionate decline in agricultural water use in the AMA from 57 percent in 1995 to 46 percent in 2025, the AMA's groundwater use by the agricultural sector will only slightly decline, from 61 percent to 60 percent.

11.7.1.3 Industrial Sector

Although projected to grow fairly rapidly, total industrial water use will remain a small proportion of the AMA's water use, accounting for 4 percent of AMA use in 1995 and 5 percent in 2025. Total water use is projected to grow from over 83,000 acre-feet to nearly 138,000 acre-feet. Although most new turf-related facilities are expected to be served by municipal water providers, rapid facility construction, notably golf course construction, leads to the rapid growth rate. Most interesting is the industrial sector's disproportionate contribution to groundwater use, accounting for 8 percent of the AMA's groundwater use in 1995, growing to 11 percent by 2025. Moving later into the projection period, it becomes apparent that the industrial sector is a relatively high contributor to overdraft given its small size.

TABLE 11-12
CURRENT USE SCENARIO DEMAND AND SUPPLY, 1995-2025
PHOENIX ACTIVE MANAGEMENT AREA

	1995	2005	2015	2025
Municipal				
Demand	869,962	998,997	1,188,898	1,395,725
Non-Indian	**862,987**	**991,752**	**1,181,367**	**1,387,556**
Indian	**6,975**	**7,246**	**7,531**	**8,169**
Supply	869,962	998,997	1,188,898	1,395,725
Non-Indian	**862,987**	**991,752**	**1,181,367**	**1,387,556**
Central Arizona Project	151,791	131,352	189,837	289,306
Direct Use	151,788	106,007	158,894	225,924
Credits Expended	3	25,345	30,943	63,383
Effluent	70,355	106,474	117,418	122,645
Direct Use	69,522	102,145	112,071	113,483
Credits Expended	833	4,329	5,347	9,162
Surface Water	393,091	548,147	622,921	673,011
Groundwater	247,750	205,779	251,191	302,594
Indian	**6,975**	**7,246**	**7,531**	**8,169**
Surface Water	1,140	1,140	1,140	1,140
Groundwater	5,835	6,106	6,391	7,029
Agricultural				
Demand	1,333,885	1,373,506	1,404,184	1,360,743
Non-Indian	**1,109,105**	**1,023,422**	**968,921**	**887,446**
Indian	**224,780**	**350,084**	**435,263**	**473,297**
Supply	1,333,885	1,373,506	1,404,184	1,360,743
Non-Indian	**1,109,105**	**1,023,422**	**968,921**	**887,446**
Central Arizona Project	121,238	74,461	50,527	50,527
Effluent	34,028	34,028	34,028	34,028
Surface Water	471,688	334,880	302,580	249,362
Groundwater	482,151	580,053	581,786	553,529
Direct Use	425,683	456,275	437,944	409,694
In-lieu of Use	56,468	123,778	143,842	143,836
Indian	**224,780**	**350,084**	**435,263**	**473,297**
Central Arizona Project	0	79,888	122,711	139,132
Effluent	2,325	2,325	2,325	2,325
Surface Water	131,424	138,188	146,047	158,888
Groundwater	91,032	129,683	164,180	172,952

TABLE 11-12
CURRENT USE SCENARIO DEMAND AND SUPPLY, 1995-2025
PHOENIX ACTIVE MANAGEMENT AREA

	1995	2005	2015	2025
Industrial				
Demand	83,088	99,933	117,649	137,628
Supply	83,088	99,933	117,649	137,628
Central Arizona Project	1,530	1,531	1,532	1,533
Effluent	3,023	3,236	3,473	3,741
Surface Water	7,250	8,307	9,485	10,813
Groundwater	71,285	86,859	103,158	121,540
Riparian				
Demand	48,000	48,000	48,000	48,000
Supply	48,000	48,000	48,000	48,000
Groundwater	48,000	48,000	48,000	48,000
Total Demand	**2,334,935**	**2,520,436**	**2,758,730**	**2,942,096**
Total Groundwater Use	**946,052**	**1,056,479**	**1,154,706**	**1,205,644**
(Less) Net Natural Recharge	24,100	24,100	24,100	24,100
(Less) Incidental Recharge	556,736	564,658	575,566	564,684
(Less) AWS Replenishment Obligation	0	2,027	23,041	51,992
(Less) AWS Allowable Groundwater	0	68,886	74,432	72,169
(Less) Artificial Recharge Cut to Aquifer	5,197	25,340	23,499	21,615
(Less) Arizona Water Banking Authority	0	31,168	33,433	0
Groundwater Overdraft	**360,019**	**340,301**	**400,636**	**471,085**

AWS = assured water supply

11.7.2 Meet TMP Scenario

If all non-Indian water using sectors meet Third Management Plan conservation requirements and continue at this level of efficiency through 2025, projected overdraft will initially decline from over 360,000 acre-feet in 1995 to approximately 284,000 acre-feet by 2005 and then increase to over 431,000 acre-feet by 2025. Overall water demand is substantially less in this scenario compared to the Current Use Scenario, amounting to over 2.6 million acre-feet in 2025, an increase of 12 percent from 1995. This is less than half the growth projected for the Current Use Scenario and reflects how moderate increases in water use efficiency can dramatically reduce water demand. Compared to the Current Use Scenario, the most precipitous drop in water use will occur in the non-Indian agricultural sector. Like the Current Use Scenario, the proportion of water used by the industrial sector is projected to change minimally.

Groundwater use is projected to be lower than 1995 levels through 2015, with a rise thereafter. Third Management Plan conservation requirements will sharply reduce the AMA's groundwater demand compared to the Current Use Scenario, reducing total groundwater demand by over 200,000 acre-feet in 2025. Cumulative groundwater savings throughout the projection period are estimated to be over 5 million acre-feet. Groundwater use will drop from 41 percent of total AMA water demand in 1995 to 38 percent by 2025.

11.7.2.1 Municipal Sector

The municipal sector's water use will increase to nearly 1.3 million acre-feet through the year 2025 under this scenario. Most of the growth in water demand is attributable to non-Indian residential and non-residential growth. As with the Current Use Scenario, water demand for urban irrigation and Indian municipal uses is projected to grow much more slowly than non-Indian municipal demand. Greater water use efficiency caused by the Third Management Plan GPCD requirements will reduce water demand by 129,000 acre-feet in 2025 as compared to the Current Use Scenario. Despite the reduction in water use, the relative size of the municipal sector will grow, rising to 48 percent of AMA water use by 2025 for both Indian and non-Indian demand.

In this scenario, groundwater use initially drops considerably as providers adjust their supplies to adhere to AWS Rules. Groundwater use rises after 2000 and increases above the 1995 level by 2025. Although some of this rise is attributable to increased use of groundwater for urban irrigation and Indian municipal uses, most of the increase is due to an increase in groundwater use by the non-Indian municipal sector.

Groundwater use is projected to be 48,000 acre-feet less by 2025 in this scenario compared to the Current Use Scenario. The municipal sector's proportion of the AMA's groundwater use initially falls from 27 percent in 1995 to 21 percent in 2010. However, despite reduced water demand in this scenario, the sector's growth in water demand remains relatively rapid compared to other sectors and the proportion rises after 2005 up to 26 percent by 2025.

11.7.2.2 Agricultural Sector

Agricultural water demand is anticipated to drop sharply after 1995 as non-Indian agricultural users meet Third Management Plan efficiency requirements. From 2000, total agricultural water use rises slightly until 2015 and then slowly falls through 2025. Non-Indian water use drops steadily through the projection period as cropped acres decline. The rise in total agricultural water use is solely attributable to increases in cropped acres and water use on Indian lands. Total agricultural water use under the Meet TMP Scenario is projected to be nearly 181,000 acre-feet less than the Current Use Scenario in 2025.

After an initial sharp drop through 2005, the volume of non-Indian groundwater use is projected to show little change annually over the 30-year projection period. Like the Current Use Scenario, this is largely due to a sharp increase in the use of in-lieu groundwater to replace Pool 1, 2, or 3 CAP water. Groundwater pumping, by contrast, is expected to steadily decline throughout the projection period. Despite lower overall demand than the Current Use Scenario, non-Indian agriculture is projected to continue to remain in groundwater overdraft through 2025. Indian agricultural water demand and supply is the same as the Current Use Scenario.

Because the Meet TMP Scenario projects a sharper decline in total water use by the agricultural sector as compared to other sectors when compared to the Current Use Scenario, the agricultural sector's proportion of water use in the AMA drops faster, from 58 percent in 1995 to 45 percent by 2025. Likewise, the agricultural sector's proportion of the AMA's groundwater use declines faster as compared to the Current Use Scenario, from 61 percent to 57 percent, although the decline is still minimal.

11.7.2.3 Industrial Sector

Water use projections for the industrial sector are not substantially different from the Current Use Scenario. Total industrial water use will remain a small proportion of the AMA's water use, accounting for 3 percent in 1995 and 5 percent by 2025. Total water use is projected to grow from over 83,000 acre-feet to nearly 131,000 acre-feet. It is projected that by 2025 the industrial sector's groundwater use will be

12 percent of the AMA's total groundwater use. Like the Current Use Scenario, the industrial sector is a growing contributor to overdraft.

TABLE 11-13
MEET TMP SCENARIO DEMAND AND SUPPLY, 1995-2025
PHOENIX ACTIVE MANAGEMENT AREA

	1995	2005	2015	2025
Municipal				
Demand	869,962	943,394	1,096,399	1,266,470
Non-Indian	**862,987**	**936,149**	**1,088,869**	**1,258,301**
Indian	**6,975**	**7,246**	**7,531**	**8,169**
Supply	869,962	943,394	1,096,399	1,266,470
Non-Indian	**862,987**	**936,149**	**1,088,869**	**1,258,301**
Central Arizona Project	151,791	117,944	165,534	236,976
Direct Use	151,788	102,320	149,209	208,018
Credits Expended	3	15,624	16,325	28,958
Effluent	70,355	105,380	119,662	119,735
Direct Use	69,522	101,287	114,675	111,624
Credits Expended	833	4,093	4,987	8,112
Surface Water	393,091	540,164	601,464	648,580
Groundwater	247,750	173,800	203,348	254,149
Indian	**6,975**	**7,246**	**7,531**	**8,169**
Surface Water	1,140	1,140	1,140	1,140
Groundwater	5,835	6,106	6,391	7,029
Agricultural				
Demand	1,333,885	1,168,137	1,208,020	1,179,184
Non-Indian	**1,109,105**	**818,733**	**773,437**	**706,567**
Indian	**224,780**	**350,084**	**435,263**	**473,297**
Supply	1,333,885	1,168,137	1,208,020	1,179,184
Non-Indian	**1,109,105**	**818,733**	**773,437**	**706,567**
Central Arizona Project	121,238	74,461	50,527	50,527
Effluent	34,028	34,028	34,028	34,028
Surface Water	471,688	291,008	264,789	219,963
Groundwater	482,151	419,046	423,413	401,369
Direct Use	425,683	317,798	302,141	280,062
In-lieu of Use	56,468	101,248	121,312	121,307
Indian	**224,780**	**350,084**	**435,263**	**473,297**
Central Arizona Project	0	79,888	122,711	139,132
Effluent	2,325	2,325	2,325	2,325
Surface Water	131,424	138,188	146,047	158,888
Groundwater	91,032	129,683	164,180	172,952
Industrial				
Demand	83,088	95,487	111,947	130,510
Supply	83,088	95,487	111,947	130,510
Central Arizona Project	1,530	1,531	1,532	1,533
Effluent	3,023	2,976	3,155	3,358
Surface Water	7,250	7,687	8,720	9,881
Groundwater	71,285	83,293	98,540	115,738

TABLE 11-13
MEET TMP SCENARIO DEMAND AND SUPPLY, 1995-2025
PHOENIX ACTIVE MANAGEMENT AREA

	1995	2005	2015	2025
Riparian				
Demand	48,000	48,000	48,000	48,000
Supply	48,000	48,000	48,000	48,000
Groundwater	48,000	48,000	48,000	48,000
Total Demand	**2,334,935**	**2,255,019**	**2,464,366**	**2,624,164**
Total Groundwater Use	**946,052**	**859,928**	**943,873**	**999,237**
(Less) Net Natural Recharge	24,100	24,100	24,100	24,100
(Less) Incidental Recharge	556,736	413,141	429,324	427,629
(Less) AWS Replenishment Obligation	0	1,490	17,890	41,340
(Less) AWS Allowable Groundwater	0	50,030	46,397	52,901
(Less) Artificial Recharge Cut to Aquifer	5,197	25,866	24,327	22,510
(Less) Arizona Water Banking Authority	0	24,148	25,904	0
Groundwater Overdraft	**360,019**	**321,153**	**375,931**	**430,756**

AWS = assured water supply

11.8 ANALYSIS AND DISCUSSION

The projections for each scenario illustrate continued groundwater overdraft throughout the projection period, with an approximate 40,000 acre-feet difference between the scenarios by 2025. Larger differences in overdraft between the two scenarios may have been expected. However, several of the components of each budget scenario are identical or similar. For example, the assumptions for Indian demand and supply, projected to be a substantial and growing component of AMA water use, are identical for both scenarios. Urban irrigation demand and supply is also identical for both scenarios. The difference in industrial water demand projected between the scenarios is small.

Where there are more substantial differences in water use demand, such as in the non-Indian municipal and agricultural sectors, countervailing factors work to draw groundwater overdraft together. Total non-Indian agricultural water demand is much lower in the Meet TMP Scenario compared to the Current Use Scenario. However, the reduction in groundwater use is much less and is offset by sharp reductions in incidental recharge from all sources of water caused by gains in water use efficiency to meet Third Management Plan requirements. In the non-Indian municipal sector, higher quantities of replenished groundwater are subtracted from groundwater overdraft calculations in the Current Use Scenario as compared to the Meet TMP Scenario, reflective of higher groundwater demand.

The groundwater overdraft calculations for the two scenarios reflect a sensitivity to several key assumptions as much as any statement regarding the effectiveness of Third Management Plan conservation requirements. Because of its relative size and water use characteristics, these assumptions tend to have the greatest bearing on agricultural demand and supply. Most notable is incidental recharge. Lack of reliable data for incidental recharge is true for all water use sectors and is a notable weakness of the scenarios. Only in the agricultural sector, however, does the lack of reliable data for current crop mix and water use efficiency have so much bearing on the quantity of incidental recharge and groundwater overdraft. Minor revisions to current incidental recharge rates in the agricultural sector could lead to substantial changes in the quantity of incidental recharge for this sector. These changes could result in larger differences between

the Current Use Scenario, which is supposed to reflect current levels of incidental recharge throughout the projection period, and the Meet TMP Scenario where improved efficiencies result in less water being applied.

Other assumptions that are critical to the water budget projections are population and cropped acres. Both of these assumptions significantly impact the demand characteristics projected in both scenarios. However, the projections are also highly variable and subject to change with future economic conditions. While short-term population projections are highly accurate, long-term projections such as that found in the scenarios are of limited reliability. The number of future cropped acres, to a certain extent, is dependent upon population growth and urbanization location and density. Future crop pricing and farm subsidies, which are difficult to predict, determine the crop mix and acres farmed.

Overall, groundwater overdraft for both scenarios is projected to continue through the year 2025 and is more pronounced in certain sectors than in others. It is apparent from examining Tables 11-12 and 11-13 that the contribution to overdraft by the non-Indian agricultural sector will remain substantial despite a decline in cropped acres. Additionally, groundwater use and the contribution to overdraft by the industrial sector will increase and become a greater relative concern. Significant improvement is found in the municipal sector, as municipal providers take steps to convert to largely renewable supplies in accordance with the Department's requirements under the AWS Rules. It is apparent that safe-yield cannot be achieved so long as the "residual pumping" by agricultural water users, industrial water users, and municipal demand not subject to assured water supply requirements that has been allowed to continue without any replenishment remains.

It is important to note the difference between the accounting of groundwater shown in the water budget scenarios to meet demand and actual hydrologic conditions during the projection period. AWS Rules require either municipal water providers or new developments to demonstrate enough renewable supplies to maintain an assured water supply for 100 years. Consistent with the management goal of the AMA, only a limited portion of the demand may be met with groundwater. Municipal water providers are likely to make extensive use of renewable supplies, especially effluent, where they may never have in the past. Besides increasing utilization of renewable supplies for direct use, substantial quantities will likely be artificially recharged for long-term storage credits through 2025. Hydrologic conditions may actually be more favorable than what is inferred from the groundwater overdraft calculations shown in Table 11-12 and 11-13 through 2025. One reason for this difference may be the artificial recharge that has been stored but has not been recovered for use is not included in the calculations for overdraft. The reason for this is that the storage of water underground is not considered an existing use, rather a supply to meet future demands. Beyond 2025, as municipal providers begin to recover the stored credits, the hydrologic benefits of the recharge will not only end but likely reverse.

Because of the large size of the Phoenix AMA, the impacts of the demands must also be measured on a more localized scale, which the scenarios in this chapter do not address. In certain areas of the AMA, continual high levels of groundwater pumping may lead to detrimental, and possibly irreversible, negative impacts to the aquifer. Even if the projections do not portray a critical picture of groundwater overdraft on an AMA-wide basis, it will quickly become crucial to better manage all supplies in certain areas of the AMA. The future possibility that residual pumpers may be obligated to replenish groundwater use, and the substantial augmentation that may occur by municipal water providers driven by the AWS Rules, are opportunities to address severe over pumping in critical areas of the AMA. Actions also include alleviating waterlogging, whether by preventing waterlogging in the first place or by redirecting groundwater pumping to waterlogged areas from areas that are in severe overdraft.

The continued high demand for groundwater projected through 2025 demonstrates that safe-yield cannot be met, whether existing trends continue or if the conservation requirements of the Third Management Plan are adhered to by water users. Both scenarios illustrate that total AMA demand is increasing.

Agricultural uses are not projected to decline to the levels anticipated when the Code was implemented. Municipal population growth is projected to increase significantly with non-residential development in both the municipal and industrial sector growing to meet the needs of the additional population. Indian water use is also expected to increase in both the agricultural and municipal sectors in response to water rights settlements and improved economic development. All of this additional demand without commensurate improvements in efficiency of water use will put additional stress on both groundwater and renewable supplies. These scenarios illustrate that beyond the Third Management Plan additional conservation, renewable supply use, and replenishment obligations will be needed if the AMA is to achieve safe-yield. To what extent these additional mechanisms will be needed requires further examination.

REFERENCES

Keane, John; Emelity, Mike; and Anderson, Robin. *Assured Water Supply Study For Salt River Project Member Lands.* Salt River Project, November 1996.

Central Arizona Water Conservation District, 1996. *Central Arizona Project 1995 Water Deliveries (AF) By Turnout.*

Central Arizona Water Conservation District, 1993. Internal memo from Tom Clark to Board of Directors, October 7, 1993.

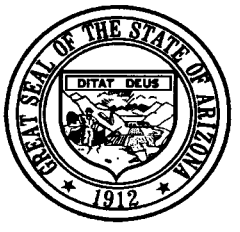
Central Arizona Project (formerly Central Arizona Water Conservation District), 1998. *Central Arizona 1997 Deliveries (AF) By Turnout.*

Maricopa Association of Governments, 1993. *208 Water Quality Management Plan*, p. 3-9.

CHAPTER

12

Future Directions



12.1 INTRODUCTION

The Phoenix Active Management Area (AMA) is a rapidly growing area with a diverse economy. Residential, commercial, and industrial growth are occurring at a record pace with similar projections for future years. Water use patterns are also showing corresponding increases. Agriculture continues to hold its position as the largest water using sector in the AMA, even though thousands of agricultural acres are converted to urban uses every year. Negotiations on Indian water settlements, as well as negotiations with the federal government on Central Arizona Project (CAP) settlements, have occurred and will continue to occur.

Constant and diverse pressures are exerted on the local water resource base. It is clear that the future of this AMA will not resemble the past. What is certain is that change will continue at a rapid pace; management issues will become even more complex and far-reachingrequiring greater regional cooperation; and the ability to meet these challenges will become more important.

Significant progress has been made in the management of the resource. Over the course of the second management period, many new programs, rules, and laws were enacted to aid in the distribution, conservation, augmentation, and management of the water supplies within AMAs. During the third management period, the Department will continue to develop new approaches to move the AMAs closer to their management goals and to protect water supplies for future use.

This Future Directions chapter is intended to provide the Department's perspective on long-term water management issues in the Phoenix AMA. It also describes future activities and alternatives for consideration that address key issues, assist in the achievement of safe-yield, and establish the framework for long-term water sustainability. Some of the concepts or directions discussed in this chapter may fall outside the Department's responsibility or authority. In addition, resolution of the continuing obstacles to safe-yield may require institutional and legislative changes or revised management approaches.

The First Management Plan initiated basic water management programs through mandatory conservation requirements for major water users. The Second Management Plan established more comprehensive and aggressive conservation requirements, coupled with an augmentation program.

This Third Management Plan was developed by building on programs that were incorporated into the First and Second Management Plans. The Third Management Plan also incorporates some new programs that will result in incremental progress toward the achievement of the safe-yield goal. Most important, it identifies alternative strategies for consideration in moving toward attainment of safe-yield. While wise water management has advanced in 15 years and should demonstrate further improvement in certain sectors during the third management period, it is apparent that considerably more effort will be required to achieve the AMA-wide safe-yield goal as well as the local management goal of a stable, long-term water supply.

12.2 THE DEPARTMENT'S PERSPECTIVE ON WATER MANAGEMENT IN THE PHOENIX ACTIVE MANAGEMENT AREA

Groundwater use in the Phoenix AMA currently exceeds the rate of natural and incidental recharge, resulting in an overdraft of over 360,019 acre-feet per year. Although the AMA is fortunate to have multiple sources of renewable water available, these sources remain underutilized to varying degrees. The low cost of groundwater in relation to the higher costs of most renewable water supplies is the primary reason for this condition. The water budgets in Chapter 11 illustrate that, based on current projections of water demand and supply, the Phoenix AMA will not be at safe-yield in 2025. Although safe-yield is an attainable goal, it is apparent that sufficient progress has not been made toward this goal, nor have the statutory and institutional structures necessary to succeed been fully established. In addition, increased

knowledge of local impacts of groundwater use, such as land subsidence and changes in groundwater quality, and concerns about long-term supply reliability have led to consideration of water resource management on a smaller scale than AMA-wide. There currently exists a lack of understanding and support by the community for a full range of water management initiatives. Knowledge by the community of the issues facing the AMA and the implications of failing to address these issues are necessary elements of any program strategy. The problems associated with achieving safe-yield, the need to educate the community on water issues, as well as the emergence of serious water management problems in certain localized areas within the AMA have led to the need to reassess the goals and the tools available to attain them.

12.2.1 The Safe-Yield Goal

In theory, safe-yield is a balance between groundwater withdrawals and recharge, resulting in stabilizing water levels on an AMA-wide basis over time. In practice, safe-yield is a much more complicated concept. Aquifer water levels are affected by underground storage and recovery activities, aquifer compaction due to subsidence, and withdrawal of groundwater made pursuant to various groundwater withdrawal authorities. Under these conditions, water levels may never completely stabilize. (The complexities are more fully described in the Preface to Section II.) Safe-yield is closely related to the concept of sustainability, which means that resource availability does not diminish over time. Safe-yield is entirely consistent with the goal of ensuring reliable long-term water supplies.

Support continues to exist for the safe-yield goal in the Phoenix AMA, but concerns exist regarding inequities in the allocation of costs and benefits between the sectors. In particular, there are concerns that the municipal sector is the only sector required to utilize renewable supplies. The municipal sector is required, through the Assured Water Supply Rules (AWS Rules), to develop and use renewable water supplies to sustain its future growth. This requirement is based on the fact that the municipal sector is allowed to grow and increase its water use over time. The agricultural sector, on the other hand, is subject to the statutory requirement that no new agricultural lands be brought into production after 1980. In addition, agricultural demand is expected to decrease over time as urbanization occurs on previously farmed lands. For those reasons, the drafters of the Groundwater Code did not include a requirement for the agricultural sector to use renewable water supplies.

The industrial sector has no renewable resource requirement, yet is expected to grow as urbanization increases.

Indian community demand is expected to increase significantly; however, Indian water use is not subject to the requirements of the Code as all other uses are.

On the positive side, multiple tools and agencies, such as the AWS Rules; the Underground Water Storage, Savings and Replenishment Act; the Central Arizona Groundwater Replenishment District (CAGRD); and the Arizona Water Banking Authority (AWBA), in addition to Departmental programs, are focused on addressing specific portions of the water management agenda. Critical accomplishments in this area include:

- Over 677,000 acre-feet of CAP water was delivered to the AMA in 1997, continuing an upward trend since 1992. Of this amount, 277,000 acre-feet was directly used by municipal, industrial, and agricultural users and 400,000 acre-feet was stored in underground facilities and in groundwater savings facilities.

- Twenty-two full-scale underground storage and groundwater savings recharge facilities have been permitted in the AMA during the last 10 years. In that time, 564,000 acre-feet has been stored and

almost 700,000 acre-feet of annual storage capacity has been permitted. In addition, 11 pilot-scale recharge facilities have been permitted.

- The AWS Rules are in place with renewable resource requirements for municipal growth.
- The Department has developed hydrologic models and uses them to assist community water management planning efforts.
- Municipal gallons per capita per day requirements assume water efficiency levels for all new housing units and turf allotments ensure efficient use for turf-related facilities.
- Over $6 million has been awarded by the Department in the Phoenix AMA for conservation and augmentation assistance grants and contracts.

The Department will identify and develop additional programs as necessary in the future.

12.2.2 Critical Area Management

There is growing consensus throughout the AMA that there is a need to separately address serious water management problems in specific geographic areas of the AMA. Hydrologic conditions vary widely within the Phoenix AMA, ranging from the waterlogged, southwest portion of the AMA to areas of severe overdraft, such as portions of the Carefree Subbasin. Land subsidence, earth fissures, and resulting aquifer compaction due to water level declines have been documented in numerous areas of the AMA. Water supply reliability is a concern for most municipal water providers in these areas, as well as for homeowners using their own domestic wells and industries using their own wells. Groundwater model projections made by the Department have identified areas of the AMA that, although are not demonstrating current problems, are expected to experience severe problems in the future if they continue to rely on groundwater.

Access to renewable water supplies is not uniform throughout the AMA. To address the variety of water-related concerns during the third management period, water management tools and processes need to be developed in association with local communities to address long-term water issues on a subregional or "critical area" basis.

12.2.3 Conjunctive Use and Management of Supplies

The Code provides a relatively consistent basis for the management of groundwater within AMAs. However, CAP water, non-CAP surface water, and effluent are all regulated differently and owned or controlled by different jurisdictions. As the Phoenix AMA uses significant amounts of all sources of water, the ability to directly manage only one source (groundwater) may weaken conservation requirements and use restrictions and make safe-yield attainment more difficult. The use of non-groundwater sources of water in an efficient manner allows more demand to be served by renewable water, meaning less reliance on groundwater. The ability to conjunctively manage all water supplies and work toward a safe and reliable water supply for the future is a logical long-term goal.

12.2.4 Utilization of Renewable Supplies

The Phoenix AMA has multiple sources of water available for use. In addition to groundwater, a non-renewable source, there are three significant renewable sources: CAP water; non-CAP surface water, such as Salt River Project water; and effluent. As has been described earlier in this plan, groundwater is over-utilized and renewable sources are underutilized. This is due primarily to the relatively low cost of producing and delivering groundwater and the significantly higher costs of producing and delivering renewable sources. Of the approximately 286,000 acre-feet of effluent produced in 1995, only slightly

more than 100,000 acre-feet was used. Effluent use must receive more attention during the third management period.

12.2.5 Implications of Indian Water Rights Claims

The current water management structure is constrained by outstanding Indian water rights claims. While some tribes have settled their claims in recent years, the largest claims remain unsettled. Failure to reach a final resolution of the issue leaves major questions about water supply and demand unanswered. Because the activities of off-reservation water users affect on-reservation conditions and vice versa, the Department will work to coordinate the water issues across reservation boundaries.

12.2.6 Integration of Water Quality Management

Water quality management problems must be addressed with water supply management needs in mind. Opportunities to match supplies of different qualities to appropriate uses and management of remediation efforts to maximize the beneficial use of treated water are part of efficient management of our water resources. Department actions will be consistent with these objectives. To work toward these objectives, the Department will closely coordinate its efforts with the Arizona Department of Environmental Quality (ADEQ) with particular emphasis in the following areas:

- Development and implementation of ADEQ effluent reuse regulations.
- Participation in the design and review of remedial action projects, including the type and amount of beneficial end uses.
- Monitoring and evaluation of the impacts of incentives for remediation. These incentives include the conservation requirement exemption and the assured water supply groundwater account exemption of 65,000 acre-feet statewide in light of AMA-wide and local area water management goals.

The Department's increased role in ADEQ's remediation programs and better integration of the data bases of the two agencies are positive steps in this coordination effort.

12.2.7 Economic Implications of Water Management

A better understanding of the economic implications of different management programs, as well as the long-term costs of not adequately managing our water resources, must be developed and communicated to water users and elected officials. In evaluating alternative management strategies, it is important to identify the cost factors involved. Management strategies must be analyzed from the perspective of total costs and benefits to the community. Decisions must be economically justified considering the long-term needs and concerns of the community. If additional regulatory approaches are considered, they should be weighed against alternative approaches, such as incentives or direct assistance.

12.2.8 Integration of Land Use Planning with Water Policy Planning

A closer association between land use planning and water policy planning is needed. County and local land use and economic development planning programs must continue to plan for and incorporate water supply and infrastructure requirements. Principal areas to be considered in the development process are:

- The need to secure and utilize renewable water resources that meet the AWS Program criteria for new residential development.

- Strategic location of wastewater treatment facilities and underground storage facilities to maximize the effective use of renewable water sources and to stabilize the local area aquifers.

- An understanding of the groundwater characteristics in local areas that may impact the community. These include changes in depth to groundwater, water quality changes, and land subsidence.

- The need to evaluate the water resource implications of development occurring on desert land rather than on retired farmland.

- Economic factors such as jobs created per gallon of water used, ability to utilize effluent or poor quality water, ability to develop aggressive reuse programs, etc.

The Department may be able to assist by providing relevant water demand and supply information, scenario analysis using hydrologic models, and planning assistance. The areas identified above need to be more closely linked to local general plans, zoning, infrastructure development, and other development decisions.

12.2.9 Community Understanding and Support

Community support is a key ingredient in the development of any local or regional program, but it is particularly important in setting water policy. The quality, quantity, and cost of the water supply are issues that concern every citizen, and their importance in the Phoenix AMA cannot be overstated. Unfortunately, very few are aware of the current groundwater overdraft conditions in the AMA and the implications of this condition if it goes unchecked. A heightened awareness of the negative implications of continued groundwater depletion and the need to pay higher costs to efficiently use more renewable resources must occur. Many people focus on growth and visible water uses such as golf courses as the cause of the problem, without recognizing that current groundwater users in every sector already exceed the natural groundwater replenishment rate. Equity considerations must move beyond the needs of current water users and consider ecological values and the needs of future generations.

12.3 OBSTACLES TO ACHIEVING SAFE-YIELD

This section identifies some of the factors limiting achievement of safe-yield and the Department's proposed role in addressing these problems.

12.3.1 Residual Groundwater Pumping

Municipal, industrial, and agricultural users are all expected to continue to pump groundwater beyond 2025. In the municipal sector, the ongoing pumping associated with undesignated providers (municipal providers without an assured water supply designation) is about 65,000 acre-feet per year. Pumping associated with untreated providers (that have no replenishment obligation) is 53,686 acre-feet per year. Most municipal water use will be served by designated providers. Designated providers are required to utilize renewable supplies, but are authorized to pump some groundwater (a total annual average of 42,000 acre-feet). In the agricultural sector, most of the remaining future demand is expected to be supplied by groundwater. Current groundwater use in this sector is approximately 572,000 acre-feet per year. The industrial water use sector will also contribute significantly to overall groundwater use. Current industrial pumpage is approximately 71,000 acre-feet per year. It is projected that moderate increases will occur in this sector through 2025.

Continued groundwater use in these sectors is authorized through service area rights, the AWS Program groundwater accounts, grandfathered rights (irrigation and Type 1 and Type 2 non-irrigation), and groundwater withdrawal permits. The authorization for such pumping under the Code was not made with

a full understanding of its relationship to the attainment of safe-yield. The total of all "allowable" pumping in the Phoenix AMA exceeds natural, incidental, and artificial recharge and is therefore a significant obstacle to the achievement of safe-yield. Any evaluation of the AMA's ability to reach safe-yield must address the problem of groundwater pumping that is expected to continue past 2025 by grandfathered right holders, water providers, and permit holders.

12.3.2 Important Factors Not Affected by Regulatory Programs

Many factors that affect the ability to achieve safe-yield are outside of the influence of current water management programs. Water demand is affected by economic and demographic conditions. For example, as crop prices rise, so do the number of acres in production. More acres planted (within the total certified irrigation acres) in most cases results in higher water demand. Increases in population and industrial growth rates have a dramatic influence on water use. More people and industries results in higher water demand. The location of new development has a dramatic effect on water resources planning. A key assumption of the Code was that urban growth would largely occur on retired agricultural land, with the water no longer needed by the farms being available to serve new houses and industries. In fact, much of the new growth is occurring on native desert land rather than on retired farmland. Development on desert land does not result in one type of demand replacing another; it results in a new demand being added to the existing demands, resulting in significantly greater demands than originally assumed.

Water costs strongly affect the amount of water use in all sectors. The undervalued cost of water in most instances, as well as the cost differential between certain renewable sources of water and groundwater, provides little incentive to maximize efficiency or reduce groundwater use. The cost of using groundwater should reflect the cost of overdrafting the aquifer. These costs include the loss of a supply, land subsidence and aquifer compaction, and water quality degradation.

Indian water rights settlements and leases have direct and significant influence on water use characteristics. Amounts and types of water identified in Indian settlements will affect the ability to achieve safe-yield.

12.3.3 Conjunctive Water Management

The Department currently has the authority to regulate only groundwater use. It has no authority to directly regulate other sources. However, under the Department's "stacking" policy (described in the Preface to Section II), if a person subject to a maximum annual water allotment uses both groundwater and non-groundwater supplies, the amount of non-groundwater supplies that are used by the person will be counted when determining the person's compliance with the allotment. The impact of the current stacking policy, in comparison to estimated water savings under a conjunctive use management program, needs to be determined. In an AMA with multiple water sources, the ability to effectively manage only one of four principal sources of water may be problematic.

12.3.4 Continuing Conservation Efforts

Developing a shared understanding of and a commitment to water conservation is important. Although it is accurate to say that renewable resource development will significantly contribute to the attainment of safe-yield, it is shortsighted to de-emphasize the contribution of conservation. It is contrary to good water management to invest billions of dollars to secure and develop a large renewable resource base but not make a strong commitment to use those resources efficiently. Yet, in certain instances, this strong commitment has not been made. At a minimum, water users should invest in conservation to the point where the cost of water saved through conservation efforts is equal to the cost of developing and supplying a non-groundwater replacement supply.

It has proven difficult to maintain a strong conservation ethic during times of surplus supply. Although the availability of excess Colorado River supplies is expected to continue in the short-term, shortages are expected, on average, 30 percent of the time in the next 100 years. Perhaps more important, Colorado River supplies are projected to be cut back 50 percent of the time after 2050.

Also, local governments and members of the development community need to understand the long-term implications of the decisions they make today. Responsible development and forward-thinking governmental decisions regarding growth and investments/commitments to conservation programs ensure long-term water resource sustainability. This philosophy and approach will be even more important in "critical areas." It is much easier to achieve conservation objectives when people understand that there is an imminent water supply problem. Conservation goals need to be reinforced through pricing structures, ordinances, incentives, informed governmental decisions, and public information about the serious long-term nature of water supply limitations in the area. The Department continues to believe that strong conservation efforts are an essential and valuable water management technique. The Department's programs are focused on the areas with the greatest conservation potential and in sectors that are expected to continue using mined groundwater. This focus on the future will provide substantial benefits over time.

12.3.5 Regulation of Private Water Companies

Private water companies have repeatedly pointed out that they have difficulty meeting Department conservation requirements and converting to renewable water sources. This is due to their lack of regulatory authority as it pertains to establishing ordinances and because of perceived conflicts between the Department's objectives and those of the Arizona Corporation Commission (ACC). Discussions have occurred between the Department and the ACC concerning the abilities of private water companies to recover investments in the development and use of renewable water supplies and the cost of conservation programs. Policies and procedures of both agencies regarding these matters are not effectively integrated. Some of these issues are resolvable by closer agency coordination and a strong commitment from both agencies. Other issues may require remedies that the two agencies are not currently capable or authorized to provide.

12.3.6 Public Education Efforts and Community Support

A major obstacle in developing and implementing water management programs is the lack of understanding by the public and the policy makers of the water management issues facing this AMA. The lack of a common understanding of the facts and issues severely constrains consensus on the complexity and seriousness of water management issues. This, combined with inaccurate and misleading information developed within certain communities alleging the absence of water management issues, hinders efforts at wise water management. As a result, persons in positions to make critical decisions regarding the development and financing of conservation and renewable resource programs are not always presented with clear, rational, cost-effective options.

12.4 CONSIDERATIONS REGARDING SAFE-YIELD AND CRITICAL AREA MANAGEMENT

Overcoming some of the challenges to achieving safe-yield may require legislative or rule changes. The Department will work with water users and regional entities to identify optimal responses to the problems that have been identified and the timeframe within which these responses are necessary. In order to develop a consensus response, a number of committees or task forces need to be established to work on solutions. Both local (AMA) and state-wide task forces will be established. Depending on the subject matter involved, issues identified at the AMA level could be considered at the state level if more than one AMA is affected by the problem or could benefit from the proposed solutions. The "big picture" issues

relating to the basic structure and effectiveness of Groundwater Code provisions will be addressed at the state level, with full representation of each major water-using sector within each of the AMAs.

One area that clearly merits further discussion in the Phoenix AMA is development of the "critical area" concept. In this context, specific problem areas within the AMA could be targeted with incentives for recharge, restrictions on new pumpage, enhanced monitoring, or regional planning and technical assistance. Specific tools and authorities could potentially be developed, such as limiting new uses in the area. The impact of new exempt wells in critical areas may need to be evaluated. Activities of the CAGRD and AWBA might be expanded to allow for replenishment on behalf of certain users who are not currently able to participate. Such activities could be focused in critical areas as well.

The approaches that are listed below should, in some combination, begin addressing the issues and overcoming the obstacles previously described.

12.4.1 Existing and Projected Overdraft

The main reasons for current and projected overdraft conditions are residual pumping and underutilization of renewable water sources. The Department will reevaluate the effectiveness of various Code provisions in moving toward the safe-yield goal by addressing sectors that are expected to cause ongoing groundwater depletions. The municipal sector is responsible for developing renewable resources to meet significant percentages of demand. Both the industrial and agricultural use sectors have no such responsibilities. The Department will evaluate alternative programs and authorities to meet the objectives of ensuring that all groundwater pumpers contribute to achieving safe-yield in some capacity.

In the area of residual pumping, possible evaluations, programs, and authorities could be:

- Limit or eliminate the ability of irrigation grandfathered rights to be converted to Type 1 non-irrigation rights with no replenishment obligation, or reexamine the conversion rate.

- Reduce groundwater mining by new General Industrial Use permits either through pumping limitations or a replenishment obligation, or by requiring the permit holder to first use available, underutilized renewable sources of water.

- Limit or require replenishment by new residential growth in small dry-lot subdivisions, existing undeveloped lots, and new subdivisions of less than six lots that are not subject to the AWS Rules. These categories of development are currently not required to use renewable sources of water, demonstrate physical availability of water supplies, or undergo well impact analyses by the Department when drilling exempt wells.

- Establish replenishment requirements for undesignated municipal providers and reevaluate allowable groundwater pumping by designated providers.

- Ensure that all water uses associated with a development plan, including golf courses, are required to meet the assured water supply restrictions regarding renewable water sources.

- Establish programs that will cause a reduction in groundwater use by agriculture. This may include incentives to reduce pumping, higher withdrawal fees to discourage pumping, replenishment obligations for agriculture's contribution to overdraft conditions, or a purchase and retirement program.

In the area of underutilization of renewable resources, possible programs and authorities could be:

- Address the disparity between the cost of groundwater and the cost of renewable supplies.

- Develop programs to increase utilization of renewable supplies, including effluent, that are consistent with overall management objectives, particularly in the sectors with the highest residual pumping.

- Encourage the CAGRD to expand its authority to replenish supplies for members and non-members.

- Increase public education efforts. Ensure that local officials, the general public, community groups, and the development community understand the complexity and seriousness of these issues and the positive aspects of renewable resource development and use in the long-term.

In addition to evaluating the reasons for overdraft, it is necessary to further determine and update the negative impacts of overdraft. The Department will:

- Further develop and continue to monitor land subsidence activities in the AMA.

- Identify and quantify existing problems created by excessive pumping, which include land subsidence and earth fissures, aquifer compaction, water quality degradation, declining groundwater levels, and physical availability problems under the AWS Program.

- Reexamine the assured water supply depth-to-water rule which currently allows groundwater levels to decline to 1,000 feet below the land surface over 100 years. This depth-to-water provision may need to be more closely tied to impacts and damage caused by groundwater declines. It is conceivable that under the current 1,000 foot limit, substantial irreversible damage could occur prior to the limit being reached.

- Develop groundwater modeling capabilities that would result in the ability to predict the extent and rate of subsidence. The ability to correlate pumping and soil conditions to land subsidence rates would be an invaluable tool in a rapidly urbanizing area.

12.4.2 Limited Authority to Manage All Sources of Water

The impact of managing all sources of water in comparison to the current groundwater authorities needs to be determined. If the amount of overdraft can be significantly reduced by a conjunctive use management approach, consideration should be given to developing revised authorities, incentive-oriented financing, or other mechanisms to encourage the use of renewable sources of water.

12.4.3 Indian Water Rights Claims

The Department will assist the Office of Indian Water Rights Settlement Facilitation in its settlement activities. Water management issues and perspectives either on an AMA-wide or critical area basis should be provided by the Department. Technical assistance could be provided in the areas of future conditions analysis and conservation program development.

12.4.4 Integration of Water Quality Management

The Department will focus on two program areas:

- A better understanding of and closer coordination with ADEQ in developing and implementing effluent reuse standards, the Aquifer Protection Permit program, and gray water use programs could result in more opportunities for reuse and recharge of effluent in the AMAs.

- Through the ADEQ's Water Quality Assurance Revolving Fund (WQARF) Program, the Department will participate in the review and development of groundwater remediation programs with particular emphasis on reinjection and beneficial end uses. The Department will assess the water management impacts of recent legislative directives regarding the exemption of WQARF pumpage in determining compliance with conservation programs and with the groundwater account provisions of the AWS Program.

12.4.5 Closer Integration of Community Development with Water Policy Planning

Issues and obstacles raised in earlier sections are being grouped together under this section due to their interrelated nature within the community. The following issues and obstacles have much in common:

- Integration of land use planning with water policy planning
- Important factors not affected by regulatory programs
- Economic implications of water management
- Community understanding and support

All of these occur within, have an impact on, and can be addressed by communities. Community decisions, be they zoning, water and wastewater infrastructure development and location, establishment of water rates and development fees, development of conditions of new service, and enactment of ordinances and conservation programs, can and should be based on an understanding of the short-term and long-term costs and benefits. An obstacle to developing and implementing responsible water management programs is the lack of understanding by the public and the policy makers of the water management issues facing them. The Department will continue to work with community groups, citizens, and local officials by assisting in the development of responsible water management programs with technical and financial assistance.

12.4.6 Commitment to Conservation

Efficient use of all sources of water continues to be a Department objective. Demand reduction through efficient use will narrow the gap between water demand and renewable supplies. Chapters 4, 5, and 6 continue the imposition of conservation requirements on all major use sectors. The Department will continue to analyze cost-effective conservation technology and improved water management techniques. Special attention will be paid in the early years of the third management period in developing more effective conservation programs for the agricultural use sector.

12.4.7 Regulation of Private Water Companies

The Department will continue to work with private water companies, the ACC, and the Legislature to develop programs that result in a greater emphasis on conservation and renewable resource programs.

12.4.8 Critical Area Management

All of the ideas and potential activities described in this chapter to address AMA-wide water management issues pertain to critical area management as well. The primary difference is that the issues and obstacles within critical areas are generally more severe. To address these localized water management problems, the Department will develop state/ local partnerships. A combination of Department initiatives and complementary initiatives at the local level will be used to assist and stabilize these areas. The types of

Department actions contemplated for critical area management will be similar to those described at the end of each AMA-wide discussion of ideas and activities. In addition, the following will be considered:

1. Obtain the authority to protect non-recoverable water and water that is stored in critical areas but is recovered outside the area of impact from new users and from existing residual pumpers who do not shift onto renewable supplies.

2. Provide the ability to manage water levels in critical areas by restricting pumping using the following mechanisms:

    - Limiting new General Industrial Use permits
    - Restricting the ways in which new service areas can be established
    - Limiting Type 1 conversions
    - Increasing conservation requirements
    - Buying out or providing incentives for extinguishing existing grandfathered rights in specific areas
    - Limiting new exempt wells

3. Cause the CAGRD and the AWBA to replenish supplies in critical areas or in the location where the groundwater pumping obligation was incurred.

4. Require groundwater pumpage that is to be replenished to be consistent with the management plan drawdown criteria in Chapter 8. These criteria currently apply only to storage credits that are recovered outside the area of hydrologic impact, but could be expanded to address all pumpage that is recharged or replenished in another location.

5. Develop well spacing rules that have specific provisions to protect critical areas.

6. Provide economic or regulatory incentives to utilize renewable supplies in lieu of pumping groundwater in critical areas.

12.5 CONCLUSIONS

The key to effective water management is to anticipate change and to develop systems flexible enough to respond to conditions unlike those experienced today. As has been noted many times, the one certainty of the future is that it will be unlike the past. The ability to identify and understand trends in water use and supply is central to the functions of the Department. It will be necessary to expand basic monitoring programs, improve the collection and management of the data that are collected, and improve hydrologic modeling capabilities to effectively manage the state's water supplies in the context of change. The Department intends to expand its technical and advanced planning capabilities to better serve the state and the AMAs in the next management period.

This Chapter has identified the agenda for activities within the Phoenix AMA that will contribute to the AMA's goals and objectives. Numerous ideas and activities have been described. The Department believes that, of all the issues raised and obstacles identified, developing a program for resolving critical area problems and addressing new groundwater withdrawal authorities should receive immediate attention. The Department will continue to work with community interests to develop innovative, cooperative solutions and to respond to the area's changing needs.