# ARIZONA WATER ATLAS
# VOLUME 1 – EXECUTIVE SUMMARY

## 1.0 Atlas Purpose and Scope

Considerable investment in water resource development and planning has occurred in many parts of Arizona, particularly within the State's active management areas (AMAs) where major water supplies, regulations imposed by the Arizona Groundwater Code and large metropolitan areas with significant financing capabilities exist. Outside of the AMAs, smaller communities may lack financial capacity for water supply development and mandatory water management provisions do not exist. Nevertheless, a number of non-AMA communities have recognized the need for water resource planning and have developed renewable water supplies, conservation programs and water management plans. However both within and outside the AMA, the need for planning, management and comprehensive and updated water resource data is ongoing.

The purpose of the Arizona Water Atlas (Atlas) is to support water planning and development efforts by providing water-related information on a local, regional and statewide level. The Atlas is also an educational resource for the general public intended to be updated on a regular basis. In addition, the Atlas project has resulted in development of a statewide water resources data repository by the Arizona Department of Water Resources (Department).

The Atlas divides Arizona into seven planning areas (Figure 1-1). "Planning areas" are composed of groundwater basins and are an organizational concept that provide for a regional perspective on water supply, demand and resource issues. There is a separate Atlas volume for each planning area (Volumes 2-8), this executive summary (Volume 1) and a water sustainability assessment (Volume 9). Volume 9 is anticipated to be completed in 2011. All completed volumes are posted on the Department's website (http://www.azwater.gov). Figure 1-1 shows the planning areas and groundwater basins and should be referenced in subsequent sections of this volume.

Included in this volume is a discussion of the organization of the Atlas, an overview of water management and planning in Arizona, a discussion on water budgets for planning purposes, a summary of water resource characteristics for the State and several appendices that describe data sources and methods of analysis, provide information on water law, management and programs, and Indian water rights claims and settlements. Atlas data and information have been compiled from a number of sources. New investigations, except as noted, were not undertaken. This volume summarizes the content of the planning area volumes, which should be consulted for more detailed information on specific planning areas, groundwater basins and communities.

## 1.1 Atlas Organization

Each Atlas planning area volume contains an overview of the planning area and a separate water resource characteristics section for each

*Navajo Generating Station, Eastern Plateau Planning Area.*

groundwater basin or AMA within the planning area. A groundwater basin is a relatively hydrologically distinct body or related bodies of groundwater. A.R.S. § 45-402(13) The overview section of each volume includes a discussion of planning area geography, hydrology, climate, environmental conditions, population and growth, water supply, cultural water demand and water resource issues. Each basin or AMA section includes maps and tables that display a variety of water resource characteristics including; geography, land ownership, climate, surface water conditions, perennial/intermittent streams and major springs, groundwater conditions, water quality, cultural water demand and assured or adequate water supply determinations. References and supplemental readings are provided as well as appendices that contain a list of Arizona Water Protection Fund projects, Community Water System annual report data with a list of systems that have submitted System Water Plans, information on surface water right and adjudication filings, and a summary of rural watershed partnership issues. Appendix A of this volume contains a detailed list of the content of the planning area volumes. Appendix B contains a discussion of the data sources and methods for each of the water resource characteristics included in the Atlas.

Section 1.4 of this volume is organized similarly to that of the planning area volumes and summarizes the data and information in them at a statewide level. This volume also contains supporting background information and is intended to be a companion volume to the planning area volumes. The concluding volume of the Atlas (Volume 9) will use data from Atlas Volumes 1-8 as well as from other studies and stakeholder input to conduct a water resource sustainability assessment for the state. This assessment will identify current and future water resource vulnerabilities such as drought sensitive water supplies and the impact of current and projected growth on water supply availability.

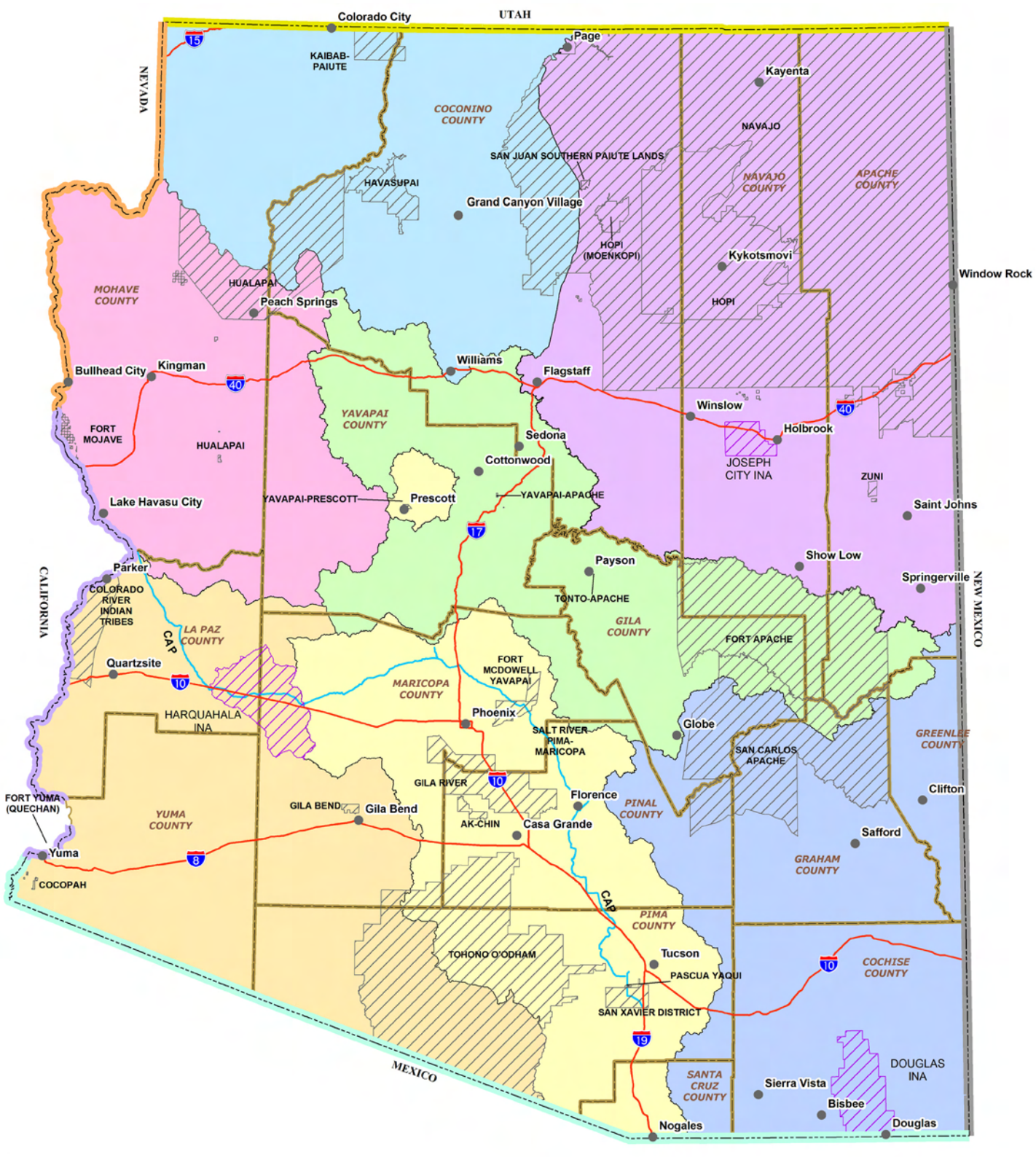
*Agriculture in the Douglas INA.*

## 1.2 Arizona Water Management and Planning Overview

Water management in Arizona involves a complex system of rules and management authorities that differ by legally defined water type and area. The system is summarized here and described in more detail in Appendix C. A fundamental component is that laws governing surface water are distinct from those governing groundwater. Surface water is subject to the doctrine of prior appropriation, based on the tenet of "first in time, first in right." Two general stream adjudications are in progress covering the Gila River and Little Colorado River systems to determine the nature, extent and priority of surface water uses and rights.

Rights to groundwater are subject to the beneficial use doctrine. Outside of the AMAs there is essentially no restriction on withdrawing groundwater as long as it is put to reasonable and beneficial use. The only exception is within three areas designated as Irrigation Non-Expansion Areas (INAs), where irrigation of new agricultural lands is restricted to prevent further groundwater declines. Within the AMAs the authority to withdraw groundwater is subject to a system of rights and permits pursuant to the Arizona Groundwater Management Act. A.R.S. § 45-401 et seq. (Code). The Code was adopted in 1980 to settle disputes among groundwater users, to secure federal funding for the Central Arizona Project (CAP), and to mitigate severe

# Figure 1-1
# Arizona Planning Areas and Groundwater Basins

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overdraft conditions in several parts of the state.[1] The Code established management goals for each AMA, a data reporting system, mandatory conservation requirements, and 100-year assured water supply requirements for new subdivisions in the AMAs.

The Phoenix, Prescott and Tucson AMAs have a management goal of safe-yield by 2025. A.R.S. § 45-562(A). The management goal of the Pinal AMA is to allow development of non-irrigation uses and to preserve existing agricultural economies for as long as feasible. A.R.S. § 45-562(B). The goal of the Santa Cruz AMA is to maintain a safe-yield condition and prevent local water tables from experiencing long-term declines. A.R.S.§ 45-562(C). (See Appendix C).

Within the AMAs, mandatory water metering and reporting requirements for groundwater rightholders has resulted in the systematic collection of water use data, which is compiled in AMA management plans. A series of five consecutive management plans are statutorily required for each AMA. A.R.S.§§ 45-564 through 568. The management plans contain conservation requirements for the agricultural, municipal and industrial water use sectors, as well as water use data, and provide the framework for the day-to-day implementation of Code mandates and Department policies for each AMA.

The Code also contains provisions that address water supplies for subdivided lands. Within the AMAs new subdivisions are subject to Assured Water Supply (AWS) provisions. A.R.S. §§ 45-576 et seq. The Code and associated AWS Rules prohibit the sale or lease of subdivided land without demonstration of a 100-year assured water supply. Water use must also be consistent with the AMA management goal, which requires use of renewable (non-groundwater) supplies or replenishment of groundwater use as well as other requirements. Local governments cannot approve a subdivision plat and the Arizona Department of Real Estate (ADRE) cannot issue a public report for the sale of lots without an AWS determination. Developers must obtain a Certificate of AWS or demonstrate that the subdivision will be served by a water provider whose service area has been issued a designation of an AWS.

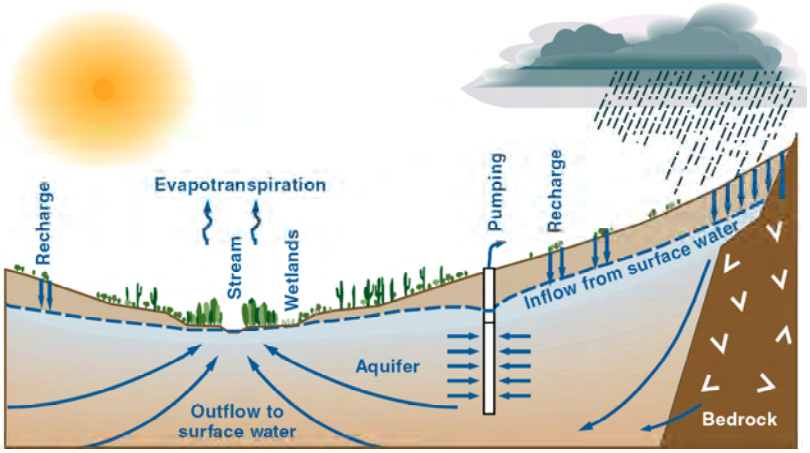
Outside of the AMAs, A.R.S.§ 45-108 requires subdivision developers to obtain a Water Adequacy Report that demonstrates that sufficient water of adequate quality is available for at least 100 years, demonstrate that the subdivision will be served by a municipal provider that has been designated as having an adequate water supply, or disclose any "inadequate" determination (to the initial buyer) in the public report and all promotional materials. The ability to market lots without demonstrating an adequate water supply is an issue in a number of rural areas where water supplies are stressed. However, legislation adopted in June 2007 (SB 1575) authorizes a county board of supervisors to adopt a provision requiring a new subdivision to have an adequate water supply in order to be approved by the platting authority. If the county does not adopt the provision, the legislation allows a city or town to adopt a local ordinance that requires a demonstration of adequacy. As of June 2010, Cochise County, Yuma County, the Town of

*Cochise County, Southeastern Arizona Planning Area. As of June, 2010, only Cochise County, Yuma County, the Town of Clarkdale and the Town of Patagonia had adopted the provisions of SB 1575.*

[1] Overdraft is a condition where groundwater withdrawals exceed recharge to the aquifer

Clarkdale and the Town of Patagonia had adopted the provisions of SB 1575.

**Figure 1-2 Schematic of a Water Budget**
(Source: Leake and others, 2000)




Developers also have the option to obtain an Analysis of AWS (within an AMA) or an Analysis of Adequate Water Supply (outside an AMA). An Analysis is for master-planned communities that are typically developed in phases. An Analysis verifies that one or more of the requirements to obtain a Certificate of AWS or a Water Adequacy Report are met. As each phase is developed, either a Certificate of AWS or a Water Adequacy Report is required, but the work that has already been completed for the Analysis can be used. If the Analysis has proven physical availability of the water supply, that demonstrated volume of water can be withdrawn for subsequent Certificates of AWS or Water Adequacy Reports within a ten year period.

Groundwater cannot be transported between groundwater basins outside of the AMAs or from a groundwater basin outside an AMA into an AMA, except for specific transfers as specified in statute. A.R.S. §§ 45-544 and 45-551. These statutes are designed to protect hydrologically distinct sources of groundwater and the economies in rural areas by ensuring the groundwater is not depleted in one groundwater basin to benefit another.

A number of statewide efforts have supported water resource planning, information needs and management efforts outside the AMAs. These include establishment of the Rural Watershed Initiative Program (1998), adoption of the 2004 Arizona Drought Plan and associated legislation (H.B. 2277) (see Section 1.4.5), initiation of the Statewide Water Conservation and Drought Program, establishment of a Rural Water Legislative Study Committee (2005-2007), and formation of a Statewide Water Advisory Group (SWAG) focused on programs for water resources development and management programs outside of AMAs (2006). In August 2009, Governor Brewer established the Blue Ribbon Panel on Water Sustainability to improve the long-term sustainability of Arizona's water supplies through increased conservation and recycling statewide with a focus on challenges to increasing wastewater reuse. Legislation passed in 2010 (H.B. 2661) established the Water Resource Development Commission (WRDC), tasked with assessing current and future water needs in Arizona including identification of future supplies and financing mechanisms for water supply acquisition and infrastructure. The WRDC must prepare a report including recommendations and suggested legislation by October 2011. (See Section 1.4.8)

## 1.3 Water Budgets

A water budget is a key component in water planning and management. The water resource data discussed in Section 1.4 and found in the planning area volumes can be used to help construct a water budget, which is an accounting of inflows and outflows of water from a basin over a specified period of time, shown in Figure 1-2. A water budget can include natural processes such as precipitation and evaporation as well

**Table 1-1 Typical components of a water budget**

| Inflow | Outflow |
|---|---|
| ***Surface Water*** | |
| • Precipitation** | • Evaporation* |
| • Streamflow from precipitation events and snowmelt** | • Evapotranspiration (e.g., riparian vegetation*) |
| • Baseflow from groundwater* | • Streamflow exiting basin* |
| • Irrigation return flow | • Surface water diversions (agricultural, municipal, industrial, stock water)** |
| • Effluent discharge* | |
| ***Groundwater*** | |
| • Natural Recharge (mountain front and stream channel from precipitation and basin underflow)** | • Evapotranspiration (e.g., riparian vegetation*) |
| • Artificial and incidental recharge* | • Underflow exiting the basin |
| | • Baseflow to surface water* |

* related or cursory data are presented in the Atlas

** detailed data is presented in the Atlas

as those processes influenced by development such as diversions and effluent discharge. Typical surface water and groundwater components of inflow and outflow are listed in Table 1-1. Streamflow and groundwater recharge are often the largest components of inflow to a basin. Cultural water demand and ET are often the largest component of outflow from a basin. In the Atlas, the term "cultural" water demand refers to the quantity of water diverted from streams and reservoirs, pumped from wells or treated and delivered for municipal, industrial and agricultural purposes. This term should not be confused with "consumptive use", which refers to the amount of cultural water demand that is lost from the hydrologic system. For example, not all surface water diverted to irrigate crops is permanently lost; a portion of the water applied to fields may flow back to streams (return flow) or infiltrate to underlying aquifers (incidental recharge).

Estimates of natural groundwater recharge, streamflow, precipitation and cultural water demands are presented by basin in Volumes 2-8. Other components of outflow and inflow are not well quantified in the Atlas or are not quantified at all due to lack of data Those not quantified are often difficult to estimate but should be considered when constructing a water budget. These include incidental recharge, irrigation return flow, baseflow, evapotranspiration, evaporation and underflow.

Incidental recharge is water that percolates to the aquifer after human use such as excess water applied to irrigate agricultural lands or turf facilities, effluent discharge to water courses or septic tank emissions. The amount of incidental recharge is affected to a large extent by population, the population not served by a centralized wastewater treatment facility, irrigation efficiency and the method of effluent discharge. Artificial recharge is water (other than groundwater) that is stored in an aquifer for future use via Underground Storage Facilities (USFs) (see Appendix C).

Water is often lost from municipal and agricultural water distribution systems due to leaks and breaks from water lines and storage tanks, illegal connections and evaporation. These may be components of incidental recharge or cultural demand. In some cases water line losses can be significant. One third of the respondents to a system water loss question in the 2003 Rural Water Resources Questionnaire (ADWR, 2004) reported losses of over 10% with losses of up to 60% reported. Within the AMAs, there are system water loss requirements for municipal, ag-

ricultural and industrial water users. Reducing system losses eliminates unnecessary pumping and related costs and may postpone or eliminate the need to secure other supplies to meet system water demands.

Evapotranspiration, primarily from riparian vegetation, has been difficult to quantify accurately over large areas but may represent a large water demand "sector" in some basins, such as in the Upper San Pedro Basin. This demand has not been evaluated on a statewide basis and has not been quantified in the Atlas, however maps showing riparian vegetation associated with streams are presented in the Atlas.

Evaporation from reservoirs and ponds is significant and varies widely across the state. Evaporation rates range from less than 3 feet/year in the mountains of central Arizona to greater than 8 feet/year along the Colorado River in western Arizona (Farnsworth and others, 1982). Regardless of the variability, the total quantity of water lost to evaporation from these sources is substantial. Average evaporative losses from reservoirs and ponds in Arizona were estimated to total 221,400 acre-feet in 2000. An additional 1,993,000 acre-feet of evaporative losses was estimated from Lakes Powell, Mead, Mohave and Havasu on the Colorado River. (BOR, 2004) Evaporative losses are also associated with uncovered water conveyance systems and irrigation.

## 1.4 Water Resource Characteristics Summary

Summarized in this section are data and information on a number of water resource characteristics discussed in detail in the planning area volumes of the Atlas. The appropriate planning area volume should be consulted for more detailed information.

### *1.4.1 Geography*

Arizona covers about 114,000 square miles of land with great geographical diversity. There are three main physiographic regions in the state. The regions and their relationship to the planning areas are shown in Figure 1-3.

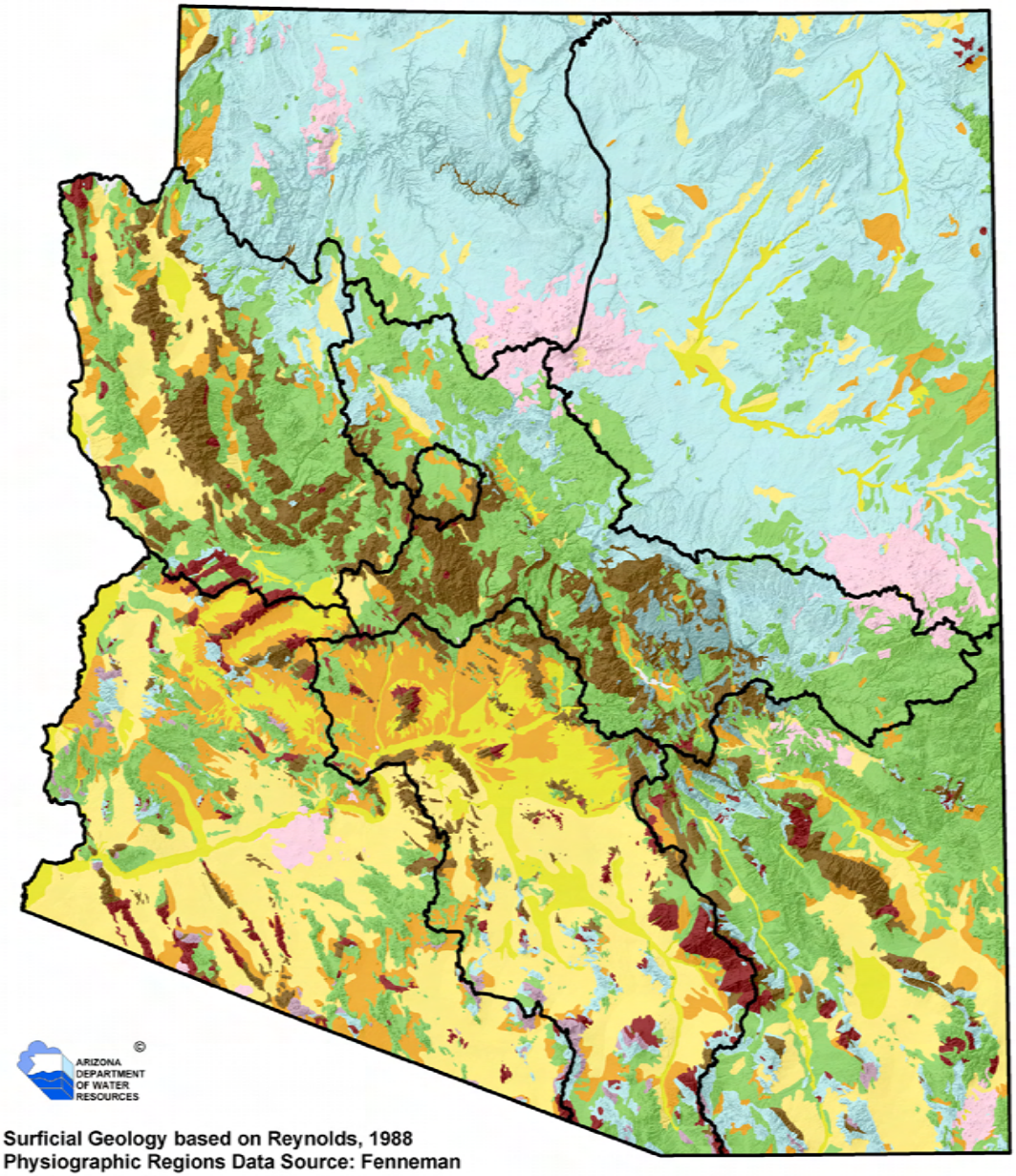
Physiographic Regions

The Basin and Range Province of southern and western Arizona is characterized by long, broad, alluvial valleys separated by north-south trending mountain ranges. Thick, productive regional aquifers are found in the basins of this province. The Upper Colorado River, Lower Colorado River, Southeastern Arizona and AMA (except Prescott AMA) planning areas are primarily within this province.

The Colorado Plateau Province covers the northern portion of the state and is characterized by sedimentary rocks that have eroded into canyons and plateaus. The Colorado Plateau Province includes the Eastern Plateau, Western Plateau and small parts of the Central Highlands and Upper Colorado River planning areas. This province contains regional aquifers within sandstone and limestone layers and relatively thin deposits of alluvium form unconfined aquifers along some streams.

The Central Highlands transition zone is located between the two provinces and includes most of the Central Highlands Planning Area, the easternmost part of the Upper Colorado River Planning Area, the Prescott AMA and the northern part of the Southeastern Arizona Planning Area. It is characterized by a relatively narrow band of mountains and most of the state's perennial streams. Groundwater is found in alluvial deposits, layered sedimentary rocks, thin alluvial deposits along major streams and fractured crystalline, sedimentary and volcanic rocks (ADWR, 1994a,b). Much of this region has minimal water storage capabilities and high runoff compared to the Basin and Range Province.

## Figure 1-3
## Surficial Geology and Physiographic Regions of Arizona



**Generalized Geologic Units**

- Holocene Alluvial Deposits
- Quarternary Surficial Deposits
- Holocene to Tertiary Volcanic Rocks
- Pleistocene to Tertiary Alluvial Deposits
- Tertiary Sedimentary and Volcanic Rocks
- Tertiary to Mesozoic Intrusive and Metamorphic Rocks
- Mesozoic to Paleozoic Sedimentary and Volcanic Rocks
- Mesozoic Intrusive and Metamorphic Rocks
- Precambrian Sedimentary Rocks
- Precambrian Intrusvie and Metamorphic Rocks
- Planning Area Boundary

**Surficial Geology based on Reynolds, 1988**
**Physiographic Regions Data Source: Fenneman and Johnson, 1946**

Planning Areas

The Eastern Plateau Planning Area occupies the northeastern quarter of Arizona and consists of one groundwater basin. Its southern boundary is defined by the Mogollon Rim, an escarpment almost 2,000 feet high in some places, that extends from central Arizona to the Mogollon Mountains in New Mexico. Relatively high elevation plateaus and mountains, volcanic cinder cones and peaks, steep cliffs, and deeply incised sandstone canyons characterize the planning area geography. Few perennial or intermittent streams occur, except at higher elevations.

The Southeastern Arizona Planning Area encompasses 14 geographically diverse groundwater basins in the southeastern corner of the state. A unique feature of the planning area is mountain ranges, known as "sky islands" that are isolated from each other by valleys of desert grasslands and desertscrub. Most of the planning area is within the Mexican Highland section of the Basin and Range Province; a higher elevation area with valleys ranging from 2,500 to 4,000 feet above sea level and mountains and valleys covering about equal areas. The planning area includes drainages of the San Pedro and upper Gila rivers and the headwaters of the Santa Cruz River.

Nine groundwater basins compose the Upper Colorado River Planning Area, located in the northwestern portion of Arizona south of the Colorado River. Arizona's three physiographic regions are found in the planning area. The planning area includes portions of the Colorado River and associated lakes (Mead, Mohave and Havasu) impounded by several dams that influence cultural uses, groundwater conditions and habitat in a significant portion of the planning area.

The Central Highlands Planning Area, composed of five groundwater basins, stretches across most of central Arizona. The planning area contains diverse topography and a large el-

*Headwaters of the Santa Cruz River, Southeastern Arizona Planning Area. The planning area includes drainages of the San Pedro and upper Gila rivers and the headwaters of the Santa Cruz River.*

evational range (from 1,500 feet to over 12,600 feet), resulting in a wide diversity of vegetation types and ecosystems, the greatest of any planning area. Topography varies from desert basins to deeply incised canyons to high elevation mountains. Because of the high elevations and associated higher precipitation, this planning area contains the state's greatest concentration of perennial streams and its most productive water producing watersheds, the Salt and Verde.

The Western Plateau Planning Area covers the northwestern corner of Arizona and includes six groundwater basins. It includes the Grand Canyon, incised by the Colorado River and its tributaries, with an average depth of 4,000 feet. South and east of the Colorado River, the Coconino Plateau marks the southwestern edge of the Colorado Plateau. In the northwest corner of the planning area, the Virgin River cuts through the Beaver Dam Mountains creating the Virgin River Gorge. Other significant geographic features are numerous high plateaus, steep cliffs, deeply incised canyons and few surface water features.

Eleven groundwater basins compose the Lower Colorado River Planning area, located in south-

western Arizona. The planning area is relatively low elevation - generally less than 3,500 feet- and is very arid; a condition that has shaped its topography and surface water characteristics. Its geography consists primarily of widely-scattered, small mountain ranges of mostly barren rock and broad, flat valleys (or plains). With the exception of the Colorado River, there are no perennial streams; broad sandy washes are the main surface water feature, flowing only in response to significant precipitation events.

The AMA Planning Area extends from the international border through central Arizona to the northern boundary of Maricopa County. The northernmost AMA, the Prescott AMA, is discontiguous from the other four AMAs. Because of its geographic extent and location in the state, this planning area exhibits a wide range of geographic features, from low elevation, broad, semi-arid Sonoran desert valleys to mountain ranges with summits over 9,000 feet. The topographic variability results in broad variations in the amount of precipitation, temperature range and vegetation type.

The distribution and type of land ownership in planning areas has implications for land and water use. Large areas of private land typically provide opportunities for land development and associated water demand, whereas federal lands are typically maintained for a purpose with little associated cultural water demand. State owned land may be sold or traded, and is often leased for grazing and farming. The percentage of land ownership types statewide and for each planning area are listed in Table 1-2. Land ownership maps for each basin are found in the planning area volumes of the Atlas.

### 1.4.2 Hydrology

Groundwater Hydrology

Anderson and others (1992) divided the alluvial groundwater basins of south-central Arizona into five categories based on similar hydrologic and geologic characteristics, summarized in Table 1-3. This table includes similar information for the Plateau basins that were not included in their study as well as typical groundwater responses to well pumpage. General groundwater characteristics for each planning area are described briefly in this section. Groundwater data including major aquifers, well yields, natural recharge estimates and water in storage are summarized in Table 1-4 for each groundwater basin within the planning areas and referenced to the basin categories.

Figure 1-3 shows a surficial geology map of Arizona. Well yields generally reflect aquifer composition and productivity. Aquifers composed of coarse grained alluvium often yield more water to wells than fine grained alluvium or crystalline and sedimentary rocks. Well yields measured across the state are shown on Figure 1-4.

**Table 1-2 Land ownership in Arizona** (Source: ALRIS 2004)

| Land Ownership Type | Planning Area | | | | | | | Statewide % |
|---|---|---|---|---|---|---|---|---|
| | Eastern Plateau % | Southeastern Arizona % | Upper Colorado River % | Central Highlands % | Western Plateau % | Lower Colorado River % | Active Management Areas % | |
| Bureau of Land Management | 1.11 | 14.23 | 34.38 | 3.68 | 29.62 | 24.67 | 10.36 | 16.86 |
| Forest Service | 10.38 | 17.09 | 2.30 | 46.76 | 13.64 | 0.00 | 8.10 | 14.04 |
| Indian Reservation | 63.93 | 14.96 | 7.58 | 22.40 | 17.24 | 16.66 | 18.62 | 23.06 |
| Local/State Parks | 0.01 | 0.08 | 0.07 | 0.02 | 0.00 | 0.02 | 1.39 | 0.23 |
| Military | 0.00 | 1.05 | 0.22 | 0.29 | 0.00 | 23.30 | 0.42 | 3.61 |
| National Parks | 1.46 | 0.25 | 6.34 | 0.02 | 16.23 | 2.99 | 0.81 | 4.01 |
| Other | 0.14 | 0.27 | 0.13 | 0.26 | 0.00 | 0.88 | 0.44 | 0.30 |
| Private | 14.75 | 22.95 | 25.56 | 0.11 | 10.95 | 7.45 | 34.64 | 18.15 |
| State Trust | 8.03 | 25.80 | 16.68 | 6.26 | 8.92 | 6.09 | 21.30 | 13.30 |
| Wilderness (USFS/BLM) | 0.18 | 3.30 | 6.22 | 9.52 | 3.40 | 3.79 | 2.72 | 4.16 |
| Wildlife Refuge | 0.00 | 0.02 | 0.51 | 0.00 | 0.00 | 14.15 | 1.20 | 2.27 |

## Table 1-3 Generalized Basin Hydrogeology [1,2]

| | | BASIN CATEGORY | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Central** | **Colorado River** | **Highland** | **Plateau [3]** | **Southeast** | **West** |
| **GEOLOGY OF MAJOR AQUIFERS** | **Recent Stream Alluvium** | Up to 300 feet in thickness of coarse material along major streams | Deposited in channels cut into basin fill | Common beneath floodplains | Sand and gravel along major streams | Relatively thin layers of sand and gravel | Limited to areas along the lower Gila River |
| | **Basin Fill and Younger Volcanics** | Upper Basin Fill -Typically less than 1,000 feet of fine- to course-grained deposits becoming courser near the basin margins and at land surface | Older alluvial deposits underlain by marine estuarine sediments (Bouse Formation) | Up to 500 feet of sediment that may include consolidated lake deposits (e.g. Verde Formation); limited in areal extent | Basaltic lava flows found locally in some basins [4] | Upper Basin Fill - typically about 300 feet of lacustrine silt and clay | Upper Basin Fill - thin and heterogeneous |
| | | Lower Basin Fill -Up to 5,000 feet of fine-grained sediments that include evaporite deposits and become coarser near the basin margins | | | | Lower Basin Fill - typically greater than 1,000 feet of coarse- to fine-grained sediment becoming coarser near the basin margins | Lower Basin Fill - coarse- to fine-grained sediment becoming coarser near basin margins |
| | **Pre-Basin and Range Sediments** | Occur at significant depths with relatively little known of their extent or character; include conglomerate | Primarily cemented sandy gravel (fanglomerate) | Not a major aquifer | Sandstone, siltstone and conglomerate interbedded with volcanic rocks in a few basins (e.g. Cottonwood Wash and Muddy Creek formations) | Moderately thick conglomerate | Conglomerate, sandstone and volcanic rock occurring at relatively shallow depths (e.g. Muddy Creek Formation) |
| | **Older Consolidated Rocks** | Not a major aquifer | Not a major aquifer | Coconino Sandstone (C Aquifer), Redwall Limestone (R Aquifer), and volcanic, igneous and metamorphic rocks locally | Coconino, Dakota, and Navajo sandstones (C, D, and N Aquifers), Muav and Redwall limestones (R Aquifer), and other sedimentary rocks (Bidahochi, Chinle, Kayenta, Mesa Verde, Moenave, and Moenkopi formations) [5] | Not a major aquifer | Not a major aquifer |
| **HYDROLOGIC CHARACTERISTICS** | **Natural Aquifer Inflows** | Mostly stream infiltration with some underflow and mountain-front recharge | Mostly stream infiltration with very minor underflow and mountain-front recharge | Mostly stream infiltration and underflow with some mountain-front recharge | Mostly mountain-front recharge where sandstones and limestones outcrop, with minor to some leakage between units | Mostly mountain-front recharge and stream infiltration with minor underflow | Mostly stream infiltration with some underflow and mountain-front recharge |
| | **Natural Aquifer Outflows** | Mostly evapotranspiration with some underflow and minor baseflow | Mostly evapotranspiration with minor baseflow and very minor underflow | Mostly baseflow and evapotranspiration with very minor underflow | Mostly discharge to springs and baseflow with minor to some leakage between units | Mostly evapotranspiration with some baseflow and minor underflow | Mostly evapotranspiration with some underflow and minor baseflow |
| | **Direction of Groundwater Flow** | From areas of recharge along basin perimeter toward central basin axis and then down valley | Away from the Colorado River toward its floodplain where evapotranspiration occurs; also some flow parallel to the river and locally towards the river where irrigation has reversed the flow gradient | From areas of recharge along basin perimeter toward central basin axis | Downgradient from permeable outcrops, along bedding planes and locally along faults and solution channels | From areas of recharge along basin perimeter toward central basin axis | Down valley |
| | **Pressure Conditions** | Locally confined due to fine-grained deposits of basin fill; otherwise, unconfined | Confined in the fanglomerate; otherwise unconfined | Typically unconfined | Can be confined over relatively large areas by overlying siltstone and claystone layers | Aquifer in lower basin fill is often confined; otherwise unconfined | Typically unconfined |
| | **Depth to Ground Water** | From land surface to as much as 700 feet bls near the mountain fronts | From land surface to a few hundred feet bls | From land surface to a few tens of feet bls; hundreds of feet or more bls for sandstone and limestone aquifers | Typically several hundred feet to over 3,000 feet bls in some areas | Above land surface (flowing wells) to more than 500 feet bls at basin perimeter | Few feet to more than 1,300 feet bls near the mountain fronts |
| **GROUNDWATER RESPONSES TO DEVELOPMENT (WELL PUMPING)** | | Mostly loss of water from storage and, near major rivers, may eventually decrease baseflow and evapotranspiration and locally increase stream infiltration. Groundwater level declines expected but locally may rise or stabilize where irrigation return flows are significant | Most well water derived from the river; may locally decrease evapotranspiration and increase stream infiltration, but not cause much loss of water from storage | Over time may increase stream infiltration and decrease baseflow and evapotranspiration; could eventually lead to groundwater level declines | Mostly a loss of water from storage with relatively large groundwater level declines possible; over time may decrease spring discharge and baseflow | Initial loss of water from storage; may eventually decrease baseflow and evapotranspiration and increase stream infiltration | Mostly a loss of water from storage; near the Gila River, may eventually decrease evapotranspiration and increase stream infiltration |

Notes:
[1] Primary source - Anderson and others (1992); secondary sources - ADWR (1994b), USGS (1984) and Anderson and Freethy (1995)
[2] Actual hydrogeologic conditions may vary considerably within individual basins and basin categories. Table 1-4 specifies which basins are grouped in each category.
[3] The Hydrologic Characteristics and Responses to Well Development listed for the Plateau basin category apply to the regional sandstone and limestone aquifers which are the primary sources of water.
[4] Gravel beds and lake deposits are important in the Aubrey and Truxton valleys, respectively, of Peach Springs Basin.
[5] The D Aquifer also includes the Cow Springs and Entrada Sandstones; the N Aquifer also includes the Wingate Sandstone; and the C Aquifer also includes the Kaibab Limestone and Upper Supai Formation.

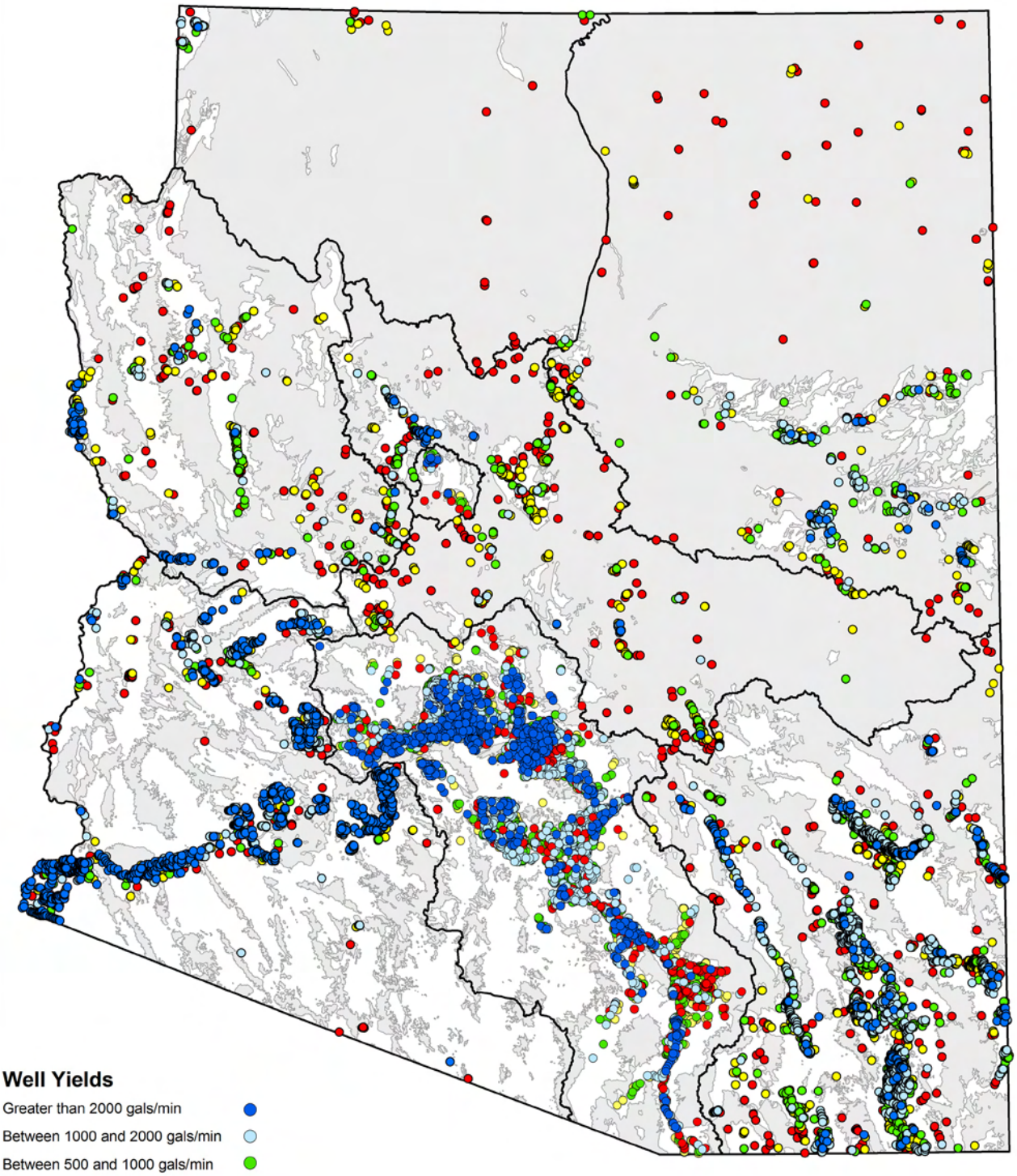
## Table 1-4 Summary of basin groundwater data

| BASIN | AREA (in square miles) | BASIN CATEGORY [1] | MAJOR AQUIFER(S) [2] | MEDIAN WELL YIELDS [3] (in gallons per minute) | | ESTIMATED NATURAL RECHARGE [4] (in 1000 acre-feet/year) | ESTIMATED WATER IN STORAGE [4] (in million acre-feet) | NUMBER OF ADWR INDEX WELLS [5] | LAST ADWR WELL SWEEP [5] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Measured | Reported | | | | Year | # of Wells Measured |
| ***Eastern Plateau Planning Area*** | | | | | | | | | | |
| Little Colorado River Plateau | 26,700 | Plateau | Recent Stream Alluvium, Volcanic Rock (Lakeside-Pinetop Aquifer) and Sedimentary Rock (Bidahochi Formation, C, D, N, Springerville, and White Mountain Aquifers) | 95 (85 wells) | 500 (386 wells) | 319 (C Aquifer), 5.4 (D Aquifer), 2.6 to 20.2 (N Aquifer) | 413 (C Aquifer), 15 (D Aquifer), 526 (N Aquifer) | 94 | 2001 | 932 |
| ***Southeastern Arizona Planning Area*** | | | | | | | | | | |
| Aravaipa Canyon | 517 | Southeast | Recent Stream Alluvium and Basin Fill | --- | 350 (36 wells) | 7 to 16.7 | 5 to 5.1 (to 1,200 feet) | 3 | 1996 | 60 |
| Bonita Creek | 457 | | Recent Stream Alluvium, Basin Fill and Volcanic Rock | --- | 1,145 (14 wells) | 9 | 1 to 2 (to 1,200 feet) | 0 | NA | NA |
| Cienega Creek | 606 | | Recent Stream Alluvium and Basin Fill | --- | 250 (35 wells) | 8.5 to 25.5 | 5.1 to 11 (to 1,200 feet) | 14 | 2005 | 117 |
| Donnelly Wash | 293 | | Basin Fill | --- | 63 (4 wells) | 3 | 0.14 to 2 (to 1,200 feet) | 0 | 1996 | 25 |
| Douglas | 949 | | Basin Fill, locally interbedded with Volcanic Rock | 718 (64 wells) | 600 (656 wells) | 15.5 to 22 | 26 to 32 (to 1,200 feet) | 27 | 2004 | 356 |
| Dripping Springs Wash | 378 | | Recent Stream Alluvium and Sedimentary Rock (Gila Conglomerate) | --- | 395 (12 wells) | 3 to 9 | 0.15 (to 1,200 feet) to <1 | 2 | 1996 | 34 |
| Duncan Valley | 550 | | Recent Stream Alluvium and Sedimentary Rock (Gila Conglomerate) | --- | 850 (165 wells) | 6 to 14.2 | 9 to 19 (to 1,200 feet) | 11 | 1987 | 182 |
| Lower San Pedro | 1,624 | | Recent Stream Alluvium and Basin Fill | 1,295 (10 wells) | 1,000 (181 wells) | 24 to 29 | 11 (to 1,200 feet) to >27 | 19 | 2006 | 205 |
| Morenci | 1,599 | | Recent Stream Alluvium and Volcanic Rock | --- | 600 (53 wells) | 15 | 3 (to 1,200 feet) | 4 | 1978 | 6 |
| Safford [6] | 4,747 | | Recent Stream Alluvium and Basin Fill | 772 (52 wells) | 600 (1,494 wells) | 105 | >27 to 69 (to 1,200 feet) | 50 | 1997 | 559 |
| San Bernardino Valley | 387 | | Recent Stream Alluvium and Volcanic Rock | --- | 450 (3 wells) | 9 | 1.6 to 2 (to 1,200 feet) | 4 | 2007 | 70 |
| San Rafael | 229 | | Recent Stream Alluvium and Basin Fill | --- | 145 (12 wells) | 5 | 4 to 5 (to 1,200 feet) | 10 | 2005 | 36 |
| Upper San Pedro | 1,825 | | Recent Stream Alluvium and Basin Fill | 335 (39 wells) | 600 (353 wells) | 35.8 | 19.8 to 59 (to 1,200 feet) | 59 | 2006 | 688 |
| Willcox | 1,911 | | Recent Stream Alluvium and Basin Fill | 622 (64 wells) | 750 (1,007 wells) | 15 to 47 | 42 to 59 (to 1,200 feet) | 47 | 2005 | 845 |
| ***Upper Colorado River Planning Area*** | | | | | | | | | | |
| Big Sandy | 1,988 | Highland / Southeast | Recent Stream Alluvium, Basin Fill and Sedimentary Rock (R Aquifer) | --- | 300 (87 wells) | 22 | 9.5 to 21 (to 1,200 feet) | 18 | 2008 | 104 |
| Bill Williams | 3,350 | Highland / West | Recent Stream Alluvium, Basin Fill and Volcanic Rock | 2 (3 wells) | 280 (195 wells) | 32 | 10 to 23 (to 1,200 feet) | 24 | 1979 | 117 |
| Detrital Valley | 892 | West | Recent Stream Alluvium, Basin Fill and Sedimentary Rock (Muddy Creek and Chemehueve Formations) | 32 (6 wells) | 35 (3 wells) | 1 | 1 to 7 (to 1,200 feet) | 11 | 2006 | 82 |
| Hualapai Valley | 1,212 | | Basin Fill, Sedimentary Rock (Muddy Creek and Chemehueve Formations) and Volcanic Rock | 967 (10 wells) | 900 (33 wells) | 2 to 3 | 3 to 21 (to 1,200 feet) | 16 | 2006 | 101 |
| Lake Havasu | 252 | Colorado River | Basin Fill | --- | 1,500 (17 wells) | 35 | 1 to 2 (to 1,200 feet) | 1 | 1998-99 | 30 |
| Lake Mohave | 980 | | Recent Stream Alluvium | --- | 1,000 (96 wells) | 183 | 1.2 to 8 (to 1,200 feet) | 3 | NA | NA |
| Meadview | 190 | West | Sedimentary Rock (Muddy Creek Formation) | 33 (5 wells) | --- | 4 | 0.06 (to 700 feet) to 1 (to 1,200 feet) | 1 | 2006 | 16 |
| Peach Springs | 1,409 | Plateau | Basin Fill and Sedimentary Rock (R Aquifer) | --- | 250 (7 wells) | NA | 1 (to 1,200 feet) to >4 | 3 | 1995 | 34 |
| Sacramento Valley | 1,587 | West | Basin Fill and Volcanic Rock | 167 (9 wells) | 100 (36 wells) | 1 to 4 | 3.6 to 14 (to 1,200 feet) | 16 | 2006 | 177 |
| ***Central Highlands Planning Area*** | | | | | | | | | | |
| Agua Fria | 1,263 | Central / Highland | Basin Fill and Sedimentary Rock (Conglomerate) | --- | 300 (49 wells) | 9 | 0.6 (to 1,200 feet) to 3.5 | 7 | 2008 | 207 |
| Salt River | 5,232 | Highland | Recent Stream Alluvium, Volcanic Rock (Pinetop-Lakeside Aquifer) and Sedimentary Rock (Gila Conglomerate and C and R Aquifers) | --- | 170 (140 wells) | 178 | >8.7 (to 1,200 feet) | 1 | NA | NA |
| Tonto Creek | 955 | | Basin Fill and Sedimentary Rock (C and R Aquifers) | --- | 120 (51 wells) | 17 to 37 | 2 to 9.4 (to 1,200 feet) | 13 | 2008 | 216 |
| Upper Hassayampa | 787 | West | Basin Fill | --- | 125 (61 wells) | 8 | 1 to 1.1 (to 1,200 feet) | 5 | 2004 | 101 |
| Verde River | 5,661 | Highland | Recent Stream Alluvium, Basin Fill interbedded with Volcanic Rock, Sedimentary Rock (Verde Formation and C and R Aquifers) and Igneous and Metamorphic Rocks | 102 (55 wells) | 260 (262 wells) | 107 to >148 | 13 to 28 (to 1,200 feet) | 130 | 2009 | 269 |

## Table 1-4 Summary of basin groundwater data (cont)

| BASIN | AREA (in square miles) | BASIN CATEGORY [1] | MAJOR AQUIFER(S) [2] | MEDIAN WELL YIELDS [3] (in gallons per minute) | | ESTIMATED NATURAL RECHARGE [4] (in 1000 acre-feet/year) | ESTIMATED WATER IN STORAGE [4] (in million acre-feet) | NUMBER OF ADWR INDEX WELLS [5] | LAST ADWR WELL SWEEP [5] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Measured | Reported | | | | Year | # of Wells Measured |
| ***Western Plateau Planning Area*** | | | | | | | | | | |
| Coconino Plateau | 5,812 | Plateau | Volcanic Rock, Basin Fill, and Sedimentary Rock (Moenkopi and Chinle Formations and C and R Aquifers) | --- | 45.5 (16 wells) | NA | 3 | 2 | NA | NA |
| Grand Wash | 959 | | Recent Stream Alluvium, Basin Fill interbedded with Volcanic Rock and Sedimentary Rock (Cottonwood Wash and Muddy Creek Formations) | --- | --- | NA | NA | 2 | NA | NA |
| Kanab Plateau | 4,247 | | Recent Stream Alluvium and Sedimentary Rock | --- | 70 (10 wells) | NA | NA | 3 | NA | NA |
| Paria | 408 | | Sedimentary Rock (N Aquifer) | --- | 520 (3 wells) | NA | 1.5 (to 1,200 feet) | 1 | NA | NA |
| Shivwits Plateau | 1,821 | | Recent Stream Alluvium | --- | 5 (17 wells) | NA | NA | 0 | NA | NA |
| Virgin River | 434 | West | Basin Fill and Sedimentary Rock (Muddy Creek Formation) | --- | 650 (53 wells) | >30 | 1.7 (to 1,200 feet) | 6 | 1991 | 65 |
| ***Lower Colorado River Planning Area*** | | | | | | | | | | |
| Butler Valley | 288 | West | Basin Fill | 1,590 (5 wells) | 2,200 (17 wells) | <1 to 1.1 | 2 (to 1,200 feet) to 20 (to 1,000 feet) | 13 | 2004 | 24 |
| Gila Bend | 1,284 | | Basin Fill | 2,221 (107 wells) | 2,700 (242 wells) | 10 to 37 | 17 to 61 (to 1,200 feet) | 31 | 2008 | 241 |
| Harquahala | 766 | | Basin Fill | 1,614 (84 wells) | 1,620 (157 wells) | <1 to <1.2 | 13 to 27 (to 1,200 feet) | 34 | 2004 | 115 |
| Lower Gila | 7,309 | | Recent Stream Alluvium and Basin Fill | 1,824 (56 wells) | 1,600 (597 wells) | >9 to 88 | 100 (to 1,200 feet) to 246 | 33 | 1992 | 589 |
| McMullen Valley | 649 | | Basin Fill | 1,132 (90 wells) | 1,500 (167 wells) | 1 | 14 to 15.1 (to 1,200 feet) | 25 | 2004 | 118 |
| Parker | 2,229 | Colorado River | Recent Stream Alluvium and Sedimentary Rock (Bouse Formation) | --- | 100 (75 wells) | 241 | 14 to 24 (to 1,200 feet) | 6 | 1995-97 | 348 |
| Ranegras Plain | 912 | West | Basin Fill | 1,994 (14 wells) | 1,150 (68 wells) | <1 to 6.1 | 9 to 27 (to 1,200 feet) | 19 | 2004 | 124 |
| San Simon Wash | 2,284 | | Basin Fill | --- | --- | 11 | 6.7 to 45 (1,200 feet) | 0 | NA | NA |
| Tiger Wash | 74 | | Basin Fill | --- | --- | <1 | 0.7 to 2 (to 1,200 feet) | 2 | 2004 | 5 |
| Western Mexican Drainage | 610 | | Basin Fill | --- | 50 (3 wells) | 1 | 3 to 4.1 (to 1,200 feet) | 1 | 2004 | 6 |
| Yuma | 792 | Colorado River | Basin Fill | 5,098 (3 wells) | 2,456 (327 wells) | 213 | 34 to 49 (to 1,200 feet) | 11 | 1992 | 587 |
| ***Active Management Areas*** | | | | | | | | | | |
| Phoenix [7] | 5,646 | Central | Recent Alluvium, Basin Fill with and without interbedded basalt, and Sedimentary Rock (conglomerate) | 1,470 (2,354 wells) | 1,280 (2,397 wells) | 24.1 | 80.4 (to 1,000 feet) | 442 | 2009 | 795 |
| Pinal [8] | 4,000 | | Recent Stream Alluvium and Basin Fill | 1,010 (1,342 wells) | 1,000 (1,582 wells) | 82.8 | 35.2 (to 1,000 feet) | 163 | 2007 | 1,066 |
| Prescott | 485 | Highland | Basin Fill and Igneous and Metamorphic Rock | 644 (137 wells) | 763 (78 wells) | 7 | 3 (to 1,000 feet) | 93 | 2009 | 103 |
| Santa Cruz | 716 | Central | Recent Stream Alluvium and Basin Fill | 628 (97 wells) | 800 (115 wells) | 61.1 | 0.16 | 52 | 2005 | 186 |
| Tucson | 3,866 | | Recent Stream Alluvium and Basin Fill (Fort Lowell Formation and Tinaja Beds) | 630 (879 wells) | 520 (1,063 wells) | 60.8 | 61 to 70 | 137 | 2005 | 1,065 |

**Notes:**
NA = Not Available
[1] See Table 1-3 for generalized hydrogeologic characteristics of basin categories and response to well development.
[2] Primarily from ADWR (1994b). See 'Groundwater Hydrology' section in overview of Atlas Volumes 2 through 8 for additional information and sources on major aquifers.
[3] Measured well yields from ADWR's GWSI and reported well yields from Wells55 for large (>10-inch) diameter registered wells.
[4] See basin groundwater data tables in Atlas Volumes 2 through 8 for recharge and storage estimate data sources. Data sources for AMA storage estimates described in overview of Atlas Volume 8 (Section 8.0.2).
[5] Current as of 2008.
[6] In 2007, water levels in 338 wells were measured in a sweep of the San Simon Valley Sub-basin of the Safford Basin.
[7] Storage estimates do not include Carefree, Fountain Hills, Lake Pleasant and Rainbow Valley sub-basins.
[8] Storage estimates do not include Aguirre Valley and Santa Rosa sub-basins.



**Well Yields**

- Greater than 2000 gals/min
- Between 1000 and 2000 gals/min
- Between 500 and 1000 gals/min
- Between 100 and 500 gals/min
- Less than 100 gals/min

- Consolidated Crystalline & Sedimentary Rocks
- Unconsolidated Sediments
- Planning Area Boundary

Note: Larger well yield shown where 2 or more wells at the same location.

**Figure 1-4**
**Measured Well Yields in Arizona**

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Source: ADWR GWSI database

The planning area volumes contain a groundwater hydrology summary in the overview section and water level and well yield maps and water level hydrographs for each groundwater basin in the planning area.

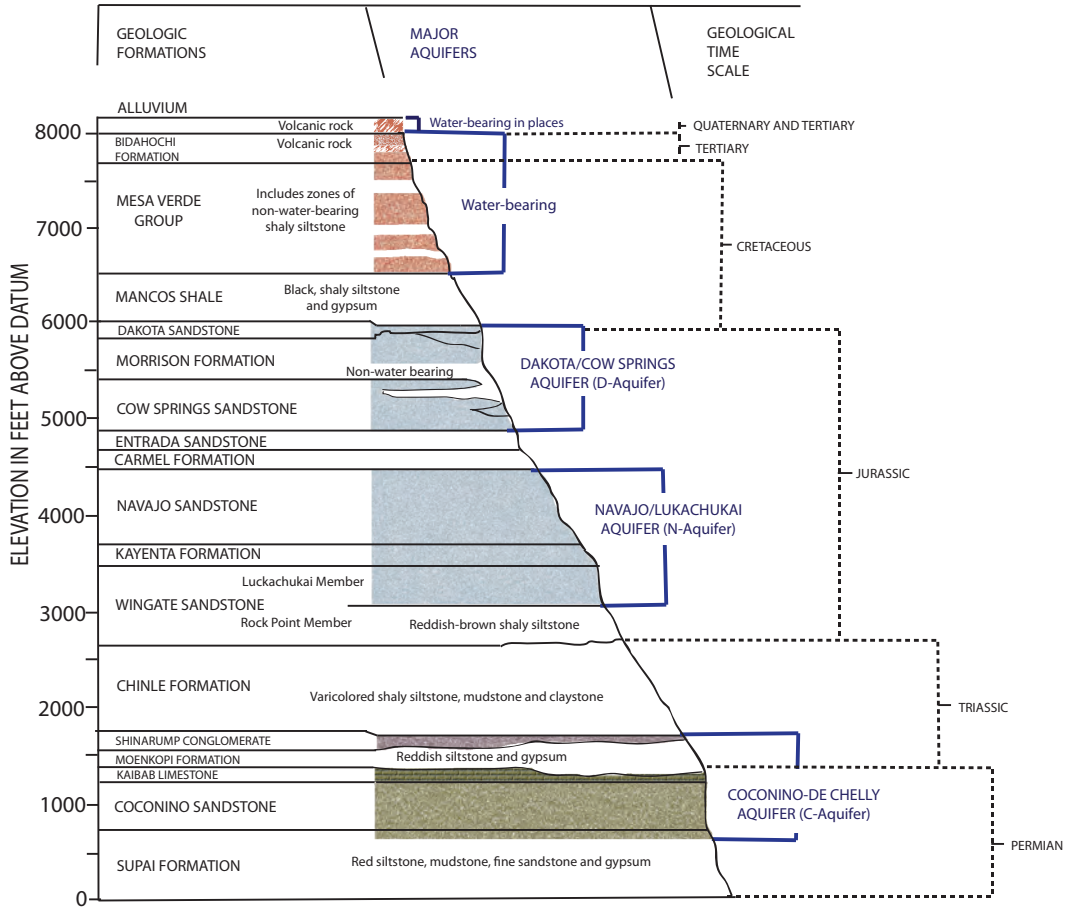
*Eastern Plateau*

A significant portion of the Eastern Plateau Planning Area is underlain by Mesozoic to Paleozoic sedimentary and volcanic rocks that form the area's regional aquifers (Figure 1-3). The sedimentary rocks include sequences of sandstones and limestones generally separated by low permeability shales and siltstones. The three largest regional aquifers are the C-, D-, and N-aquifers but several local aquifers are also important water sources. Figure 1-5 shows a generalized cross-section of most of the planning area's water-bearing formations. Major groundwater recharge areas are located along the planning area's southern and eastern boundary. Discharge from the regional aquifers is primarily to springs and baseflow to streams. Groundwater in storage for the Little Colorado River Plateau basin aquifers is estimated to exceed 500 million acre-feet (maf) (ADWR, 1990).

*Southeastern Arizona*

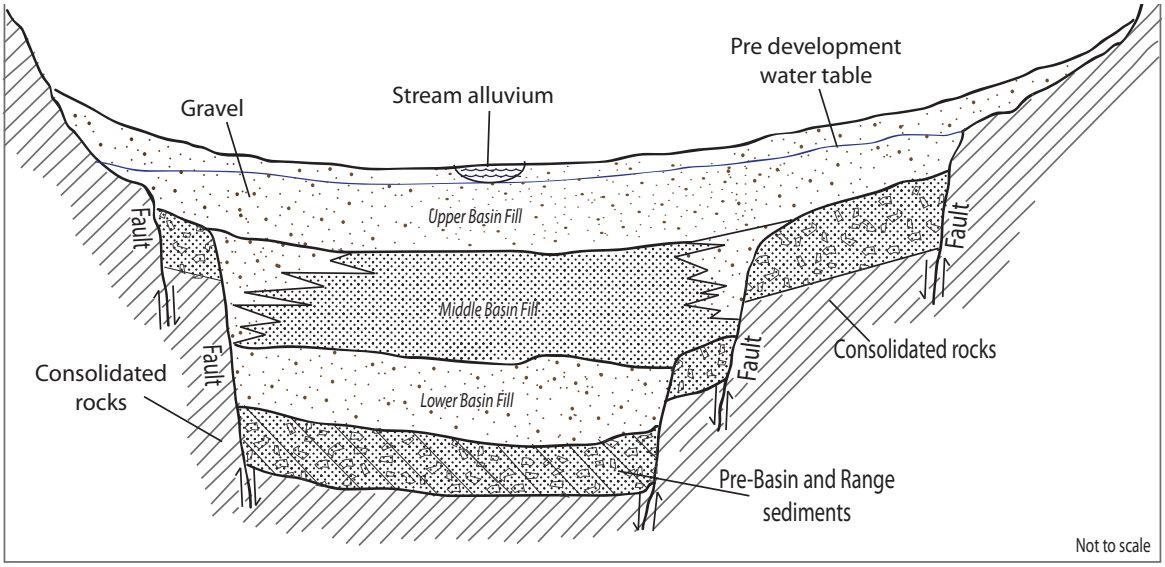
The Southeastern Arizona Planning Area is generally characterized by alluvial basins with relatively large reserves of groundwater in gently sloping valleys separated by mountain ranges (Figure 1-6). The principal water-bearing deposits in the southeast basins consist of moderately thick sediments which were deposited prior to, and during the formation of the Basin and Range province. Basin-fill sediments include fine-grained clays and silts to coarser-grained

**Figure 1-5 Generalized Cross-section of Water Bearing Formations in the Eastern Plateau Planning Area**




Source: ADWR, 1989

**Figure 1-6 Generalized Geologic Cross-Section for the Basin and Range Province**




Source: ADWR, 1993

sand and gravels. The major groundwater inflow components are mountain front recharge and stream infiltration and potentially underflow from adjacent basins. Groundwater outflow consists of evapotranspiration, pumpage, discharge to streams as baseflow and underflow to basins, including into Mexico. Estimates of the total groundwater in storage for the 14 groundwater basins that comprise the planning area range from about 150 to 250 maf.

*Upper Colorado River*

The Upper Colorado River Planning Area is characterized by semi-arid to arid alluvial basins with few perennial streams. As shown in Figure 1-3, there are extensive outcrops of sedimentary and volcanic rocks of varying ages throughout the planning area. Large areas of basin fill covered by alluvial and surficial deposits are found in the western part of the planning area, primarily in the west basins. Most basins are categorized as West or Colorado River basins (Table 1-4). Groundwater inflow from streambed infiltration during runoff events, and outflow to spring discharge and pumpage, is relatively small in the west basins of the planning area. In the Colorado River basins, groundwater inflow is from infiltration of Colorado River water and outflow is primarily from pumpage and evapotranspiration. Estimates of the total groundwater in storage for the nine groundwater basins that comprise the planning area range from about 30 to 100 maf.

*Central Highlands*

The Central Highlands Planning Area is characterized by a band of mountains consisting of igneous, metamorphic and sedimentary rocks (Figure 1-3). High elevations, steep topography, relatively high runoff and small water storage capabilities are unique to this planning area as compared to the alluvial basins located in the southern part of the State. Numerous springs occur where permeable water-bearing formations overlie lower permeability formations or bedrock (Figure 1-7). Alluvial and surficial deposits are relatively limited, occurring primarily in the western part of the planning area and along parts of the Verde and Salt river drainages. Groundwater inflow is from streambed infiltration, underflow and mountain front recharge. Outflow is primarily evapotranspiration, spring discharge and baseflow. Estimates of the total groundwater in storage for the five planning area basins range from about 25 to 50 maf.

*Western Plateau*

The Western Plateau Planning Area is characterized by relatively flat-lying, alternating sequences of sandstones, limestones and shales. As shown in Figure 1-3, Mesozoic to Paleozoic sedimentary and volcanic rocks cover most of the planning area. Faults and folds in these rocks affect groundwater movement along a regional gradient. The westernmost basins contain basin-fill sediments that consist of silt, sand and gravel. Groundwater data for the planning area is limited due to its relatively small population and associated lack of water development. Groundwater inflow is generally from mountain front recharge and baseflow and outflow is to spring discharge. Estimates of groundwater in storage for three of the six groundwater basins that comprise the Western Plateau Planning Area total about 6 maf.

*Lower Colorado River*

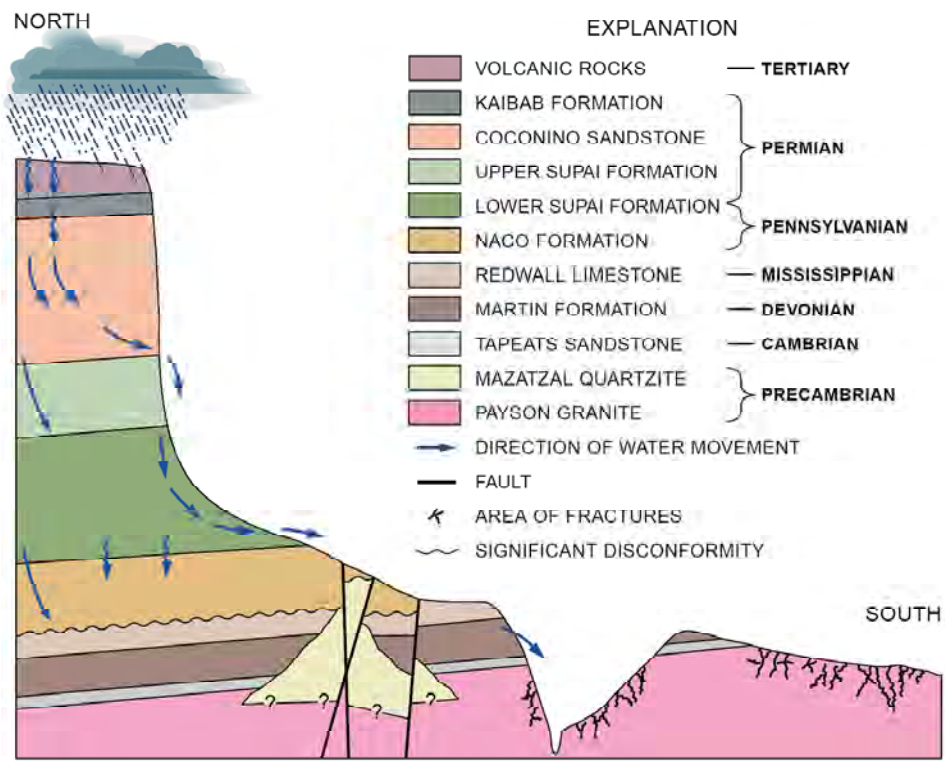
The groundwater basins of the Lower Colorado River Planning Area contain alluvial valleys with significant volumes of groundwater in storage. As shown in Figure 1-3, much of the basin is covered by Quaternary surficial deposits and Holocene to Tertiary alluvial deposits. The basin fill can have very productive water-bearing units. With the exception of infiltration of Colorado River water, and stream infiltration along the Gila River drainage, groundwater inflow is minimal due to the aridity of the area. Groundwater outflow is primarily due to well pumpage and evapotranspiration. Estimates of the total groundwater in storage for the nine groundwater basins that comprise the planning area range from about 200 to 520 maf.

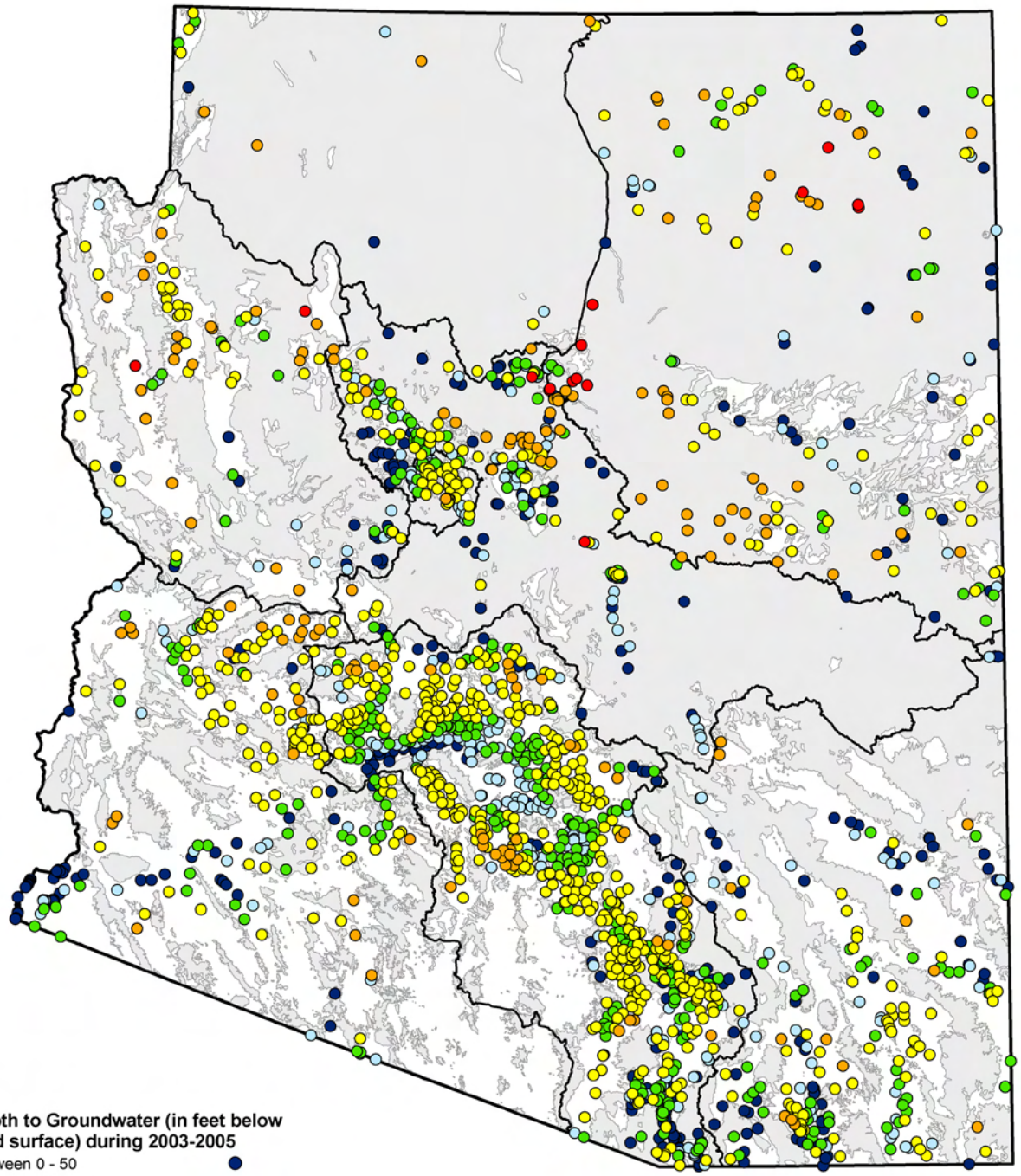
*Active Management Areas*

With the exception of the Prescott AMA, a large portion of the AMA Planning Area is located in the Basin and Range physiographic province. Basin-fill deposits are the principal water-bearing sediments in these basins. The basins are characterized by relatively small to moderate amounts of mountain-front recharge and streamflow infiltration while underflow in and out of the basins can be significant. Groundwater pumping is a large outflow component. The aquifer system of the Prescott AMA is composed of basin-fill deposits that include thick sequences of productive volcanic rocks. Natural recharge occurs via surrounding consolidated rock and from streamflow infiltration. The estimated groundwater in storage for the entire planning area (which does not include estimates for six sub-basins) ranges from 180 to 189 maf.

Water levels in wells, and changes in water levels over time, can vary substantially in the basins depending on well location and local hydrogeologic conditions. Detailed water level data for each basin are presented in the planning area volumes.

**Figure 1-7 Generalized Hydrologic Cross-Section from the Mogollon Rim to the Town of Payson**
(Source: Parker and Flynn, 2000)





**Depth to Groundwater (in feet below land surface) during 2003-2005**

- Between 0 - 50
- Between 50 - 100
- Between 100 - 200
- Between 200 - 500
- Between 500 - 1,000
- Greater than 1,000

Consolidated Crystalline & Sedimentary Rocks

Unconsolidated Sediments

Planning Area Boundary

Note: Deeper occurrence of groundwater shown where 2 or more wells at same general location.

**Figure 1-8**
**Recent Depths to Groundwater in Arizona**

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Source: ADWR and USGS GWSI databases

*Areas of significant groundwater level decline exist in the AMAs and within agricultural areas of the Southeastern Arizona Planning Areas.*

Depths to groundwater data across the state are displayed in Figure 1-8. As shown, water levels can be quite deep in the sedimentary rocks of the eastern plateau and relatively shallow along watercourses that drain the basins. Groundwater level changes across the state over an approximately ten-year period are shown on Figure 1-9. Significant groundwater level rises in some parts of the AMA Planning Area are primarily due to use of CAP water instead of groundwater and cessation of agricultural pumping. However, areas of significant groundwater level decline also exist in the AMAs and within agricultural areas of the Lower Colorado River and Southeastern Arizona planning areas.

Surface Water Hydrology

The U.S. Geological Survey (USGS) divides the United States into successively smaller hydrologic units based on surface hydrologic features. A 6-digit code corresponds to accounting units, which are used by the USGS for designing and managing the National Water Data Network. Figure 1-10 shows watersheds in Arizona at the accounting unit level as well as the location large reservoirs (>500 af or >50-acre surface area) and USGS streamflow gages. All or parts of 18 accounting unit watersheds are found in Arizona. Detailed information on these and other surface water features are found in the planning area volumes.

Streamflow data for major Arizona streams are listed in Table 1-5 and associated gage locations are mapped in Figure 1-11 along with the location of major (>20,000 acre-feet) reservoirs. The general location of intermittent and perennial streams and major springs (>10 gallon per minute [gpm] discharge rate) across Arizona are shown on Figure 1-12. More precise locations and data for these surface water features are included in planning area volumes of the Atlas.

*Eastern Plateau Planning Area*

Portions of five watersheds occur in this planning area. The largest are the Little Colorado River Watershed, which occupies the southern two-thirds of the planning area, and the Lower San Juan River Watershed drained primarily by Chinle Creek, which flows north to the San Juan River, a tributary to the Colorado River. The Little Colorado River was formerly perennial throughout its length but is now intermittent in many reaches. A number of perennial and intermittent streams occur at higher elevations in the Little Colorado River Watershed (Figure 1-12).

*Upper Little Colorado River, Eastern Plateau Planning Area. The Little Colorado River was formerly perennial throughout its length but is now intermittent in much of the middle and lower reaches.*

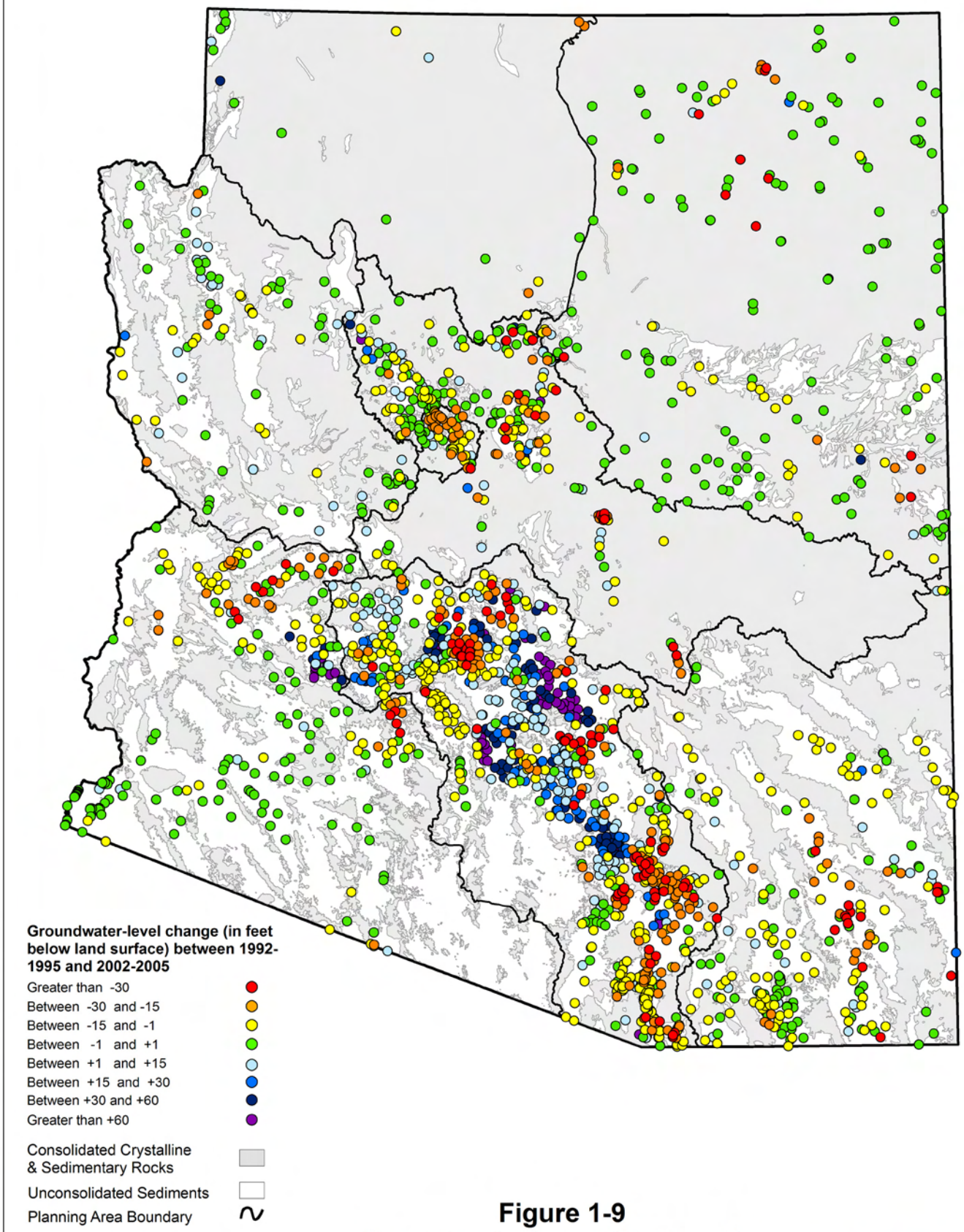
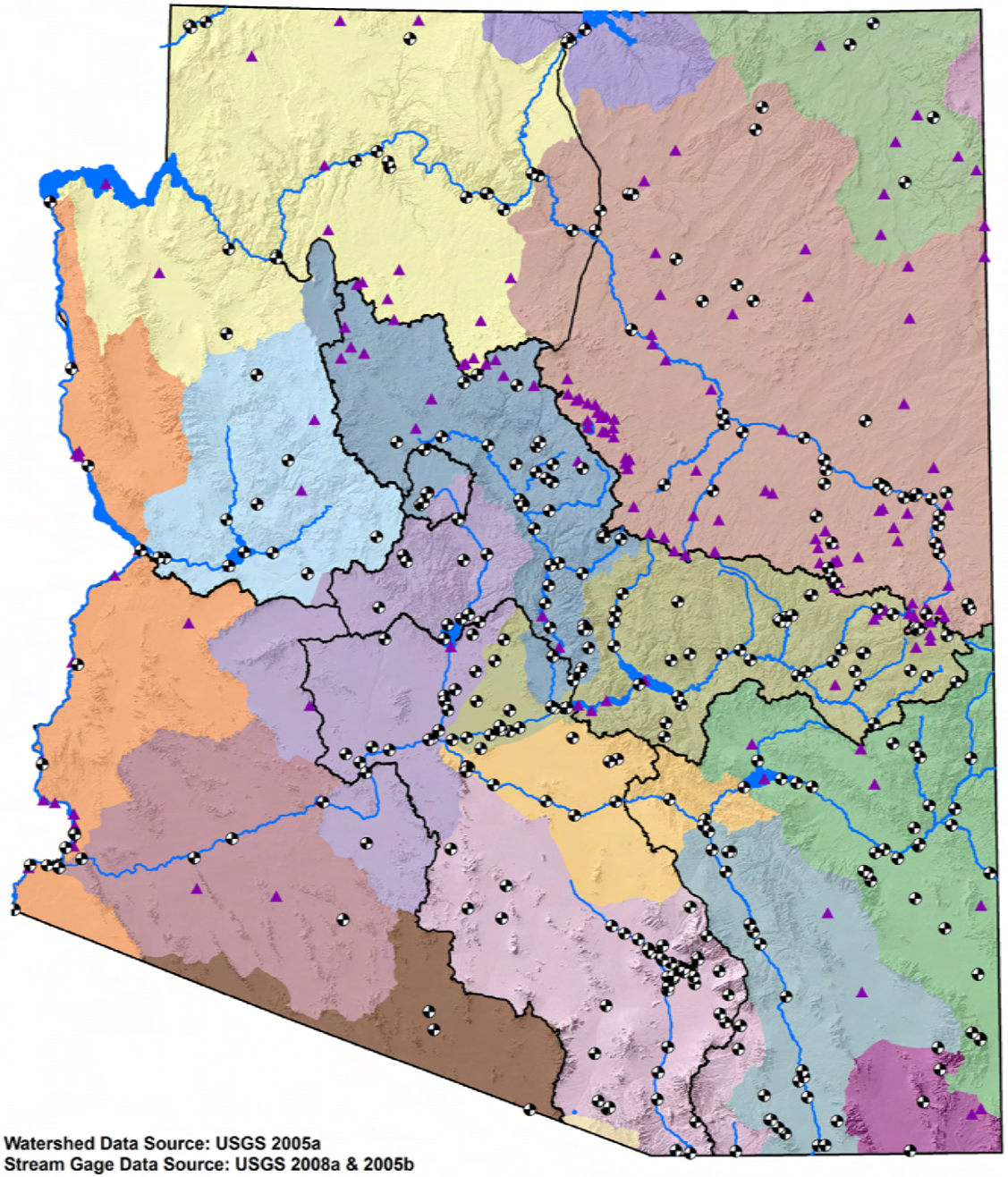



**Figure 1-9**
**Groundwater-Level Changes in Arizona between 1992-1995 and 2002-2005**



## Figure 1-10
## Arizona Watersheds, Large Reservoirs and USGS Streamflow gages

**6-Digit Hydrologic Unit Code (HUC) Watershed Boundaries**

- Upper CO River, Lake Powell Area - 140700
- Upper San Juan River - 140801
- Lower San Juan River - 140802
- Lower CO River, Lees Ferry to Lake Mead - 150100
- Little CO River - 150200
- Lower CO River below Lake Mead - 150301
- Bill Williams River - 150302
- Upper Gila River - 150400
- Middle Gila River - 150501
- San Pedro River - 150502
- Santa Cruz River - 150503
- Salt River - 150601
- Verde River - 150602
- Agua Fria River-Lower Gila River - 150701
- Lower Gila River below Painted Rock Dam - 150702
- Rio Sonoyta - 150801
- Rio Asuncion - 150802
- Rio Bavispe - 150803
- Large Reservoir (>500 af capacity or >50 acre surface area)
- USGS Streamflow Gage
- Stream Channel
- Planning Area Boundary

**Watershed Data Source: USGS 2005a**
**Stream Gage Data Source: USGS 2008a & 2005b**
**Reservoir Data Source: ADWR 2008a**

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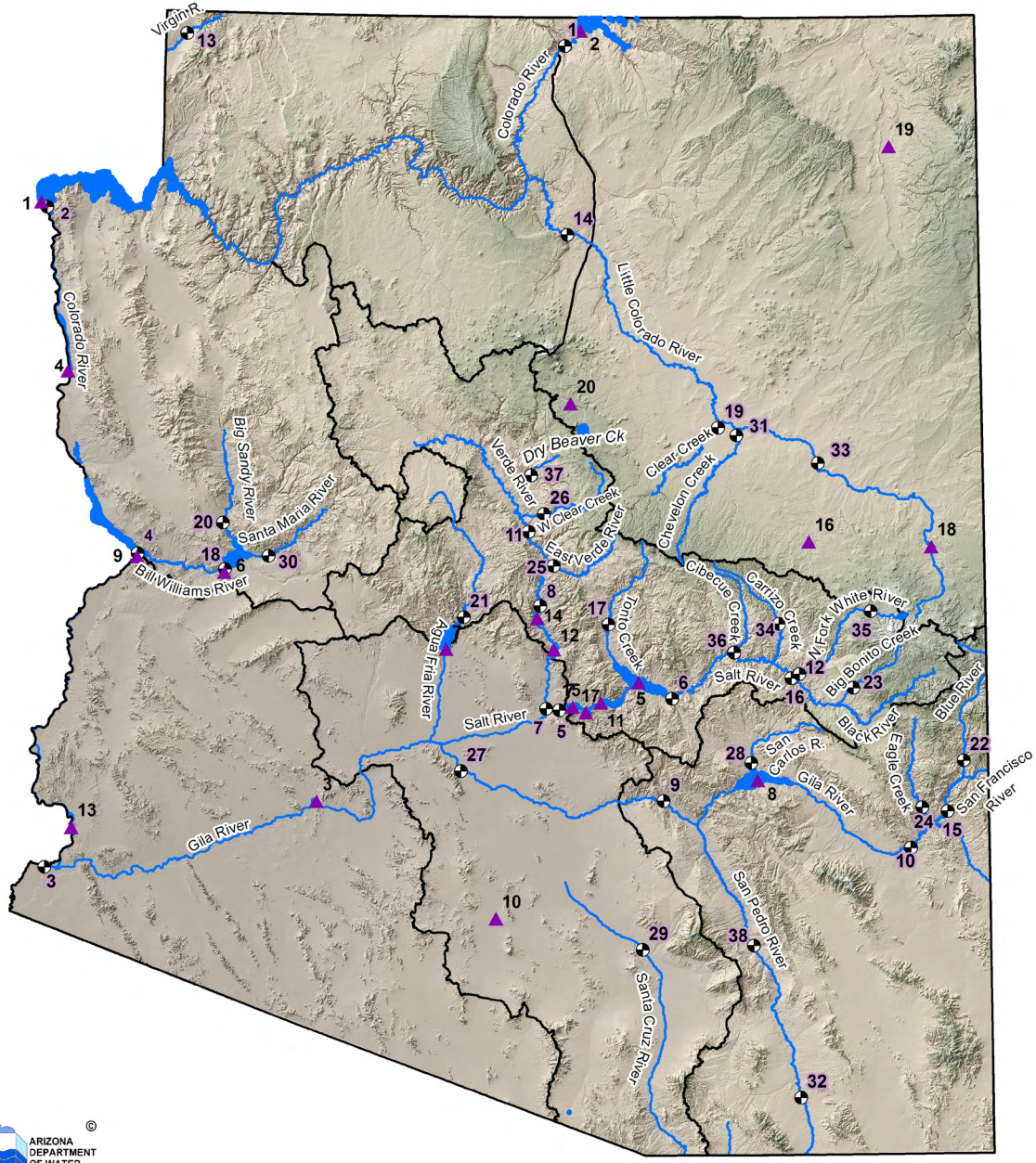


# Figure 1-11
# Major Streams and Reservoirs in Arizona

Major Stream
USGS Streamflow Gage (Table 1-5)
Major Reservoir
Planning Area Boundary

## Major (>20,000 af capacity) Reservoirs in Arizona

| Map Key | Reservoir/Lake Name | Dam name, if different | Max Storage (in 1000 af) |
|---|---|---|---|
| 1 | Lake Mead | Hoover Dam | 29,755 |
| 2 | Lake Powell | Glen Canyon Dam | 28,035 |
| 3 | Painted Rock Reservoir | | 4,832 |
| 4 | Lake Mohave | Davis Dam | 1,818 |
| 5 | Roosevelt Lake | | 1,653 |
| 6 | Alamo Reservoir | | 1,409 |
| 7 | Lake Pleasant | New Wadell Dam | 1,109 |
| 8 | San Carlos Reservoir | Coolidge Dam | 1,073 |
| 9 | Lake Havasu | Parker Dam | 651 |
| 10 | Lake Saint Clair | | 375 |
| 11 | Apache Lake | Horse Mesa Dam | 245 |
| 12 | Bartlett Reservoir | | 178 |
| 13 | Imperial Reservoir | | 160 |
| 14 | Horseshoe Reservoir | | 132 |
| 15 | Saguaro Lake | Stewart Mountain Dam | 69 |
| 16 | Schoens Lake | | 62 |
| 17 | Canyon Lake | Mormon Flat Dam | 58 |
| 18 | Lyman Lake | | 45 |
| 19 | Many Farms | | 33 |
| 20 | Upper Lake Mary | | 21 |

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**Stream Location Data Source: ALRIS, 2005**

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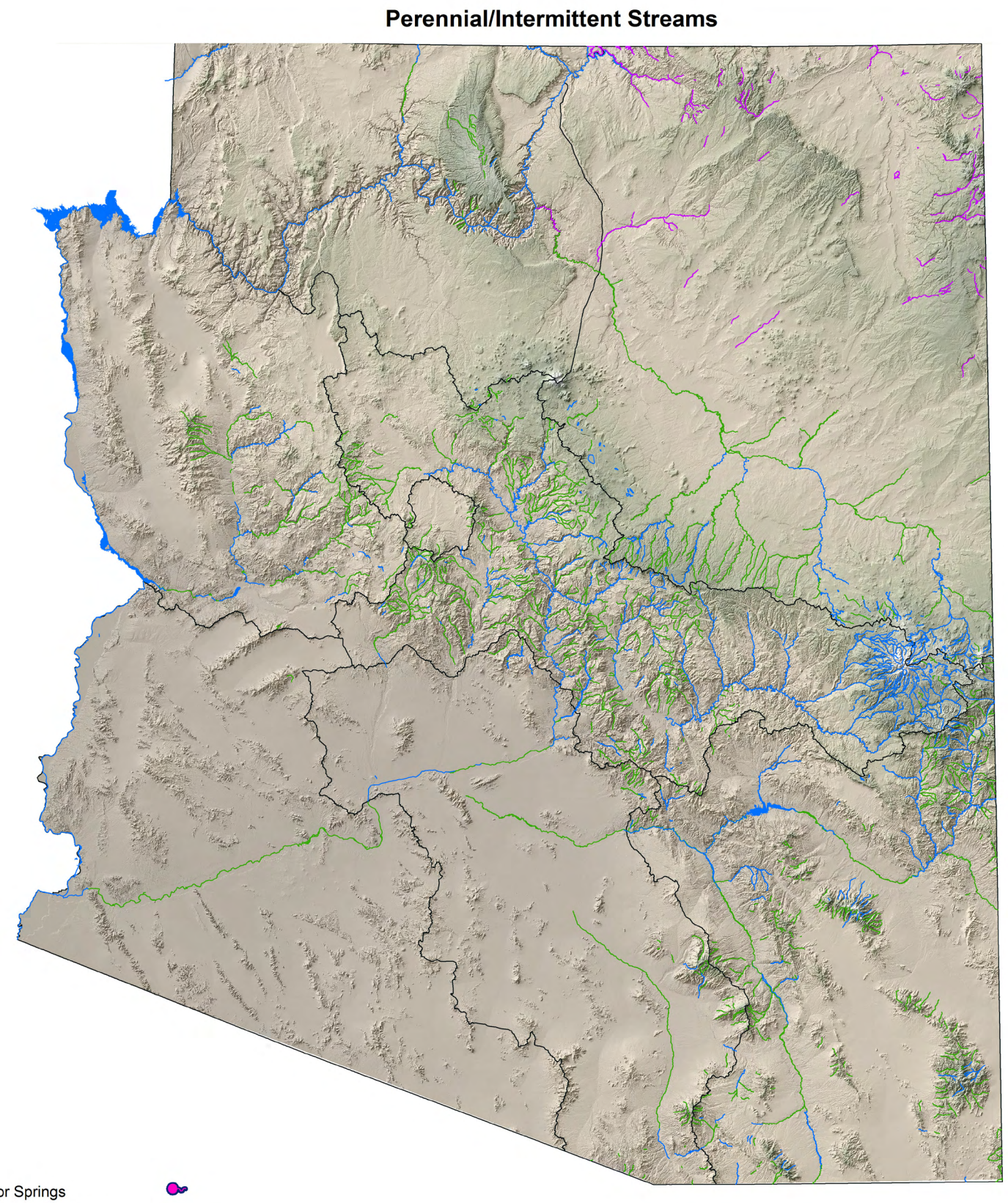
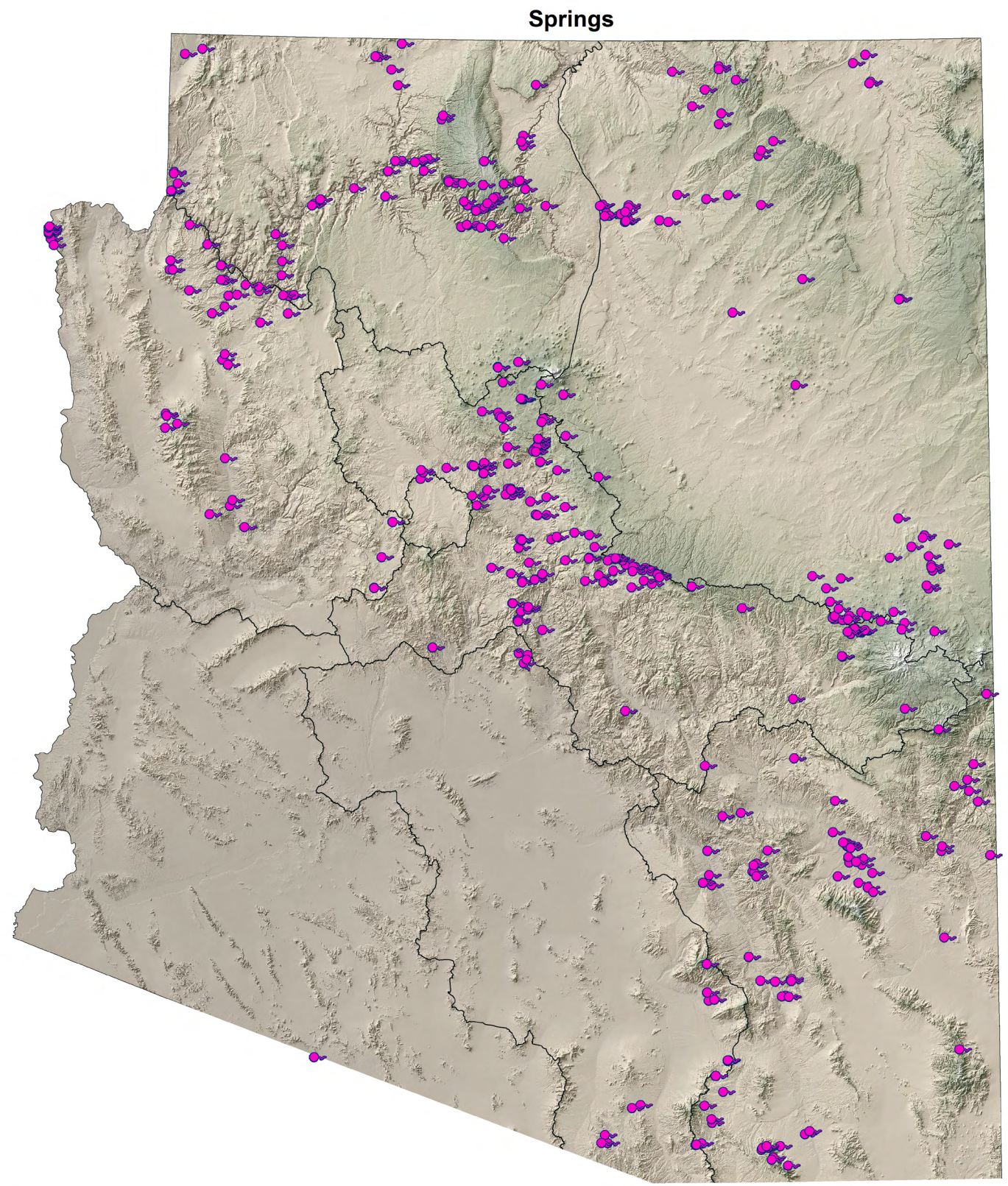
## Table 1-5 Flow characteristics of major Arizona streams[a]

| STREAM | USGS STATION | | | LOCATION | | | PERIOD OF RECORD | AVERAGE SEASONAL FLOW (% of annual flow)[d] | | | | ANNUAL FLOW/YEAR (in acre-feet)[e] | | | | YEARS OF ANNUAL FLOW RECORD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Name | Drainage Area (in mi²) | Map Key[b] | Basin | Planning Area | | Winter | Spring | Summer | Fall | Minimum | Median | Mean | Maximum | |
| Colorado River | 9380000 | at Lees Ferry | 111,800 | 1 | Little Colorado River Plateau | Eastern Plateau | 10/1921-current (real time) | 16 | 44 | 24 | 16 | 1,383,521 (1963) | 9,375,509 | 10,885,307 | 20,322,048 (1984) | 83 |
| Colorado River | 9421500 | below Hoover Dam | 171,700 | 2 | Lake Mohave | Upper Colorado River | 4/1934-current (real time) | 24 | 29 | 26 | 21 | 5,919,516 (1934) | 9,183,655 | 10,109,870 | 21,350,096 (1984) | 70 |
| Colorado River | 9521000 | at Yuma | 242,900 | 3 | Yuma | Lower Colorado River | 1/1904-11/1983 (discontinued) | 17 | 44 | 25 | 14 | 682,711 (1961) | 9,628,539 | 10,090,123 | 25,969,073 (1909) | 60 |
| Colorado River | 9427520 | below Parker Dam | 182,700 | 4 | Parker | Lower Colorado River | 11/1934-current (real time) | 23 | 28 | 28 | 20 | 5,534,256 (1993) | 7,229,140 | 8,918,956 | 20,409,560 (1984) | 61 |
| Salt River | 9502000 | below Stewart Mountain Dam | 6,232 | 5 | Phoenix AMA | Active Management Areas | 10/1934-current (real time) | 24 | 33 | 34 | 9 | 114,962 (2003) | 585,878 | 711,279 | 3,276,254 (1993) | 65 |
| Salt River | 9498500 | near Roosevelt | 4,306 | 6 | Salt River | Central Highlands | 1/1913-current (real time) | 41 | 31 | 13 | 15 | 152,798 (2002) | 518,499 | 644,942 | 2,422,315 (1916) | 89 |
| Verde River | 9511300 | near Scottsdale | 6,615 | 7 | Phoenix AMA | Active Management Areas | 3/1961-current (real time) | 45 | 22 | 15 | 18 | 96,980 (2002) | 298,074 | 454,965 | 1,794,415 (1993) | 44 |
| Verde River | 9508500 | below Tangle Creek above Horseshoe Dam | 5,858 | 8 | Verde River | Central Highlands | 8/1945-current (real time) | 51 | 17 | 11 | 20 | 131,073 (2002) | 294,733 | 409,875 | 1,583,014 (1993) | 57 |
| Gila River | 9474000 | at Kelvin | 18,011 | 9 | Lower San Pedro | Southeastern Arizona | 1/1911-current (real time) | 31 | 23 | 32 | 14 | 56,398 (1961) | 324,351 | 370,675 | 2,375,969 (1993) | 93 |
| Gila River | 9448500 | at head of Safford Valley near Solomon | 7,896 | 10 | Safford | Southeastern Arizona | 10/1920-current (real time) | 41 | 18 | 20 | 22 | 48,953 (1956) | 273,008 | 337,069 | 1,559,116 (1993) | 77 |
| Verde River | 9506000 | near Camp Verde | 5,009 | 11 | Verde River | Central Highlands | 4/1934-current (real time) | 59 | 17 | 11 | 14 | 99,934 (2002) | 222,679 | 299,621 | 990,650 (1993) | 24 |
| Black River | 9490500 | near Fort Apache | 1,232 | 12 | Salt River | Central Highlands | 11/1912-current (real time) | 42 | 35 | 9 | 15 | 45,188 (2002) | 233,904 | 280,932 | 818,301 (1993) | 45 |
| Virgin River | 9415000 | at Littlefield | 5,090 | 13 | Virgin | Western Plateau | 10/1929-current (real time) | 32 | 33 | 15 | 20 | 73,140 (1977) | 141,935 | 174,502 | 506,912 (1983) | 72 |
| Little Colorado River | 9402000 | near Cameron | 26,459 | 14 | Coconino Plateau | Western Plateau | 6/1947-current (real time) | 34 | 26 | 27 | 14 | 10,215 (2000) | 138,315 | 162,519 | 816,449 (1973) | 55 |
| San Francisco River | 9444500 | at Clifton | 2,766 | 15 | Morenci | Southeastern Arizona | 10/1910-current (real time) | 41 | 20 | 16 | 22 | 30,415 (1951) | 91,606 | 146,532 | 678,755 (1915) | 79 |
| White River | 9494000 | near Fort Apache | 632 | 16 | Salt River | Central Highlands | 10/1917-current (real time) | 28 | 48 | 12 | 12 | 27,446 (2002) | 149,177 | 144,517 | 345,424 (1993) | 45 |
| Tonto Creek | 9499000 | above Gun Creek near Roosevelt | 675 | 17 | Tonto Creek | Central Highlands | 12/1940-current (real time) | 61 | 12 | 8 | 19 | 2,853 (2002) | 66,297 | 113,232 | 469,256 (1978) | 62 |
| Bill Williams River | 9426000 | below Alamo Dam | 4,633 | 18 | Bill Williams | Upper Colorado River | 10/1939-current (real time) | 54 | 16 | 16 | 14 | 1,275 (1975) | 33,963 | 82,317 | 701,711 (1993) | 63 |
| Clear Creek | 9399000 | near Winslow | 621 | 19 | Little Colorado River Plateau | Eastern Plateau | 6/1906-9/2007 (discontinued) | 39 | 49 | 2 | 9 | 3,852 (1967) | 46,697 | 60,719 | 183,890 (1978) | 51 |
| Big Sandy River | 9424450 | near Wikieup | 2,742 | 20 | Bill Williams | Upper Colorado River | 3/1966-current (real time) | 80 | 5 | 4 | 10 | 2,448 (2002) | 27,011 | 58,901 | 421,461 (1993) | 36 |
| Agua Fria River | 9512800 | near Rock Springs | 1,111 | 21 | Agua Fria | Central Highlands | 1/1970-current (real time) | 75 | 7 | 7 | 11 | 1,528 (1975) | 19,692 | 57,664 | 360,541 (1992) | 31 |
| Blue River | 9444200 | near Clifton | 506 | 22 | Morenci | Southeastern Arizona | 11/1967-current (real time) | 39 | 22 | 14 | 25 | 9,487 (2002) | 38,091 | 50,373 | 176,695 (1983) | 30 |
| Big Bonito Creek | 9489700 | near Fort Apache | 119 | 23 | Salt River | Central Highlands | 10/1957-9/1981 (discontinued) | 29 | 49 | 11 | 12 | 13,828 (1961) | 41,267 | 49,530 | 102,805 (1979) | 23 |
| Eagle Creek | 9447000 | above pumping plant near Morenci | 622 | 24 | Morenci | Southeastern Arizona | 4/1944-current (real time) | 49 | 14 | 15 | 22 | 12,311 (1953) | 34,398 | 48,850 | 405,530 (1993) | 58 |
| East Verde River | 9507980 | near Childs | 331 | 25 | Verde River | Central Highlands | 9/1961-current (real time) | 59 | 16 | 10 | 15 | 1,499 (2002) | 34,036 | 46,674 | 208,558 (1993) | 38 |
| West Clear Creek | 9505800 | near Camp Verde | 241 | 26 | Verde River | Central Highlands | 12/1964-current (real time) | 54 | 20 | 8 | 18 | 11,152 (2002) | 34,542 | 45,858 | 133,245 (1993) | 38 |
| Gila River | 9479500 | near Laveen | 20,615 | 27 | Pinal AMA | Active Management Areas | 1/1940-9/1994 (discontinued) | 67 | 6 | 13 | 15 | 0 (1969) | 9,420 | 45,227 | 1,189,109 (1993) | 52 |
| San Carlos River | 9468500 | near Peridot | 1,026 | 28 | Safford | Southeastern Arizona | 4/1914-current (real time) | 61 | 5 | 13 | 21 | 4,070 (2002) | 28,677 | 43,480 | 296,181 (1993) | 73 |
| Santa Cruz River | 9486500 | at Cortaro | 3,503 | 29 | Tucson AMA | Active Management Areas | 10/1939-current (real time) | 27 | 10 | 39 | 24 | 1,706 (1956) | 38,655 | 41,897 | 182,136 (1993) | 53 |
| Santa Maria River | 9424900 | near Bagdad | 1,129 | 30 | Bill Williams | Upper Colorado River | 4/1966-current (real time) | 74 | 6 | 5 | 15 | 0 (1996, 2002) | 15,063 | 40,551 | 168,005 (1980) | 32 |
| Chevelon Creek | 9398000 | near Winslow | 785 | 31 | Little Colorado River Plateau | Eastern Plateau | 1/1906-12/2006 (discontinued) | 49 | 33 | 6 | 11 | 10,715 (1956) | 32,651 | 38,756 | 99,909 (1952) | 44 |
| San Pedro River | 9471000 | at Charleston | 1,234 | 32 | Upper San Pedro | Southeastern Arizona | 3/1904-current (real time) | 14 | 5 | 65 | 16 | 6,778 (2002) | 33,203 | 38,636 | 152,798 (1914) | 84 |
| Little Colorado River | 9394500 | at Woodruff | 8,072 | 33 | Little Colorado River Plateau | Eastern Plateau | 3/1905-current (real time) | 27 | 12 | 46 | 15 | 5,524 (2000) | 26,860 | 35,839 | 165,791 (1919) | 74 |
| Carrizo Creek | 9496500 | near Show Low | 439 | 34 | Salt River | Central Highlands | 6/1951-current (real time) | 28 | 49 | 10 | 13 | 3,758 (1956) | 22,232 | 35,030 | 124,556 (1993) | 41 |
| North Fork White River | 9491000 | near McNary | 78 | 35 | Salt River | Central Highlands | 6/1945-9/1985 (discontinued) | 15 | 57 | 16 | 13 | 12,673 (1951) | 32,442 | 34,855 | 73,140 (1983) | 31 |
| Cibecue Creek | 9497800 | near Chrysotile | 295 | 36 | Salt River | Central Highlands | 5/1959-current (real time) | 45 | 17 | 18 | 21 | 10,066 (1961) | 23,535 | 32,597 | 128,176 (1993) | 43 |
| Dry Beaver Creek | 9505350 | near Rimrock | 142 | 37 | Verde River | Central Highlands | 10/1960-current (real time) | 61 | 21 | 3 | 15 | 253 (1996) | 21,978 | 31,271 | 105,727 (1978) | 42 |
| San Pedro River | 9472000 | near Redington | 2,927 | 38 | Lower San Pedro | Southeastern Arizona | 6/1943-9/1995 (discontinued) | 19 | 2 | 64 | 16 | 297 (1997) | 21,399 | 31,033 | 131,073 (1955) | 50 |

Sources: USGS 2008a & 2005b

**Notes:**
[a] Streams considered major if calculated median or mean annual flows exceed 20,000 and 30,000 acre-feet, respectively.
[b] Representative stations, listed in order of largest mean flows. See Figure 1-11. Other stations exist on some streams, but are not included here.
[c] Period of record current as of November 2008; all other data retrieved from USGS in 2005 or 2007 (AMAs only).
[d] Seasonal flows based on average monthly values and may not sum to 100% due to rounding.
[e] Annual flows are for calendar years and only listed if stations have at least 20 complete years of record.




Major Springs
Intermittent Streams
Perennial Streams
Intermittent or Perennial Streams
Planning Area Boundary

**Figure 1-12**
**Perennial/Intermittent Streams and Major (>10 gpm) Springs in Arizona**

ARIZONA DEPARTMENT OF WATER RESOURCES ©

**Stream Data Source: AZGF, 1993 and 1997; Brown and others, 1981; Cooley and others, 1969; Hack, 1942; Gregory, 1916**
**Spring Data Source: ADWR, 2008b**

*Lake Powell, Eastern Plateau Planning Area. Recent storage volumes in Lake Powell are much below average due to drought and continued releases of water for downstream storage and use.*

The Colorado River forms the extreme northwestern boundary of the planning area with a mean flow of 10.9 maf measured at a gage at Lees Ferry below Glen Canyon Dam (Table 1-5, Figure 1-11). Changes in reservoir storage in Lake Powell, much of which is located in Utah, are shown on Figure 1-13. As shown, recent storage volumes are much below average due to drought and continued releases of water for downstream storage and use. Ninety-three other large reservoirs are located in the planning area.

Seventy-seven major springs have been identified in the planning area, primarily clustered near Tuba City, in the vicinity of Pinetop-Lakeside and in the Saint Johns-Concho area. The largest is Silver Spring northeast of Show Low with a measured discharge of over 3,600 gpm.

*Southeastern Arizona Planning Area*

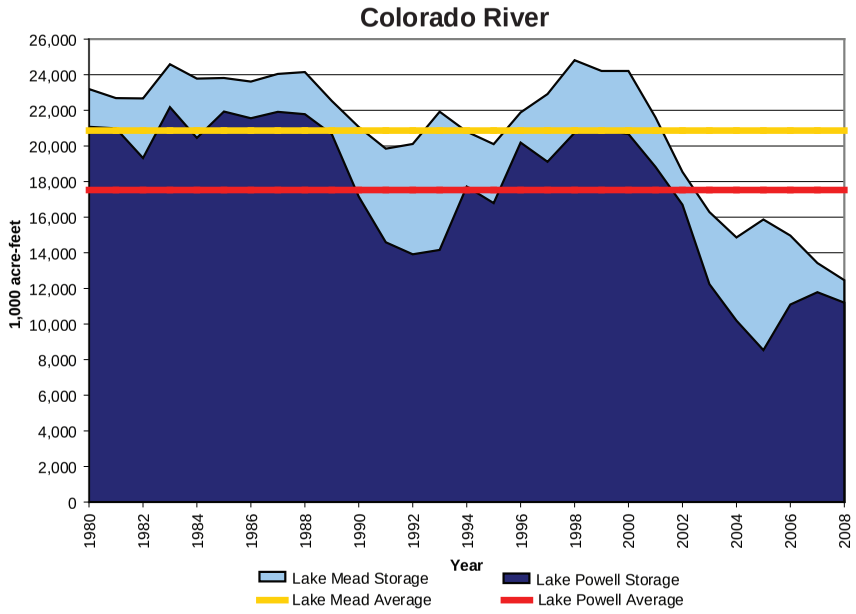
Portions of five watersheds are found in the Southeastern Arizona Planning Area. Major drainages are the Gila River and its major tributary in the planning area, the San Pedro River. The Gila River is perennial from the New Mexico border to the Safford Valley but becomes intermittent east of Safford due to irrigation diversions and seasonal flow variations. Gila River flows are impounded in San Carlos Reservoir behind Coolidge Dam at the boundary of the Middle Gila and Upper Gila watersheds. Reservoir releases maintain an average of about 260,000 acre-feet per year (AFA) of flow in the Gila River below the dam. Portions of the San Pedro River and other watercourses are perennial (Figure 1-12). The Rio de Bavispe Watershed in the southeast part of the planning area drains south into Mexico. A portion of the Santa Cruz Watershed including the headwaters of the Santa Cruz River is found in the southwest corner of the planning area. The Santa Cruz River flows southward into Mexico before turning north and reentering the U.S. east of Nogales, Arizona in the Santa Cruz AMA.

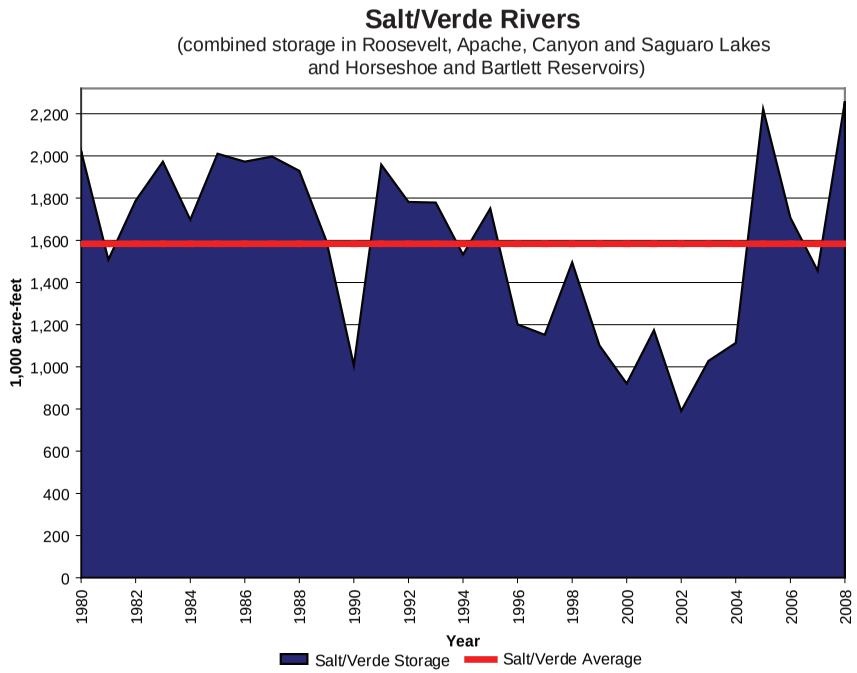
There are 21 active streamgages in the planning area; the highest mean flow, 370,675 AFA, was measured at a gage on the Gila River at Kelvin, located below the confluence with the San Pedro River (Table 1-5). Storage volumes in San Carlos Reservoir are shown in Figure 1-13 and indicate wide fluctuations during the 1980-2008 time period. There are 21 other large reservoirs in the planning area, with 12 located in the Safford Basin.

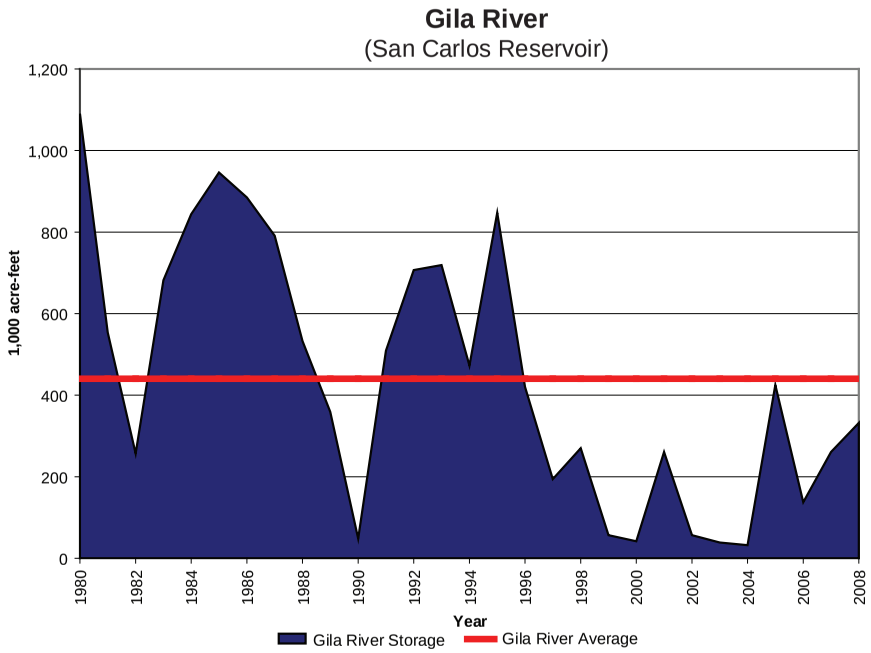
The largest of the 69 major springs in the planning area is Warm Springs, located at the headwaters of the San Carlos River, with a measured discharge of almost 3,400 gpm. A number of

*Gila River, Southeastern Arizona Planning Area. The Gila River is perennial from the New Mexico border to the Safford Valley.*

## Figure 1-13 May 1st Reservoir Storage on the Colorado, Gila and Salt/Verde Rivers on May 1st, 1980-2008




Data sources: BOR 2010a, SRP 2008 and Gila Commisioner (various dates)

*Bill Williams River, Upper Colorado River Planning Area. With the exception of the Bill Williams River, the major tributaries to the Colorado River in the planning area are ephemeral and contribute little to its flow.*

large springs also occur downstream of the Town of Pima near the Gila River.

*Upper Colorado River Planning Area*

The Bill Williams Watershed as well as portions of four others occur in the Upper Colorado River Planning Area. With the exception of the Bill Williams River, the major tributaries to the Colorado River in the planning area are ephemeral and contribute little to its flow. Lake Mead, created by Hoover Dam, and the reservoirs impounded by Parker and Davis dams further downstream, store large volumes of Colorado River water for downstream users (Figure 1-11). There are six other large reservoirs in the planning area. Historic storage volumes in Lake Mead are shown in Figure 1-13.

The Bill Williams Watershed is drained by the Bill Williams River and its major tributaries, the Big Sandy and Santa Maria rivers and by Burro Creek. A number of perennial and intermittent streams exist in the watershed (Figure 1-12). Construction of Alamo Dam on the Bill Williams River in 1968 significantly impacted streamflow below the dam, which historically had produced some of the largest floods in Arizona history (Webb and others, 2007). Mean annual streamflow at gages along the Colorado River exceed 10 maf and are controlled by releases from dams. Other than these controlled releases, the largest mean annual flow (over 82,000 acre-feet) in the planning area was recorded at a gage on the Bill Williams River located below Alamo Dam (Table 1-5).

There are 61 major springs in the planning area including several located below Hoover Dam and others in the vicinity of Kingman. The largest is Spencer, located in north-central Peach Springs Basin with a measured discharge of 1,730 gpm.

*Central Highlands Planning Area*

Included in the Central Highlands Planning Area are portions of three watersheds: the Agua Fria-Lower Gila River, Salt and Verde. The Salt and Verde watersheds are the major water producing watersheds in the state. The Agua Fria-Lower Gila River Watershed is drained by the Agua Fria and Hassayampa rivers, neither of which are perennial throughout their lengths.

*Oak Creek, Central Highlands Planning Area*

The Salt River Watershed is drained by the Salt River and its many tributaries including Tonto Creek. The Salt River originates in the high elevations of the White Mountains and is perennial throughout the planning area. There are numerous perennial streams particularly in the high elevation eastern portion of the Watershed including the Black and White rivers (Figure 1-12). The Salt River is impounded behind four dams in its lower reaches – Roosevelt, Horse Mesa, Mormon Flat and Stewart Mountain, which provide water supply storage and flood control for the Phoenix metropolitan area.

The Verde River Watershed is drained by the Verde River, which is perennial throughout its length. Almost all the major perennial tributaries to the Verde River drain areas to its north and east and include Oak Creek, West Clear Creek, and the East Verde River. The Verde River is impounded in its lower reach behind Bartlett and Horseshoe dams, which store water for use in the Phoenix area. Changes in the combined storage volume of the Salt and Verde reservoirs are shown in Figure 1-13, which illustrate the effects of prolonged drought from the late-1990s through the mid-2000s. There are another 19 large reservoirs in the planning area including Lake Pleasant, which stores primarily CAP water for use in the CAP service area of Maricopa, Pima and Pinal counties (Appendix C).

Over ten streamflow gages in the planning area report annual mean flows in excess of 30,000 acre-feet (Table 1-5). The largest flow in the planning area was measured on the Salt River near Roosevelt with an average mean flow of over 644,900 acre-feet. There are 143 major springs in the planning area (Figure 1-12), primarily located along upper and lower Oak Creek, south of Camp Verde, below the Mogollon Rim north of Payson and near McNary. The highest measured discharge rate is 21,647 gpm at Fossil Creek Springs in the Tonto Creek Basin.

*Virgin River, Western Plateau Planning Area. Average annual flow on the Virgin River measured at the Littlefield gage is about 174,500 AFA.*

*Western Plateau Planning Area*

Portions of three watersheds occur in this planning area: Upper Colorado River-Lake Powell; Little Colorado River; and Lower Colorado River, Lees Ferry to Lake Mead. The Colorado and Little Colorado rivers are the major drainages in the area. Perennial streams include the Colorado River, Virgin River, a 13-mile stretch of the Little Colorado River below Blue Springs, the Paria River, and Havasu and Diamond creeks.

Flow in the Colorado River downstream from Lake Powell is controlled by releases from Glen Canyon Dam, which has significantly impacted flow volumes and historic seasonal variations in flow. Prior to construction of Glen Canyon Dam, flow in the Colorado was highly unpredictable with wide year-to-year variability and spring flooding. This is reflected in seasonal flow records at the gage at Lees Ferry (Table 1-5). Average annual flow on the Virgin River measured at the Littlefield gage is about 174,500 AFA, and about 162,500 AFA on the Little Colorado River near Cameron (Table 1-5). In addition to Lake Powell and the easternmost part of Lake Mead, there are 16 large reservoirs, most located in the Coconino Plateau Basin.

Seventy-eight major springs have been identified in the planning area. The largest by far is the Blue Springs area with an estimated discharge of over 101,000 gpm. A number of major

*Colorado River, Lower Colorado River Planning Area*

springs issue from limestones and sandstones in the vicinity of the Colorado River including Havasu Springs (28,500 gpm) and Tapeats Spring (18,700 gpm). Estimated discharge from the Littlefield Springs along the Virgin River is 8,980 to 22,400 gpm. A group of major springs with discharge rates between 11 and 90 gpm are also found in the north-central part of the Kanab Plateau Basin.

*Lower Colorado River Planning Area*

The entire Lower Gila River below Painted Rock Dam Watershed and the Rio Sonoyta Watershed (in the U.S.) and portions of the Lower Colorado River below Lake Mead and Agua Fria River-Lower Gila River watersheds are found in the planning area. Major surface water drainages are the Colorado River, Gila River, San Cristobal Wash, Centennial Wash and San Simon Wash, which flows south to the Rio Sonoyta in Mexico. The area is extremely arid and the Colorado River is the only perennial stream. Drainages to the Colorado River are ephemeral and contribute little to flow with the exception of the Gila River during flood events. This section of the Gila River flows only in response to precipitation events, irrigation return flow or releases from upstream dams. In the planning area it is impounded behind Painted Rock Dam, primarily a flood control structure that is normally dry. Dams on the Colorado River in the planning area include Imperial, Laguna and Morelos. In total, there are 15 large reservoirs in the planning area. Dam construction and diversions, including major diversions from Imperial Dam to California and Arizona, have fundamentally altered the character and the volume of flow in the Colorado River. The United States is obligated by treaty to allow 1.5 maf of water to flow annually to Mexico from the Colorado River (Appendix D).

Average seasonal and annual flows at two Colorado River gages in the planning area are listed in Table 1-5. Mean annual flow at the Yuma gage is over 10 maf. Major and minor (1-10 gpm) springs only occur in the Rio Sonoyta Watershed in the Western Mexican Drainage Basin. The only major spring, Quitobaquito Springs, has a combined discharge of 28 gpm.

*Active Management Area Planning Area*

The AMA planning area encompasses portions of six watersheds. From north to south they are: the Verde River, the Agua Fria River-Lower Gila River, the Salt River, the Middle Gila River, the Santa Cruz River and the Rio Asuncion.

The Verde River Watershed is drained by the Verde River, which is perennial and joins the Salt River below Stewart Mountain Dam. The Agua Fria River-Lower Gila River is drained by the largely ephemeral Agua Fria River and Hassayampa rivers and the Gila River. The Agua

*Salt River, AMA Planning Area.*

Fria River is impounded by New Waddell Dam at the northern boundary of the Phoenix AMA and only flows below the dam when water is released during major flood events. The Gila River enters the Pinal AMA, flows through the Middle Gila Watershed and becomes part of the Agua Fria River – Lower Gila River Watershed below its confluence with the Salt River. The Gila River is now primarily ephemeral due to upstream diversions except the reach downstream of the confluence of the Salt River where discharge from the City of Phoenix 23rd and 91st Avenue wastewater treatment plants and return flow from agricultural areas maintains perennial flow in both the Gila and Salt rivers. Upstream of the treatment plants, the Salt River, which drains the Salt River Watershed, is ephemeral below Granite Reef Diversion Dam.

A large portion of the AMA Planning Area falls within the Santa Cruz River Watershed, drained by the Santa Cruz River, which flows north from Mexico to the Gila River. It is largely ephemeral with two segments of perennial flow due to wastewater discharges. A small part of the Rio Asuncion Watershed is located along the international border. This watershed drains southwest to the Sea of Cortez and contains a perennial stream, Sycamore Creek.

In addition to the perennial streams mentioned previously, non-effluent dependent perennial reaches in the planning area include: Seven Springs Wash and Camp, Cave, Sycamore, Queen and Arnett creeks in the Phoenix AMA; Sabino, Romero, Cienega and Rincon creeks in the east central part of the Tucson AMA; and Sonoita Creek in the Santa Cruz AMA. Seasonal and annual flows at gages on the Salt, Verde, Gila and Santa Cruz rivers are listed in Table 1-5. Of these, the largest mean flow was measured on the Salt River below Stewart Mountain Dam at almost 711,300 AFA. There are a total of 16 large reservoirs in the planning area. Relatively few major springs (13) have been identified with most located in the Tucson AMA. The largest spring is Del Rio Spring in the northern part of the Prescott AMA with a discharge of 874 gpm.

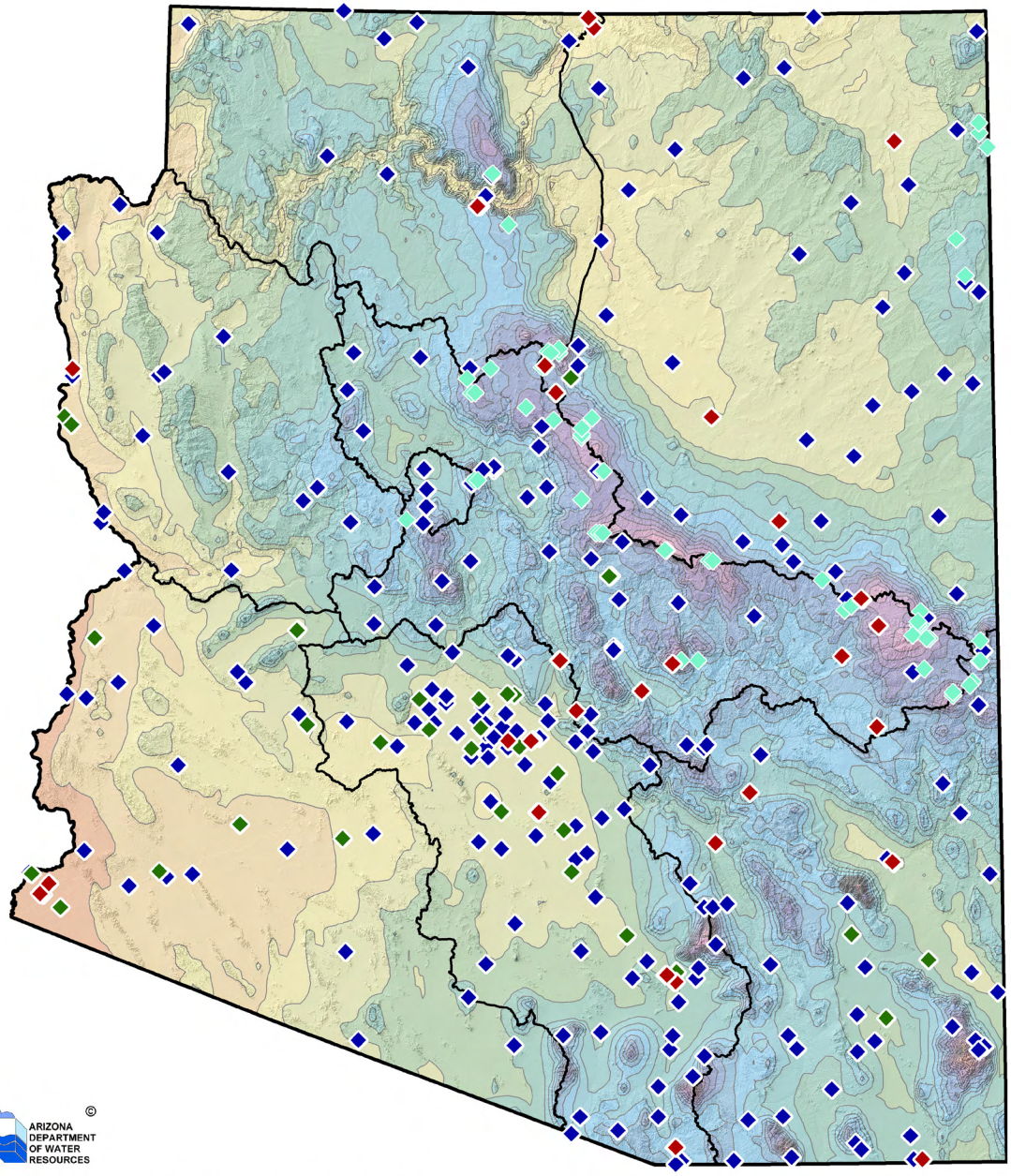
*AMA Planning Area, Granite Reef Diversion Dam. The Salt River is ephemeral below Granite Reef Diversion Dam.*

### 1.4.3 Climate

Climate is a critical factor in water resource planning and management. A more detailed discussion of Arizona's climate is found in Appendix E. Arizona's climate can be characterized by five features: warm temperatures, aridity, and strong seasonality, year-to-year (interannual) variability and decade-to-decade persistence in precipitation. Elevational differences result in significant climate variability across the state. State precipitation variability and the location of meteorological stations are shown in Figure 1-14. Data for these stations and precipitation maps are presented in Volumes 2-8 for each basin.

Precipitation in Arizona is characterized by two distinct precipitation seasons: the summer "monsoon" season, generally from July to mid-September and a winter season from November through mid-April (Figure 1-15). Winter precipitation is more hydrologically effective than summer precipitation because it is more widespread, is generally of low intensity and long duration, coincides with cooler temperatures and lower evaporation rates and, when stored as

# Figure 1-14
# Arizona Meteorologic Stations and Average Precipitation and Temperature



**Average Annual Precipitation (1961-1990) inches per year**

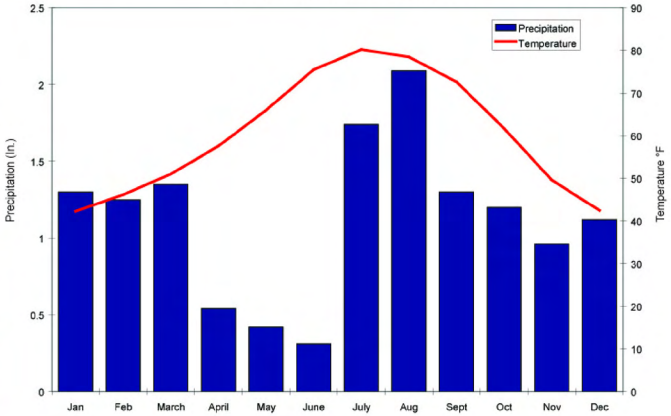
- 0-4
- 4-6
- 6-8
- 8-10
- 10-12
- 12-14
- 14-16
- 16-18
- 18-20
- 20-22
- 22-24
- 24-26
- 26-28
- 28-30
- 30-32
- 32-34
- 34-36
- 36-38
- 38-40
- 40-42
- 42-44

**Meteorological Stations**

- Pan ET
- NOAA/NWS
- AZMet
- NRCS Snow

Planning Area Boundary

**Average Monthly Temperatures and Precipitation in Arizona 1971-2000**




**Data Source: National Climatic Data Center, 2001**

ARIZONA DEPARTMENT OF WATER RESOURCES ©

**Precipition Data Source: Oregon State University, 1998**

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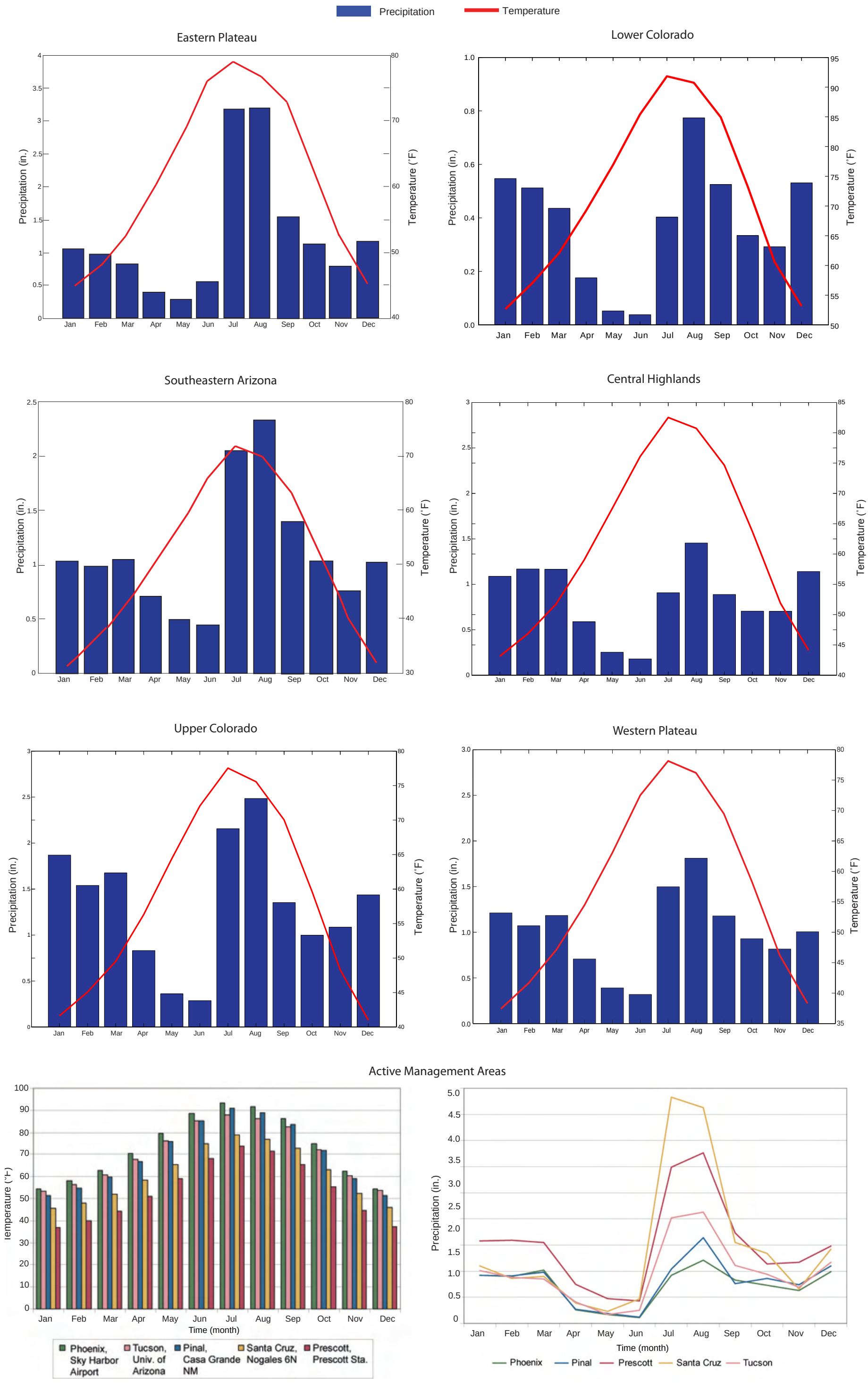
## Figure 1-15 Average Monthly Precipitation and Temperature by Planning Area, 1971-2000



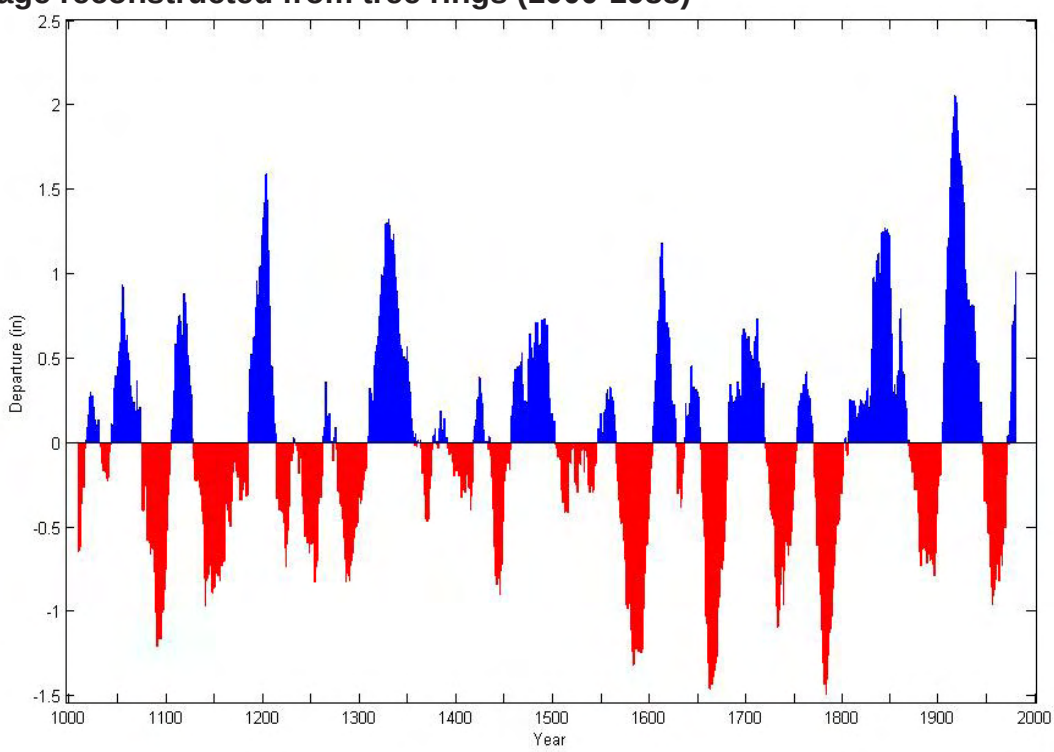

Source: WRCC 2008
Non-AMA figures by CLIMAS

snow, is released gradually, resulting in greater infiltration. Summer rainfall is more localized, of higher intensity and short duration and subject to high evaporation rates.

Arizona's precipitation is also characterized by a high degree of year-to-year variation. The strongest influence on interannual climate and weather variations in Arizona is the El Niño-Southern Oscillation (ENSO), a multi-season to multi-year variation in equatorial Pacific Ocean temperatures and associated atmospheric circulation. Decadal-scale Pacific Ocean circulation persistence can result in long-term drought, which can significantly reduce water supplies as demonstrated in the extremely dry conditions between 1999 and 2005 and during the 1950s. When these sustained circulation patterns are characterized by warm tropical Pacific Ocean temperatures, the result can be above average precipitation such as the post-1976 wet period which lasted until approximately 1998. Precipitation reconstructed from tree-ring records show dry episodes longer and more severe than any that have occurred during the last 100 years. Notable multi-year droughts occurred in almost every century over the last 1,000 years (Figure 1-16).

Temperature and associated evapotranspiration rates also vary widely across Arizona. Average daily temperatures range from the mid 90's (˚F) below 500 feet elevation to the high 50's at elevations above 8,000 feet. A significant feature of Arizona temperature records since 1930 is the trend toward increasing temperatures during the last 30-40 years (Figure 1-17). In some regions, increased temperatures are due primarily to the urban heat island effect from heat-retaining paved areas and buildings replacing desert landscapes in major urban areas. Temperatures in rural communities have also increased, though not at the same rate and not in every town. High temperatures typically result in higher cultural

**Figure 1-16 Arizona winter (November-April) precipitation departures from average reconstructed from tree rings (1000-1988)**

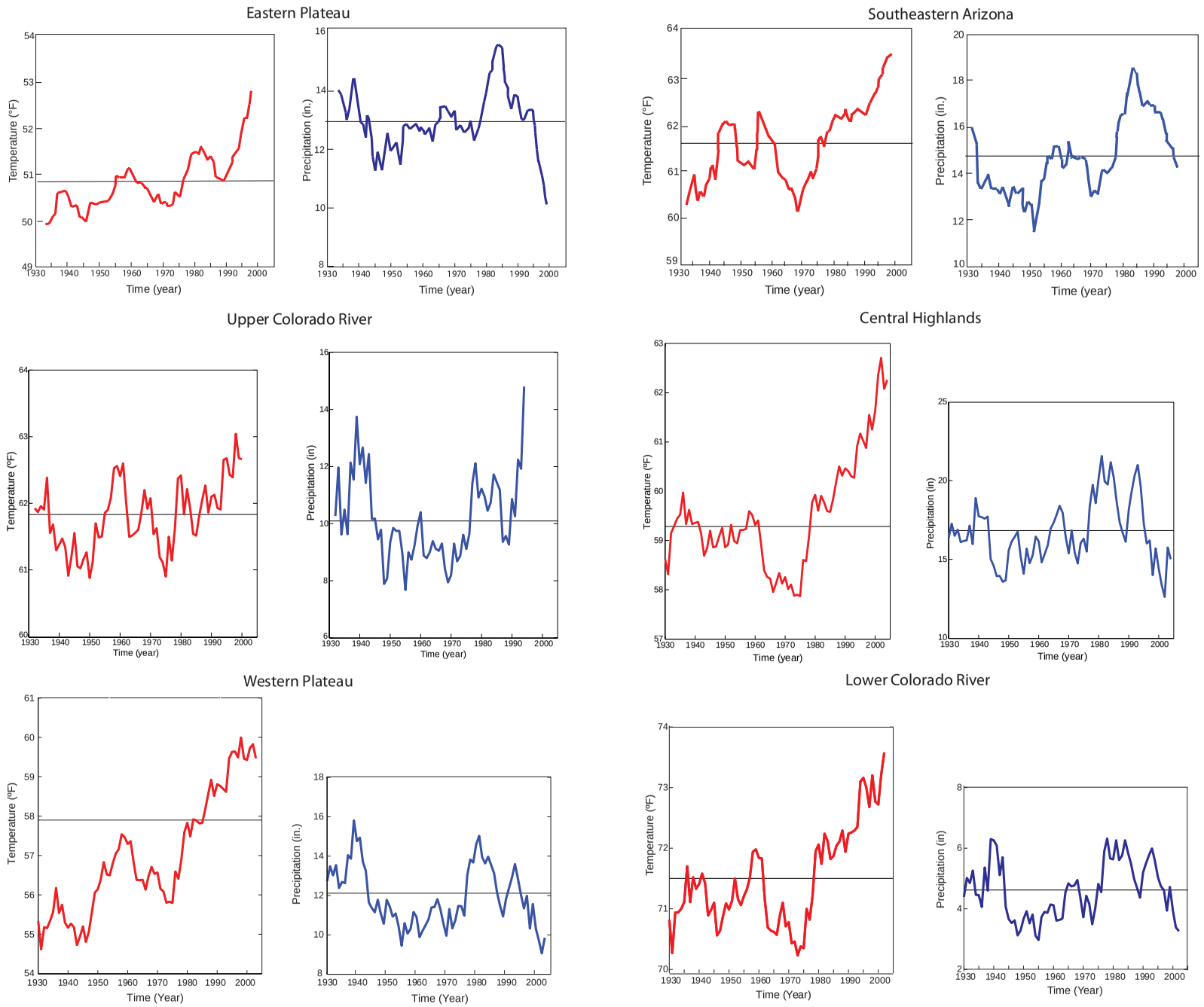



*Data are presented as a 20-year moving average (e.g. the value for 1951 is the average of 1942-1961) to show variability on decadal time scales. Average precipitation for the period is 5.8 in. annually. Source: University of Arizona Laboratory of Tree-Ring Research and CLIMAS.*

## Figure 1-17 Average Water-Year Temperature and Total Precipitation by Planning Area, 1930-2002 (excludes the AMAs)

*Temperature*
- 1930-2002 average
- 5-year running average

*Precipitation*
- 1930-2002 average
- 5-year running average




Source: WRCC 2008
Modified from CLIMAS figures

water demands and increased evaporation and evapotranspiration rates.

### 1.4.4 Environmental Conditions

Environmental conditions reflect the geography, climate and cultural activities in an area and may be a critical consideration in water resource planning, management and development. Among conditions that should be considered are biotic communities (Figure 1-18), riparian habitat and restoration activities, instream flow claims, threatened and endangered species, protected areas such as parks, monuments and wilderness areas, and unique and managed waters. Maps, tables and a discussion of environmental conditions specific to each planning area are included in Volumes 2-8.

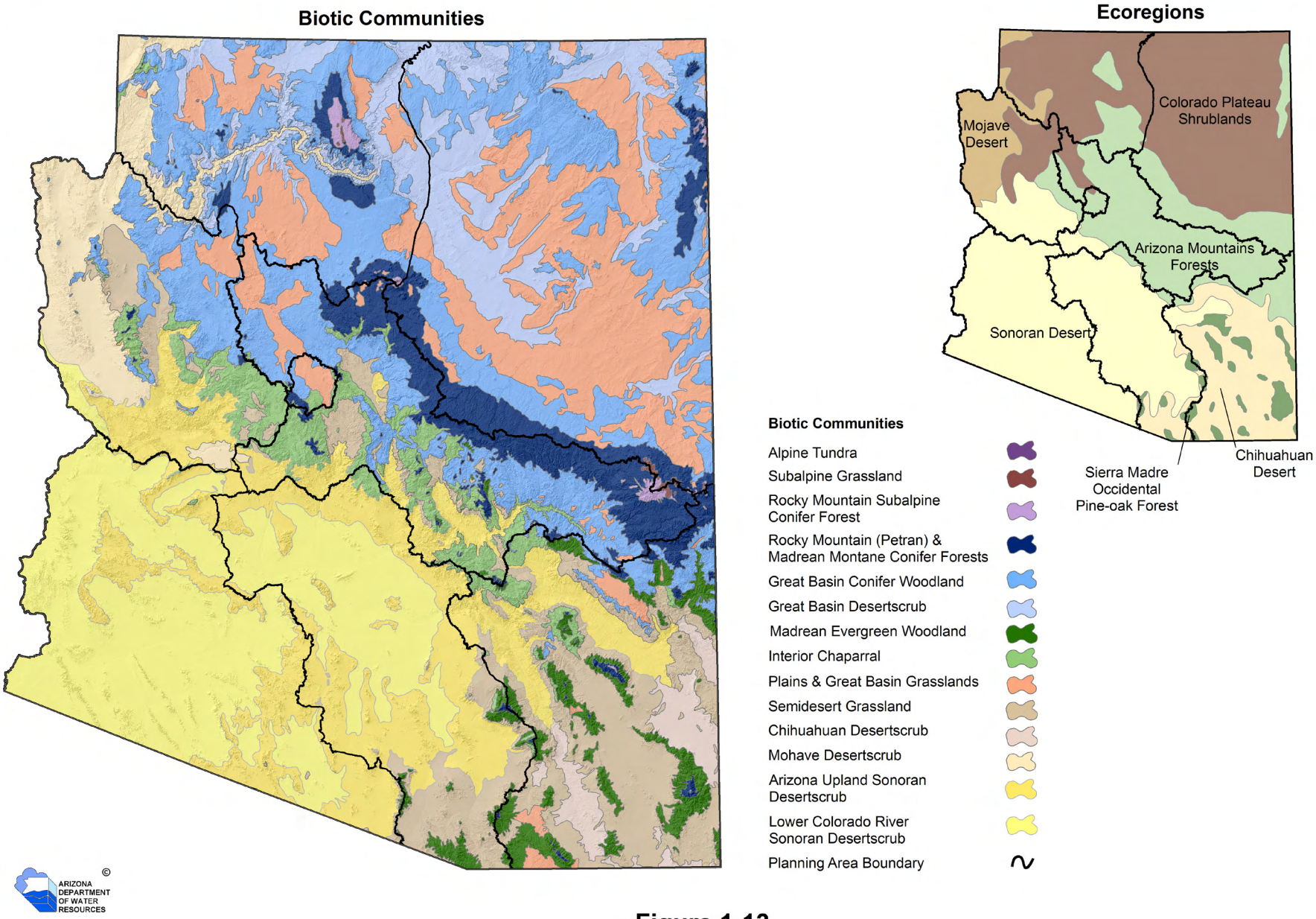
Vegetation type reflects climate and geography and has varying sensitivity to drought, disease and wildfire as well as water demand via evapotranspiration. A number of areas of the state experienced high pinon and ponderosa pine tree mortality in the early 2000s due to a combination of severe drought, high tree densities and a subsequent bark beetle infestation. Wildfire risk increases with the number of dead trees, which provide fuel. Several major wildfires occurred during the severe drought years between 2002 and 2005, including Arizona's largest fire in recorded history, the Rodeo-Chediski that consumed about 462,000 acres in the Central Highlands and Eastern Plateau planning areas. In areas severely burned, peak stream flows after the fire were substantially greater than previously measured, in part due to reduction in rainfall infiltration when surface organic matter is burned. Increased peak flows can degrade stream channels, increase sediment production and cause flood damage (Neary and others, 2003).

A vegetation type of considerable concern in Arizona is riparian vegetation. The Arizona Water Protection Fund (AWPF) program provides funds for protection and restoration of Arizona's

*AWPF site in the Eastern Plateau Planning Area*

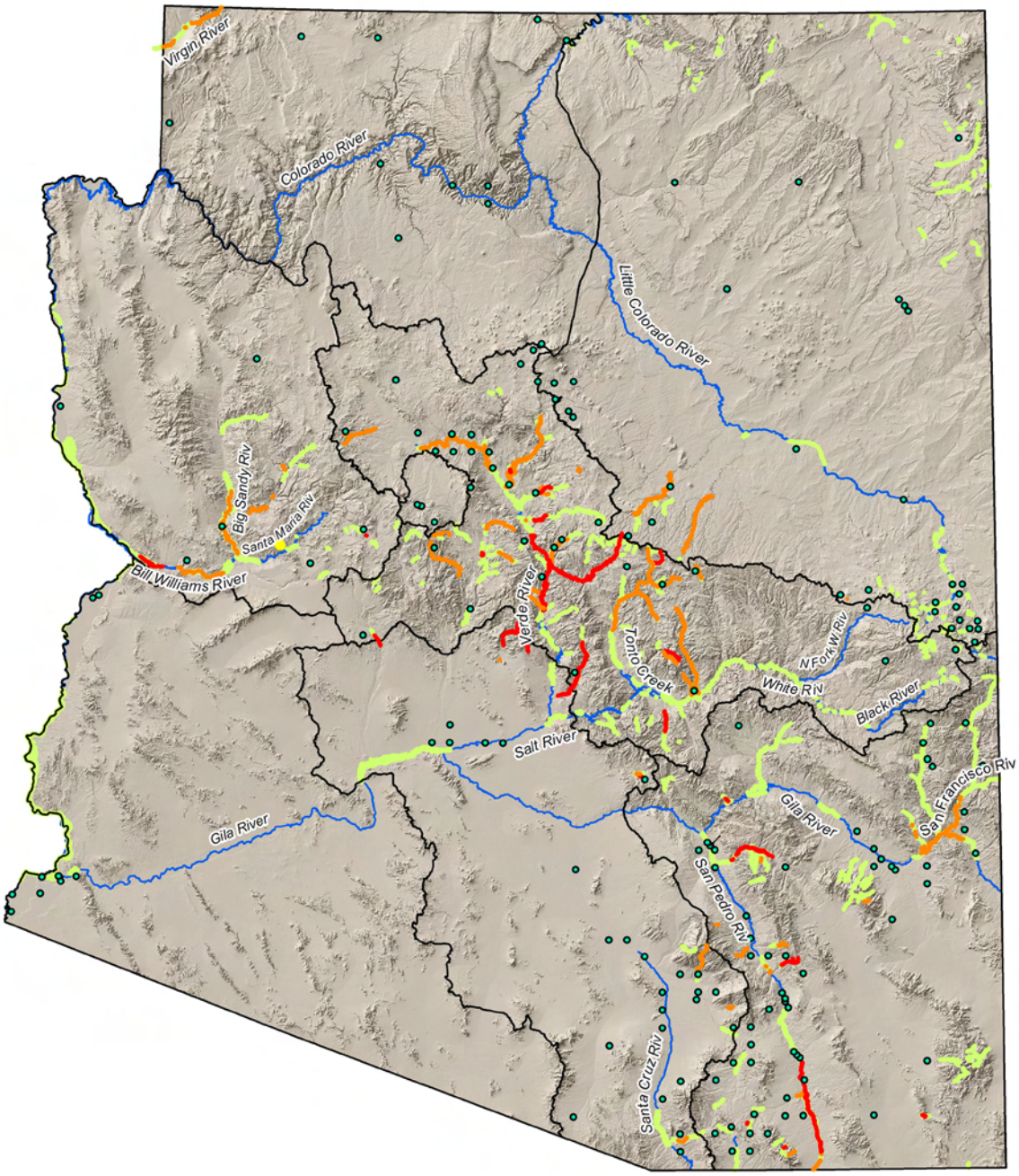
rivers and streams and associated riparian habitat. The general location of riparian vegetation adjacent to perennial streams and AWPF grants is shown on Figure 1-19. As of fiscal year 2008, 164 AWPF grants had been issued. A complete list of the grants keyed to a map is presented in Appendix F. Also shown on Figure 1-19 are instream flow water right claims. An instream flow right is a non-diversionary appropriation of surface water for recreation and wildlife use. As of 2008, 69 applications were pending, and 37 certificates and one permit had been issued.

The presence of a listed threatened and endangered species pursuant to the Endangered Species Act (ESA) may be an important consideration in water resource management in a particular area. For example, the Roosevelt Habitat Conservation Plan was developed to minimize and mitigate the impacts from operating Roosevelt Dam and Lake on several endangered species including the southwestern willow flycatcher. The plan includes acquisition and protection of riparian habitat along the San Pedro, Verde and Gila rivers, and other river systems, and other conservation measures to protect habitat. In the Upper San Pedro Basin, Fort Huachuca's Biological Opinion regarding protection of several endangered species makes Fort Huachuca responsible for both direct and indirect effects of its actions, including water




Biotic Communities Source: Brown and Lowe, 1980
Ecoregions Source: Olson and others, 2001

**Figure 1-13**
**Arizona Biotic Communities and Ecoregions**




**Instream Flow Reach**

- Application Pending
- Permit Issued
- Certificate Issued
- Riparian Area (assoc. with perennial streams)
- AWPF Grant Location
- Major Streams
- Planning Area Boundary

**Figure 1-19**
**Instream Flow Permits, Riparian Areas and Arizona Water Protection Fund Grant Locations**

© ARIZONA DEPARTMENT OF WATER RESOURCES

**Data Sources: ADWR 2008c, AZGF 1993 and ADWR 2008d**

*LCR MSCP mitigation site in the Lower Colorado River Planning Area*

use in the community related to the Fort. The Defense Authorization Act of 2004, Public Law 108-136, Section 321, stipulates how Section 7 of the ESA applies to Fort Huachuca and directs the Secretary of the Interior to prepare reports (through the Upper San Pedro Partnership) to Congress on steps to reduce the overdraft and restore the sustainable yield of groundwater in the Sierra Vista Subwatershed by 2011.

To comply with the requirements of the ESA, state and federal water, power and wildlife interests created the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). The LCR MSCP is a cooperative, habitat conservation program that identifies specific measures to address the needs of 26 threatened, endangered and other species that rely on habitat associated with the lower Colorado River (USDOI, 2004). The Pima County MSCP is another example of a large scale plan to comply with the "take" provisions of the ESA and is part of a larger planning effort known as the Sonoran Desert Conservation Plan, which covers 5.9 million acres in Pima County.[2] The plan directs growth to areas with the least natural, historic, and cultural resource values as well as sets aside sensitive habitat through land acquisitions. (Pima County, 2006)

Protected areas such as national parks, monuments, wilderness areas, preserves and wildlife refuges exclude large scale water development within their boundaries. These areas are identified in each planning area volume and may represent a substantial amount of land within a basin or planning area (See Table 1-2).

The Arizona Department of Environmental Quality (ADEQ) has designated nineteen "unique waters" in the state that have exceptional recreational or ecological significance and/or provide habitat for threatened or endangered species. These include portions of Aravaipa and Bonita creeks in the Southeastern Arizona Planning Area, Oak Creek in the Verde River Basin and a number of streams in the White Mountains. No degradation of a unique water is allowed under the ADEQ Surface Water Quality Standards rules.

Other "managed" waters in Arizona include Fossil Creek and a portion of the Verde River in the Central Highlands Planning Area designated as Wild and Scenic Rivers. Flows of Arizona's major rivers (the Colorado, Salt, Verde and Gila rivers) are impounded behind dams and managed for electrical generation purposes and to store water to meet downstream flow obligations pursuant to decrees, settlements and interstate compacts. These actions have fundamentally altered flow regimes and ecosystems along these river systems.

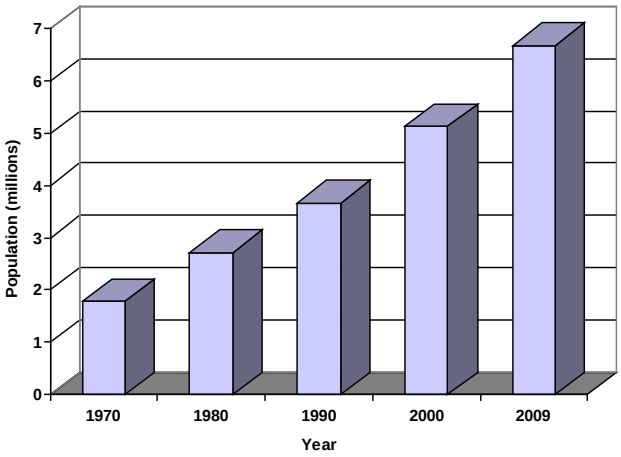
*Aravaipa Creek, Southeastern Arizona Planning Area.*

[2] As defined in the ESA, to take means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in other conduct." 16 U.S.C. section 1531 [18].

### 1.4.5 Population

Arizona is the nation's second fastest growing state, growing at a rate of about 3% per year. Growth from 1970 to 2009 is shown in Figure 1-20. Arizona grew by about 1 million residents per decade between 1970 and 1990, and then grew from 3.6 million to 5.1 million inhabitants, a 40% increase, in the decade from 1990 to 2000. Although the annual growth rate has recently slowed to about 2%, by July 2009, population had increased by 1.58 million people, a 30.3% increase since the 2000 census (ADOC, 2009).

**Figure 1-20 Arizona Population 1970-2009**




Between 2000 and 2009, Pinal County grew 98.2%, the most rapid of any county in Arizona. During that time period some rural Arizona counties – Yavapai, Mohave and Yuma, grew at rates comparable to that of Maricopa County, which contains the rapidly growing Phoenix metropolitan area (ADOC, 2009). Table 1-6 lists historic and projected planning area and groundwater basin population. While most planning areas show substantial growth, the AMA planning area growth rate continues to outpace the rest of the state with a projected 85% of the state's population in 2030, an increase from 78% in 1980.

Rapid population growth and drought conditions can have significant impacts on water supplies and infrastructure in some areas. Figure 1-21 and Table 1-7 identify Arizona communities with population growth greater than 2% per year between the 2000 Census and the Department of Commerce 2009 estimate.[3] The highest growth rates and greatest concentration of high growth rate communities are located in the AMAs, particularly in smaller communities near larger cities. It should be noted that some high growth rates may be due in part to annexation of unincorporated land with its associated population. This is the case with the town of Marana in the Tucson AMA. Although some incorporated cities, such as Sierra Vista, did not experience more than a 3% annual growth rate, unincorporated areas adjacent to them grew rapidly.

<u>Population Growth and Water Use</u>

The state has limited mechanisms to address the connection between land use, population growth and water supply. The Growing Smarter Plus Act of 2000 (Act) links growth and water management planning by requiring counties with a population greater than 125,000 (2000 Census) to include water resources planning in their comprehensive plans. These counties include Maricopa, Mohave, Pima, Pinal, Yavapai

*Main Street Yuma, Lower Colorado River Planning Area. In 2005, the Arizona Legislature passed House Bill 2277, expanding water use reporting and planning statewide.*

[3] For some communities the estimates for 2009 show less population than previous estimates for 2006, which are presented in Atlas Volumes 2-8. These declines reflect adjustments to growth rates used to generate estimates, not an actual decline in population.

## Table 1-6 Planning area and basin historic and projected population

| Basin | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 | 2020 | 2030 |
|---|---|---|---|---|---|---|---|---|---|
| ***Eastern Plateau*** | | | | | | | | | |
| Little Colorado River | 175,451 | 192,452 | 209,454 | 229,649 | 249,545 | 274,386 | 299,227 | 343,049 | 378,392 |
| **Sub-total** | **175,451** | **192,452** | **209,454** | **229,649** | **249,545** | **274,386** | **299,227** | **343,049** | **378,392** |
| ***Southeastern Arizona*** | | | | | | | | | |
| Aravaipa Canyon | 74 | 101 | 129 | 132 | 135 | 140 | 144 | 151 | 159 |
| Bonita Creek | 5 | 13 | 20 | 21 | 21 | 23 | 24 | 26 | 28 |
| Cienega Creek | 1,695 | 2,178 | 2,662 | 3,508 | 4,355 | 4,880 | 5,404 | 6,672 | 7,820 |
| Donnelly Wash | 27 | 68 | 109 | 137 | 165 | 185 | 205 | 245 | 285 |
| Douglas | 16,600 | 20,397 | 24,193 | 25,207 | 26,220 | 28,911 | 31,609 | 37,790 | 41,800 |
| Dripping Springs Wash | 329 | 273 | 217 | 196 | 175 | 186 | 197 | 220 | 288 |
| Duncan | 3,225 | 3,151 | 3,077 | 3,417 | 3,757 | 3,683 | 3,609 | 3,610 | 3,655 |
| Lower San Pedro | 19,300 | 17,599 | 15,898 | 15,707 | 15,515 | 18,710 | 21,905 | 29,180 | 34,736 |
| Morenci | 8,620 | 6,940 | 5,260 | 5,200 | 5,141 | 5,066 | 4,990 | 5,021 | 5,113 |
| Safford | 27,638 | 29,293 | 30,948 | 36,614 | 42,281 | 45,110 | 47,938 | 52,282 | 56,570 |
| San Bernardino Valley | 20 | 51 | 83 | 74 | 66 | 74 | 82 | 95 | 105 |
| San Rafael | 143 | 140 | 137 | 142 | 147 | 158 | 169 | 177 | 182 |
| Upper San Pedro | 50,999 | 57,079 | 63,159 | 70,586 | 78,013 | 87,671 | 97,329 | 113,044 | 125,700 |
| Willcox | 9,064 | 9,418 | 9,773 | 11,063 | 12,354 | 13,862 | 15,369 | 16,973 | 18,237 |
| **Sub-total** | **137,739** | **146,701** | **155,665** | **172,004** | **188,345** | **208,659** | **228,974** | **265,486** | **294,678** |
| ***Upper Colorado River*** | | | | | | | | | |
| Big Sandy | 434 | 490 | 546 | 844 | 1,142 | 1,423 | 1,704 | 2,166 | 2,541 |
| Bill Williams | 5,532 | 4,835 | 4,138 | 4,414 | 4,691 | 5,482 | 6,272 | 7,068 | 7,700 |
| Detrital | 757 | 853 | 949 | 1,161 | 1,373 | 2,142 | 2,910 | 3,628 | 4,212 |
| Hualapai Valley | 11,361 | 15,660 | 19,960 | 28,752 | 37,544 | 40,539 | 43,533 | 55,261 | 64,789 |
| Lake Havasu | 17,487 | 21,932 | 26,377 | 35,484 | 44,591 | 56,192 | 67,792 | 89,215 | 106,614 |
| Lake Mohave | 13,653 | 22,152 | 30,651 | 41,100 | 51,549 | 58,404 | 65,259 | 79,878 | 91,747 |
| Meadview | 104 | 278 | 453 | 637 | 823 | 1,000 | 1,176 | 1,495 | 1,755 |
| Peach Springs | 1,804 | 1,384 | 965 | 1,372 | 1,780 | 2,228 | 2,676 | 3,391 | 3,969 |
| Sacramento Valley | 7,245 | 8,910 | 10,575 | 14,075 | 17,575 | 22,192 | 26,808 | 34,099 | 40,020 |
| **Sub-total** | **58,377** | **76,494** | **94,614** | **127,839** | **161,068** | **189,599** | **218,130** | **276,201** | **323,347** |
| ***Central Highlands*** | | | | | | | | | |
| Agua Fria | 2,839 | 4,076 | 5,313 | 6,762 | 8,210 | 10,389 | 12,568 | 16,104 | 19,135 |
| Salt River Valley | 27,318 | 27,995 | 28,671 | 28,864 | 29,057 | 30,299 | 31,541 | 33,978 | 36,094 |
| Tonto Creek | 1,934 | 3,275 | 4,615 | 6,295 | 7,975 | 9,032 | 10,088 | 12,641 | 14,538 |
| Upper Hassayampa | 6,050 | 7,056 | 8,062 | 9,270 | 10,479 | 11,414 | 12,348 | 15,072 | 18,362 |
| Verde River | 36,049 | 46,269 | 56,489 | 72,899 | 89,309 | 101,898 | 114,487 | 138,296 | 155,456 |
| **Sub-total** | **74,190** | **88,671** | **103,150** | **124,090** | **145,030** | **163,032** | **181,032** | **216,091** | **243,585** |
| ***Western Plateau*** | | | | | | | | | |
| Coconino Plateau | 6,977 | 7,349 | 7,722 | 8,443 | 9,164 | 11,525 | 13,886 | 16,081 | 17,500 |
| Grand Wash | 10 | 11 | 12 | 14 | 15 | 15 | 15 | 15 | 15 |
| Kanab Plateau | 2,815 | 3,664 | 4,513 | 5,222 | 6,233 | 8,077 | 9,921 | 12,552 | 14,688 |
| Paria | 237 | 362 | 487 | 521 | 528 | 547 | 566 | 637 | 695 |
| Shivwits Plateau | 4 | 6 | 8 | 10 | 12 | 12 | 12 | 12 | 12 |
| Virgin River | 99 | 150 | 200 | 866 | 1,532 | 1,860 | 2,188 | 2,783 | 3,267 |
| **Sub-total** | **10,142** | **11,542** | **12,942** | **15,076** | **17,485** | **22,036** | **26,588** | **32,080** | **36,177** |
| ***Lower Colorado River*** | | | | | | | | | |
| Butler Valley | 5 | 8 | 10 | 13 | 15 | 15 | 15 | 15 | 16 |
| Gila Bend | 3,437 | 3,262 | 3,087 | 3,672 | 4,256 | 6,415 | 8,573 | 10,268 | 15,392 |
| Harquahala | 359 | 590 | 821 | 715 | 608 | 780 | 951 | 1,697 | 2,443 |
| Lower Gila | 9,873 | 9,571 | 9,270 | 10,283 | 11,297 | 12,594 | 13,890 | 17,192 | 20,967 |
| McMullen Valley | 280 | 853 | 1,427 | 2,426 | 3,426 | 3,991 | 4,555 | 5,696 | 6,945 |
| Parker | 11,339 | 11,634 | 11,928 | 14,042 | 16,155 | 17,137 | 18,119 | 20,037 | 21,775 |
| Ranegras Plain | 1,024 | 802 | 581 | 743 | 905 | 978 | 1,050 | 1,128 | 1,198 |
| San Simon Wash | 4,852 | 5,488 | 6,124 | 5,980 | 5,837 | 7,119 | 8,400 | 10,622 | 13,646 |
| Tiger Wash | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Western Mexican Drain | 10 | 15 | 20 | 27 | 33 | 38 | 42 | 51 | 59 |
| Yuma | 73,319 | 87,337 | 101,355 | 127,141 | 152,928 | 181,600 | 210,272 | 261,091 | 305,904 |
| **Sub-total** | **104,498** | **119,560** | **134,622** | **165,042** | **195,460** | **230,664** | **265,867** | **327,797** | **388,345** |
| ***Active Management Areas*** | | | | | | | | | |
| Phoenix AMA | 1,471,074 | 1,855,960 | 2,150,726 | 2,571,732 | 3,118,049 | 3,650,464 | 4,341,229 | 5,561,461 | 6,763,848 |
| Pinal AMA | 40,956 | 52,997 | 62,423 | 74,494 | 99,143 | 136,130 | 212,699 | 464,909 | 624,128 |
| Prescott AMA | 35,641 | 44,112 | 54,917 | 68,634 | 90,061 | 112,359 | 137,244 | 176,560 | 217,862 |
| Santa Cruz AMA | 18,728 | 20,911 | 27,747 | 31,950 | 37,049 | 47,201 | 49,101 | 60,706 | 70,343 |
| Tucson AMA | 510,609 | 573,864 | 654,576 | 766,720 | 835,504 | 952,670 | 1,059,194 | 1,285,487 | 1,488,999 |
| **Sub-total** | **2,077,008** | **2,547,844** | **2,950,389** | **3,513,530** | **4,179,806** | **4,898,824** | **5,799,467** | **7,549,123** | **9,165,180** |
| **Total** | **2,637,405** | **3,183,264** | **3,660,836** | **4,347,230** | **5,136,738** | **5,987,200** | **7,019,285** | **9,009,827** | **10,829,704** |

Source: ADWR, 2009

## Table 1-7 High growth communities in Arizona[1`]

| Map Key & Rank | City/Town | 2009 Estimated Population | 2000 Census Population | Percent Change 2000-2009 | Average Annual Percent Change |
|---|---|---|---|---|---|
| 1 | Maricopa City | 39,429 | 1,482 | 2561% | 285% |
| 2 | Sahuarita | 24,968 | 3,242 | 670% | 74% |
| 3 | Buckeye | 52,764 | 8,497 | 521% | 58% |
| 4 | Queen Creek | 25,429 | 4,316 | 489% | 54% |
| 5 | El Mirage | 33,610 | 7,609 | 342% | 38% |
| 6 | Surprise | 109,482 | 30,848 | 255% | 28% |
| 7 | Goodyear | 61,916 | 18,911 | 227% | 25% |
| 8 | Marana | 34,191 | 13,556 | 152% | 17% |
| 9 | Youngtown | 6,513 | 3,010 | 116% | 13% |
| 10 | Avondale | 76,900 | 35,883 | 114% | 13% |
| 11 | Gilbert | 217,521 | 109,697 | 98% | 11% |
| 12 | Eloy | 19,005 | 10,375 | 83% | 9% |
| 13 | Casa Grande | 45,993 | 25,224 | 82% | 9% |
| 14 | San Luis | 27,629 | 15,322 | 80% | 9% |
| 15 | Florence | 25,794 | 14,466 | 78% | 9% |
| 16 | Chino Valley | 13,080 | 7,835 | 67% | 7% |
| 17 | Prescott Valley | 38,958 | 23,535 | 66% | 7% |
| 18 | Somerton | 11,713 | 7,266 | 61% | 7% |
| 19 | Show Low | 12,368 | 7,695 | 61% | 7% |
| 20 | Coolidge | 12,159 | 7,786 | 56% | 6% |
| 21 | Dewey-Humboldt[2] | 4,499 | 3,613 | 25% | 6% |
| 22 | Oro Valley | 43,521 | 29,700 | 47% | 5% |
| 23 | Peoria | 158,712 | 108,364 | 46% | 5% |
| 24 | Kingman | 29,189 | 20,069 | 45% | 5% |
| 25 | Thatcher | 5,819 | 4,022 | 45% | 5% |
| 26 | Taylor | 4,526 | 3,176 | 43% | 5% |
| 27 | Star Valley[3] | 2,169 | 1,536 | 41% | 5% |
| 28 | Cave Creek | 5,208 | 3,728 | 40% | 4% |
| 29 | Tolleson | 6,923 | 4,974 | 39% | 4% |
| 30 | Chandler | 245,087 | 176,581 | 39% | 4% |
| 31 | Carefree | 3,958 | 2,927 | 35% | 4% |
| 32 | Litchfield Park | 5,122 | 3,810 | 34% | 4% |
| 33 | Pinetop-Lakeside | 4,758 | 3,582 | 33% | 4% |
| 34 | Lake Havasu City | 55,502 | 41,938 | 32% | 4% |
| 35 | Wellton | 2,363 | 1,829 | 29% | 3% |
| 36 | Fountain Hills | 26,107 | 20,235 | 29% | 3% |
| 37 | Saint Johns | 4,208 | 3,269 | 29% | 3% |
| 38 | Prescott | 43,573 | 33,938 | 28% | 3% |
| 39 | Wickenburg | 6,451 | 5,082 | 27% | 3% |
| 40 | Payson | 17,242 | 13,620 | 27% | 3% |
| 41 | Douglas | 17,758 | 14,312 | 24% | 3% |
| 42 | Snowflake | 5,528 | 4,460 | 24% | 3% |
| 43 | Flagstaff | 65,522 | 52,894 | 24% | 3% |
| 44 | Sierra Vista | 46,597 | 37,775 | 23% | 3% |
| 45 | Bullhead City | 41,609 | 33,769 | 23% | 3% |
| 46 | Pima | 2,442 | 1,989 | 23% | 3% |
| 47 | Camp Verde | 11,603 | 9,451 | 23% | 3% |
| 48 | Cottonwood | 11,190 | 9,179 | 22% | 2% |
| 49 | Yuma | 94,361 | 77,515 | 22% | 2% |
| 50 | Colorado City | 4,033 | 3,334 | 21% | 2% |
| 51 | Scottsdale | 243,501 | 202,705 | 20% | 2% |
| 52 | Eagar | 4,814 | 4,033 | 19% | 2% |
| 53 | Phoenix | 1,575,423 | 1,321,045 | 19% | 2% |
| 54 | Apache Junction | 37,864 | 31,814 | 19% | 2% |

**Source:** ADOC, 2009

[1] High growth = community with greater than 2% average annual population increase between 2000-2009. Average annual percent increase for Arizona during 2000-2009 was 3%.

[2] Dewey-Humboldt was incorporated in 2004; population shown is 2005 estimated census population and percent change is between 2005-2009.

[3] Star Valley was incorporated in 2005; 2000 census data is for the Star Valley (Sun Valley) Census Designated Place.

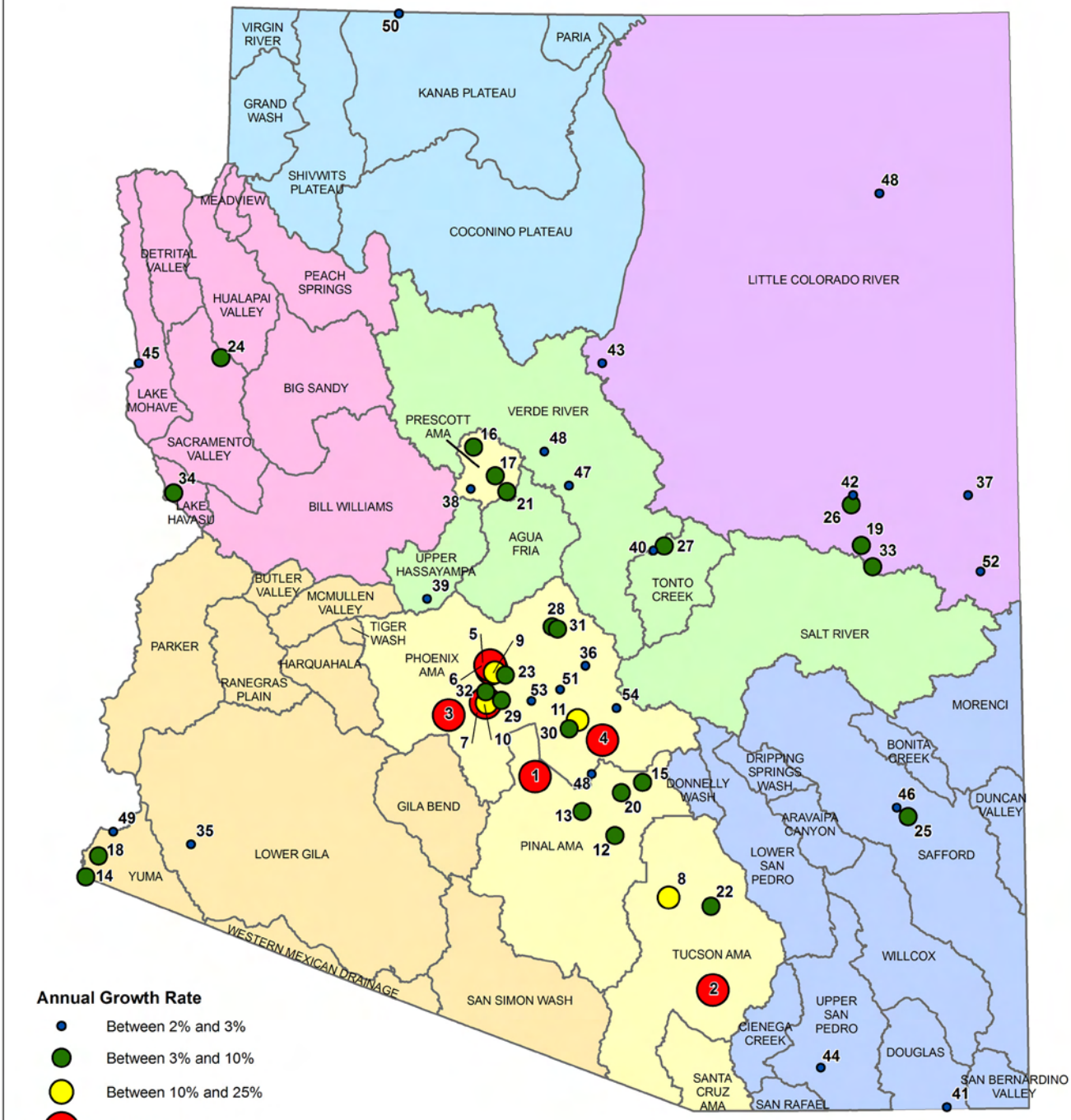



**Figure 1-21**
**High Growth Rate Communities (2000-2009)**

and Yuma. The Act also required that 53 communities include a water resources element in their general plans. Brief discussion and references to completed plans are listed in Volumes 2-8 of the Atlas.

In 2005, the Arizona Legislature passed House Bill 2277, (A.R.S. 45 § 331-343), which expanded water use reporting and planning statewide and now requires all community water systems[4] to submit a Water System Plan that includes a Water Supply Plan, a Drought Preparedness Plan and a Water Conservation Plan. It also requires all community water systems to submit an annual report of water withdrawals, diversions and deliveries. The reports and plans are intended to reduce community water systems' vulnerability to drought, and to promote water resource planning to ensure that water providers are prepared to respond to water shortage conditions. Annual water report information and a list of water plans are found in Appendices of Volumes 2-8 of the Atlas.

The Assured and Adequate Water Supply programs relate growth to water supply and demand to some extent but do not control growth or the location of growth if the demonstration criteria are met. These programs are discussed in Section 1.2, in Appendix C and in each of the planning area volumes which contain maps and tables of all assured and adequate water supply determinations at the basin and planning area level. Table 1-8 summarizes water adequacy determinations, which apply outside of the AMAs. As mentioned previously, in most non-AMA areas of the state, lots may be sold without an adequacy determination, but there must be disclosure to the initial buyer if the subdivision water supply is inadequate. Many applicants request an inadequate determination because the law does not prohibit development, it simply re-

## Table 1-8 Adequacy determinations outside of the AMAs

| Planning Area | Subdivisions | | Lots with Inadequate Determinations | |
|---|---|---|---|---|
| | Total | Number of Lots[1] | Number | Approx. Percent |
| Eastern Plateau | 304 | 18,790 | 8,687 | 46% |
| Southeastern Arizona | 293 | >32,258 | >8,881 | 28% |
| Upper Colorado River | 409 | >68,823 | >23,454 | 34% |
| Central Highlands | 552 | >40,617 | >12,983 | 32% |
| Western Plateau | 86 | 5,409 | 2,235 | 41% |
| Lower Colorado River | 348 | >36,942 | >3,218 | 9% |
| **Total** | **1,992** | **>202,839** | **>59,458** | **29%** |

**Percent of Lots with Inadequacy Determinations by Reason [2]**

| Planning Area | Physical/Continuous | | | | Physical/Continuous plus | | | Legal[7] | Water Quality | Legal & Water Quality | Unable to locate records |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Insufficient Data[3] | Insufficient Supply[4] | Insufficient Infrastructure[5] | Multiple[6] | Legal | Water Quality | Legal & Water Quality | | | | |
| Eastern Plateau | 74.2% | 5.3% | 0.7% | 7.9% | | 0.7% | | 0.7% | 4.0% | | 6.0% |
| Southeastern Arizona | 42.9% | 1.0% | | | 2.0% | 6.1% | | 36.7% | 5.1% | | 5.1% |
| Upper Colorado River | 51.4% | 4.7% | | 35.5% | | | 1.9% | 1.9% | 0.9% | | 3.7% |
| Central Highlands | 54.9% | 6.1% | | 24.4% | 1.4% | 4.2% | | 0.9% | 5.6% | 0.5% | 1.9% |
| Western Plateau | 62.3% | 3.3% | 8.2% | 18.0% | 1.6% | | | | 1.6% | | 4.9% |
| Lower Colorado River | 61.8% | 1.8% | | | | 5.5% | | 5.5% | 18.2% | | 7.3% |

Source: ADWR 2008e

[1] Data on number of lots are missing for some subdivisions; actual number is larger.

[2] Each determination of the adequacy of water supplies available to a subdivision is based on the information available to ADWR and the standards of review and policies in effect at the time the determination was made. In some cases, ADWR might make a different determination if a similar application were submitted today, based on the hydrologic data and other information currently available, as well as current rules and policies.

[3] Applicant chose not to submit necessary information, and/or available hydrologic data was insufficient to make determination.

[4] Existing water supply unreliable or physically unavailable; for groundwater, depth-to-water exceeds criteria.

[5] Distribution system is insufficient to meet demands or applicant proposed water hauling.

[6] Multiple Physical/Continuous reasons cited.

[7] Applicant failed to demonstrate a legal right to use the water or failed to demonstrate the provider's legal authority to serve the subdivision.

[4] Community water system is defined as a public water system that serves at least 15 service connections used by year-round residents or that regularly serves at least 25 year-round residents. A.R.S. § 45-341

**Table 1-9 Assured water supply applications in the AMAs**

| | Assured Water Supply | | | Water Adequacy Reports (# of Subdivisions) |
|---|---|---|---|---|
| | Certificates (# of Subdivisions) | Analyses | Designations | |
| Phoenix AMA | 1,118 | 61 | 15 | 208 |
| Pinal AMA | 214 | 19 | 5 | 16 |
| Prescott AMA | 104 | 2 | 1 | 8 |
| Santa Cruz AMA | 34 | 6 | 2 | 32 |
| Tucson AMA | 230 | 16 | 9 | 90 |
| **Total** | **1,700** | **104** | **32** | **354** |

Source: ADWR 2008e

quires disclosure. The reason for an inadequacy determination may range from an actual deficiencies in one of the criteria or failure of the developer to submit required information. To distinguish between an actual inadequacy and a failure to comply, Table 1-8 includes the number of different types of inadequacy determinations. Insufficient data was the primary reason for an inadequate determination in all planning areas.

Table 1-9 lists the number of different applications approved under the assured water supply program. Certificates of AWS are issued for subdivisions that meet the AWS criteria. An Analysis of AWS is generally used to prove that water will be physically available for master planned communities but may be used to demonstrate other criteria required for a Certificate of AWS. "Designated" water providers have demonstrated an AWS for their entire service area. Because the Adequate Water Supply program was in effect in the planning area prior to 1980, some Water Adequacy Reports issued for older developments in the AMAs exist. Figure 1-22 shows the location of` assured and adequate water supply determinations across the State. Table 1-10 lists all designated water providers keyed to Figure 1-22.

**Table 1-10 Designated water providers in Arizona as of May 2010**

| Map Key | Water Provider Name | Planning Area | Groundwater Basin | County | Designation | | |
|---|---|---|---|---|---|---|---|
| | | | | | Number | Type | Issue Date |
| 1 | American Ranch DWID | Central Highlands | Verde River | Yavapai | 40-400437.0000 | Adequate | 3/14/2002 |
| 2 | Apache Junction Water Utilities Communities Facilities District | AMA | Phoenix | Pinal | 26-400989.0000 | Assured | 2/1/2005 |
| 3 | Arizona Water Co - Pinetop/ Lakeside | Eastern Plateau | Little Colorado River Plateau | Navajo | 40-900000.0000 | Adequate | 10/25/1973 |
| 4 | Baca Float Water Company | AMA | Santa Cruz | Santa Cruz | 26-400800.0000 | Assured | 11/17/2004 |
| 5 | Bachmann Springs Utility Company | Southeastern Arizona | Upper San Pedro | Cochise | 40-401893.0000 | Adequate | 7/5/2006 |
| 6 | Beaver Dam Water Company | Western Plateau | Virgin River | Mohave | 40-700494.0000 | Adequate | 11/10/2009 |
| 7 | Big Park Water Company | Central Highlands | Verde River | Yavapai | 41-400325.0001 | Adequate | 5/7/2009 |
| 8 | Camp Verde Water System, Inc | Central Highlands | Verde River | Yavapai | 40-700446.0000 | Adequate | 4/15/2008 |
| 9 | Cerbat Water Company | Upper Colorado | Hualapai Valley | Mohave | 40-300106.0000 | Adequate | 7/14/1998 |
| 10 | Chaparral City Water Company | AMA | Phoenix | Maricopa | 26-401242.0000 | Assured | 2/11/2004 |
| 11 | City of Avondale | AMA | Phoenix | Maricopa | 86-002003.0001 | Assured | 2/4/2008 |
| 12 | City of Benson | Southeastern Arizona | Upper San Pedro | Cochise | 41-401803.0001 | Adequate | 7/14/2008 |
| 13 | City of Bullhead City | Upper Colorado | Lake Mohave | Mohave | 41-400649.0001 | Adequate | 2/11/2008 |
| 14 | City of Chandler | AMA | Phoenix | Maricopa | 86-002009.0001 | Assured | 6/4/2009 |
| 15 | City of Cottonwood | Central Highlands | Verde River | Yavapai | 40-700578.0000 | Adequate | 4/27/2009 |
| 16 | City of Douglas | Southeastern Arizona | Douglas | Cochise | 40-900001.0000 | Adequate | 5/17/1973 |

## Table 1-10 Designated water providers in Arizona as of May 2010 (cont)

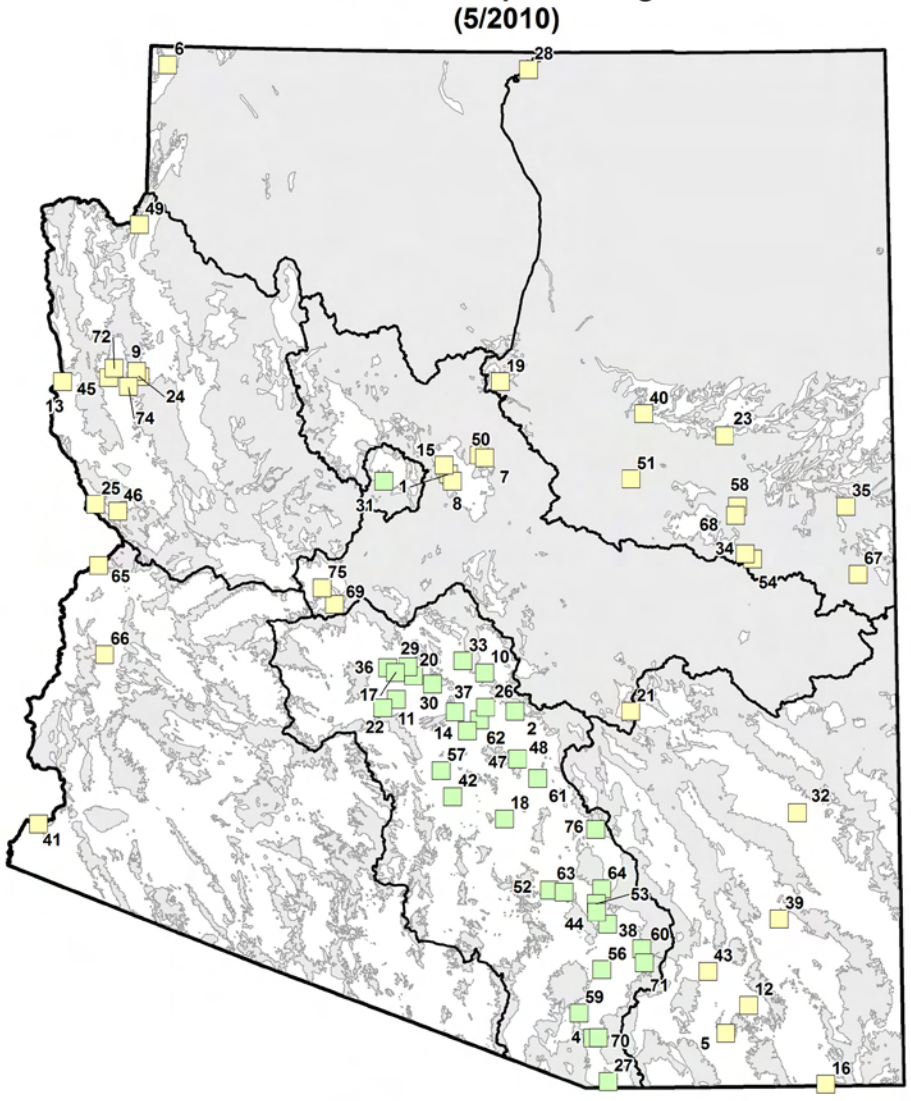
| Map Key | Water Provider Name | Planning Area | Groundwater Basin | County | Designation | | |
|---|---|---|---|---|---|---|---|
| | | | | | Number | Type | Issue Date |
| 17 | City of El Mirage | AMA | Phoenix | Maricopa | 26-400054.0000 | Assured | 11/2/1999 |
| 18 | City of Eloy | AMA | Pinal | Pinal | 26-402148.0000 | Assured | 2/20/2007 |
| 19 | City of Flagstaff | Eastern Plateau | Little Colorado River Plateau | Coconino | 40-900002.0000 | Adequate | 5/17/1973 |
| 20 | City of Glendale | AMA | Phoenix | Maricopa | 26-002018.0000 | Assured | 9/25/1997 |
| 21 | City of Globe | Central Highlands | Salt River | Gila | 40-900003.0000 | Adequate | 5/15/1973 |
| 22 | City of Goodyear | AMA | Phoenix | Maricopa | 26-402090.0000 | Assured | 1/27/2008 |
| 23 | City of Holbrook | Eastern Plateau | Little Colorado River Plateau | Navajo | 40-900005.0000 | Adequate | 5/17/1973 |
| 24 | City of Kingman | Upper Colorado | Hualapai Valley | Mohave | 40-900007.0000 | Adequate | 5/17/1973 |
| 25 | City of Lake Havasu City | Upper Colorado | Lake Havasu | Mohave | 40-900008.0000 | Adequate | 6/18/1973 |
| 26 | City of Mesa | AMA | Phoenix | Maricopa | 26-002023.0000 | Assured | 9/19/1997 |
| 27 | City of Nogales | AMA | Santa Cruz | Santa Cruz | 26-401358.0000 | Assured | 4/19/2005 |
| 28 | City of Page | Eastern Plateau | Little Colorado River Plateau | Coconino | 40-900009.0000 | Adequate | 6/15/1973 |
| 29 | City of Peoria | AMA | Phoenix | Maricopa | 26-400679.0000 | Assured | 10/17/2002 |
| 30 | City of Phoenix | AMA | Phoenix | Maricopa | 26-002030.0000 | Assured | 12/31/1997 |
| 31 | City of Prescott | AMA | Prescott | Yavapai | 86-401501.0001 | Assured | 12/30/2009 |
| 32 | City of Safford | Southeastern Arizona | Safford | Graham | 40-900011.0000 | Adequate | 5/17/1973 |
| 33 | City of Scottsdale | AMA | Phoenix | Maricopa | 26-400619.0000 | Assured | 4/25/2002 |
| 34 | City of Show Low | Eastern Plateau | Little Colorado River Plateau | Navajo | 40-300412.0000 | Adequate | 4/15/1999 |
| 35 | City of St. Johns | Eastern Plateau | Little Colorado River Plateau | Apache | 40-900012.0000 | Adequate | 5/16/1973 |
| 36 | City of Surprise | AMA | Phoenix | Maricopa | 26-300431.0000 | Assured | 9/7/1999 |
| 37 | City of Tempe | AMA | Phoenix | Maricopa | 26-002043.0000 | Assured | 12/31/1997 |
| 38 | City of Tucson | AMA | Tucson | Pima | 26-400957.0000 | Assured | 6/12/2007 |
| 39 | City of Willcox | Southeastern Arizona | Willcox | Cochise | 40-900017.0000 | Adequate | 5/17/1973 |
| 40 | City of Winslow | Eastern Plateau | Little Colorado River Plateau | Navajo | 40-900018.0000 | Adequate | 5/17/1973 |
| 41 | City of Yuma | Lower Colorado | Yuma | Yuma | 40-900019.0000 | Adequate | 5/17/1973 |
| 42 | Copper Mountain Communities Facilities District (City of Casa Grande) | AMA | Pinal | Pinal | 26-400728.0000 | Assured | 7/21/2003 |
| 43 | Empirita Water Company, LLC | Southeastern Arizona | Cienega Creek | Cochise | 41-401435.0001 | Adequate | 12/10/2008 |
| 44 | Flowing Wells Irrigation District | AMA | Tucson | Pima | 26-700470.0000 | Assured | 4/14/2009 |
| 45 | Golden Valley Water Improvement District | Upper Colorado | Sacramento Valley | Mohave | 40-900004.0000 | Adequate | 7/13/1995 |
| 46 | Havasu Heights Domestic Water Improvement Distr | Upper Colorado | Sacramento Valley | Mohave | 40-700420.0000 | Adequate | 5/8/2008 |
| 47 | Johnson Utilities L.L.C. - Phoenix | AMA | Phoenix | Pinal | 86-400665.0001 | Assured | 1/2/2009 |
| 48 | Johnson Utilities L.L.C. - Pinal | AMA | Pinal | Pinal | 86-401382.0001 | Assured | 12/1/2008 |
| 49 | Joshua Valley Utility Company | Upper Colorado | Sacramento Valley | Mohave | 40-900006.0000 | Adequate | 7/26/1985 |
| 50 | Little Park Water Company | Central Highlands | Verde Valley | Yavapai | 41-400324.0001 | Adequate | 5/7/2009 |

## Table 1-10 Designated water providers in Arizona as of May 2010 (cont)

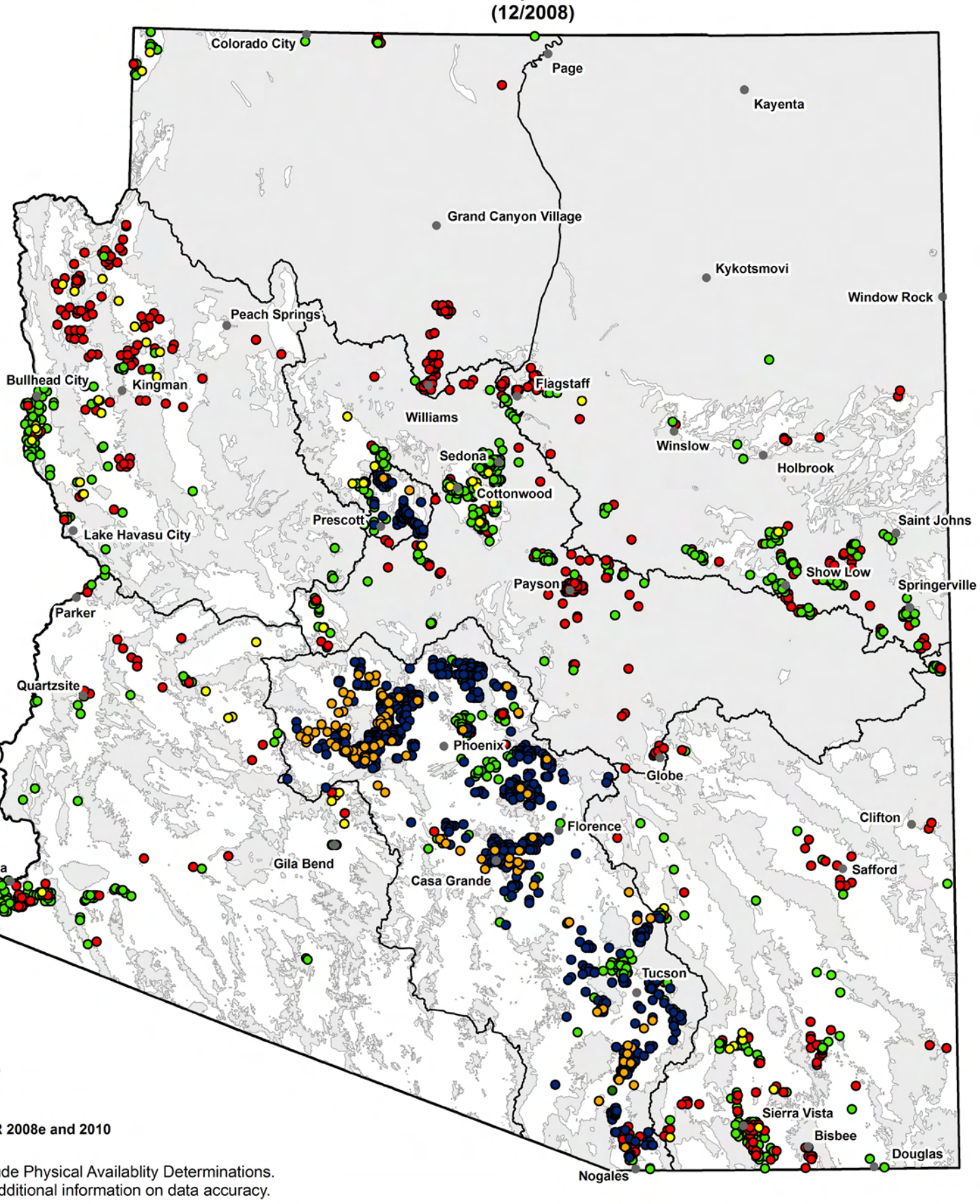
| Map Key | Water Provider Name | Planning Area | Groundwater Basin | County | Designation | | |
|---|---|---|---|---|---|---|---|
| | | | | | Number | Type | Issue Date |
| 51 | Livco Water Company | Eastern Plateau | Little Colorado River Plateau | Apache | 40-700641.0000 | Adequate | 4/8/2010 |
| 52 | Metro Water District - West | AMA | Tucson | Pima | 26-401922.0000 | Assured | 9/25/2006 |
| 53 | Metropolitan Domestic Water | AMA | Tucson | Pima | 26-401062.0000 | Assured | 7/31/2006 |
| 54 | Park Valley Water Company, Inc and Fools Hollow | Eastern Plateau | Little Colorado River Plateau | Navajo | 40-402065.0000 | Adequate | 10/16/2007 |
| 55 | Pineview Water Company, Inc. | Eastern Plateau | Little Colorado River Plateau | Navajo | 40-402066.0000 | Adequate | 9/20/2007 |
| 56 | Sahuarita Water Company LLC | AMA | Tucson | Pima | 86-401203.0001 | Assured | 1/27/2009 |
| 57 | Santa Cruz Water Company | AMA | Pinal | Pinal | 26-402008.0000 | Assured | 12/27/2007 |
| 58 | Snowflake Municipal Water Company | Eastern Plateau | Little Colorado River Plateau | Navajo | 40-401841.0000 | Adequate | 1/17/2006 |
| 59 | Sopori Domestic Water Improvement District | AMA | Santa Cruz | Santa Cruz | 26-700558.0000 | Assured | 3/30/2010 |
| 60 | Spanish Trail Water Company | AMA | Tucson | Pima | 86-700205.0000 | Assured | 1/5/2009 |
| 61 | Town of Florence | AMA | Pinal | Pinal | 26-401284.0000 | Assured | 1/25/2005 |
| 62 | Town of Gilbert | AMA | Phoenix | Maricopa | 26-402208.0000 | Assured | 10/30/2007 |
| 63 | Town of Marana | AMA | Tucson | Pima | 26-402254.0000 | Assured | 5/7/2007 |
| 64 | Town of Oro Valley | AMA | Tucson | Pima | 26-400765.0000 | Assured | 6/26/2003 |
| 65 | Town of Parker | Lower Colorado | Parker | La Paz | 40-900010.0000 | Adequate | 5/17/1973 |
| 66 | Town of Quartzsite | Lower Colorado | Parker | La Paz | 40-500041.0000 | Adequate | 3/14/2008 |
| 67 | Town of Springerville | Eastern Plateau | Little Colorado River Plateau | Apache | 40-900013.0000 | Adequate | 5/17/1973 |
| 68 | Town of Taylor | Eastern Plateau | Little Colorado River Plateau | Navajo | 40-900014.0000 | Adequate | 12/21/1982 |
| 69 | Town of Wickenburg | Central Highlands | Upper Hassayampa | Maricopa | 40-900016.0000 | Adequate | 5/17/1973 |
| 70 | Tubac Water Company, Inc | AMA | Santa Cruz | Santa Cruz | 26-700409.0000 | Assured | 12/10/2008 |
| 71 | Vail Water Company | AMA | Tucson | Pima | 26-401752.0000 | Assured | 11/10/2005 |
| 72 | Valley Pioneers Water Company | Upper Colorado | Sacramento Valley | Mohave | 40-900015.0000 | Adequate | 2/1/1995 |
| 73 | Voyager at White Mountain Lakes Water Company | Eastern Plateau | Little Colorado River Plateau | Navajo | 40-700359.0000 | Adequate | 2/19/2008 |
| 74 | Walnut Creek Water Company | Upper Colorado | Sacramento Valley | Mohave | 40-401425.0000 | Adequate | 6/27/2005 |
| 75 | Wickenburg Ranch Water Co., LLC | Central Highlands | Upper Hassayampa | Yavapai | 40-700417.0000 | Adequate | 2/11/2008 |
| 76 | Willow Springs Utilities, LLC | AMA | Tucson | Pinal | 26-402225.0000 | Assured | 4/15/2008 |

Source: ADWR 2010

# Figure 1-22
# Assured and Adequate Water Supply Determinations and Designations in Arizona*




Assured Water Supply Designation
Adequate Water Supply Designation
Certificate of Assured Water Supply
Analysis of Assured Water Supply
Water Report (Adequate)
Water Report (Inadequate)
Analysis of Adequate Water Supply
Consolidated Crystalline & Sedimentary Rocks
Unconsolidated Sediments
Planning Area Boundary
City, Town or Place



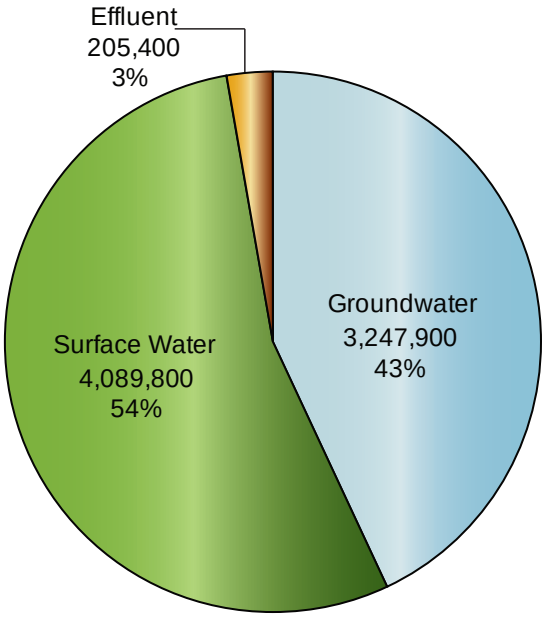

Sources: ADWR 2008e and 2010

*Does not include Physical Availablity Determinations.
See table for additional information on data accuracy.

### 1.4.6 Water Supplies

Arizona's water supplies include water from the Colorado River (including Central Arizona Project water), instate surface water, groundwater and reclaimed water or effluent. Water supply availability and use varies substantially throughout the State's planning areas as shown in Figure 1-30. The average annual percentage and volume of surface water (Colorado River and instate surface water), groundwater, and effluent utilized from 2001-2005 is shown in Figure 1-23. Statewide, water diverted from streams has been the largest supply used, however groundwater is the dominant supply in most planning areas. While groundwater levels in wells may vary over time, groundwater is generally a reliable water supply in most parts of the state while in-state surface water supplies may fluctuate widely from year to year due to precipitation variability. Effluent reuse is increasing and although it represented just 3% of the total water supply in Arizona, it was an important supply in some planning areas. In some areas, water quality conditions, including designated sites of environmental contamination, affect the use of certain water supplies.

**Figure 1-23 Average Annual Water Supplies Utilized in Arizona, 2001-2005 (in AF and % of total)**




Colorado River Water and the Central Arizona Project

Colorado River water supplies derive primarily from snow in the Rocky Mountains of Wyoming, Colorado, and Utah. Arizona has an annual allotment of 2.8 maf of Colorado River water for consumptive use. Consumptive use (CU) is defined here as diversions from the mainstream of the Colorado River minus returns. The right or authorization to beneficially use Colorado River water is defined as an entitlement. Entitlements are created by decree, through a contract with the Secretary of the Interior (Secretary) or by Secretarial reservation (See Appendices C and D). Of the state's total Colorado River allotment, over 1.3 maf is available for use by municipal, industrial and agricultural users along the Colorado River in the Upper and Lower Colorado River planning areas. A summary of Arizona v. California decree accounting and entitlements are listed in Table 1-11 for basins in these planning areas. In addition, the Navajo Generating Station and the community of Page in the Eastern Plateau Planning Area divert water from Lake Powell for municipal and industrial use pursuant to Arizona's 50,000 AFA Upper Basin allocation. (BOR, 2007) The remaining amount of Colorado River water may be diverted annually via the CAP delivery system to users in the Phoenix, Tucson and Casa Grande areas (shown on Figure 1-1). CAP water is diverted from the Colorado River at Lake Havasu into

*CAP Canal, Phoenix AMA*

## Table 1-11 Arizona v. California Decree accounting of the consumptive use of Colorado River water in Arizona (in acre-feet/year)

| Basin/Year [1] | 1971-75 | 1976-80 | 1981-85 | 1986-90 | 1991-95 | 1996-00 | 2001-05 [2] | Current Entitlement[3] |
|---|---|---|---|---|---|---|---|---|
| Bill Williams | | | | | | | | |
| *Agricultural* | None | | | | | | | 0 |
| *Industrial* | None | | | | | | | 0 |
| *Municipal* | 0 | 0 | 0 | 0 | 20 | 18 | 24 | 84 |
| *Environmental* | None | | | | | | | 0 |
| Detrital Valley | | | | | | | | |
| *Agricultural* | None | | | | | | | 0 |
| *Industrial* | None | | | | | | | 0 |
| *Municipal* | 0 | 0 | 0 | 0 | 116 | 146 | 104 | Unspecified |
| *Environmental* | None | | | | | | | 0 |
| Lake Havasu | | | | | | | | |
| *Agricultural* | None | | | | | | | 0 |
| *Industrial* | None | | | | | | | 0 |
| *Municipal* | 5,554 | 8,075 | 8,872 | 11,604 | 13,376 | 15,053 | 13,013 | 29,254 |
| *Environmental* [4] | 14,300 | 14,064 | 7,828 | 15,456 | 15,927 | 12,561 | 5,306 | 16,317 |
| Lake Mohave | | | | | | | | |
| *Agricultural* | 20,209 | 47,172 | 73,885 | 83,109 | 96,123 | 107,700 | 72,326 | 144,535 |
| *Industrial* | 216 | 220 | 158 | 103 | 80 | 0 | 0 | 175 |
| *Municipal* | 295 | 298 | 581 | 6,062 | 7,857 | 9,669 | 8,851 | 44,192 |
| *Environmental* [4] | 14,300 | 14,064 | 7,828 | 15,456 | 15,927 | 12,561 | 5,306 | 16,317 |
| Lower Gila | | | | | | | | |
| *Agricultural* [6] | 309,367 | 209,015 | 258,612 | 312,237 | 241,267 | 278,826 | 260,818 | 272,980 |
| *Industrial* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Municipal* | 2 | 5 | 6 | 7 | 19 | 62 | 80 | 265 |
| *Environmental* [5] | 40 | 59 | 22 | 743 | 1,800 | 1,773 | 665 | 6,262 |
| Parker | | | | | | | | |
| *Agricultural* | 334,058 | 354,197 | 338,033 | 407,512 | 425,204 | 429,193 | 389,668 | 693,486 |
| *Industrial* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Municipal* | 829 | 1,070 | 1,770 | 1,815 | 1,891 | 2,339 | 1,876 | 8,004 |
| *Environmental* [4] | 148 | 13,128 | 8,768 | 11,822 | 19,719 | 18,368 | 11,785 | 56,238 |
| Sacramento Valley | | | | | | | | |
| *Agricultural* | None | | | | | | | 0 |
| *Industrial* | None | | | | | | | 0 |
| *Municipal* | None | | | | | | | 0 |
| *Environmental* [4] | 8,066 | 7,934 | 4,416 | 8,719 | 8,984 | 7,086 | 2,993 | 9,205 |
| Yuma | | | | | | | | |
| *Agricultural* [6] | 676,165 | 631,711 | 564,313 | 571,245 | 543,251 | 560,581 | 457,679 | 582,257 |
| *Industrial* | 1,046 | 1,021 | 839 | 610 | 469 | 2,250 | 674 | 1,772 |
| *Municipal* | 13,272 | 10,146 | 12,174 | 13,137 | 15,255 | 21,625 | 21,296 | 54,945 |
| *Environmental* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTAL** | 1,397,867 | 1,312,178 | 1,288,105 | 1,459,633 | 1,407,284 | 1,479,812 | 1,252,464 | 1,405,907 |
| *Central Arizona Project* [7] | 0 | 0 | 33,502 | 499,917 | 717,514 | 1,330,109 | 1,555,215 | Unspecified |

Source: USBOR 2003-2009

**Notes:**

[1] Where the reported consumptive use for individual users does not cover an entire 5-year period, the average is based on the years of record.

[2] In 2003, the United States Bureau of Reclamation began deducting unmeasured return flows from the diversions by individual diverters. Prior to this time, Reclamation only deducted the total amount of unmeasured return flow from the total Lower Basin diversions.

[3] Entitlement amounts do not include 72,000 AFA for the Ak-Chin (50,000 AFA) and Salt River-Pima Maricopa Indian (22,000 AFA) water rights settlements, which are delivered by the CAP to reservations.

[4] The Havasu National Wildlife Refuge spans an area that is located in the Lake Mohave, Lake Havasu, and Sacamento Valley basins; Consumptive use has been prorated based on the percentage of the refuge land in each basin.

[5] The Imperial National Wildlife Refuge spans the Parker and Lower Gila basins; consumptive use has been prorated based on the percentage of refuge land in each basin.

[6] The Wellton-Mohawk Irrigation and Drainage District (IDD) spans the Lower Gila and Yuma basins. Consumptive use has been prorated based on the percentage of IDD land area in each basin.

[7] The CAP diverts water out of Lake Havasu at the Mark Wilmer Pumping Plant located in the Bill Williams Basin. The water has multiple uses in Maricopa, Pinal, and Pima counties.

a 336-mile aqueduct system that lifts the water more than 2,900 vertical feet through a series of pumping plants to users in central Arizona. The Central Arizona Water Conservation District (CAWCD) operates and maintains the CAP.

When Colorado River water allocations were identified in the Colorado River Compact in 1922, the river data showed an average annual "natural" flow of approximately 16.4 maf at Lees Ferry below Lake Powell (See Appendix D). Natural flow is the flow without cultural depletions. A tree-ring based assessment completed in 2005 found that for the period 1521-1964, the mean annual flow at Lees Ferry was about 14.2 maf (Hirschboeck and Meko, 2005). The Bureau of Reclamation's current estimate of natural flow for the period 1906 through 2007 is about 15 maf and their natural flow data show a low of approximately 5.6 maf in 1977 and a high of 25.2 maf in 1984. This situation highlights the importance of the Colorado River dams and reservoirs to store water for use during dry periods. Currently, the Lower Basin (Arizona, California and Nevada) is fully utilizing its 7.5 maf annual allocation. Upper Basin (Colorado, New Mexico, Utah and Wyoming) annual demand is approximately 4.2 maf and Mexico is utilizing its full 1.5 maf annual apportionment.

There is a priority system associated with Colorado River contracts in the event of shortages of supply. Contract priority is an important consideration in water resource planning (see Volumes 4 and 7). The first water to be shorted within Arizona is the CAP and water users of similar priority along the mainstream of the Colorado River. The Arizona Water Banking Authority (AWBA) was established in 1996 to store unused Colorado River water to meet future needs. The AWBA enabled Arizona to use its full allocation earlier than expected and stores water to be used in times of shortage to firm water supplies for Arizona. The primary functions of the AWBA are discussed in Appendix C.

*Salt River, Phoenix AMA. The Salt, Verde and Gila rivers are essential supplies for water users in central Arizona.*

Surface Water

Arizona surface water supplies derive chiefly from snow along the Mogollon Rim and high elevation mountains of east central Arizona and western New Mexico. The Salt, Verde and Gila rivers are essential supplies for water users in central Arizona. The Salt River Project (SRP), through the Salt River Valley Water Users' Association, annually delivers a total of almost 1 maf of surface water from the Salt and Verde rivers and groundwater to its service area in the Phoenix AMA. SRP manages several dams on the Salt and Verde rivers that produce hydroelectricity and has substantial surface water right claims in the Salt and Verde watersheds. Water supplies utilized by the towns of Cottonwood, Clarkdale, Camp Verde, Payson and others are derived from the watersheds of the Salt and Verde rivers. The water supplies of the upper Gila River communities of Safford, Thatcher and others are impacted by senior surface water rightholders downstream of their communities; the Globe-Equity Decree and by Indian water rights settlements (see Appendices C and G).

Other surface water supplies utilized in Arizona include diversions from the Little Colorado River, San Pedro River, Bonita Creek and other smaller streams, runoff stored in local reservoirs and springs. These supplies may be more drought sensitive than the larger regional

systems. Communities that utilize local surface water supplies include Eagar, Flagstaff, Jerome, Tombstone and Williams. The Morenci Mine in the Morenci Basin uses surface water transported from the adjacent Salt River Basin in the Central Highlands Planning Area. Surface water is used for agricultural irrigation in every planning area, either from a local or regional source or from the Colorado River.

The legal availability of a surface water supply is an important consideration. As described in detail in Appendix H, the legal framework and process under which surface water right applications and claims are administered and determined is complex. Each type of surface water right filing has been assigned a unique number as explained in Appendix H and listed in Table 1-12 by planning area. The act of filing a statement of claim of right to use public waters (36) does not in itself create a water right. Arizona has two general stream adjudications in progress to determine the nature, extent and priority of water rights across the entire river systems of the Gila River and the Little Colorado River (LCR). Figure 1-24 shows the location of surface water diversion points listed in the Department's surface water rights registry. Locations of registered wells, many of which are referenced as the basis of claim in adjudication Statement of Claimants (SOCs) are also shown in Figure 1-24.

Groundwater

With the exception of the Lower Colorado River and AMA planning areas, groundwater is the primary water supply utilized for cultural uses, accounting for approximately 43% of the state's total water supply annually during 2001-2005. While a number of hydrologic studies and groundwater models have been completed in the AMAs, there is often less known about the groundwater conditions outside AMAs where fewer comprehensive studies have been done.

The Department conducts water level and water quality measurements periodically statewide

**Table 1-12 Count of surface water right and adjudication filings by planning area[1]**

| PLANNING AREA | TYPE OF FILING | | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | BB[2] | 3R[3] | 4A[3] | 33[3] | 36[4] | 38[5] | 39[6] | |
| Eastern Plateau | 134 | 163 | 196 | 373 | 3,289 | 3,275 | 12,099 | **19,529** |
| Southeastern Arizona | 483 | 395 | 716 | 898 | 8,288 | 6,415 | 19,288 | **36,483** |
| Upper Colorado River | 0 | 224 | 329 | 469 | 2,858 | 2,084 | 0 | **5,964** |
| Central Highlands | 1 | 287 | 625 | 897 | 8,517 | 3,928 | 25,443 | **39,698** |
| Western Plateau | 0 | 415 | 207 | 554 | 1,177 | 1,270 | 324 | **3,947** |
| Lower Colorado River | 0 | 26 | 48 | 86 | 355 | 304 | 2,323 | **3,142** |
| Active Management Areas | 1 | 269 | 341 | 687 | 4,072 | 2,913 | 27,134 | **35,417** |
| **Total** | **619** | **1,779** | **2,462** | **3,964** | **28,556** | **20,189** | **86,611** | **144,180** |

**Notes:**

[1] Based on a query of ADWR's surface water right and adjudication registries in February 2009. A file is only counted in this table if it provides sufficient information to allow a Point of Diversion (POD) to be mapped within the planning area. If a file lists more than one POD in a given planning area, it is only counted once in the table for that planning area. Several surface water right and adjudication filings are not counted here due to insufficient locational information. However, multiple filings for the same POD are counted.

[2] Court decreed rights; not all of these rights have been identified and/or entered into ADWR's surface water rights registry.

[3] Application to construct a reservoir, filed before 1972 (3R); application to appropriate surface water, filed before 1972 (4A); and application for permit to appropriate public water or construct a reservoir, filed after 1972 (33).

[4] Statement of claim of rights to use public waters of the state, filed pursuant to the Water Rights Registration Act of 1974.

[5] Claim of water right for a stockpond and application for certification, filed pursuant to the Stockpond Registration Act of 1977.

[6] Statement of claimant, filed in the Gila or LCR General Stream Adjudications.

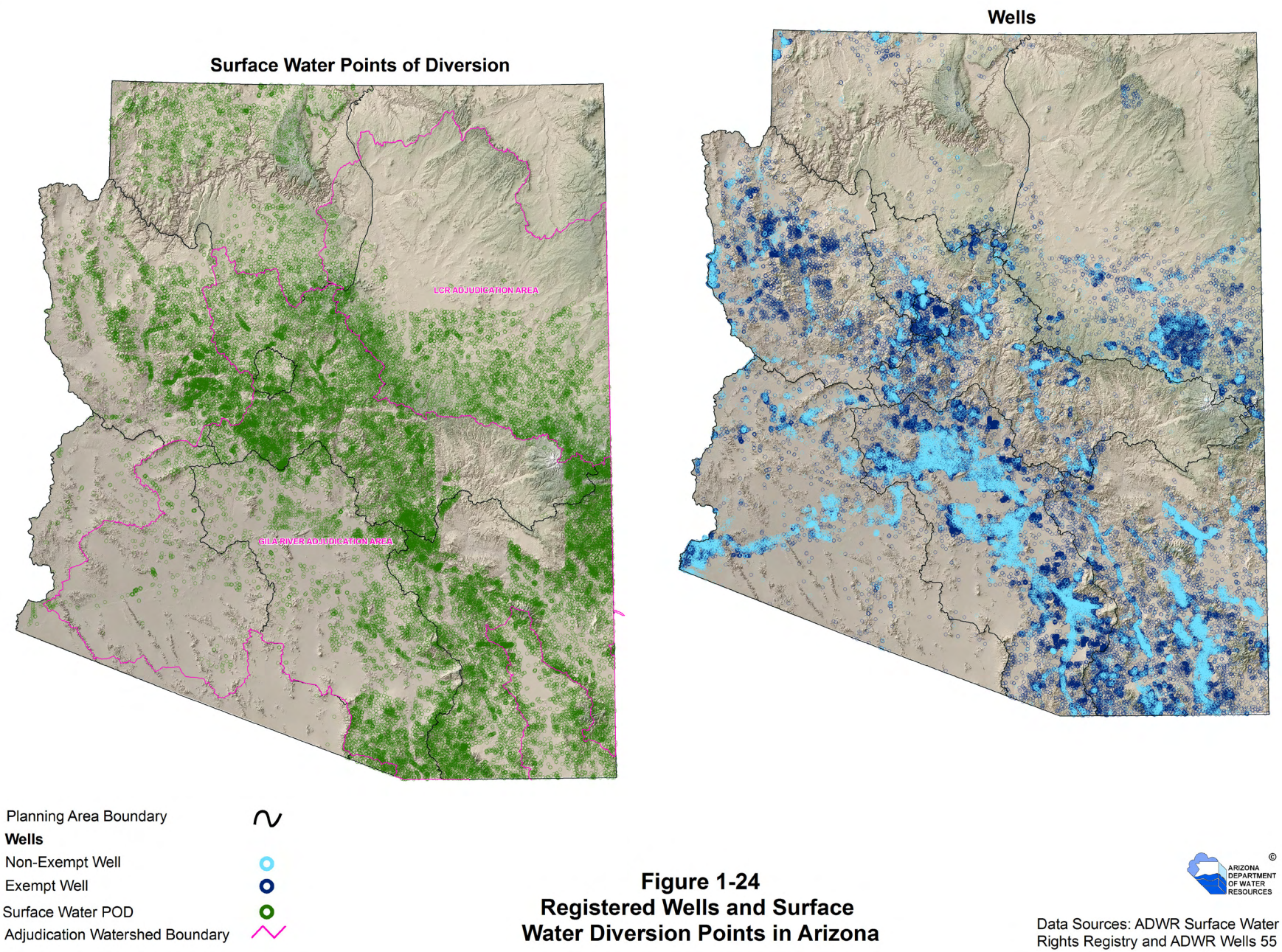



**Figure 1-24**
**Registered Wells and Surface Water Diversion Points in Arizona**

and maintains a repository for statewide groundwater well data, the Groundwater Site Inventory (GWSI) database, available on the Department's website (www.azwater.gov). The database includes well log data and historic groundwater level records. Approximately 1,700 wells are designated as Index Wells statewide out of over 43,700 GWSI sites and are typically measured once each year by the Department (Figure 1-25). The Department also operates a network of about 120 automated groundwater monitoring sites throughout the state. Hydrographs for Index Wells and Automated Groundwater Monitoring Sites are also available on the Department's website.

As discussed in Section 1.4.2, some areas of the state have relatively deep basin-fill aquifers with substantial amounts of groundwater in storage. This is generally true for the southern part of Arizona including much of the Pinal, Phoenix and Tucson AMAs. In other areas however, hydrologic conditions are less favorable. Aquifers may be alluvial or unproductive, particularly in mountainous areas, or depth to groundwater may be very great. This is the case in the Payson area and in much of the Santa Cruz AMA, where thin alluvial or fractured rock aquifers make them sensitive to precipitation events and susceptible to drought. Poor water quality can also be an issue. For example, some of

*Automated well in the Prescott AMA*

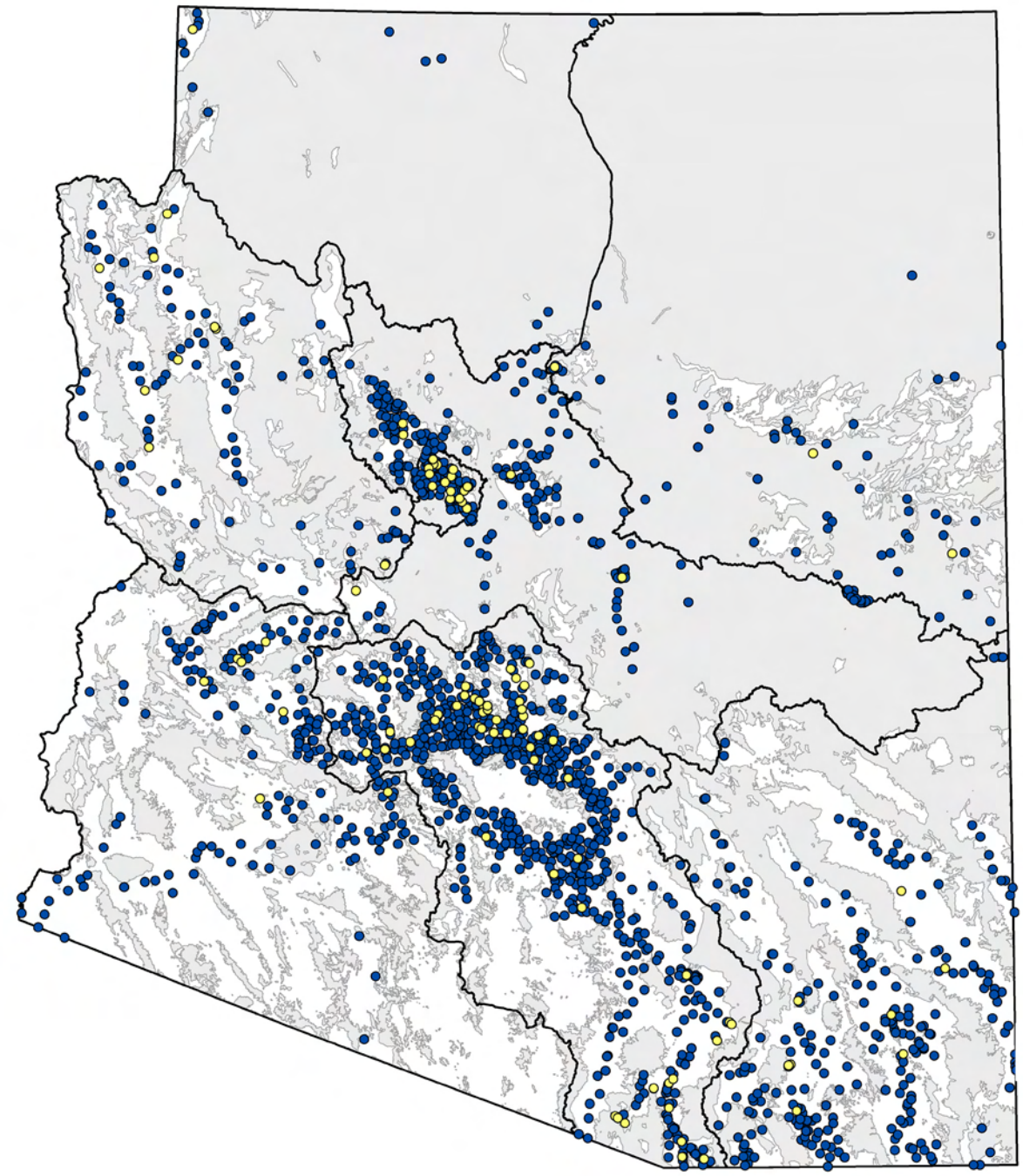
*Effluent recharge in the Phoenix AMA.*

the regional aquifers of the Eastern Plateau are characterized by high levels of total dissolved solids, and may be unsuitable for use without treatment.

As drought and growth stress the availability of surface water supplies, communities that historically have relied on surface water are exploring groundwater resource options including drilling additional wells and acquiring land for wellfield development.

Effluent

Access to renewable water supplies, especially outside of the AMAs, may be physically or legally limited. An exception is reclaimed water or effluent, which increases with population growth served by a sewer system. Effluent has met up to 8% of the municipal demand and 27% of the agricultural demand in the Eastern Plateau Planning Area and 28% of the industrial demand in the AMA Planning Area. Table 1-13 summarizes recent effluent use by planning area. While the percentage of reporting treatment facilities is low in some planning areas, data are available for the largest facilities. Of the 53% of total facilities for which treatment volumes and reuse data are available, 53% of that effluent has been reused primarily for turf irrigation, groundwater recharge, agricultural irrigation and for cooling purposes at the Palo Verde Nuclear Generating Station in the Phoenix AMA. The highest per-



Index Well
Automated Well
Consolidated Crystalline & Sedimentary Rocks
Unconsolidated Sediments
Planning Area Boundary

**Figure 1-25**
**ADWR Index and Automated Wells in 2008**

ARIZONA DEPARTMENT OF WATER RESOURCES ©

Source: ADWR GWSI

**Table 1-13 Annual effluent generation and use by planning area (c. 2006)**

| Planning Area | Percent of Reporting Facilities[1] | Volume Generated (acre-feet) | Direct Use[2] (acre-feet) | Permitted Recharge Facility Storage[3] (acre-feet) | Created Wetland Delivery[4] (acre-feet) | Disposal[5] (acre-feet) | % use by reporting facilities |
|---|---|---|---|---|---|---|---|
| Eastern Plateau Planning Area | 83% | 36,100 | 14,900 | 0 | 2,700 | 18,500 | 49% |
| Southeastern Arizona Planning Area | 86% | 10,600 | 1,670 | 2,000 | 0 | 6,930 | 35% |
| Upper Colorado River Planning Area | 53% | 8,700 | 3,400 | 0 | 0 | 5,300 | 39% |
| Central Highlands Planning Area | 48% | 9,300 | 1,200 | 300 | 426 | 7,374 | 21% |
| Western Plateau Planning Area | 71% | 2,200 | 300 | 0 | 0 | 1,900 | 14% |
| Lower Colorado River Planning Area | 58% | 16,700 | 1,600 | 0 | 0 | 15,100 | 10% |
| Active Management Areas | 43% | 419,346 | 200,700 | 34,000 | 1,350 | 183,296 | 56% |
| *Phoenix AMA* | *42%* | *315,000* | *177,200* | *13,100* | *1,350* | *123,350* | *61%* |
| *Pinal AMA* | *33%* | *6,900* | *4,800* | *600* | *0* | *1,500* | *78%* |
| *Prescott AMA* | *67%* | *6,900* | *2,700* | *3,600* | *0* | *600* | *91%* |
| *Santa Cruz AMA* | *50%* | *16,311* | *0* | *0* | *0* | *16,311* | *0%* |
| *Tucson AMA* | *42%* | *74,235* | *16,000* | *16,700* | *0* | *41,535* | *44%* |
| **Arizona Total** | **53%** | **502,946** | **223,770** | **36,300** | **4,476** | **238,400** | **53%** |

Various sources, see Arizona Water Atlas Volumes 2-8

[1] Facilities that have reported both volume generated and a disposal method.

[2] Includes effluent used for irrigation, golf courses, and industrial use. The Upper Colorado River Planning Area includes an estimated 200 af of use at the Bagdad Mine. According to the GRIC annual report, 10,686 af of effluent (through exchange) was used for irrigation in the Phoenix AMA by the GRIC during 2008. This additional use is not included here.

[3] Quantities delivered to constructed and managed facilities, minus annual recovery, evaporation and cut to the aquifer. The Fort Huachuca recharge facility in the Southeastern Arizona Planning Area and the Green Valley Park Lakes recharge facility in the Central Highlands Planning Area are not permitted, but the estimated volume recharged is listed..

[4] Created wetland accessible to the public that is not permitted as a recharge facility.

[5] Includes the following disposal methods: watercourse, evaporation pond, discharge to another facility and non-permitted infiltration basins.

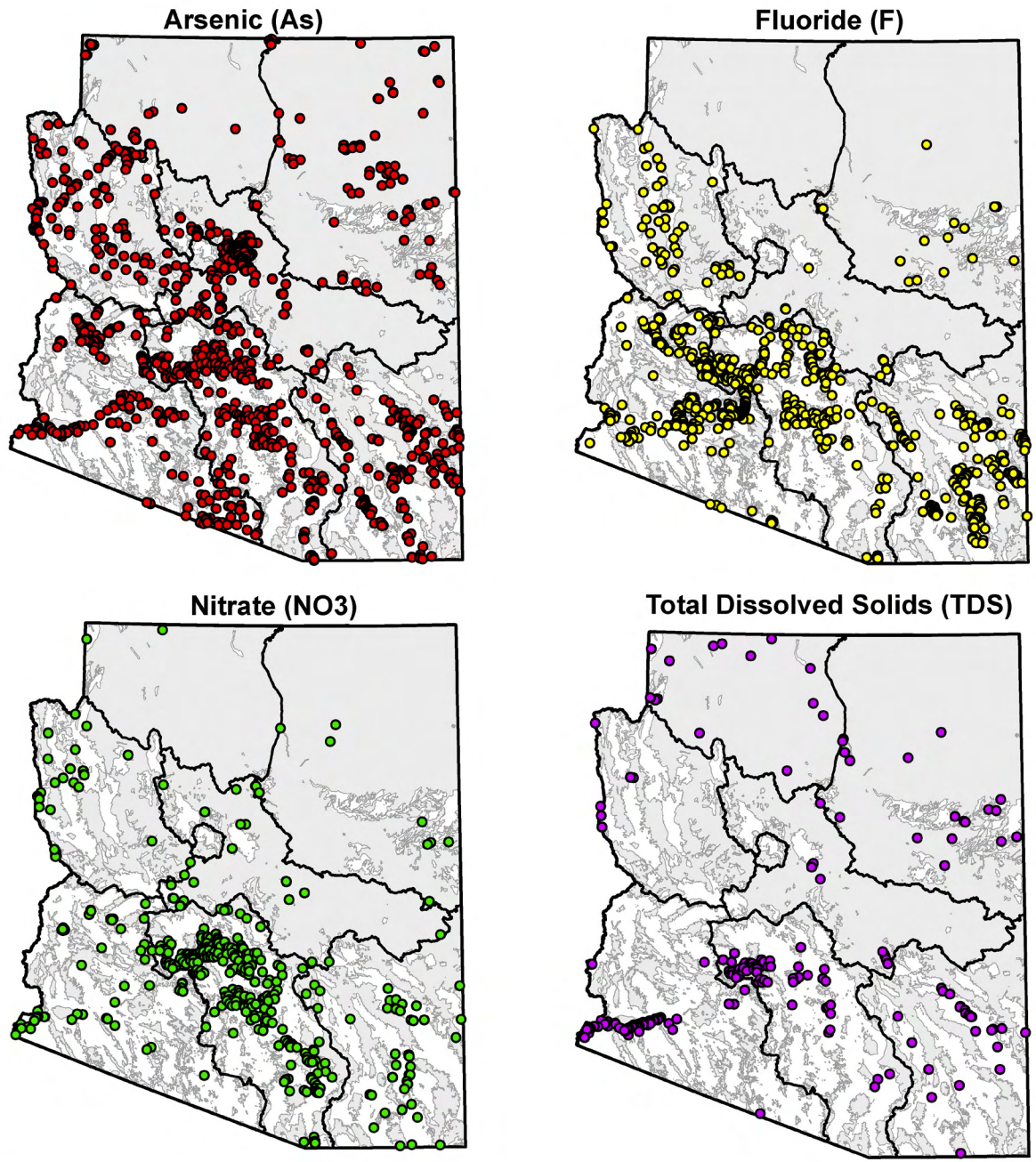
centage of reuse is in the Prescott AMA where 91% of the treated effluent is either recharged or used directly for golf course irrigation. A constraint on more reuse is that potential users, such as parks and golf courses, are often distant from treatment facilities and communities lack financing to construct the necessary delivery infrastructure.

Contamination Sites

Sites of environmental contamination and exceedences of drinking water standards (DWS) may impact the use of some water supplies. An inventory of primary DWS exceedences and Department of Defense (DOD), Leaking Underground Storage Tank (LUST), Resource Conservation and Recovery Act (RCRA), Superfund, Uranium Mill Tailings Remedial Action (UMTRA), Voluntary Remediation Program (VRP) and Water Quality Assurance Revolving Fund (WQARF), sites was conducted for each planning area. More information on water quality programs is found in Appendices C and D. Water quality and contamination site information is compiled in maps and tables in both the overview and basin sections of Atlas Volumes 2-8. The most commonly exceeded DWS constituents in Arizona are arsenic, fluoride and nitrate as shown on Figure 1-26. While there is no primary DWS for total dissolved solids (TDS), locations of concentrations in excess of 3,000 milligrams per liter (mg/L), which requires special well construction, are also shown on Figure 1-26. TDS levels in Arizona waters are typically elevated due to natural hydrogeologic factors or have resulted from irrigation practices. The location of contamination sites and impaired waters (a lake or stream not meeting one or more surface water quality standards as established in A.R.S. § 49-231) are shown on Figure 1-27.

### *1.4.7 Cultural Water Demand*

Cultural water demand refers to the quantity




## Figure 1-26
## Common Groundwater Quality Exceedances[1, 2]

**Sampling Location**

- As
- F
- NO3
- TDS[3]
- Consolidated Crystalline & Sedimentary Rocks
- Unconsolidated Sediments
- Planning Area Boundary

**Notes:**

1. Parameter concentrations equaled or exceeded drinking water quality standards. The information presented in this map may not indicate the quality of water supplied by public water systems which must comply with Federal and State water quality regulations.
2. A more comprehensive list of sampling data, obtained from a variety of sources, has been compiled and presented in Volumes 2 through 8 of the Water Atlas. Most samples were collected from groundwater wells, but includes some springs and mines.
3. Samples contained over 3,000 milligrams per liter (mg/L) of TDS and would require special well construction per Arizona Administrative Code (A.A.C.) R12-15-812(B). There is not a Primary Drinking Water Standard for TDS; however, the Secondary Drinking Water Standard is 500 mg/L.

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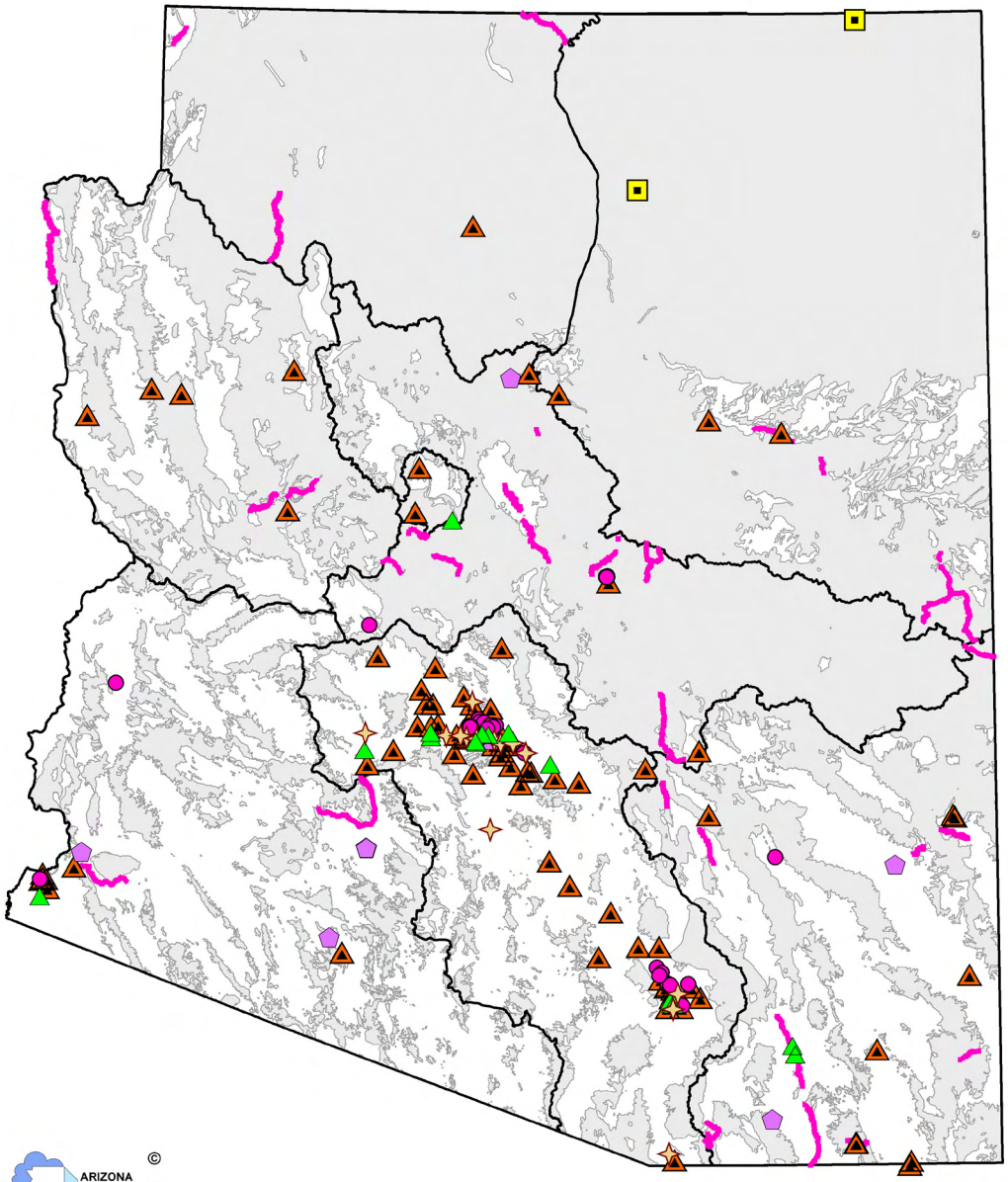
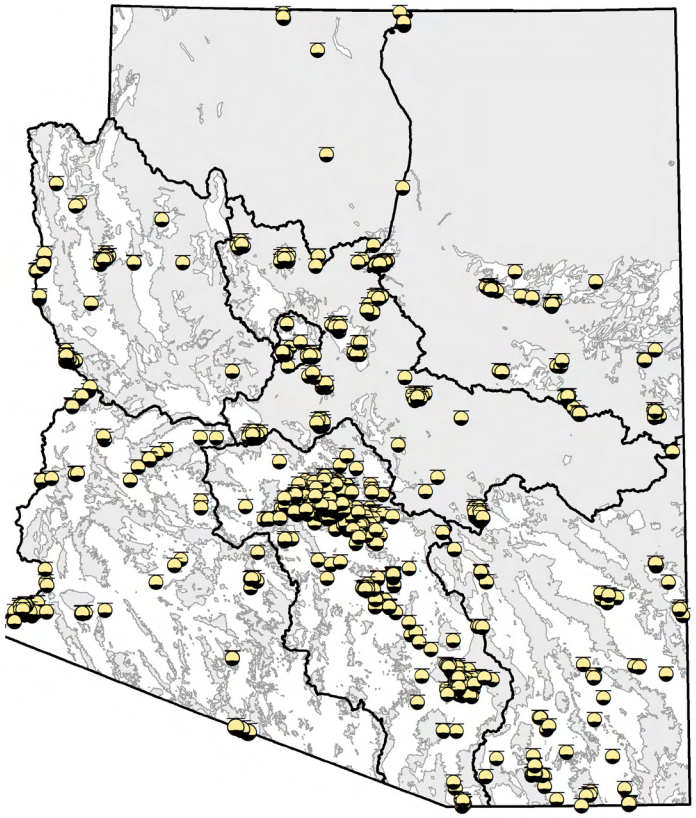
**Source: Compilation of data from ADWR and others.**

# Figure 1-27
# Contamination Sites in Arizona



- Leaking Underground Storage Tank (LUST)
- Superfund
- Water Quality Assurance Revolving Fund (WQARF)
- Resource Conservation and Recovery Act (RCRA) Site
- Department of Defense
- Voluntary Remediation Program (VRP)
- Uranium Mill Tailings Remedial Action (UMTRA)
- Impaired Stream or Lake
- Consolidated Crystalline & Sedimentary Rocks
- Unconsolidated Sediments
- Planning Area Boundary



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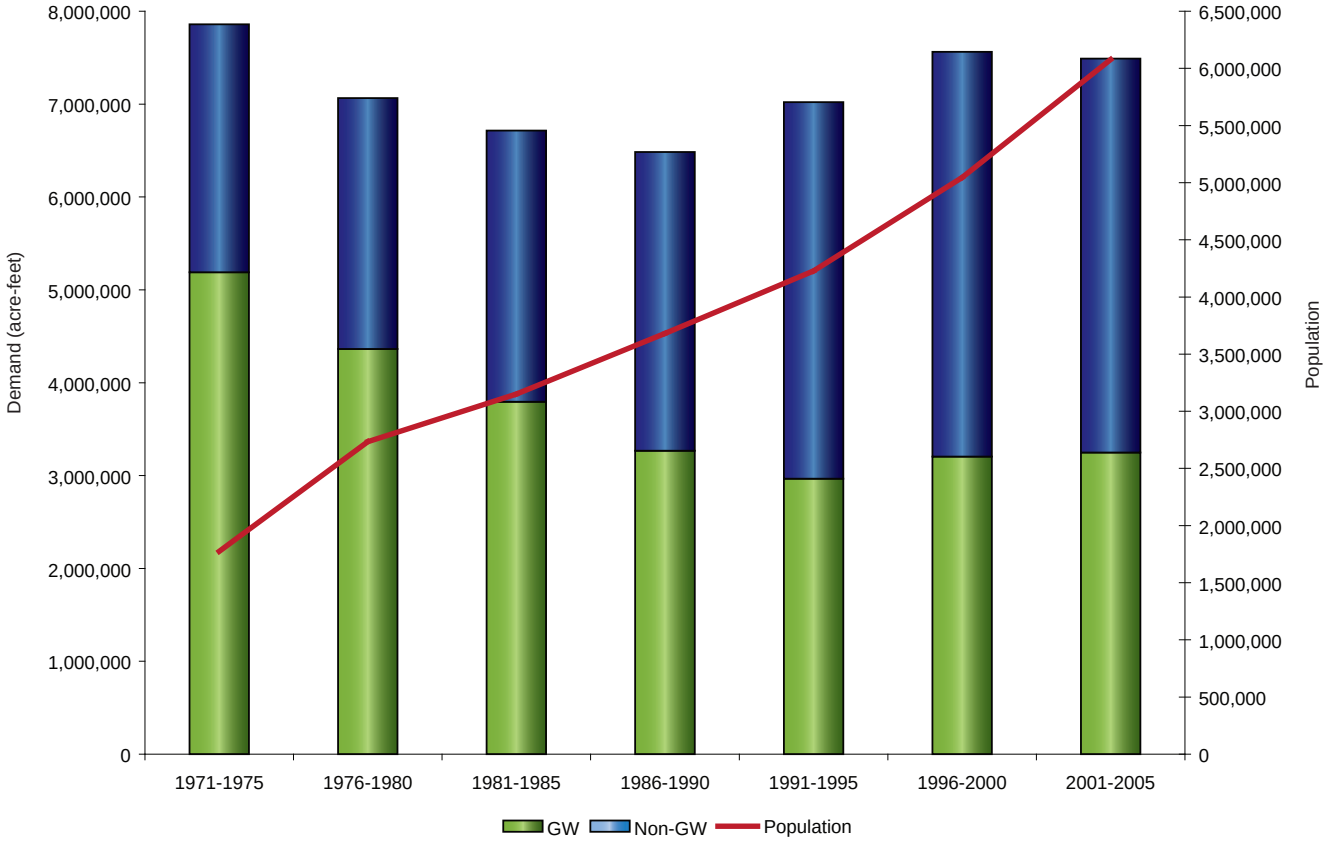
Data Source: ADEQ 2006

of water diverted from streams, reservoirs and springs; pumped from wells; or treated wastewater delivered for municipal, industrial and agricultural purposes (see also Section 1.3). Data presented here provide a general assessment of water demands in Arizona by municipal, agricultural and industrial users. These demand sectors are defined according to AMA regulatory definitions (see Definitions section). A general description of water demand data sources and methods is found in Appendix B and fully documented in each volume.

As shown graphically in Figure 1-28, while the population of Arizona has increased significantly, water demand statewide has declined or remained stable due to retirement of agricultural lands, increased water use efficiency and effluent reuse. In addition, use of non-groundwater supplies (CAP, effluent, and surface water) has increased substantially compared to pre-1990 levels, primarily due to importation of CAP water to central Arizona. Figure 1-29 shows the demand and water supply use trends in each planning area. Recent (2001-2005) AMA water demand is comparable to that in the early 1980s despite a doubling of population between the 1980 and 2000 census and use of non-groundwater supplies has increased by 52%. By contrast, demand in the Lower Colorado River, Upper Colorado River and Southeastern Arizona planning areas has increased from the early 1980s.

Average annual planning area water demand and the water supply used by each demand sector during 2001-2005 is shown in Figure 1-30 and summarized to the basin level in Table 1-14. These demands include water pumped from wells (including from the Colorado River

**Figure 1-28 Comparison of Arizona's Average Annual Water Demand to Its Population, 1971-2005**



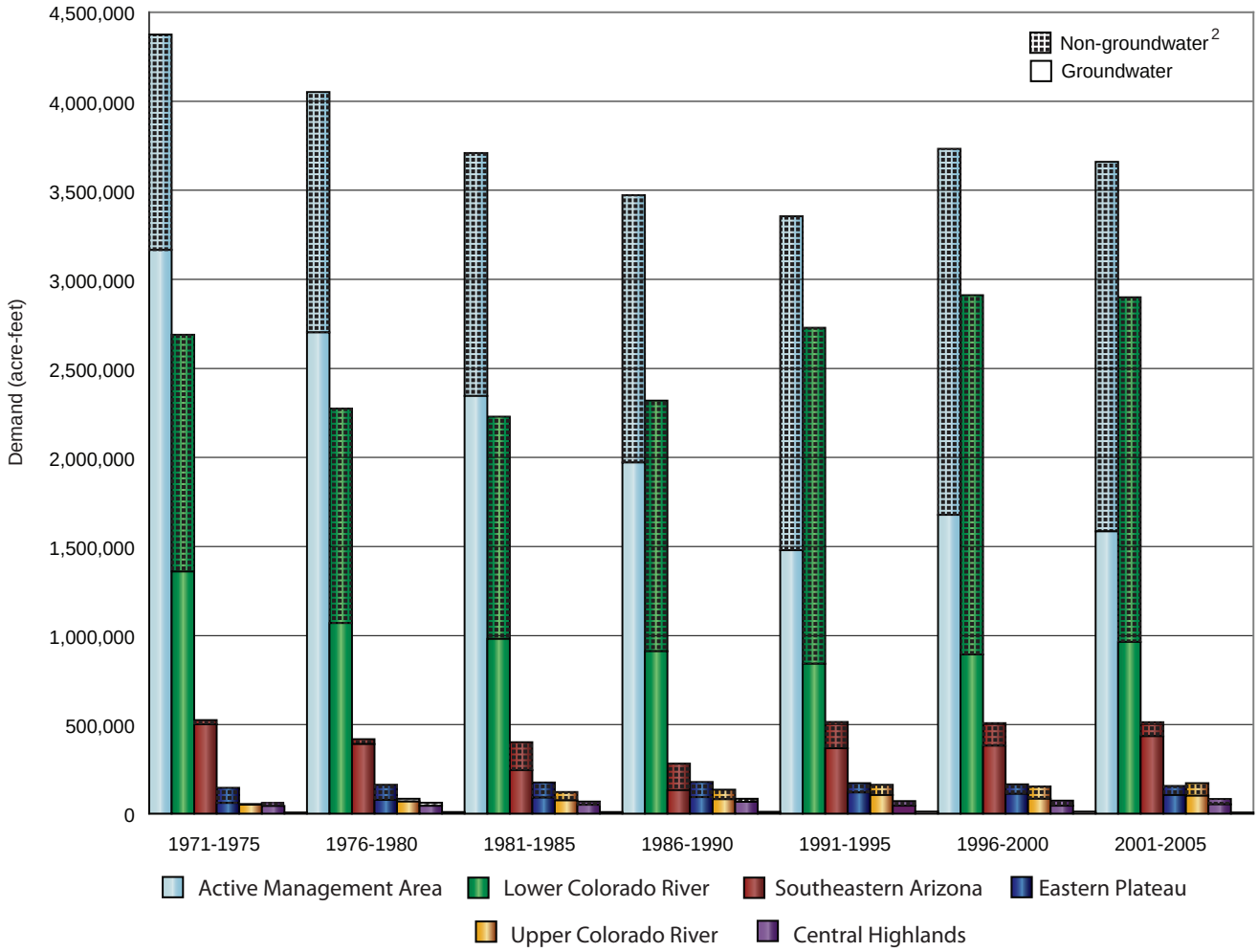

Various data sources, see Arizona Water Atlas Volumes 2-8

accounting surface), diverted from streams, and reused effluent. Water that returns to the Colorado River (return flow) for Colorado River contract accounting purposes (approximately 0.85 maf/year) in the Upper and Lower Colorado River planning areas (Table 1-11) is not subtracted from the total. The annual volume of water pumped and diverted during 2001-2005 was approximately 7.65 maf.

Water demand in the planning areas varies significantly by volume, water source and demand sector. Approximately half of the state's water demand occurs in the AMAs where non-groundwater supplies such as CAP and in-state surface water account for most of the municipal and agricultural water supply. CAP water use includes both direct use and CAP water used "in-lieu" of groundwater pumping by the agricultural sector and recovery of CAP recharge credits by municipal users.[5] A Groundwater Savings (GSF) Permit allows the permit holder to deliver the in-lieu water to the recipient who agrees to replace groundwater pumping with in-lieu water, creating a groundwater savings.

Municipal water demand centers, active agricultural lands and the general location of major industrial water users are shown on Figure 1-31. Average total water use in Arizona by demand sector for 2001-2005 is shown on Figure 1-32.

**Figure 1-29 Change in Average Annual Water Demand in Arizona Planning Areas[1]**




Various data sources, see Arizona Water Atlas Volumes 2-8
1 Water demand in the Western Plateau Planning Area is relatively small (<11,000 acre-feet) and not shown here due to scale.
2 Non-groundwater may include surface water, effluent, Central Arizona Project water and tailwater. In most basins outside of the AMAs, non-groundwater is surface water.

[5] In AMA water budgets,"in-lieu" CAP water is accounted for as a debit to the groundwater supply because credits are accrued by the storer that may be recovered in the future through groundwater pumping.

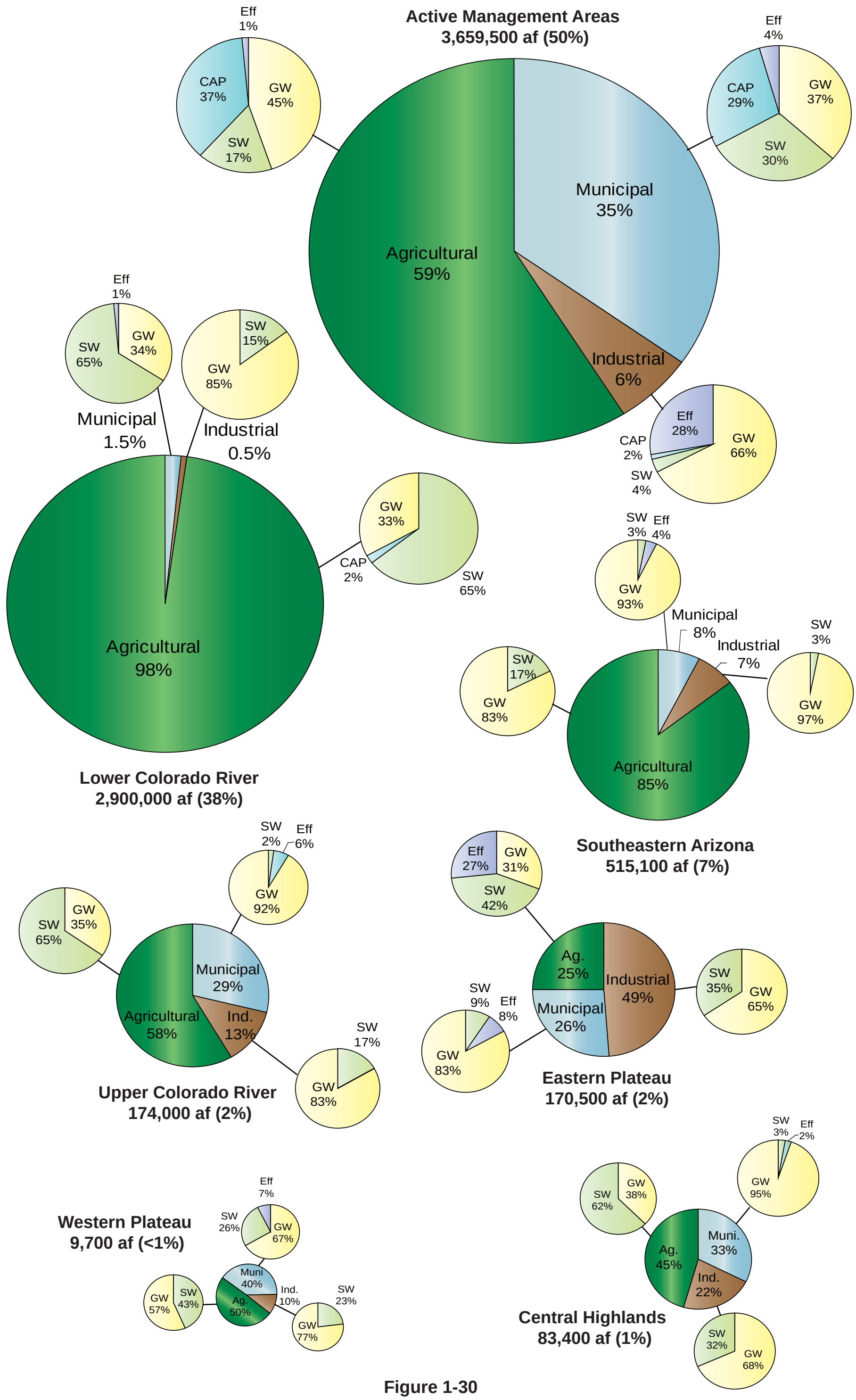



**Figure 1-30**
**Average Annual Planning Area Water Demand by Sector and Water Source During 2001-2005**

Source: ADWR 2008c

## Table 1-14 Average annual cultural water demand (2001-2005)[1]

| Basin | Total Number of Registered Water Supply Wells Drilled through 2005 | | Average Annual Demand (in acre-feet) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Well Pumpage | | | Surface Water Diversions[2] | | | Effluent | | |
| | Q ≤ 35 gpm | Q > 35 gpm | Municipal | Industrial | Agricultural | Municipal | Industrial | Agricultural | Municipal | Industrial | Agricultural |
| ***Eastern Plateau*** | | | | | | | | | | | |
| Little Colorado River | 7,990 | 1,657 | 37,300 | 54,407 | 13,100 | 4,100 | 28,707 | 18,000 | 3,600 | NR | 11,300 |
| **Sub-total** | **7,990** | **1,657** | **37,300** | **54,407** | **13,100** | **4,100** | **28,707** | **18,000** | **3,600** | **NR** | **11,300** |
| ***Southeastern Arizona*** | | | | | | | | | | | |
| Aravaipa Canyon | 192 | 50 | <300 | NR | <1,000 | NR | NR | <1,000 | NR | NR | NR |
| Bonita Creek | 12 | 15 | 3,200 | NR | NR | NR | NR | NR | NR | NR | NR |
| Cienega Creek | 1,874 | 169 | 600 | <300 | 500 | NR | NR | NR | NR | NR | NR |
| Donnelly Wash | 140 | 6 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| Douglas | 1,666 | 899 | 5,500 | NR | 47,300 | NR | NR | NR | NR | NR | NR |
| Dripping Springs | 119 | 40 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| Duncan Valley | 866 | 325 | 600 | 300 | 10,000 | NR | NR | 9,900 | NR | NR | NR |
| Lower San Pedro | 1,630 | 398 | 2,300 | 15,900 | 7,500 | 300 | NR | <1,000 | 145 | NR | NR |
| Morenci | 505 | 145 | 1,400 | 8,200 | NR | 600 | 1,100 | NR | NR | NR | NR |
| Safford | 2,698 | 2,278 | 3,300 | 800 | 120,400 | NR | NR | 61,300 | 500 | NR | NR |
| San Bernardino | 164 | 12 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| San Rafael | 224 | 26 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| Upper San Pedro | 5,021 | 1,106 | 17,300 | 1,900 | 9,900 | <300 | NR | 4,300 | 830 | NR | NR |
| Willcox | 3,150 | 1,873 | 2,700 | 6,200 | 167,400 | <300 | NR | NR | 211 | NR | NR |
| **Sub-total** | **18,261** | **7,342** | **37,650** | **33,450** | **363,500** | **1,200** | **1,100** | **76,500** | **1,686** | **NR** | **NR** |
| ***Upper Colorado*** | | | | | | | | | | | |
| Big Sandy | 1,240 | 212 | <300 | 15,600 | <300 | NR | NR | NR | NR | NR | NR |
| Bill Williams | 1,627 | 445 | 900 | <300 | 4,100 | 500 | NR | NR | NR | NR | NR |
| Detrital Valley | 168 | 51 | <300 | NR | NR | <300 | NR | NR | NR | NR | NR |
| Hualapai Valley | 918 | 90 | 8,900 | <300 | NR | NR | NR | NR | NR | NR | NR |
| Lake Havasu | 99 | 45 | 16,500 | <300 | NR | <300 | <300 | NR | 2,433 | NR | NR |
| Lake Mohave | 1,887 | 353 | 18,800 | 600 | 30,400 | 400 | 3,700 | 64,900 | 715 | NR | NR |
| Meadview | 21 | 15 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| Peach Springs | 36 | 18 | 350 | <300 | NR | NR | NR | NR | NR | NR | NR |
| Sacramento Valley | 1,010 | 151 | 2,100 | 1,600 | NR | NR | NR | NR | NR | NR | NR |
| **Sub-total** | **7,006** | **1,380** | **48,000** | **18,400** | **34,500** | **1,200** | **3,850** | **64,900** | **3,148** | **NR** | **NR** |
| ***Central Highlands*** | | | | | | | | | | | |
| Agua Fria | 1,776 | 310 | 1,800 | NR | 1,500 | NR | NR | NR | NR | NR | NR |
| Salt River | 1,593 | 412 | 4,000 | 8,100 | <1,000 | <300 | 4,900 | 6,400 | NR | NR | NR |
| Tonto Creek | 1,948 | 280 | 2,400 | <300 | <1,000 | NR | NR | 1,000 | 200 | NR | NR |
| Upper Hassayampa | 1,890 | 312 | 2,600 | 800 | <1,000 | NR | NR | NR | NR | NR | NR |
| Verde River | 11,093 | 1,659 | 15,200 | 3,200 | 11,100 | 600 | 800 | 16,000 | 980 | NR | NR |
| **Sub-total** | **18,300** | **2,973** | **26,000** | **12,250** | **14,100** | **750** | **5,700** | **23,400** | **1,180** | **NR** | **NR** |
| ***Western Plateau*** | | | | | | | | | | | |
| Coconino Plateau | 172 | 38 | 500 | NR | NR | 300 | NR | NR | 273 | NR | NR |
| Grand Wash | 11 | 1 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| Kanab Plateau | 220 | 119 | 1,600 | NR | <1,000 | 1,000 | NR | <1,000 | NR | NR | NR |
| Paria | 12 | 4 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| Shivwits Plateau | 17 | 2 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| Virgin River | 268 | 136 | <300 | 700 | 2,100 | NR | <300 | 1,500 | NR | NR | NR |
| **Sub-total** | **700** | **300** | **2,700** | **700** | **2,600** | **1,300** | **150** | **2,000** | **273** | **NR** | **NR** |
| ***Lower Colorado[3]*** | | | | | | | | | | | |
| Butler Valley | 18 | 21 | <300 | NR | 9,700 | NR | NR | NR | NR | NR | NR |
| Gila Bend | 146 | 391 | 1,000 | 4,700 | 289,000 | NR | NR | 54,000 | NR | NR | NR |
| Haraquahala | 157 | 212 | 950 | 500 | 36,500 | NR | 300 | 69,600 | NR | NR | NR |
| Lower Gila | 718 | 850 | 2,000 | 3,600 | 246,000 | 500 | NR | 383,200 | NR | NR | NR |
| McMullen Valley | 338 | 240 | 500 | <300 | 89,100 | NR | NR | NR | NR | NR | NR |
| Parker | 1,749 | 191 | 3,800 | <300 | <1,000 | 500 | NR | 630,600 | 220 | NR | 896 |
| Ranegras Plain | 522 | 138 | 400 | NR | 28,800 | NR | NR | NR | NR | NR | NR |
| San Simon Wash | 7 | 1 | 1,000 | NR | 3,900 | NR | NR | NR | NR | NR | NR |
| Tiger Wash | 7 | 1 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| tern Mexican Drainage | 20 | 5 | <300 | NR | NR | NR | NR | NR | NR | NR | NR |
| Yuma | 2,689 | 693 | 8,300 | 500 | 232,200 | 32,000 | 2,000 | 762,000 | 460 | NR | NR |
| **Sub-total** | **6,371** | **2,743** | **18,400** | **9,600** | **935,700** | **33,000** | **2,300** | **1,899,400** | **680** | **NR** | **896** |
| ***Active Management Areas*** | | | | | | | | | | | |
| Phoenix | 13,535 | 10,683 | 295,600 | 88,800 | 429,900 | 701,300 | 10,300 | 594,500 | 41,600 | 65,900 | 55,100 |
| Pinal | 2,077 | 3,256 | 24,700 | 13,200 | 439,600 | 3,700 | 900 | 533,200 | 500 | 2,200 | 1,700 |
| Prescott | 10,651 | 724 | 14,600 | 1,400 | 3,500 | 800 | 80 | 400 | 1,900 | NR | 1,400 |
| Santa Cruz | 1,246 | 593 | 7,800 | 1,500 | 13,000 | NR | NR | NR | NR | NR | NR |
| Tucson | 7,145 | 4,848 | 124,100 | 51,400 | 76,400 | 44,400 | 600 | 32,100 | 12,200 | 100 | NR |
| **Sub-total** | **34,654** | **20,104** | **466,800** | **156,300** | **962,400** | **750,200** | **11,880** | **1,160,200** | **56,200** | **68,200** | **58,200** |
| **Total** | **75,021** | **29,157** | **636,850** | **285,107** | **2,325,900** | **791,750** | **53,687** | **3,244,400** | **66,767** | **68,200** | **70,396** |

Various data sources see Arizona Water Atlas Volumes 2-8

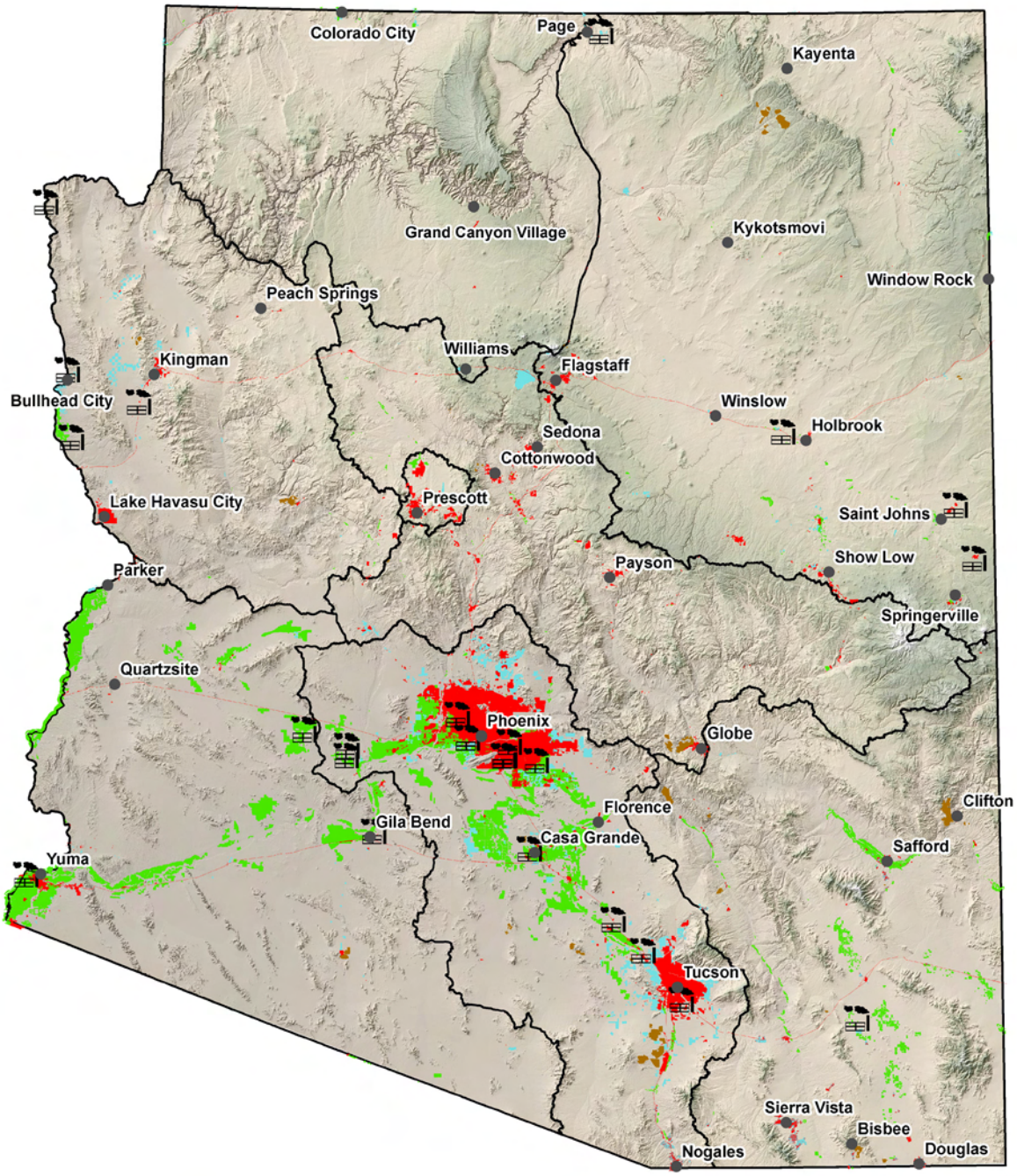
**Notes:**

NR = Not Reported

[1] Amount shown is water pumped from wells (including from the Colorado River accounting surface) or diverted from streams and includes Colorado River return flow (0.85 MAF). Evaporation losses from stockponds and reservoirs, long-term storage credits (CAP and effluent), intentionally created surplus and system losses (approx. 0.3 MAF) are not included. To calculate totals, half of the less than (<) values were assumed.

[2] Surface water supplies may include streamflow, spring discharge, spill/tail water and Central Arizona Project water.

[3] Groundwater demand for agriculture in the Lower Gila and Yuma Basins includes water pumped from drainage wells.




Agriculture
M&I - High Intensity
M&I - Low Intensity
Large Mine
Power Plant
Planning Area Boundary
City, Town or Place

**Figure 1-31**
**Cultural Water Demand Centers in Arizona**

ARIZONA DEPARTMENT OF WATER RESOURCES ©

**Primary Data Source: USGS National Gap Analysis Program, 2004**

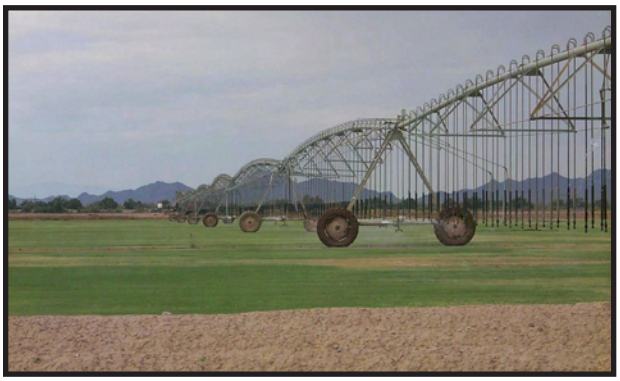
Agricultural Demand

Agriculture continues to be the largest water demand sector in the state, accounting for 75% of water demand (not counting return flow) from 2001-2005 (Figure 1-32). Agricultural demand accounts for all but 2% of the total demand in the Lower Colorado River Planning Area, met primarily by Colorado River water. Agriculture is the largest demand sector in every planning area except the Eastern Plateau (Figure 1-30).

While current agricultural demand has declined in most planning areas from 1970-1980 levels, since 1990 agricultural demand has increased in the AMA, Lower Colorado River and Southeastern Arizona planning areas (Figure 1-33). Increasing agricultural use in the AMAs is due to a combination of new agricultural tribal lands, changes in cropping practices and cultivation of alfalfa rather than historic, lower water demand crops.

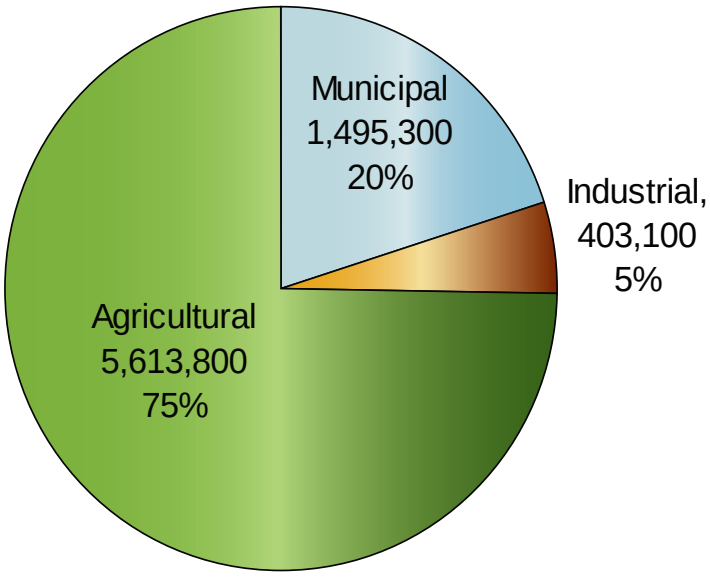
Agricultural use in the AMAs and INAs must be reported to the Department annually and holders of Colorado River water entitlements must report use annually to the Bureau of Reclamation. Elsewhere, basin demand has been estimated based on acreage, crops grown and irrigation method (see Appendix B).

Surface water meets most agricultural demand in the Upper Colorado River, Lower Colorado River, Eastern Plateau and Central Highlands planning areas. In the AMAs a mix of water supplies are utilized including groundwater, CAP water, in-state surface water and effluent (Figure 1-30). In the Eastern Plateau Planning Area, wastewater discharged from the Catalyst Paper Mill is applied to pasture and accounts for 27% of the agricultural water supply. Information on agricultural water demand by basin is found in Volumes 2-8.



*Agriculture in the AMA Planning Area. Agriculture continues to be the largest water demand sector in the state, accounting for 75% of water demand (not counting return flow) from 2001-2005 .*

**Figure 1-32 Average Annual Water Demand in Arizona by Sector, 2001-2005 (in AF and percentage of total)**




Municipal Demand

Municipal demand is composed of water delivered by a public or private water system and pumped from domestic wells to serve individual homes or several homes. During 2001-2005, municipal demand accounted for about 20% of the statewide demand. Municipal water use data are reported annually in AMAs and in INAs (by users withdrawing more than ten acre-feet a year). In addition, beginning with the 2006 reporting year, community water systems statewide report annual water use to the Department. Domestic wells are generally not metered and because there are no reporting requirements anywhere in the state, domestic well demand must be estimated.

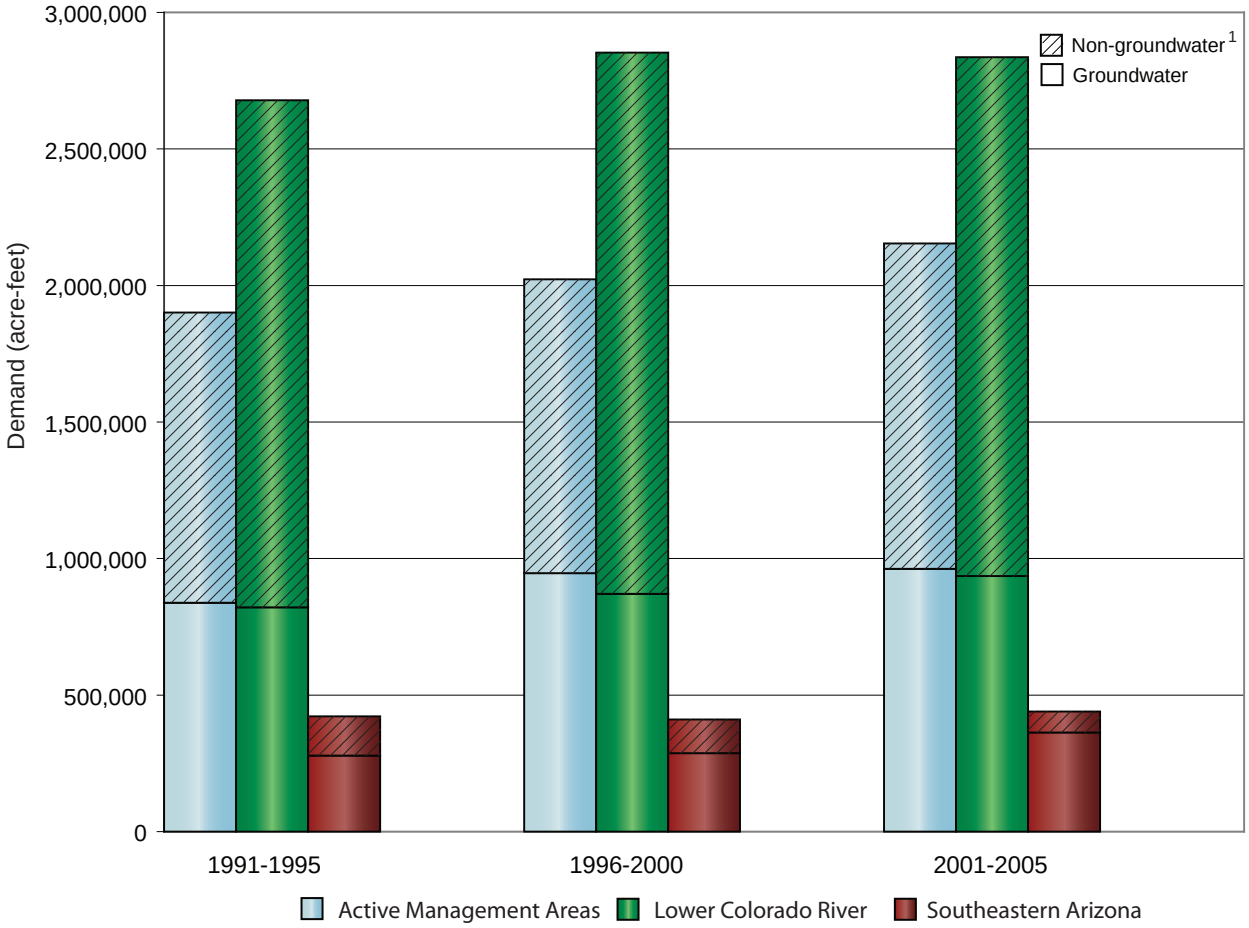
The percentage of municipal demand ranges from 1.5% in the Lower Colorado River Planning Area to 40% in the Western Plateau Planning Area. Municipal demand represents just 35% of the demand in the AMA Planning Area although most of the State's population resides in AMAs. Principal municipal supplies are groundwater with the exception of the AMA planning area where a mixture of CAP, in-state surface water, effluent and groundwater are used (Figure 1-30). Information on municipal basin and individual water system demand is found in Volumes 2-8.

Industrial Demand

Industrial demand, generally consisting of mining, electrical generation, dairies, feedlots and turf irrigation accounted for about 5% of the state total from 2001-2005. Industrial demand is defined as water used by an industrial facility that is not served by a municipal water system.

Industrial demand data are reported annually to the Department in the AMAs and INAs (by users withdrawing more than ten acre-feet a year) and collected for some types of industrial users by the USGS (USGS, 2007). Industrial demand is a significant demand sector in the

**Figure 1-33 Average Annual Agricultural Water Demand for Selected Planning Areas**




1 Non-groundwater may include surface water, effluent, CAP water and tailwater. In most basins outside of the AMAs, non-groundwater is surface water.

Source: ADWR, 2008f,g

Eastern Plateau Planning Area accounting for 49% of the demand and in the Central Highlands Planning Area at 22%. Elsewhere, industrial sector demand ranges from 0.5% to 13% of the planning area total (Figure 1-30).

Planning area industrial demand by industrial category is listed in Table 1-15. The primary industrial user in the Eastern Plateau and Lower Colorado River planning areas is power plants. Mining is the predominant industrial user in the Central Highlands, Southeastern Arizona and Upper Colorado River planning areas. Golf courses are the largest industrial use in the AMA and Western Plateau planning areas. Groundwater meets most of the industrial demand in every planning area, although 28% of the industrial demand in the AMA Planning Area is met with effluent delivered to the Palo Verde Nuclear Generating Station. Information on industrial basin and industrial category demand is found in Volumes 2-8.

Tribal Demand

Tribal water demand is included in the totals described above and varies significantly throughout the state although it is a relatively small component of planning area demands. As listed in Table 1-16, most tribal water demand is for agricultural irrigation. As Indian water right claims have been settled, several tribes including the Gila River Indian Community (Phoenix

**Table 1-15 Average annual planning area industrial demand by category**

| | 1991-1995 | 1996-2000 | 2001-2005 |
|---|---|---|---|
| **Type/***Planning Area* | **Water Use (acre-feet)** | | |
| **Power Plant** | | | |
| *Eastern Plateau* | 52,918 | 56,943 | 63,279 |
| *Southeastern Arizona* | 6,000 | 5,200 | 5,700 |
| *Upper Colorado River* | 0 | 0 | 4,900 |
| *Lower Colorado River* | 285 | 700 | 7,670 |
| *Active Management Areas* | 52,200 | 61,700 | 69,410 |
| **Turf**[1] | | | |
| *Eastern Plateau* | 1,266 | 1,326 | 1,596 |
| *Southeastern Arizona* | 1,596 | 1,806 | 2,316 |
| *Upper Colorado River* | 0 | 440 | 530 |
| *Central Highlands* | 2,910 | 3,010 | 3,334 |
| *Western Plateau* | 920 | 920 | 920 |
| *Lower Colorado River* | 440 | 440 | 440 |
| *Active Management Areas* | 53,300 | 70,100 | 77,800 |
| **Dairy/Feedlot** | | | |
| *Eastern Plateau* | 472 | 524 | 546 |
| *Southeastern Arizona* | 262 | 272 | 502 |
| *Upper Colorado River* | 0 | 0 | 80 |
| *Central Highlands* | 790 | 790 | 790 |
| *Western Plateau* | 30 | 30 | 30 |
| *Lower Colorado River* | 3,400 | 3,500 | 3,700 |
| *Active Management Areas* | 10,370 | 13,600 | 19,200 |
| **Mining**[2] | | | |
| *Eastern Plateau* | 11,144 | 11,445 | 6,241 |
| *Southeastern Arizona* | 48,195 | 47,085 | 25,831 |
| *Upper Colorado River* | 16,740 | 17,800 | 16,610 |
| *Central Highlands* | 17,900 | 14,100 | 14,160 |
| *Lower Colorado River* | 350 | 380 | 550 |
| *Active Management Areas* | 54,900 | 53,700 | 45,800 |
| **Other**[3] | | | |
| *Eastern Plateau* | 17,092 | 15,530 | 11,452 |
| *Southeastern Arizona* | 290 | 290 | 290 |
| *Lower Colorado River* | 2,600 | 2,900 | 1,200 |
| *Active Management Areas* | 16,900 | 18,000 | 21,620 |

**Source:** ADEQ 2005, ADWR 2008 f,g, and USGS 2007

[1] In the AMA Planning Area turf-related facilities include golf courses, schools, parks, cemeteries and common areas of subdivisions. Water use outside of the AMAs is predominately by golf courses.

[2] Mining uses include both hard rock mines and sand and gravel operations.

[3] Other category includes large cooling facilities, new large landscape, paper mills and other industrial users.

AMA) and Tohono O'odham Nation (Pinal and Tucson AMAs) have expanded their irrigated agricultural acreage with a commensurate increase in water demand. Information on tribal water demand is found in Volumes 2-8.

### 1.4.8 Water Resource Issues

A number of issues face communities and regions in Arizona including population growth and associated concerns about sustainable water supplies, lack of sufficient data to make informed water management decisions, drought, legal questions related to surface water availability, aging water delivery infrastructure, insufficient financial resources, water level declines, environmental protection, and Endangered Species Act (ESA) implications. These concerns have resulted in groundwater studies, regional planning, legislation, establishment of conservation easements and other activities. Issues vary from area to area and are discussed

**Table 1-16 Average annual water demand on Arizona Indian Reservations (2001-2005)**

| Planning Area/*Reservation* | Population (2000 Census) | Groundwater/Surface Water (acre-feet) | | |
|---|---|---|---|---|
| | | Agricultural | Municipal | Industrial |
| **Eastern Plateau** | **111,800** | 0/1,550[1] | 11,040/160 | 0[2] |
| *Navajo* | *104,600* | | | |
| *Hopi* | *6,900* | | | |
| *San Juan Southern Paiute* | *300* | | | |
| *Zuni* | *NA* | | | |
| **Southeastern Arizona** | **8,300** | ~5,300 | | 0 |
| *San Carlos Apache* | *8,300* | | | |
| **Upper Colorado River** | **2,200** | NA | ~300 | 0/4,000 |
| *Fort Mojave* | *800* | | | |
| *Hualapai* | *1,400* | | | |
| **Central Highlands** | **21,200** | 200/3,750 | 700/60 | 0 |
| *Fort Apache* | *20,400* | | | |
| *Tonto Apache* | *100* | | | |
| *San Carlos Apache* | *NA* | | | |
| *Yavapai-Apache* | *700* | | | |
| **Western Plateau** | **3,950** | 46 | 310 | 0 |
| *Havasupai* | *650* | | | |
| *Kaibab-Paiute* | *200* | | | |
| *Navajo* | *3,100* | | | |
| **Lower Colorado River** | **10,850** | 658,000 | | 0 |
| *Cocopah* | *1,000* | | | |
| *Colorado River Indian Tribes* | *3,400* | | | |
| *Gila Bend* | *600* | | | |
| *Fort Yuma (Quechan)* | *50* | | | |
| *Tohono O'odham* | *5,800* | | | |
| **Active Management Areas** | **34,730** | 135,600/131,600[3] | 8,900/200 | 1,300/0 |
| *Ak-Chin* | *750* | | | |
| *Fort McDowell Yavapai* | *900* | | | |
| *Gila River* | *14,000* | | | |
| *Pascua Yaqui* | *7,700* | | | |
| *Salt River Pima-Maricopa* | *6,200* | | | |
| *Tohono O'odham* | *5,000* | | | |
| *Yavapai-Prescott* | *180* | | | |

**Sources:** ACC (2005); ADWR (1992, 2007, 2008f,g,h,i); BIA (1998); BOR(2006), CAP (2008); ITCA (2008); Truini and others (2005); USGS (2007, 2008b)
NA = Not Available
[1] Navajo irrigated acreage estimated based on 2005 aerial imagery. Does not include dryland farming by the Hopi Tribe and Navajo Nation.
[2] Does not include water withdrawn from tribal lands leased by Peabody Energy for use at the Black Mesa Mines
[3] Includes CAP water

for each planning area in Volumes 2-8. Appendix I lists issues identified by watershed groups in Arizona organized by planning area.

Water resource issues have been identified by community groups, through the distribution of surveys and from other sources. While not a complete list, some of the key issues identified in each planning area are listed below.

Eastern Plateau

- Accessibility of groundwater supplies in some areas due to hydrologic conditions and water quality problems
- Infrastructure deficiencies that influence access to water supplies
- Lack of financial resources for infrastructure development or repair
- Drought impacts on surface water supplies
- Ability to meet future water demands for many communities
- Widespread water hauling on the Navajo Reservation and other locations
- Resolution of Indian water rights settlements
- Impact of mine pumping on tribal water supplies

Southeastern Arizona

- Population growth and associated concerns about sustainable water supplies
- Water level declines and land subsidence in some areas
- Increasing agricultural demand in some areas
- Insufficient data to make informed water management decisions
- Legal issues related to surface water availability and the legal nature of water supplies
- ESA implications and environmental protection
- Aging infrastructure and the lack of financial resources to make capital improvements

Upper Colorado River

- Large master-planned communities proposed in Detrital Valley, Hualapai Valley and Sacramento Valley basins
- Potential for extensive solar power development and associated water demand
- Unregulated lot splits and large number of domestic wells with associated lack of regulation
- Limited groundwater data in many areas and limited funding for studies, planning, projects and infrastructure
- Limited groundwater and Colorado River water supplies
- Colorado River accounting surface rulemaking and impacts on water users

Central Highlands

- Unregulated lot splits and large number of existing and projected private domestic wells
- Significant projected growth
- Limited and deep (costly) groundwater supplies available to meet current and projected demands
- Drought-sensitive groundwater and surface water supplies
- Seasonal demand/peaking problems in Payson/Pine/Strawberry area
- Lack of access to water development on public lands

*Colorado River, Upper Colorado River Planning Area.*

*Roosevelt Lake, Central Highlands Planning Area.*

- Inter basin water transfer conflicts (Big Chino, Payson)
- Subflow/adjudication decisions and potential impact on legal access to water
- Limited funding for planning, projects, infrastructure, augmentation and studies
- ESA issues involving critical habitat and pumping impacts on perennial streams
- Environmental issues pertaining to Fossil Creek and the Verde River

Western Plateau

- Limited and deep (costly) groundwater supplies; physical accessibility issues in areas
- Drought sensitive and inadequate surface water supplies in some areas
- Need to develop water supply alternatives to meet current and future demands
- Lack of sufficient financial resources for planning, projects, water supply development and studies; limited groundwater data
- Concerns regarding resource development and environmental needs e.g. potential for groundwater development to impact springs in the Grand Canyon and on tribal lands
- Interstate stream issues involving the Virgin River
- Numerous water haulers with few hauling stations sometimes cut-off during drought

Lower Colorado River

- Equitable Colorado River shortage sharing
- Issues related to transfers of Colorado River entitlements
- Colorado River accounting surface rulemaking and impacts on water users
- Consequences related to compliance with the International Treaty with Mexico
- Salinity control and water quality
- Groundwater transportation issues; groundwater may be withdrawn and transported outside the planning area from three designated basins
- Environmental protection and restoration
- Local management of water resources to meet the needs of growing communities while maintaining the agricultural economy

Active Management Area

- Allowable groundwater pumping conflicts with meeting AMA goal
- Feasibility of meeting AMA management goals by 2025
- Drought sensitivity of CAP supplies
- Physical and legal access to limited renewable water supplies
- Need to construct infrastructure and secure necessary funding to allow full use of renewable water supplies
- Concerns about the spatial disconnect between water storage (recharge) and pumping location
- Statutory differences between groundwater and non-groundwater and conjunctive use
- Desire for environmental protection and restoration in some areas with associated allocation of water resources
- Mechanism needed to address water management problems in specific geographic areas
- Long term roles of the Central Arizona Groundwater Replenishment District (CAGRD) and the Arizona Water Banking Authority to ensure long-term availability of

renewable supplies

- Increasing salinity in groundwater and soil from use of CAP, surface water and effluent

In March 2003, the Department sent a questionnaire to over 600 rural water providers, cities and towns, counties and tribal governments in order to gather information on drought impacts in support of preparation of the Arizona Drought Preparedness Plan. It was also hoped that information could be gathered about water supply and demand issues in rural Arizona to support other projects. Results from the survey were published in October 2004 (ADWR, 2004).

Four priority issues were mentioned consistently: the need for additional water supplies for future needs, lowering water tables, aging infrastructure, and inadequate sources of capital to pay for infrastructure improvements. Interestingly, while many respondents reported that domestic wells were a significant source of water for households in their area, few mentioned that they caused any water supply problems.

To support this initial information gathering effort and to collect additional information for the Atlas, the Department conducted a second, brief, direct-contact survey in 2004, focused on 360 rural water providers. Because of the direct contact effort, response was received from 246 water providers, a 65% response rate. The 2004 survey lacked the drought and growth impact focus of the 2003 survey but included questions about water demand and supply, water-level trends, metering and water quality.

Results of the issues ranking portion of the 2004 survey, with 212 total responses, are summarized in Table 1-17. Shown is the percentage of respondents reporting that the listed issue was a moderate or major concern, with the highest three percentages in each planning area highlighted in bold. As shown, the lack of capital for infrastructure repair was most often identified as an issue of moderate or major concern in every planning area. Although results vary between planning areas, other common priority issues were infrastructure in need of repair, inadequate storage capacity to meet peak demand and drought. A summary of survey results for each planning area are found in Volumes 2-7.

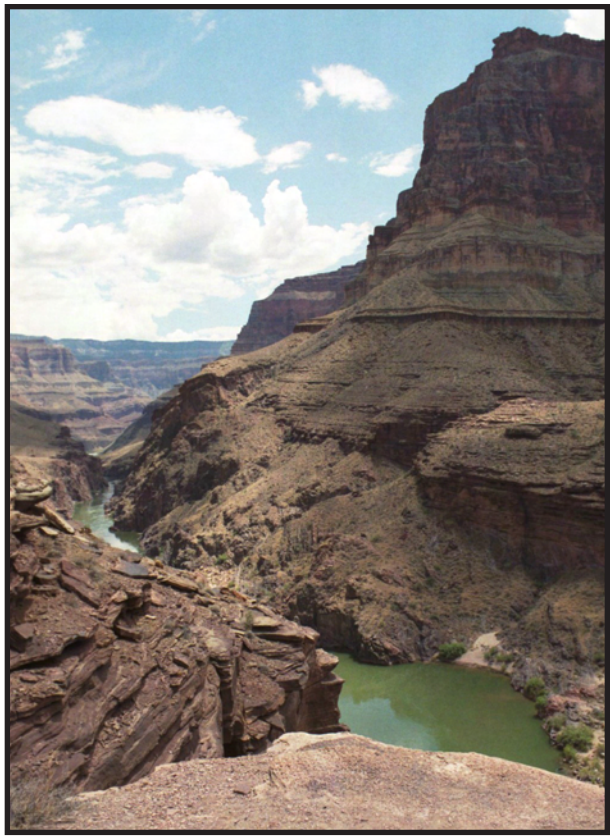
Current and Future Developments in State Water Planning

Several current statewide initiatives focus on assessing future water needs and promoting

**Table 1-17 Percent of 2004 survey respondents reporting issue was a moderate or major concern**

| Issue | Planning Area | | | | | |
|---|---|---|---|---|---|---|
| | Eastern Plateau (39 respondents) | Southeastern Arizona (44 respondents) | Upper Colorado River (23 respondents) | Central Highlands (66 respondents) | Western Plateau (10 respondents) | Lower Colorado River (30 respondents) |
| Inadequate storage capacity to meet peak demand | **31%** | 34% | 30% | 13% | **43%** | **26%** |
| Inadequate well capacity to meet peak demand | 28 | 25 | 26 | 18 | 14 | 10 |
| Inadequate water supplies to meet current demand | 13 | 20 | 13 | 15 | **43** | 6 |
| Inadequate water supplies to meet future demand | **31** | 32 | 35 | 32 | **43** | 23 |
| Infrastructure in need of replacement | **49** | **41** | **39** | **36** | 29 | **45** |
| Inadequate capital to pay for infrastructure improvements | **56** | **61** | **44** | **38** | **71** | **58** |
| Drought related water supply problems | 26 | **39** | **39** | **38** | 29 | 6 |

**Source:** ADWR, 2005



*Colorado River, Western Plateau Planning Area*

water sustainability. These efforts include the Blue Ribbon Panel on Water Sustainability, the Water Resource Development Commission, the Colorado River Basin Water Supply and Demand Study, Bureau of Reclamation appraisal and feasibility level studies, and Volume 9 of the Arizona Water Atlas. These efforts are discussed briefly below and represent a comprehensive approach to evaluating Arizona's future water needs.

Governor Brewer established the Blue Ribbon Panel on Water Sustainability in August 2009 with a final report due November, 2010. Its purpose is to "*advance water sustainability statewide by increasing reuse, recycling, and conservation to protect Arizona's water supplies and natural environment while supporting continued economic development and to do so in an effective, efficient and equitable manner*". The Panel's goal is to provide recommendations on statute, rule, and policy changes that, by the year 2020 will significantly:

1. Increase the volume of reclaimed water reused for beneficial purposes in place of raw or potable water;
2. Advance water conservation, increase the efficiency of water use by existing users, and increase the use of recycled water for beneficial purposes in place of raw or potable water;
3. Reduce the amount of energy needed to produce, deliver, treat, and reclaim and recycle water by the municipal, industrial, and agricultural sectors;
4. Reduce the amount of water required to produce and provide energy by Arizona power generators; and
5. Increase public awareness and acceptance of reclaimed and recycled water uses and the need to work toward water sustainability.

The Water Resource Development Commission was legislatively established in 2010 (H.B. 2661) to assess current and future water needs in Arizona including identification of future supplies and financing mechanisms for water supply acquisition and infrastructure. The Commission must prepare a report including recommendations and suggested legislation by October 2011. The Commission is expected to integrate the findings from studies mentioned in this sub-section in its analysis.

The Colorado River Basin Water Supply and Demand Study is a comprehensive regional study involving the Bureau of Reclamation and representatives of the seven Colorado River Basin States. Beginning in January 2010, the study will define current and future imbalances in water supply and demand in the Colorado River Basin and adjacent areas of the Basin States that receive Colorado River water for approximately the next 50 years. The study, to be completed by January 2012, will also develop and analyze adaptation and mitigation strategies to resolve those imbalances (BOR, 2010b). In Arizona the initial phase of the study included generation of population, water supply

and demand projections through 2060 for those areas of the state that use, or plan to use, Colorado River water (including CAP water).

At a more local level, several appraisal studies have been completed in rural Arizona under the Bureau of Reclamation's Rural Water Program (RWP) including North Central Arizona, the Mogollon Highlands and the Sierra Vista Subwatershed. An appraisal study is also underway for the Central Yavapai Highlands. Under the RWP, an appraisal level study is conducted to evaluate water supply and demand conditions and prepare a preliminary assessment of alternatives to determine if there is a viable alternative to warrant a more detailed investigation at the feasibility level. Investigations have progressed to the feasibility level in the Sierra Vista Subwatershed, North Central Arizona and Mogollon Highlands study areas. A feasibility study is a detailed investigation that identifies a preferred alternative to meet future needs. (BOR, 2010c)

Volume 9 of this Atlas (Water Sustainability Assessment) will evaluate water resource vulnerability and sustainability conditions across Arizona to support and improve water planning and management decisions at the state, regional and local level. "Sustainability" will be defined differently in different parts of the state depending on local management goals. This assessment will compile and incorporate information from Atlas Volumes 2-8, other water supply and demand studies and previously conducted evaluations and public processes including those mentioned above.

As Arizona continues to grow and water demands increase, local development of water resources will increasingly be influenced by statewide and regional conditions. Water management and planning will need to extend beyond local boundaries as interrelationships often exist across the state, both rural and urban. The recent efforts summarized above should provide additional information and strategies to address Arizona's water needs now and in the future and hopefully resolve the most pressing issues identified within planning areas.

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