# ARIZONA WATER ATLAS
# VOLUME 7
## LOWER COLORADO RIVER PLANNING AREA

**Arizona Department of Water Resources**
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## CONTENTS

## FIGURES

## TABLES

# ARIZONA WATER ATLAS
# VOLUME 7 –LOWER COLORADO RIVER PLANNING AREA

## PREFACE

Volume 7, the Lower Colorado River Planning Area, is the seventh in a series of nine volumes that comprise the Arizona Water Atlas. The primary objectives in assembling the Atlas are to present an overview of water supply and demand conditions in Arizona, to provide water resource information for planning and resource development purposes and help to identify the needs of communities.

The Atlas divides Arizona into seven planning areas (Figure 7.0-1). There is a separate Atlas volume for each planning area, an introductory volume composed of background information, and an executive summary volume. "Planning areas" are an organizational concept that provide for a regional perspective on supply, demand and water resource issues. A complete discussion of Atlas organization, purpose and scope is found in Volume 1. Also included in Volume 1 is general background information for the state, a description of data sources and methods of analysis for the tables and maps presented in the Atlas, and appendices that provide information on water law, management and programs, and Indian water rights claims and settlements.

There are additional, more detailed data available to those presented in this volume. These data may be obtained by contacting the Arizona Department of Water Resources (Department).

## 7.0 Overview of the Lower Colorado River Planning Area

The Lower Colorado River Planning Area is composed of eleven groundwater basins in southwestern Arizona. The planning area contains the driest and hottest portions of Arizona. Large areas of federal lands consisting of military reservations, wildlife refuges and national monuments are located in the planning area. Elevations range from over 7,700 feet in the Baboquivari Mountains along the southeastern boundary of the planning area to about 70 feet at the Colorado River where it enters Mexico. All of Yuma County and most of La Paz County (91% of the county) are contained within the planning area as well as portions of Maricopa (38%), Pima (43%) and Yavapai (1%) counties. Five Indian reservations including the Cocopah, Colorado River Indian Tribes, Gila Bend, Fort Yuma-Quechan and Tohono O'odham are located within the planning area. One of the planning area basins, Harquahala, has been designated as an Irrigation Non-expansion area (INA) due to insufficient groundwater to provide a reasonably safe supply for irrigation.

Although much of the planning area is relatively sparsely populated, there are several major population centers, particularly in the Yuma area. The 2000 Census planning area population was approximately 194,100 with basin populations ranging from less than 10 in the Tiger Wash Basin to almost 153,000 in the Yuma Basin. Yuma is the largest community with over 77,000 residents in 2000. Other population centers include Fortuna Foothills and San Luis located near Yuma, Parker/Parker Strip, Ajo, Gila Bend and Quartzsite.

An average of over 3,038,400 acre-feet of water is used annually in the planning area for agricultural,

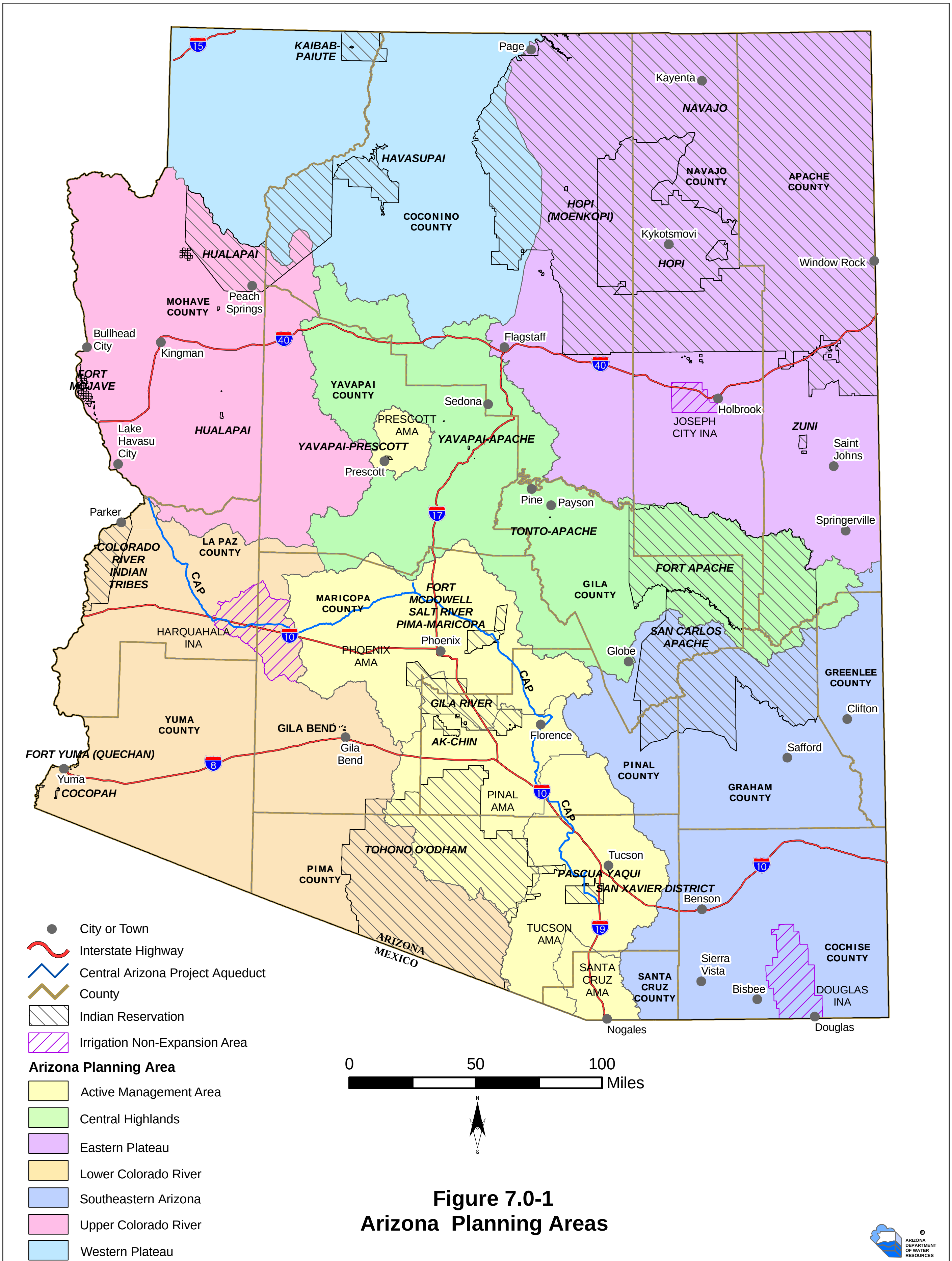



**Figure 7.0-1**
**Arizona Planning Areas**

municipal and industrial uses (cultural water demand) - almost as much water demand as the state's five active management areas combined. Of this total demand, approximately 1,027,250 acre-feet is well pumpage, 2,010,500 acre-feet are surface water diversions from the Colorado River, Gila River and the Central Arizona Project and about 680 acre-feet is effluent reuse. The agricultural demand sector is by far the largest with approximately 2,974,200 acre-feet of demand a year – 98% of the total demand. Average annual municipal sector demand is about 49,400 acre-feet and industrial demand is about 14,850 acre-feet.

### 7.0.1 Geography

The Lower Colorado River Planning Area encompasses about 17,200 square miles (sq. mi.) and includes the Butler Valley, Gila Bend, Harquahala, Lower Gila, McMullen Valley, Parker, Ranegras Plain, San Simon Wash, Tiger Wash, Western Mexican Drainage and Yuma basins. Basin boundaries, counties and prominent cities, towns and places are shown in Figure 7.0-2. The planning area is bounded on the north by the Bill Williams Basin in the Upper Colorado River Planning Area, on the east by the Phoenix, Pinal and Tucson Active Management Areas (AMA), on the south by the international boundary with Mexico and on the west by the State of California and the international boundary. The planning area includes all or part of four watersheds, which are discussed in Section 7.0.2. The Cocopah Indian Reservation (10 sq. mi.) and the Gila Bend Indian Reservation (16.3 sq. mi.) are entirely within the planning area. Approximately 86% (391 sq. mi.) of the Colorado River Indian Tribes Reservation, 57% (2,471 sq. mi.) of the Tohono O'odham Indian Reservation, and 4% (3 sq. mi.) of the Fort Yuma-Quechan Indian Reservation are also located within the planning area (Figure 7.0-1). The Gila Bend and Tohono O'odham reservations are two of the four land bases that make up the Tohono O'odham Nation. Comparable in size to the state of Connecticut, the Nation is the second largest Indian reservation in the United States.

The entire planning area is within the Basin and Range physiographic province characterized by northwest-southeast trending mountain ranges separated by broad alluvial valleys (See Volume 1, Figure 1-2). The planning area is relatively low elevation – generally less than 3,500 feet. Higher elevation mountain ranges occur along part of the northern boundary and in the Baboquivari Mountains that form the southeastern boundary where elevations rise to over 7,700 feet. The lowest elevation is about 70 feet where the Colorado River enters Mexico at the Southerly International Boundary (SIB) in the Yuma Basin. The basin with the largest elevational range is the San Simon Wash Basin with a range of 1,650 to 7,730 feet.

A unique geographic feature of the planning area is the arid climate, which has shaped its topography and surface water characteristics. In the more arid western part of the planning area, the geography consists of widely-scattered, small mountain ranges of mostly barren rock and broad, flat valleys (or plains). A number of groundwater basins in the planning area take their name from this geographic feature, e.g. Butler Valley, McMullen Valley and Ranegras Plain. Other examples of major valleys and plains are the Mohawk Valley in the Lower Gila Basin and the La Posa Plain in the Parker Basin. Relatively large areas of sand dunes occur south of Yuma and west of the Gila and Tinajas Altas Mountains in an ancient river terrace. To the southeast, the terrain contains more numerous mountain ranges and narrower valleys with higher rainfall and more plant diversity and density


**Figure 7.0-2**
**Lower Colorado River Planning Area**

(ASDM, 2007a). With the exception of the Colorado River, there are no perennial streams in the planning area. The Gila River was historically perennial for most of its length but by the beginning of the 20th century the effects of farming and construction of dams both upstream and within the planning area caused cessation of perennial flows (Tellman, et al., 1997). Broad sandy washes are the main surface water feature in the planning area, flowing only in response to significant precipitation events

## 7.0.2 Hydrology[1]

### *Groundwater Hydrology*

The groundwater basins of the Lower Colorado River Planning Area are composed of alluvial valleys with significant volumes of groundwater in storage. Basins adjacent to the Colorado River were categorized by Anderson, et al., (1992) as Colorado River basins. Colorado River infiltration was historically the main source of inflow to aquifers in these basins. Other basins in the planning area receive minimal groundwater inflow due to the aridity of the area. These other basins were categorized by Anderson, et al., (1992) as “west” basins. The geology of the Colorado River Basins and west basins are also somewhat different and are described below. More detailed information on groundwater level changes, water quality, well yields, depth to water, groundwater in storage, groundwater recharge and other groundwater conditions are found in the individual basin sections.

Colorado River Basins

Colorado River Basins include the Parker and Yuma basins. In these basins the direction and occurrence of groundwater are influenced by the amount of streamflow in the Colorado River, which supplies the largest portion of groundwater recharge. Stream alluvium occurs along the Colorado River and its tributary washes and groundwater in the alluvium is hydraulically connected to the river.

In general, the aquifer consists of recent stream alluvium overlying older, more cemented basin fill deposits, which in turn overlie the Bouse Formation. The Bouse Formation consists of two zones. The upper zone is composed of medium to coarse-grained sand which can yield moderate amounts of groundwater under unconfined conditions. The lower zone contains fine-grained sediments which produce limited amounts of groundwater. Groundwater is found under confined (artesian) conditions in this lower zone. A fanglomerate unit (composed primarily of cemented gravel and thin basalt flows) underlies the Bouse Formation and can yield moderate amounts of groundwater. (Anderson, et al., 1992)

*Parker Basin*

In the Parker Basin along the Colorado River, groundwater occurs under confined conditions in the Bouse Formation and fanglomerate unit and under unconfined conditions in alluvial deposits. The recent stream alluvium consists of silt, sand and gravel deposits and groundwater in these deposits is hydraulically connected to the river. In the eastern portion of the Parker Basin, groundwater is found in smaller amounts under unconfined conditions. In this area, groundwater flows toward

[1] Except as noted, information in this section is taken from the Arizona Water Resources, Asessment , Volume II, ADWR (August, 1994).

the Colorado River along stream courses.  Elsewhere, groundwater flows away from the River or parallel to it.

Groundwater quality is generally good in the Parker Basin although arsenic, fluoride, nitrate and organic compounds at concentrations exceeding the Drinking Water Standard have been measured in wells.  Most water quality measurements have been made in the Quartzsite area where septic tanks have caused nitrate contamination of groundwater.

*Yuma Basin*

Cenozoic basin fill is the primary aquifer in the Yuma Basin.  Thickness of the basin fill may exceed 16,000 feet in some areas but only the upper 2,000 to 2,500 feet is considered hydrologically important because of its excellent transmissive properties.  This aquifer is subdivided into three zones.  In descending order these are the upper fine-grained zone, the coarse-gravel zone and the wedge zone.  The upper zone includes younger alluvium and the uppermost deposits of older alluvium.  Little water is pumped from this zone although beneath irrigated areas, the water table lies within this zone.  The middle, coarse-gravel zone is the principal water producing unit in the Yuma basin. Depths to the coarse-gravel zone begin at about 100 feet in the Colorado and Gila River valleys and at about 180 feet below land surface beneath Yuma Mesa. Throughout most of the Yuma basin the wedge zone underlies the coarse-gravel zone and overlies the Bouse formation. The wedge zone is a major water-bearing deposit and consists of interbedded sands, gravel and cobbles.  Depth to the top of this zone is about 160 feet near Laguna Dam and 300 feet in the southern Yuma Valley (Overby, 1997).  The underlying Bouse Formation is a potential source of groundwater but units that underlie this formation (marine sedimentary rocks and volcanic rocks) are highly mineralized and deep and are not utilized.

Prior to development, nearly all groundwater recharge was from the Colorado and Gila Rivers through direct channel infiltration and annual flooding. The general groundwater flow pattern was from the Colorado and Gila Rivers southward under Yuma Mesa. A significant source of groundwater recharge now comes from percolation of excess water applied to crops.  Irrigation water in excess of crop requirements is applied to reduce salt accumulation in the root-zone.  A groundwater mound has developed under Yuma Mesa, as a result of agricultural irrigation and because groundwater flow away from the area is insufficient to drain rising water levels.  This mound and rising groundwater levels in the Yuma area have affected groundwater flow patterns.  In the western part of the basin, groundwater flow is now generally toward the Colorado River from Imperial Dam to the Northerly International Boundary (NIB).  South of the mound, groundwater flow is generally south toward the natural drainage, but there also is a component of flow now toward the Colorado River and under the river toward the Mexicali Valley in Mexico (Dickinson, et al., 2006).  In the eastern part of the Yuma Basin, groundwater moves from northwest to southeast across the Yuma Desert and exits the basin into Mexico east of the Algodones Fault (Overby, 1997).  The Algodones Fault trends northwest to southeast across the basin south of Yuma and is a barrier to groundwater movement as reflected in water levels on either side of the fault.

Groundwater levels in the basin are also influenced by water management activities.  The "242 Well Field and Lateral" is located east of San Luis in a 5-mile wide strip of land and consists of 21 wells that intercept part of the groundwater flow moving south into Mexico from Yuma Mesa.

Irrigation drainage water is a component of this groundwater flow. Water pumped from the well field is delivered to Mexico through the 242 Lateral and other laterals to meet international treaty obligations for Colorado River water deliveries. This activity, as well as groundwater pumping in Mexico, lowers groundwater levels in private wells in the vicinity of the wellfield (USBOR, 2007a).

Ground water quality varies across the Yuma Basin with elevated concentrations of total dissolved solids (TDS), arsenic, lead, agricultural pesticides, nitrate and volatile organic compounds in some areas (see Table 7.11-10). Groundwater was originally more similar in chemical composition to its source waters (Colorado and Gila rivers), but the quality has been altered by more than one hundred years of irrigation (Overby, 1997).

West Basins

West basins include Butler Valley, Gila Bend, Harquahala, Lower Gila, McMullen Valley, Ranegras Plain, San Simon Wash, Tiger Wash and Western Mexican Drainage basins. Groundwater inflows and outflows are small in these basins and there are no perennial streams. Groundwater inflows consist of minor amounts of mountain front recharge and stream infiltration. Basins are composed of a relatively thin, heterogeneous layer of upper basin fill underlain by lower basin fill. The lower basin fill consists of a unit of primarily fine-grained material underlain by a medium to coarse grained unit. Pre-Basin and Range sediments underlie the basin fill. Stream alluvium deposits occur along the lower Gila River and may be locally productive water-bearing sediments (Anderson, et al., 1992).

*Butler Valley Basin*

Butler Valley Basin contains basin fill deposits that make up the principal aquifer. These deposits range from about 500 feet in the southwest area to nearly 1,500 feet thick in the central portion of the basin. The valley is surrounded by mountains and some groundwater may be found along the basin margins in thin alluvium and in volcanic, granitic, metamorphic and sedimentary rocks. A 1½-mile wide area bordered by mountains where Cunningham Wash exits the basin is known as the Narrows. Groundwater is found under confined conditions northeast of the Narrows in T7N, R15W and confined conditions may occur in other areas due to the presence of clay layers. Groundwater flow is generally from northeast to southwest (Oram, 1987). Groundwater quality is generally good with locally high fluoride and arsenic concentrations in some areas.

*Gila Bend Basin*

Basin fill material is the principal aquifer in the Gila Bend Basin. Groundwater occurs primarily under unconfined conditions, but there are several areas where fine-grained layers in the alluvium create either underlying confined conditions or overlying perched water-table conditions as a result of percolation of irrigation water. Water levels in wells measured in 2003-2004 ranged from 34 feet in a well along the mountain front to almost 640 feet east of Gila Bend. Groundwater flow direction is generally from the Gila Bend Mountains east to the Gila River in the area north of Gila Bend. In the center of the basin, groundwater movement is toward the southwest (see Figure 7.2-6). Groundwater pumpage historically caused several cones of depression to form, with the largest cone north of Gila Bend and parallel to the Gila River. As shown in Figure 7.2-6 water level decline are still significant (>30 feet) in wells in this area.

Groundwater is recharged primarily from Gila River flow events and when river water is impounded behind Painted Rock Dam. Some recharge also occurs from infiltration of irrigation water, underflow from the Gila River and tributaries into the basin and precipitation.

Groundwater quality is generally poor across the basin with many measurements of arsenic and fluoride concentrations meeting or exceeding drinking water standards. High concentrations of TDS and nitrate have also been detected (see Table 7.2-7).

*Harquahala Basin*

Groundwater in the Harquahala Basin is found primarily in basin fill material composed of heterogeneous deposits of clay, silt, sand and gravel. The basin fill may be as much as 5,000 feet thick near Centennial. Groundwater is generally unconfined, although clay layers can cause semi-confined to confined conditions. Clay layers also cause perched water-table conditions in the east-central and southeastern parts of the basin from percolation of irrigation water. In the southeastern part of the basin the basin fill consists of coarse deposits of sand and gravel. North of T1S, fine-grained beds primarily composed of clay overly the coarse deposits. Wells in this area penetrate the fine-grained sequence and withdraw water from the underlying coarse-grained sequence. The fine-grained beds become thicker towards the northwest and grade into an alternating sequence of fine-grained and coarse-grained layers that overlie a conglomerate that begins at a depth of 800 to 850 feet below land surface (Hedley, 1990). Reportedly, the best well yields occur from this alternating sequence in the west-central part of the basin.

Groundwater recharge is negligible, coming primarily from infiltration of runoff in Centennial Wash. There may also be underflow from McMullen Valley Basin to the north. Seepage and infiltration of water from the Central Arizona Project (CAP) canal, which runs west to east across the southern part of the basin, may be another source of recharge.

Well pumpage caused the Harquahala Basin to be severely overdrafted from the 1950s through the mid 1980s, resulting in large water level declines and formation of a cone of depression in the south central portion of the basin. Prior to the 1950s groundwater moved from northwest to the southeast and exited where Centennial Wash leaves the basin. Introduction of CAP water in place of groundwater pumping has allowed groundwater levels to rise by more than 30 feet in a number of wells (see Figure 7.3-6). The Harquahala Basin was designated as an INA in 1984 pursuant to A.R.S. § 45-432 to prevent new lands from being brought into agricultural production. However, under A.R.S. § 45-555 groundwater may be withdrawn and transported from the basin to an initial active management area (such as the adjacent Phoenix AMA) under specific circumstances including a provision that groundwater levels not decline by an average of more than ten feet per year.

Groundwater quality is generally suitable for irrigation purposes, but elevated TDS, fluoride, arsenic and other constituent concentrations in some wells require treatment to meet drinking water standards.

*Lower Gila Basin*

Groundwater in the Lower Gila Basin occurs in both recent stream alluvium and basin fill. The stream alluvium consists of sand, gravel and boulders in the larger washes and the floodplain of the Gila River. The thickness of the stream alluvium ranges from 10 feet in smaller washes to 110 feet in the Gila River floodplain. The basin fill consists of three units. The upper sandy unit is composed of sand and gravel with some silt and clay layers. This unit is typically 200 to 380 feet thick. The middle fine-grained unit contains primarily silts and clays with occasional thin sand and gravel beds. The middle unit ranges from 250 to 750 feet thick. The lower coarse-grained unit is composed of coarse sand and gravel and contains some well-cemented zones. The thickness of this unit is variable. Well yields exceeding 2,000 gallons per minute (gpm) are commonly found in the vicinity of the Gila River, southeast of Dateland and north of Hyder.

Groundwater development in the eastern part of the Lower Gila Basin is in the broad alluvial plains that border the Gila River, where the main aquifer is the upper sandy unit in the basin fill. Groundwater is primarily unconfined. Historically, cones of depression occurred in irrigated areas north of Hyder, east of Dateland and in the Palomas Plain west of Hyder. Some historic groundwater level declines were as much as 15 feet per year. Recent data show more stable water level conditions in measured wells in the eastern part of the basin (see Figure 7.4-6).

In the western part of the basin, groundwater levels in the Gila River floodplain historically ranged from 10 to 20 feet below land surface and the streambed alluvium was the primary source of groundwater. As irrigation activity increased in the 1930s, groundwater levels declined and salinity increased. To provide a dependable water supply for irrigation, Colorado River water was brought to the area in 1952 and groundwater pumping for irrigation ceased. Infiltration of excess irrigation water to the stream alluvium aquifer raised water levels, necessitating the need for a system of drainage wells to maintain groundwater levels below crop root zones and canals to transport the drainage water out of the basin.

Groundwater recharge is primarily from infiltration of runoff in washes and the Gila River floodplain. Underflow from the Painted Rock Dam on the eastern basin boundary and releases from the dam during floods also contributes to groundwater recharge. Water releases from Painted Rock Dam in 1975 resulted in an estimated 59,500 acre-feet of recharge. In the far western part of the basin, infiltration of excess irrigation water is the largest source of recharge.

Groundwater flow directions have been impacted by irrigation pumpage at some locations in the basin, for example east of Dateland where a cone of depression exists (see Figure 7.4-6). Prior to development, groundwater flow was from north and southeast toward the Gila River and then downstream to the southwest. Infiltration of irrigation water in the western part of the basin has created groundwater mounds in the floodplain aquifer which affect groundwater flow.

Groundwater quality varies in the eastern part of the basin with elevated fluoride concentrations reported at a number of wells. In the western part of the basin, the quality of groundwater in the Gila River floodplain is unsuitable for most uses, with elevated TDS concentrations common as well as fluoride and arsenic.

*McMullen Valley Basin*

The principal aquifer in the McMullen Valley basin is alluvial-fan deposits in the basin fill. These deposits underlie most of the valley floor, varying in thickness from 230 feet in the Wenden-Salome area to 3,100 feet north of Aguila. Most large irrigation wells tap into this unit. Fine grained lake-bed deposits of low permeability overlie the alluvial fan deposits in the central and lower parts of the valley. These deposits range in thickness from 150 feet southwest of Wenden to about 1,100 feet northeast of Wenden. Because of their relatively low permeability, the lake-bed deposits may impede downward percolation of water, creating a perched aquifer. Stream alluvium has been deposited by Centennial Wash and its tributaries and is composed of silt, sand and clay. This unit is 50 feet thick in the lower end of the basin, 100 feet thick in the Wenden-Salome area, and over 450 feet thick north of Aguila. There has been some groundwater development in the stream alluvium for domestic and stock use, but irrigation pumpage has dewatered the unit in the Aguila area (Remick, 1981). The basal unit of the basin fill is a conglomerate present at a depth of about 850 to 1,600 feet below land surface and is largely unexplored.

Fluoride, arsenic and nitrate concentrations exceeding drinking water standards are found at wells throughout the basin. Elevated concentrations of nitrate have been measured in a number of wells near Salome (see Table 7.5-7).

*Ranegras Plain Basin*

Groundwater in the Ranegras Plain Basin occurs primarily in older (Tertiary) basin fill deposits composed of clay, volcanics, conglomerate and smaller amounts of sand and gravel. Although yields in some wells are relatively low due to the presence of clays, yields from large diameter wells reach 4,000 gpm with a median yield of 1,100 gpm (Table 7.7-6). The thickness of the basin fill deposit is not well known but is at least about 1,500 feet northwest of Vicksburg. The younger (Quaternary) alluvium, which includes stream alluvium, overlies the basin fill and is composed primarily of sand and gravel with a thickness of less than a few hundred feet. Perched groundwater occurs in the central part of T6N, R16W and in Sections 9 and 10 of T5N, R16W where water levels are 10 to 60 feet higher than the surrounding area. (Johnson, 1990)

Groundwater flow is generally to the northwest toward the community of Bouse but agricultural groundwater withdrawals have created a cone of depression southwest of Vicksburg (see Figure 7.7-6).

Natural groundwater recharge is from infiltration of runoff in Bouse Wash, Cunningham Wash and along mountain fronts. About 32 miles of the CAP canal runs through the northeastern portion of the basin and may contribute 2,000 to 3,000 acre-feet of recharge a year. (Johnson, 1990)

Groundwater quality is generally poor with elevated TDS concentrations measured in a number of wells. Of 48 wells measured between 1984 and 1989, only five wells had TDS levels below the secondary maximum contaminant level of 500 milligrams per liter recommended by the Environmental Protection Agency (EPA). The highest TDS concentrations were measured in the north-central part of the basin (Johnson, 1990). Water quality measurements taken between 1979 and 2000 also show a number of wells with elevated fluoride and arsenic concentrations (Table 7.7-7).

*San Simon Wash Basin*

Basin fill comprises the principal aquifer in the San Simon Wash Basin. The thickness of the basin fill ranges from near zero at the mountain fronts to over 8,000 feet near the international boundary. Four sedimentary units have been identified in the basin. Alluvial-fan deposits occur on the basin perimeter and vary in depth and well yield. Streambed alluvium consisting of sand, gravel and boulders occurs along stream channels and may yield significant volumes to wells. Deltaic deposits consisting of a sequence of clay, silt, sand and gravel are found near Papago Farms (T19S, R1E) where deposits may be 800 feet thick and well yields are high (Figure 7.8-6). Lakebed deposits consisting of thick sequences of fine-bedded silts and clays extend to depths of more than 1,000 feet. Wells drilled into these lakebed deposits in the center of the basin generally yield less than 50 gpm. Groundwater occurs under unconfined conditions in the basin. Depth to water averages about 300 feet below land surface and well yields appear to be highest at depths of 400 to 700 feet. Groundwater flow is generally toward the southwest, then south into Mexico. (Hollett, 1985)

Elevated arsenic concentrations are found in groundwater south of Pisinimo and near the international boundary and may occur in the lake-bed deposits in the center of the basin. Fluoride concentrations that equal or exceed drinking water standards occur in the area around Papago Farms and the international boundary (Table 7.8-7).

*Tiger Wash Basin*

Tiger Wash Basin is a shallow, alluvial basin composed of heterogeneous deposits of clay, silt, sand and gravel that are likely less than 1,000 feet thick. There are few wells in the basin with recent water level depths ranging from 29 feet to 219 feet below land surface (Figure 7.9-6). There appears to be a groundwater divide near the center of the basin from which groundwater flows to the southwest and to the northeast (Hedley, 1990).

Two water quality exceedences have been reported in basin wells, with concentrations of arsenic and nitrate that equal or exceed the drinking water standard (Table 7.9-7).

*Western Mexican Drainage Basin*

The Western Mexican Drainage Basin contains broad alluvial-filled valleys consisting of unconsolidated gravel, sand, silt and clay deposits that make up the main water-bearing unit. Groundwater flow is toward Mexico. Water levels varied from 27 to 237 feet below land surface at wells measured in 2003-2004 and levels appear to be declining near Lukeville, likely due to development in the Sonoyta area of Sonora, Mexico. Well yields are generally less than 100 gpm. Water quality data collected between 1976 and 1988 along the international boundary west of Lukeville show concentrations of fluoride, arsenic and lead that equal or exceed the drinking water standard (Table 7.10-7).

## Surface Water Hydrology

The U.S. Geological Survey (USGS) divides and subdivides the United States into successively smaller hydrologic units based on hydrologic features. These units are classified into four levels. From largest to smallest these are: regions, subregions, accounting units and cataloging units. A hydrologic unit code (HUC) consisting of two digits for each level in the system is used to identify any hydrologic area (Seaber et al., 1987). A 6-digit code corresponds to accounting units, which are used by the USGS for designing and managing the National Water Data Network. There are all or portions of four watersheds in the planning area at the accounting unit level: Lower Colorado River below Lake Mead; Lower Gila River below Painted Rock Dam (all); Agua Fria River-Lower Gila River; and the Rio Sonoyta (Figure 7.0-3). More detailed information on stream flow, springs, reservoirs and general surface water characteristics are found in the individual basin sections.

Lower Colorado Below Lake Mead

This watershed extends north to Hoover Dam and includes all or parts of three basins in the Upper Colorado River Planning Area (see Volume 4, Figure 4.0-3). Within the Lower Colorado River Planning Area, all or parts of Butler Valley, Ranegras Plain, Parker, Harquahala, Lower Gila and Yuma basins are included in the watershed. The Colorado River is the only perennial surface water in the entire watershed. Within the planning area, the river flows for about 200 miles south of Parker Dam to Mexico at the Southerly International Boundary. There are many diversions and several dams along the Colorado River. Dams include Imperial, Laguna and Morelos. There are major diversions from Imperial Dam to the All-American Canal, which delivers agricultural water to California and to the Gila Gravity Canal for use in Arizona. Drainages to the Colorado River in the planning area are ephemeral and contribute little to river flow with the exception of the Gila River during flood events.

Dam construction and diversions have fundamentally altered flow in the Colorado River, including the portion in the planning area. Historically, the Colorado was a broad, meandering, unpredictable, sediment-laden watercourse, with annual flooding and frequent changes in the configuration of the channel. It sometimes overtopped its banks and flowed west to the Salton Sink, forming intermittent lakes. In the early 1900s water began to be diverted from the Colorado River via the Imperial Canal to irrigate California's Imperial Valley. When the canal filled with silt, a cut was made in the west bank of the river to temporarily allow water to flow into the valley. In 1905, massive flooding on the Colorado overtopped this diversion canal and diverted the river toward the Salton Sink (Salton Sea Authority, 2000). This flow flooded the valley, destroying farms and towns and began filling the Salton Sink, creating the modern Salton Sea. Flow continued for 18 months and for a time the Colorado ceased flowing into Mexico (Tellman et al., 1997). There were concerns that if the cutback erosion in the flow channel reached the Colorado River, it would be permanently diverted to the Salton Sink. In 1907 the Southern Pacific Railroad, which had substantial business interests in the region, repaired the gap in the diversion canal and the river resumed its natural course toward the Gulf of California.

Prior to dam construction on the Colorado River, the river flowed to the Gulf of California, forming a delta with a maze of lagoons and dense riparian habitat. Today only about 420,000 acres of the original two million acre delta survives and the river reached the sea only about half of the years between 1981 and 2002. Since 1979, an average of about 100,000 acre-feet of salty drainage water from the Wellton-Mohawk Irrigation District is delivered annually to the eastern side of the delta, creating the Cienega de Santa Clara (Glenn, et al., 2004).

There are no major (>10gpm) or minor (1-10 gpm) springs in the entire watershed, and only 15 to 16 smaller springs, primarily in the Parker Basin.

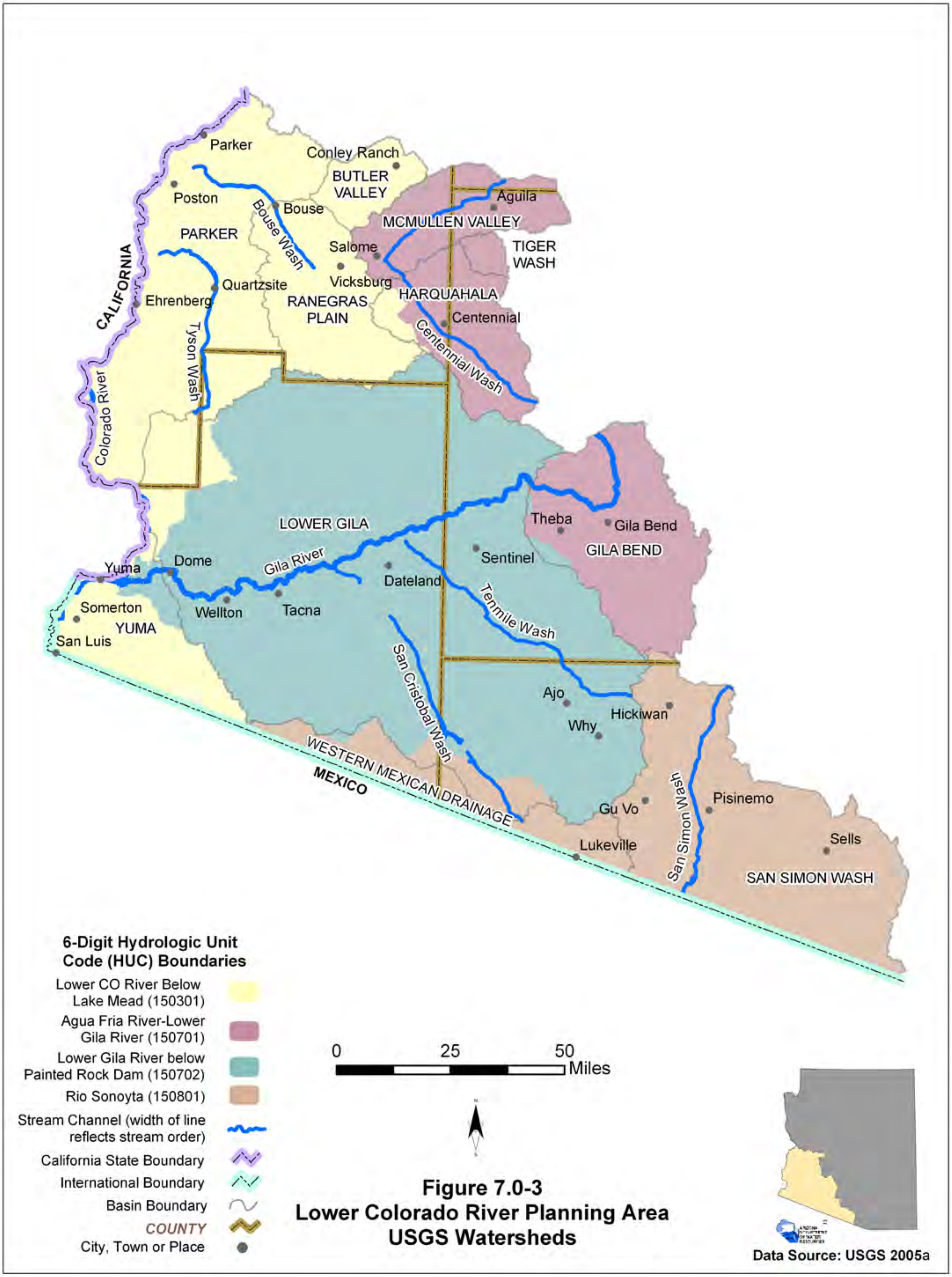



**Figure 7.0-3**
**Lower Colorado River Planning Area**
**USGS Watersheds**

Lower Gila River Below Painted Rock Dam

This watershed includes almost all of the Lower Gila Basin and part of the Yuma Basin. Major surface water drainages are the Gila River, Tenmile Wash and San Cristobal Wash (see Figure 7.0-3).

The Gila River drains the eastern and central parts of the planning area and extends 150 miles from Gillespie Dam (located where the Gila River enters the planning area in the Gila Bend Basin) to the confluence with the Colorado River in the Yuma Basin. The river originates in New Mexico and flows 600 miles from east to west across Arizona. The entire Gila River Watershed drains about 57,900 square miles and is the largest watershed in Arizona, covering over half of the state's total land area (Tellman, et al., 1997).

Historically, the Gila flowed in the planning area in the spring due to winter rain and snowmelt and in the summer following monsoon storms. Construction of upstream dams, beginning with Coolidge Dam near Florence in 1929, resulted in loss of flows and water supplies downstream. In the planning area, the Gila River flows only in response to precipitation events, irrigation return flow or releases from upstream dams. Recent sources list the river as either intermittent (AZGF, 1997) or ephemeral (ADWR, 1994a). The Gila River is a flashy stream, showing wide variations in annual flow in the planning area. There are four operating streamflow gages on the Gila River. Two gages are above Painted Rock Dam in the Agua Fria River-Lower Gila River Watershed in the Gila Bend Basin, one is in the Lower Gila Basin and one is in the Yuma Basin. All four gages have years with no flow (see Tables 7.2-2, 7.4-2 and 7.11-2). By contrast, total annual flow at the gages below Gillespie Dam and below Painted Rock Dam were over 5 million acre-feet (maf) in 1993. Further downstream near the confluence with the Colorado, the gage at the Gila River near Dome recorded a maximum annual flow of over 4.7 maf in 1993, but an annual median flow of less than 4,800 acre-feet.

Construction of Gillespie Dam in 1921, and Painted Rock Dam in 1959, impounded Gila River flow in the planning area for diversion to agricultural areas and to prevent flooding downstream. Gillespie Dam was breached during January, 1993 when a 135 foot section of the dam collapsed during flooding. The same flood event filled Painted Rock Dam to full capacity of 2.5 maf, making it the largest lake in Arizona, and high volumes of spillwater caused extensive downstream damage. The reservoir is normally dry.

There are no major (>10gpm) or minor (1-10 gpm) springs in the Lower Gila River Watershed below Painted Rock Dam, and only six to eight smaller springs.

Agua Fria River-Lower Gila River Watershed

The Agua Fria River - Lower Gila River Watershed includes the drainage areas of the Agua Fria River and the Gila River from below its confluence with the Salt River to Painted Rock Dam. Within the Lower Colorado River Planning Area, Gila Bend, Harquahala, McMullen Valley and Tiger Wash basins are included in the watershed. The Gila River is the only major watercourse (discussed above). Centennial Wash is the major tributary in the planning area and is an ephemeral stream with no streamgage data within the planning area. The only streamgage data for the watershed, other than those on the Gila River, is a discontinued gage at Sauceda Wash near Gila

Bend with a maximum annual flow of about 1,100 acre-feet (see Table 7.2-2).

There are no major (>10gpm) or minor (1-10 gpm) springs in the Agua Fria River-Lower Gila River Watershed, and only five to seven smaller springs, three of which are located in the Tiger Wash Basin.

Rio Sonoyta Watershed

The Rio Sonoyta Watershed in Arizona includes the San Simon Wash and Western Mexican Drainage basins and the south central portion of the Lower Gila Basin. Major drainages in the San Simon Wash Basin, all ephemeral, are San Cristobal Wash, San Simon Wash and Vamori Wash. Vamori Wash flows northwest to San Simon Wash, which in turn flows south to the Rio Sonoyta in Mexico. There are two active streamgages in the watershed in the San Simon Wash Basin, one at Vamori Wash at Kom Vo and one on San Simon Wash near Pisinimo. These ephemeral streams flow primarily in the summer as a result of monsoon precipitation. Annual mean flow at the Vamori Wash gage is over 6,600 acre-feet and almost 2,400 acre-feet at the San Simon gage (see Table 7.8-2). The largest ephemeral tributary to the Rio Sonoyta in the Western Mexican Drainage Basin is Aguajita Wash, located near the mountain fronts east of Quitobaquito and Cipriano Hills.

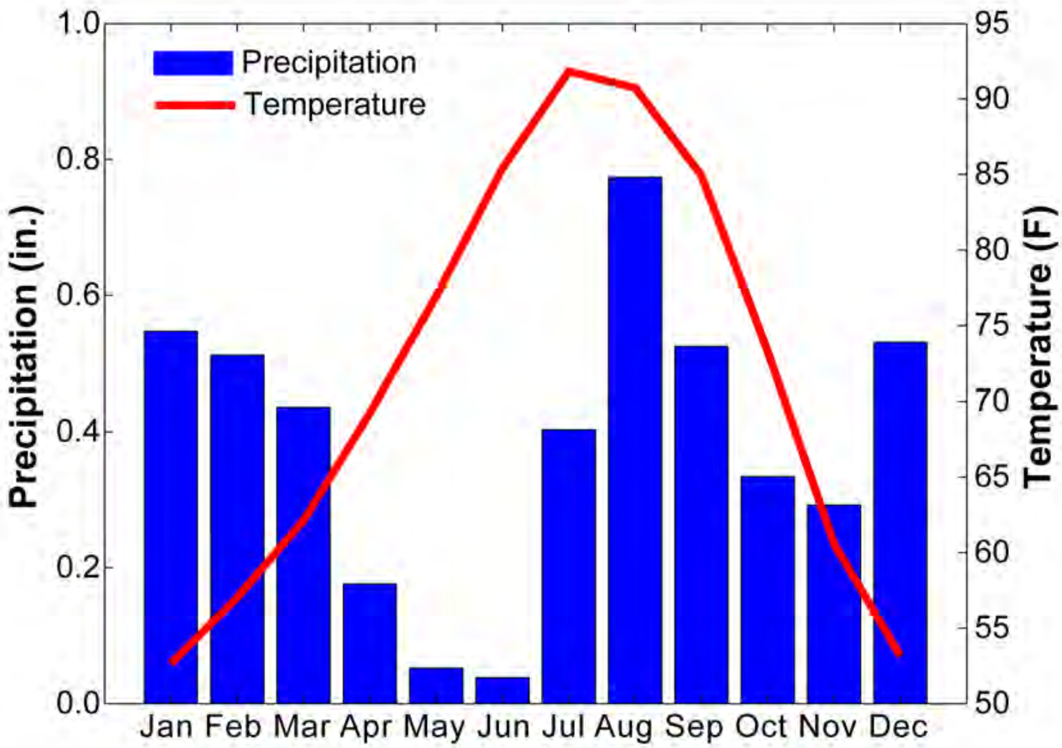
The only major (>10gpm) and minor (1-10 gpm) springs in the entire planning area are found in this watershed in the Western Mexican Drainage Basin. Quitobaquito Springs are the only major springs with a combined discharge of 28 gpm. Located adjacent to the international boundary in Organ Pipe Cactus National Monument, the springs flow from fractured granite that forms the Quitobaquito Hills. Groundwater moves through the fractured granite and discharges in a line of springs on the southwest side of Quitobaquito Hills (Carruth, 1996). Two of the largest springs have been capped and diverted into a manmade stream channel that flows to a half-acre pond that provides habitat for the endangered Quitobaquito pupfish (Knowles, 2003). The springs are relatively warm, (a near constant 74°F), and slightly brackish. The two minor springs in the planning area are located nearby. In total there are 15 to 23 total springs in the watershed, with most located in the San Simon Wash Basin.

### 7.0.3 Climate[2]

The Lower Colorado River Planning Area is characterized by the highest average annual temperature in the state, 71.5°F, which is much warmer than the statewide average of 59.5°F. Average annual precipitation in the planning area is 4.6 inches, though totals are probably considerably higher at high elevation ranges where precipitation is not recorded. Annual precipitation totals vary widely across the planning area, from 6-9 inches at Organ Pipe Cactus National Monument, Aguila, and Kofa Mine stations to less than 3 inches at Yuma Airport. On average, the Lower Colorado River exhibits the bi-modal precipitation seasonality characteristic of Arizona (Figure 7.0-4); however, the northwestern part of the planning area, near Parker, exhibits a stronger late winter peak, more typical of the Mohave Desert.

[2] Information in this section was provided by Institute for the Study of Planet Earth, Climate Assessment for the Southwest (CLIMAS), University of Arizona, December 2007.

**Figure 7.0-4 Average monthly precipitation and temperature from 1930-2002**

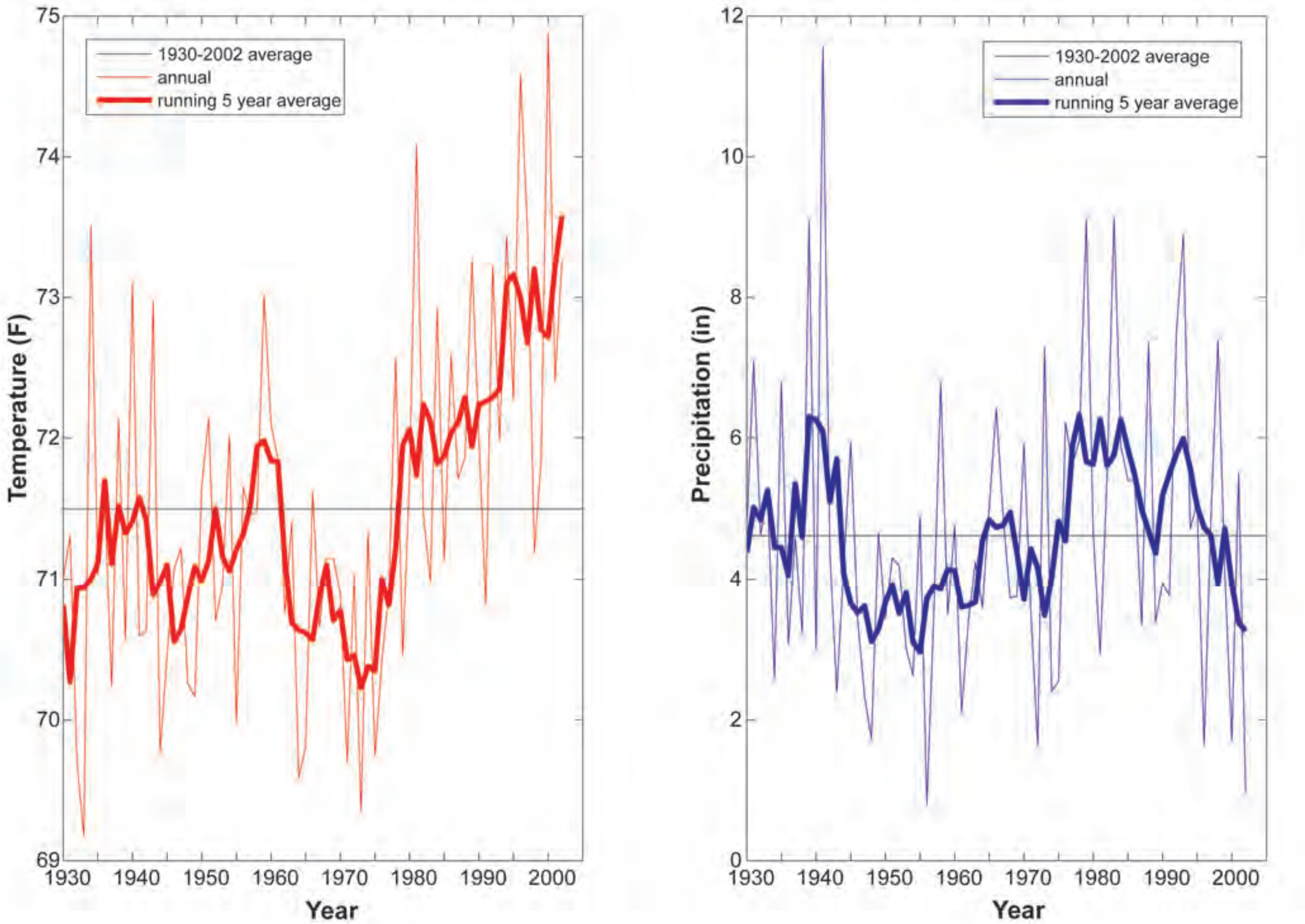



Data are from the Western Regional Climate Center. Figure author: Gregg Garfin, CLIMAS.

Frontal storm systems moving west-to-east, guided by the jet stream, deliver the area's winter and spring precipitation. Summer monsoon thunderstorms deliver abundant moisture to the eastern part of the Lower Colorado River Planning Area. The planning area shows a very strong response to El Niño conditions, with winters registering wet conditions 59% of the time and dry conditions only 24% of the time. Strong El Niño years, such as 1941, 1982, 1983, 1992 and 1993, show high precipitation (Figure 7.0-5). The precipitation response to La Niña conditions is not as pronounced with dry winters occurring only 50% of the time. Neutral El Niño-Southern Oscillation conditions yield dry Lower Colorado River Planning Area winters 57% of the time – a strong indication of the extreme aridity in this region.

Average annual temperatures in the Lower Colorado River Planning Area have been increasing since the 1930s, and especially rapidly since the mid-1970s (Figure 7.0-5). The long-term trend is superimposed on decadal variability generated primarily by Pacific Ocean and atmosphere variations. Decadal variations are particularly obvious in the instrumental record of precipitation. Drought conditions were present for the decades of the 1940s-1960s and since the mid-1990s; the 1980s and early 1990s were relatively wet. This part of the state exhibits Arizona's highest year to-year precipitation variability, with especially high variability during the dry 1940s-1960s.

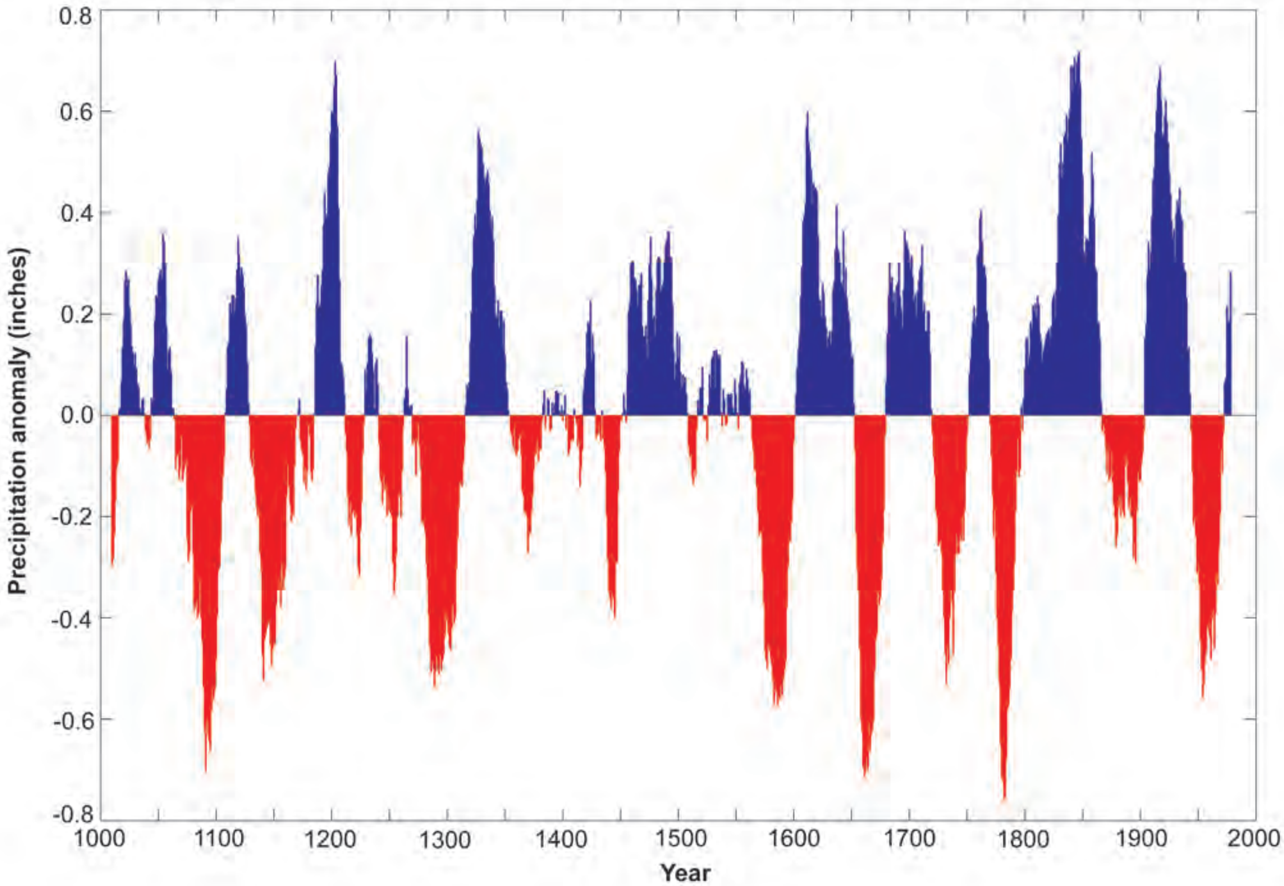
**Figure 7.0-5  Average annual temperature and total annual precipitation for the Lower Colorado River Planning Area from 1930-2002**




Horizontal lines are average temperature (71.5 °F) and precipitation (4.6 inches), respectively. Light lines are yearly values and highlighted lines are 5-year moving average values.  Data are from the Western Regional Climate Center. Figure author: Gregg Garfin, CLIMAS.

Winter precipitation records dating to 1000 A.D. estimated from tree-ring reconstructions for Arizona climate divisions show extended periods of above and below average precipitation in every century (Figure 7.0-6).  A climate division is a region within a state that is generally climatically homogeneous.  Arizona has been divided into seven climate divisions and most of the Lower Colorado River Planning Area is within Climate Division 5, which includes La Paz and Yuma counties.  Markedly dry periods in Climate Division 5 include the late 1000s, mid-1100s, the late 1200s, late 1500s, and several shorter, but very intense, periods during the last 300 years. Winters were relatively wet during the late 1400s, early 1600s, much of the 1800s, and the early 1900s.

**Figure 7.0-6 Winter (November - April) precipitation departures from average 1000-1988 - Climate Division 5**




Data are presented as a 20-year moving average to show variability on decadal time scales. Data: Fenbiao Ni, University of Arizona Laboratory of Tree-Ring Research and CLIMAS. Figure author: Gregg Garfin, CLIMAS.

## 7.0.4 Environmental Conditions

Environmental conditions reflect the geography, climate and cultural activities in an area and may be a critical consideration in water resource management and development. Discussed in this section is vegetation, protection of riparian areas through the Arizona Water Protection Fund Program, threatened and endangered species, public lands protected from development as national monuments, wildlife refuges and wilderness areas, and managed waters. No instream flow claims (a non-diversionary appropriation of surface water for recreation and wildlife use) have been filed in this planning area

### *Vegetation*

Information on ecoregions and biotic (vegetative) communities in the planning area are shown on Figure 7.0-7. With the exception of a very small area of Chihuhuan desert and Sierra Madre Occidental pine-oak forest along the southeastern boundary, the entire planning area is within the Sonoran Desert ecoregion. Biotic communities range from Lower Colorado River Valley Sonoran desertscrub to Madrean evergreen woodland. Most of the planning area is covered by Lower Colorado River Valley and Arizona Uplands Sonoran desertscrub.

Madrean evergreen woodland occurs at the highest elevations of the San Simon Wash Basin in the Baboquivari Mountains where mean annual precipitation exceeds 16 inches. The woodland consists of evergreen oaks, Alligator Bark and One-seed junipers, and Mexican pinyon and transitions to semidesert grassland at lower elevation. Cacti of the semidesert grassland may extend well into the woodland. (Brown, 1982)

Interior chaparral occupies mid-elevation foothill, mountain slopes and canyons in small areas along the boundary of McMullen Valley and Butler Valley Basin and along the McMullen Valley/Harquahala/Tiger Wash basin boundaries. Interior chaparral is found in areas between about 3,500 and 6,000 feet in elevation that receive 15 to 25 inches of annual precipitation (Brown, 1982). Chaparral consists of dense shrubs that grow around the same height with occasional taller shrubs or small trees. Typical shrubby species are mountain mahogany, shrub live oak, and manzanita. Chaparral plants are well adapted to drought conditions. (AZGF, 2004)

The western limit of the semidesert grassland community occurs in the eastern part of the planning area. A small area adjoins the Madrean evergreen woodland community in the Baboquivari Mountains and smaller areas exist in the central part of the San Simon Wash Basin and in eastern McMullen Valley Basin. Semidesert grasslands receive between about 10 to 17 inches of annual rainfall. Grasses were originally perennial bunch grasses with intervening areas of bare ground. Where heavily grazed, grasses have shifted to annual species where summer rainfall is low, or to low growing sod grasses where rainfall is moderate to heavy. Shrubs, cacti and herbaceous plants are commonly found in the semidesert grassland community. (Brown, 1982)

Two subdivisions of the Sonoran desertscrub region exist in the planning area-the Lower Colorado River Valley subdivision and the Arizona Upland subdivision. The Lower Colorado River Valley subdivision is the hottest and driest of the Sonoran desertscrub subdivisions. There is intense competition for water, with plants widely spaced and more concentrated along drainage channels. In some areas the soil is covered by a single layer of tightly packed pebbles known as “desert pavement” that restricts plant types to ephemeral species. High concentrations of sodium in the soil below the pavement may also restrict plant growth. Sand dunes occur near Yuma and Parker. Characteristic plants include creosote bush, bursage, saltbush, and mixed, more diverse vegetation along washes and other areas with more water. These areas may include blue palo verde, ironwood and jojoba. Also commonly found in the subdivision are several types of cholla and other cacti. (Turner and Brown, 1982)

The Arizona Upland subdivision borders the Lower Colorado River Valley subdivision and occurs primarily on slopes and sloping plains at elevations of 980 to over 3,000 feet where it merges with interior chaparral or semidesert grassland. This subdivision receives more precipitation than the other Sonoran desertscrub subdivisions with average annual precipitation between 8 to 16 inches. Vegetation is scrubland or low woodland in appearance with blue and foothill palo verde, ironwood, mesquite and cat-claw acacia as common tree species. Cacti are extremely important in this subdivision including saguaro, organ pipe, cholla and barrel cacti. (Turner and Brown, 1982)

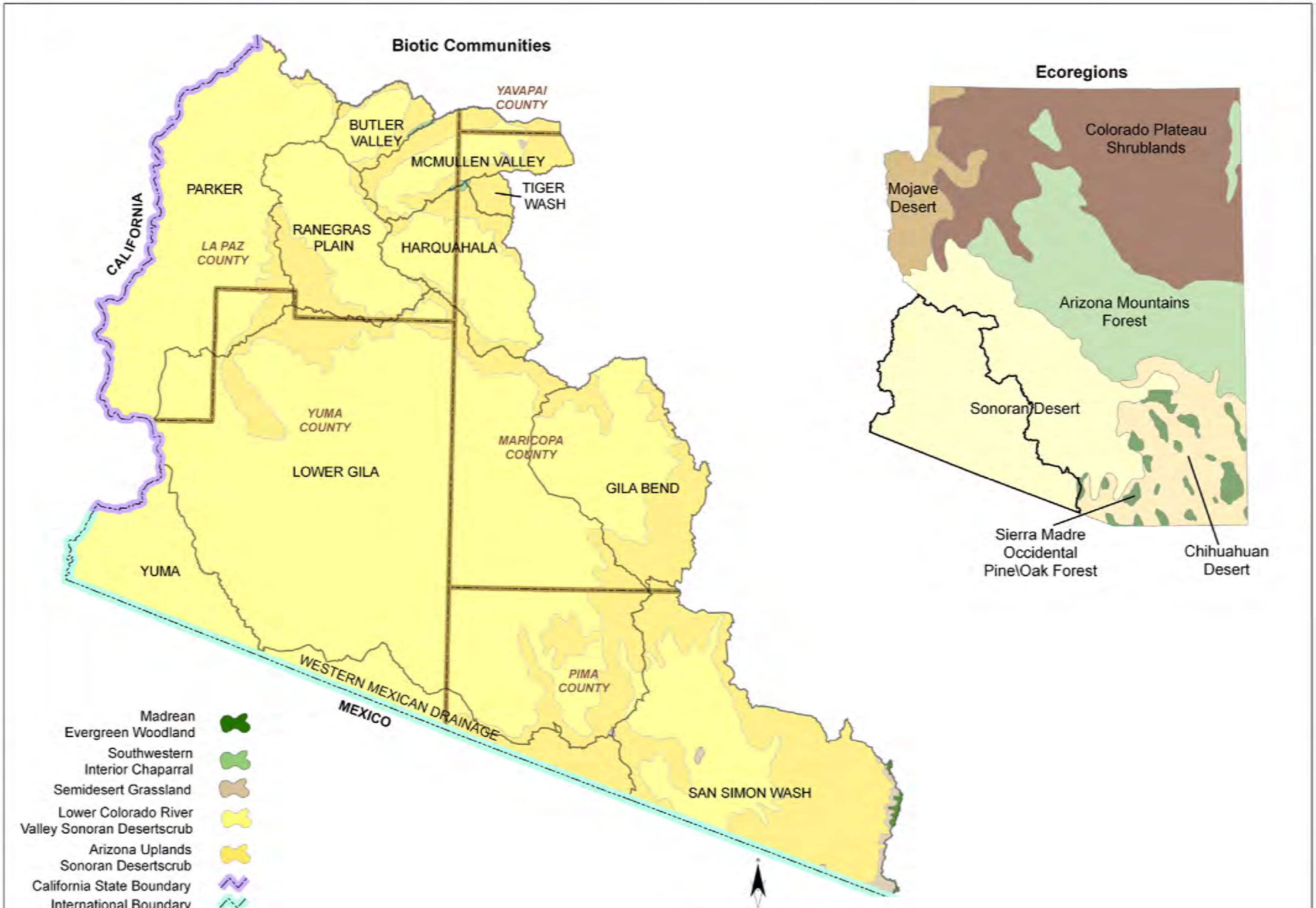



**Figure 7.0-7**
**Lower Colorado River Planning Area**
**Biotic Communities and Ecoregions**

Bufflegrass (Pennisetum ciliare), was introduced to the United States in the 1930s as livestock forage, and since the 1980s it has spread rapidly and can now be found on the edges of roads in most of southern Arizona. It is problematic in the Sonoran Desert because it grows densely, crowding out and competing for water with native plants and it is a fire-prone perennial that alters the natural fire regime. (ASDM, 2007b) When wildfires occur, the densely growing grass spreads fire rapidly and it thrives after fires while native species do not (Brooks and Pyke, 2002).

Some efforts to control the spread of bufflegrass have been successful. Organ Pipe Cactus National Monument undertook a large eradication effort through yearly weeding efforts and has managed to control and largely prevent its proliferation in the area (Burns, 2007).

The riparian corridor of the lower Colorado River was historically a mixture of cottonwood and willow trees with backwater wetlands. These habitats were maintained by the natural flow regime consisting of spring floods that washed salts from the banks, supported germination of tree seeds, and created seasonal wetlands (University of Arizona, 2003). In Mexico, the Colorado River Delta was historically two million acres in size and was a maze of lagoons and thickly forested. Today, only about 420,000 acres of riparian, wetland and intertidal habitat remain. This habitat is largely maintained by the delivery of irrigation drainage water from the Wellton-Mohawk Irrigation District in Arizona. This water has flowed to the eastern side of the delta since 1979, creating the largest wetland in the Sonoran Desert, the Cienega de Santa Clara (Glenn, et al., 2004).

There are reaches of riparian vegetation along the Colorado River that now consist primarily of tamarisk, mesquite and smaller areas of marsh and strand (riparian obligate plants adapted to periodic flooding, scouring, or soil deposition). There are scattered patches of cottonwood-willow along the river below Headgate Rock Dam. East of Yuma, tamarisk and strand vegetation are found along the Gila River west of highway 95. (AZGF, 1994)

### *Arizona Water Protection Fund Programs*

The objective of the Arizona Water Protection Fund (AWPF) program is to provide grants for the protection and restoration of Arizona's rivers and streams and associated riparian habitats. Six restoration projects in the Lower Colorado River Planning Area had been funded by the AWPF through 2005. Four projects were funded in the Yuma Basin for wetland and watershed restoration, exotic species control and revegetation. Two projects in the Parker Basin projects funded habitat restoration and revegetation and exotic species control. A list of projects and project types funded in the Lower Colorado River Planning Area through 2005 is found in Appendix A of this volume. A description of the program, a complete listing of all projects funded, and a reference map is found in Appendix C of Volume 1.

### *Threatened and Endangered Species*

A number of listed threatened and endangered species may be present in the Lower Colorado River Planning Area. Those listed by the U.S. Fish and Wildlife Service (USFWS) as of May 2006 are shown in Table 7.0-1.[3] Presence of a listed species may be a critical consideration in water resource

[3] An "endangered species" is defined by the USFWS as "an animal or plant species in danger of extinction throughout all or a significant portion of its range," while a "threatened species" is "an animal or place species likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

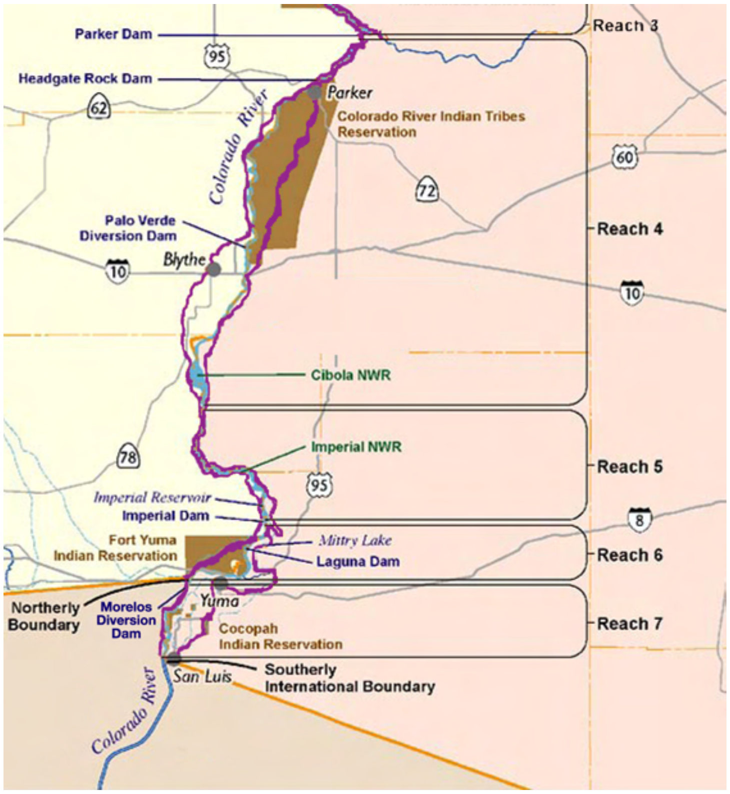
## Table 7.0-1 Listed threatened and endangered species in the Lower Colorado River Planning Area

| Common Name | Threatened | Endangered | Elevation/Habitat |
|---|---|---|---|
| Bald Eagle | X | | Varies/Large trees or cliffs near water. |
| Bonytail Chub | | X | 235 - 1,960 ft/Main stream portions of mid-sized to large rivers (both strong current and pools), usually over mud or rocks. |
| Cactus Ferruginous Pygmy-Owl | | X | 1,300 - 4,000 ft/Cottonwoods, willows, mesquite bosques and dry washes. |
| California Brown Pelican | | X | Varies/Lakes and rivers. |
| Kearny's Blue Star | | X | 3,685 - 4,500 ft/Canyon bottoms and sides in oak woodlands. |
| Lesser Long-Nosed Bat | | X | 1,190 - 7,320 ft./Desert grassland and shrubland up to oak transition. |
| Nichol's Turk's Head Cactus | | X | 2,400-4,100 ft./Sonoran desertscrub. |
| Quitobaquito Pupfish | | X | 0-4,950 ft/Small ponds and springs. |
| Razorback Sucker | | X | <6,000 ft./Riverine and lacustrine areas, not in fast moving water. |
| Sonoran Pronghorn | | X | 400 - 1,600 ft/Broad alluvial valleys separated by block-faulted mountains. |
| Southwestern Willow Flycatcher | | X | <8,500 ft./Cottonwood-willow and tamarisk along rivers and streams. |
| Yuma Clapper Rail | | X | <4,500 ft./Fresh water and brackish marshes |

Source: USFWS 2006

management and development in a particular area. The USFWS should be contacted for details regarding the Endangered Species Act (ESA), designated critical habitat and current listings.

**Figure 7.0-8 LCR MSCP Reaches in the Lower Colorado River Planning Area**




**Source:** Lower Colorado River Multi-Species Conservation Program, 2004

Actions related to operation of the Lower Colorado River water delivery and electrical power generation systems by both federal and non-federal entities may affect listed species and habitat or contribute to the listing of additional species in the future. The ESA directs Federal agencies to support the conservation of listed threatened and endangered species and to make sure that their actions do not jeopardize the continued existence of listed species or result in adverse modification of critical habitat. To comply with the requirements of the ESA, state and federal water and power 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). Its purposes include: 1) protection of habitat while ensuring current river water and power operations; 2) addressing the needs of listed species under the ESA; and 3) reduction of the likelihood of listing additional species along the river (USBOR, 2007b). LCR MSCP reaches 4-7 are within the planning area and their general location is shown in Figure 7.0-8.

The LCR MSCP also addresses compliance with the "take" provisions of the ESA. Incidental take of a listed species, as the result of carrying out an otherwise lawful activity, is not allowed without acquiring a permit from the U.S. Fish and Wildlife Service. The LCR MSCP documents the extent of the incidental take related to river operations and maintenance activities by both Federal and non-Federal entities and includes measures to avoid, minimize and mitigate the effect of the take (USDOI, 2004).[4]

Implementation of the LCR MSCP began in 2005. The program area extends from the full pool elevation of Lake Mead to the SIB with Mexico, a distance of 400 river miles and includes the historical floodplain of the Colorado River (USBOR, 2007b). The LCR MSCP is intended to serve as a coordinated and comprehensive conservation approach for a 50-year period and

[4] As defined by the ESA, 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])

therefore includes measures for species not currently listed that may become listed in the future. Implementation of the program is funded by a partnership of state, Federal and other public and private stakeholders in Arizona, California and Nevada. The plan will create riparian, marsh and backwater habitat for six federally listed species and 20 other native species including conservation programs for razorback sucker and bonytail chub, both federally listed endangered species.

Historically the “Great Valley”, what is now known as the Palo Verde Valley in California and Cibola Valley from the Parker area downstream to Cibola Lake, supported an extensive riparian woodland ecosystem and this area is a focal area for conservation measures under the LCR MSCP. Significant conservation measures intended to restore native riparian woodland habitats, once common along the lower Colorado River, have been implemented in Arizona at Cibola Valley Conservation Area (CVCA) in the Cibola Valley Irrigation and Drainage District, Cibola National Wildlife Refuge (CNWR), and Imperial National Wildlife Refuge (INWR). Measures include planting cottonwood, willow, mesquite, and other seedlings to create habitat for riparian woodland obligate species at CVCA, CNWR, and INWR, creation of marsh habitat for Yuma clapper rail and California black rail at INWR, and creation of isolated refugia for razorback sucker and bonytail at INWR. Investigations continue on the suitability of existing backwaters for conversion into habitat suitable for razorback sucker and bonytail. In addition, experimental habitat restoration measures have been implemented at the ‘Ahakhav Tribal Preserve on the Colorado River Indian Tribes Reservation.

### *National Monuments, Wildlife Refuges and Wilderness Areas*

The Lower Colorado River Planning Area contains 15 wilderness areas administered by the Bureau of Land Management (BLM), four National Wildlife Refuges (NWR) and two National Monuments (Figure 7.0-9). Both monuments and three wildlife refuges also contain wilderness areas. In total there are 2.3 million acres of protected federal lands in the planning area, accounting for 21% of the land area.

Eight BLM wilderness areas are entirely within the planning area as well as parts of seven others. Wilderness Areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition. Designated wilderness areas managed by the BLM, their size, basin location and a brief description of the area are listed in Table 7.0-2.

The largest protected area in the planning area is the Cabeza Prieta NWR, the third largest refuge in the contiguous United States with an area of over 860,000 acres. Designated in 1939, it lies within the Lower Gila and Western Mexican Drainage basins and shares a 56-mile border with the Mexican state of Sonora. Most of the refuge is designated as wilderness. The refuge provides habitat for desert bighorn sheep, the endangered Sonoran pronghorn and lesser long-nosed bat, as well as 420 plant species and more than 300 kinds of wildlife. (USFWS, 2007a) The U.S. pronghorn population is estimated at around 50 animals.

Cibola NWR straddles the Colorado River, with almost 13,000 acres located in the Parker Basin and the remainder in California. The refuge was established in 1964 to restore and protect historic habitat and wintering grounds for migratory birds and other wildlife. About 85% of Arizona’s

### Table 7.0-2 BLM Wilderness areas in the Lower Colorado River Planning Area

| Wilderness Area | Acres in the Planning Area | Basin | Description |
|---|---|---|---|
| Big Horn Mountains | 18,000 (partial) | Harquahala | Desert plain escarpments, hills, fissures, chimneys and narrow canyons. |
| Eagletail Mountains | 100,000 | Harquahala, Ranegras & Lower Gila | Large desert plain with natural arches, high spires, monoliths, jagged sawtooth ridges and numerous washes six to eight miles long. |
| East Cactus Plain | 15,000 | Parker | Intricate crescent dune topography and dense dunescrub vegetation known only in this area. |
| Gibraltar Mountain | 19,000 | Parker | Volcanic rock dissected by deep, sandy washes and rocky canyons, includes may alcoves and caves. |
| Harcuvar Mountains | 22,000 (partial) | McMullen Valley & Butler Valley | Bajadas and mountains with an isolated 3,500-acre "island" of interior chaparral habitat. |
| Harquahala Mountains | 23,000 | Tiger Wash, McMullen & Harquahala | Contains 5,691-foot- high Harquahala Peak, the highest point in southwest Arizona. |
| Hummingbird Springs | 5,500 (partial) | Harquahala | Includes Sugarloaf Mountain which rises steeply from the Tonopah Desert plains. |
| Muggins Mountains | 7,700 | Lower Gila | Rugged peaks dissected by deeply cut drainages. |
| New Water Mountains | 25,000 | Ranegras | Craggy spires, sheer rock outcrops, natural arches, slick rock canyons and deep sandy washes. |
| North Maricopa Mountains* | 40,000 | Gila Bend | Low-elevation Sonoran Desert mountain range and extensive surrounding desert plains. |
| Rawhide Mountains | 4,900 (partial) | Butler Valley | Low hills punctuated by numerous rugged outcrops. |
| Signal Mountain | 12,000 (partial) | Lower Gila | Sharp volcanic peaks, steep-walled canyons, arroyos, craggy ridges and outwash plains. |
| South Maricopa Mountains* | 40,000 (partial) | Gila Bend | Low-elevation Sonoran Desert mountain range and extensive surrounding desert plains. |
| Trigo Mountains | 30,000 | Parker | Sawtooth ridges and steep-sided canyons heavily dissected by washes. |
| Woolsey Peak | 60,000 (partial) | Gila Bend & Lower Gila | Sloping lava flows, basalt mesas, rugged peaks and ridges. |
| Total Acres | 400,100 | | |

**Source:** BLM 2006
* Wilderness areas are within the boundaries of a National Monument.

wintering Canadian Goose population is found on the refuge. (USFWS, 2007b)

Kofa NWR, at 665,400 acres, is located in the Lower Gila, Parker and Ranegras Plain basins. Established in 1939, it provides habitat for desert bighorn sheep, currently numbering 800-1,000 individuals, and protection for the California fan palm, the only native palm in Arizona (USFWS, 2007c). Most of the refuge is designated as wilderness.

Imperial NWR protects wildlife habitat along 30 miles of the Colorado River in Arizona and California, including the last unchannelized section of the river before it enters Mexico. The entire refuge encompasses almost 25,800 acres, of which 15,000 acres is designated wilderness. In Arizona, refuge lands are located in the Lower Gila and Parker basins. Efforts are underway to restore wetlands, control tamarisk, plant cottonwood and willow trees, protect lakes and manage

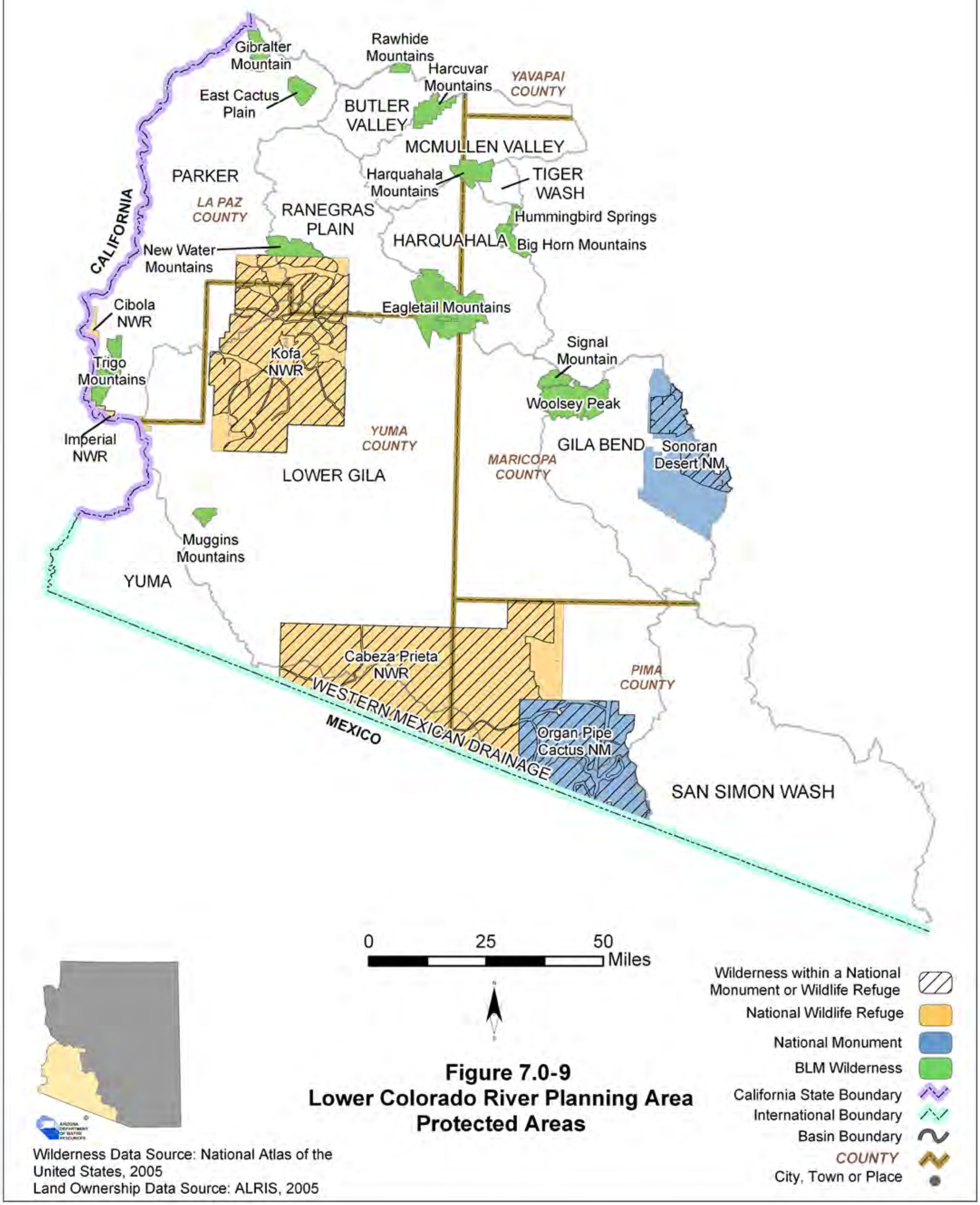



**Figure 7.0-9**
**Lower Colorado River Planning Area Protected Areas**

Wilderness Data Source: National Atlas of the United States, 2005
Land Ownership Data Source: ALRIS, 2005

marshlands and croplands to provide food and habitat for wintering migratory birds. (USFWS, 2007d)

Organ Pipe Cactus National Monument preserves approximately 106,800 acres of relatively unspoiled Sonoran Desert ecosystem in the Lower Gila and Western Mexican Drainage basins. The Monument contains twenty-six species of cactus and provides habitat for the endangered Quitobaquito Pupfish and Sonoran Pronghorn. About 95% of the Monument is designated as wilderness. The United Nations designated the monument as an International Biosphere Reserve in 1976. Due to the remoteness of the area, each year thousands of people illegally enter the U.S. through the monument using unofficial roads and trails. This traffic has adversely impacted habitat including deposition of trash, damage to plants, pollution of water sources, and soil erosion. (NPS, 2007)

A portion of the 496,000-acre Sonoran Desert National Monument, established by executive proclamation in 2001, is located in the Gila Bend Basin. The monument contains extensive areas of saguaro cactus forest, and archeological and historic sites. Three wilderness areas are contained within the monument boundaries. (BLM, 2007)

### *Managed Waters*

Water management decisions and operations outside of the planning area affect the character of the Colorado River within the planning area. Use of Colorado River water is primarily under the jurisdiction of the federal government and was developed through a number of Congressional acts, Supreme Court Decisions, multi-state compacts and an international treaty collectively known as the “Law of the River.” More detail on management issues affecting the river are found in Section 7.0-8.

Historically, the Colorado River was highly unpredictable with annual variation of 5 maf to 24 maf at its point of discharge to the Gulf of California. Sediments were carried downstream with spring floods, forming beaches and a large delta where the river met the sea. These floods often changed the course of the river. Today the river flow does not always reach the Gulf due to diversions, sediment is trapped behind dams and the river is channelized through parts of its length.

Prior to development, the Colorado River delta area was one of the richest estuaries in the world. Upstream diversions have severely impacted the delta with a small remnant remaining in the Cienega de Santa Clara. This remnant has been maintained as a result of bypassed saline return flows generated by the Wellton-Mohawk Irrigation and Drainage District. Salinity standards established by the 1944 Treaty with Mexico require that these return flows can no longer be returned to the river in Arizona. The Cienega was designated as a Biosphere Reserve in 1994 (Tellman, et al., 1997). Discussions are ongoing on how to manage and utilize return flows in the Yuma area while still sustaining the Cienega.

### 7.0.5 Population

The Lower Colorado River Planning Area is growing rapidly with a 44% population increase between 1990 and 2000. Census data for 2000 show about 194,100 residents and Arizona Department of Economic Security (DES) population projections suggest that the planning area population will more than triple by 2050, to about 586,400 residents. Historic, current and projected basin populations are shown in the cultural water demand tables for each basin in Sections 7.1-7.11.

The most populous basin is the Yuma Basin with 79% of the total planning area population in 2000. Several basins have population totals less than 100 residents. The 2000 Census populations for each basin and Indian reservation, listed from highest to lowest, are shown in Table 7.0-3.

**Table 7.0-3 2000 Census population of basins and Indian reservations in the Lower Colorado River Planning Area**

| Basin/Reservation | 2000 Census Population |
|---|---|
| Butler Valley | 18 |
| Gila Bend | 2,791 |
| *Gila Bend* | *NA* |
| Harquahala | 609 |
| Lower Gila | 11,303 |
| McMullen Valley | 2,291 |
| Parker | 16,166 |
| *Colorado River Tribes* | *3,389* |
| Ranegras Plain | 904 |
| San Simon Wash | 5,833 |
| *Tohono O'odham* | *5,833* |
| Tiger Wash | <10 |
| Western Mexican Drainage | 34 |
| Yuma | 152,883 |
| *Cocopah* | *1,025* |
| *Fort Yuma (Quechan)* | *45* |

Shown in Table 7.0-4 are incorporated and unincorporated communities in the planning area with 2000 Census populations greater than 1,000 and growth rates for two time periods. Communities are listed from highest to lowest population in 2000. As shown, there are a number of rapidly growing communities in the planning area. San Luis, along the international border, had the most rapid growth rate during both time periods. Fortuna Foothills, an unincorporated community east of Yuma is also growing rapidly with a 165% growth rate between 1990 and 2000. Yuma, Fortuna Foothills and Quartzsite experience a large seasonal population increase in the winter when seasonal residents arrive to enjoy the relatively warm climate. This seasonal population is not accounted for in the population estimates and projections unless these communities are listed as the primary residence.

**Table 7.0-4 Communities in the Lower Colorado River Planning Area with a 2000 Census population greater than 1,000**

| Communities | Basin | 1990 Census Pop. | 2000 Census Pop. | Percent Change 1990-2000 | 2005 Pop. Estimate | Percent Change 2000-2005 | Projected 2050 Pop. |
|---|---|---|---|---|---|---|---|
| City of Yuma* | Yuma | 54,923 | 77,515 | 41% | 88,775 | 13% | 255,612 |
| Fortuna Foothills | Yuma | 7,737 | 20,478 | 165% | 27,437 | 25% | 71,684 |
| City of San Luis* | Yuma | 4,212 | 15,322 | 264% | 22,930 | 33% | 71,521 |
| City of Somerton* | Yuma | 5,282 | 7,266 | 38% | 9,750 | 25% | 25,615 |
| Town of Ajo | Lower Gila | 2,919 | 3,705 | 27% | NA | NA | NA |
| Town of Quartzsite* | Parker | 1,876 | 3,354 | 79% | 3,600 | 7% | 5,221 |
| Parker Strip | Parker | 1,646 | 3,302 | 101% | 3,721 | 11% | 6,460 |
| Town of Parker* | Parker | 2,897 | 3,140 | 8% | 3,280 | 4% | 4,202 |
| Town of Gila Bend* | Gila Bend | 1,747 | 1,980 | 13% | 1,805 | -10% | NA |
| Town of Wellton* | Lower Gila | 1,066 | 1,829 | 72% | 1,970 | 7% | 2,854 |
| Town of Ehrenberg* | Parker | 1,226 | 1,357 | 11% | 1,390 | 2% | 1,607 |
| **Total >1,000** | | 85,531 | 139,248 | 63% | 164,658 | 63% | >444,775 |
| **Other** | | 49,097 | 54,814 | 12% | NA | NA | 141,630 |
| **Total** | | **134,628** | **194,062** | 44% | NA | NA | **586,406** |

**Source:** DES 2005: www.workforce.az.gov, U.S. Census Bureau 2006
**Notes:** 2005 population estimates not available for unincorporated communities
NA = not available
* = incorporated communities

## *Population Growth and Water Use*

Arizona has limited mechanisms to address the connections between land use, population growth and water supply. A legislative attempt to link growth and water management planning is the Growing Smarter Plus Act of 2000 (Act) which requires that counties with a population greater than 125,000 (2000 Census) include planning for water resources in their comprehensive plans. Of the five counties in the planning area, four fit the size criteria in 2000; Maricopa, Pima, Yavapai and Yuma. Yuma County is entirely within the planning area. The Yuma County 2010 Comprehensive Plan provides a general overview on the quality and quantity of water in the county, including information on drinking water and distribution and wastewater management (Yuma County, 2000)

The Act also requires that twenty-three communities outside AMAs include a water resources element in their general plans.  In the Lower Colorado River Planning Area this requirement applies to Yuma, Quartzsite, San Luis and Somerton and all communities have complied.  Plans must consider water demand and water resource availability in conjunction with growth, land use and infrastructure.

Beginning in 2007, all community water systems in the state were required to submit Annual Water Use Reports and System Water Plans to the Department. 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.  In addition, the information will allow the State to provide regional planning assistance to help communities prepare for, mitigate and respond to drought.  An Annual Water Use Report will be submitted each year by the systems, beginning June 1, 2007, and include information on water pumped or diverted, water received, water delivered to customers, and effluent used or received. The System Water Plan will be updated and submitted every five years and consist of three components- a Water Supply Plan, a Drought Preparedness Plan and a Water Conservation Plan. Systems serving populations greater than 1,850 were required to submit plans by January 1, 2007.  Systems that serve populations less than 1,850 are required to submit plans by January 1, 2008.  Plans have been submitted by the large systems of City of Yuma, Town of Parker, Ajo Improvement Company/Phelps Dodge Corporation, City of Somerton, and Arizona Water Company-Ajo System (a small system).  Water system, water supply and water demand information from these plans is presented in this document.

The Department's Water Adequacy Program also relates water supply and demand to growth to some extent, but does not control growth.  Developers of subdivisions outside of AMAs are required to obtain a determination of whether there is sufficient water of adequate quality available for 100 years.  If the supply is inadequate, lots may still be sold, but the condition of the water supply must be disclosed in promotional materials and in sales documents.  Legislation adopted in June 2007 (SB 1575) authorizes a county board of supervisors to adopt a provision, by unanimous vote, which requires a new subdivision to have an adequate water supply in order for the subdivision to be approved by the platting authority.  If adopted, cities and towns within the county may not approve a subdivision unless it has an adequate water supply.  If the county does not adopt the provision, the legislation allows a city or town to adopt a local adequacy ordinance that requires a demonstration of adequacy before the final plat can be approved.

Subdivision adequacy determinations (Water Adequacy Reports), including the reason(s) for inadequate determinations, are provided in the basin sections of this volume and are summarized for each basin in Table 7.0-5.  As shown on the table, a high percentage of lots have been determined to have an adequate water supply and only basins with relatively few subdivided lots have a high percentage of inadequacy determinations.

Two water providers in the planning area, Parker and the City of Yuma, are designated as having an adequate water supply for their entire service area.  A service area designation exempts subdivisions from demonstrating water adequacy if served by the provider.

**Table 7.0-5 Water adequacy determinations in the Lower Colorado River Planning Area**

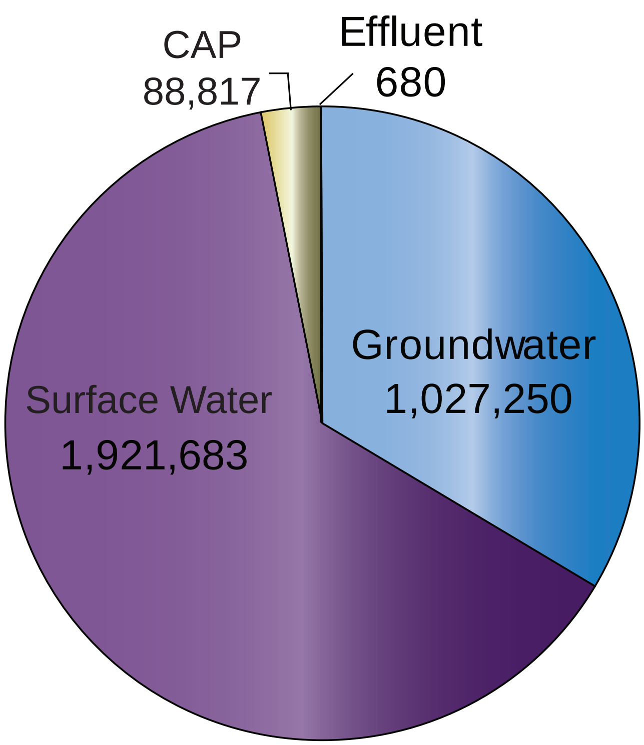
| Basin | Number of Subdivisions | Number of Lots[1] | Lots w/ Adequate Detrm. | Lots w/ Inadequate Determ. | Approx. Percent of Lots w/ Inadequate Determ. |
|---|---|---|---|---|---|
| Gila Bend | 4 | ≥89 | ≥24 | 65 | 73% |
| Harquahala | 3 | ≥65 | ≥35 | 30 | 46% |
| Lower Gila | 26 | 2,664 | 2,313 | 351 | 13% |
| McMullen Valley | 9 | 2,030 | 1,904 | 126 | 6% |
| Parker | 22 | ≥1,539 | ≥1,279 | ≥260 | 17% |
| Ranegras Plain | 4 | 135 | 26 | 109 | 81% |
| Yuma | 227 | ≥24,579 | ≥24,358 | 221 | <1% |

**Source:** ADWR 2005a
**Notes:**
[1] Data on number of lots are missing for some subdivisions; actual number maybe larger (≥)

## 7.0.6 Water Supply

Water supplies in the Lower Colorado River Planning Area include groundwater, surface water, Central Arizona Project water and effluent. As shown on Figure 7.0-10, most water used is surface water diverted from the Colorado River, and to a lesser extent, the Gila River. Colorado River water is the major supply in the Lower Gila, Parker and Yuma basins and CAP water is the largest supply in the Harquahala Basin. Gila River water combined with effluent discharge from the Phoenix AMA is an agricultural supply in the Gila River Basin. Elsewhere, groundwater is the primary water supply. Colorado River water is also used to meet environmental needs at the Imperial Wildlife Refuge in the Parker and Lower Gila basins. A discussion of

**Figure 7.0-10 Water supply utilized in the Lower Colorado River Planning Area in acre-feet (average annual use 2001-2003)**



Colorado River water entitlements and accounting is presented below. For purposes of the Atlas, water diverted from a watercourse or spring is considered surface water and if it is pumped from wells it is accounted for as groundwater. This is reflected in the cultural water demand tables in each basin section.

### *Colorado River Water*

Decree Accounting

The right or authorization to beneficially use Colorado River water is defined as an entitlement. Entitlements held by Colorado River water users are created by decree of the United States Supreme Court in Arizona v. California et al. (Decree), through a contract with the Secretary of the Interior (Secretary) under Section 5 of the Boulder Canyon Project Act (BCPA) of December 21, 1928, or by Secretarial Reservation.

Table 7.0-6 shows the annual total amount of Colorado River water that was consumptively used for each category of water use within each basin in the planning area based on an accounting system established by Decree. Article V of the Decree directs the U.S. Bureau of Reclamation (Reclamation) to prepare an annual report of diversions from the mainstream, return flow of water to the mainstream that makes water available for downstream consumptive use in the U.S. or in satisfaction of the Mexican Treaty obligation, and the consumptive use of such water. The Article V report lists diversions and return flow separately by diverter, point of diversion and state, for each of the lower basin states.

According to the Article V report, consumptive use of Colorado River water in the planning area for agricultural, municipal, industrial and environmental purposes averaged 1,197,486 acre-feet annually for the 2001-2003 time period out of a total annual entitlement of 1,676,209 acre-feet. The table shows the quantities of water diverted by surface water diversions, in-river pumps, or pumped from wells assumed to be located within the hydraulically connected aquifer of the Colorado River. When determining consumptive water use, the Article V accounting system considers measured return flow and estimates of unmeasured return flows to the mainstream.

Reclamation has made a preliminary delineation of the lateral and vertical extent of the Colorado River aquifer to provide a basis for accounting of withdrawals against river water allocations. On August 18, 2006, Reclamation initiated a rulemaking process for Regulating Non-Contract Use of Colorado River Water in the Lower Basin (71 FR 47763) to prevent non-contract Colorado River water use from depleting the river and taking water from holders of Colorado River water entitlements. Reclamation's most current assessment indicates that most existing non-contract water use results from water withdrawn from wells located within the hydraulically connected aquifer of the Colorado River or from river pumps.

Because of the complexity of the accounting system and its unique methodology, the cultural water demand tables in Sections 7.4, 7.5 and 7.11 of this volume (those basins that utilize this supply), reflect the amount of water pumped from wells and diverted from streams. The tables do not attempt to distinguish whether the water is used pursuant to the entitlement system.

## Table 7.0-6 Arizona v. California Decree accounting of the consumptive use of Colorado River water in the Lower Colorado River Planning Area (in acre-feet/year)

| Basin/Year[1] | 1971-75 | 1976-80 | 1981-85 | 1986-90 | 1991-95 | 1996-00 | 2001-03[2] | Entitlement[3] |
|---|---|---|---|---|---|---|---|---|
| Parker | | | | | | | | |
| *Agricultural* | 334,058 | 354,197 | 338,033 | 407,512 | 425,204 | 429,193 | 392,450 | 693,486 |
| *Industrial* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Municipal* | 829 | 1,070 | 1,770 | 1,815 | 1,891 | 2,339 | 2,011 | 8,004 |
| *Environmental*[4] | 148 | 13,128 | 8,768 | 11,822 | 19,719 | 18,368 | 14,338 | 56,238 |
| Lower Gila | | | | | | | | |
| *Agricultural* [5] | 309,367 | 209,015 | 258,612 | 312,237 | 241,267 | 278,826 | 273,365 | 272,980 |
| *Industrial* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Municipal* | 2 | 5 | 6 | 7 | 19 | 62 | 76 | 265 |
| *Environmental* [4] | 40 | 59 | 22 | 743 | 1,800 | 1,773 | 920 | 6,262 |
| Yuma | | | | | | | | |
| *Agricultural* [5] | 676,165 | 631,711 | 564,313 | 571,245 | 543,251 | 560,581 | 492,110 | 582,257 |
| *Industrial* | 1,046 | 1,021 | 839 | 610 | 469 | 2,250 | 892 | 1,772 |
| *Municipal* | 13,272 | 10,146 | 12,174 | 13,137 | 15,255 | 21,625 | 21,325 | 54,945 |
| *Environmental* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **TOTAL** | 1,334,927 | 1,220,352 | 1,184,538 | 1,319,126 | 1,248,876 | 1,315,019 | 1,197,486 | 1,676,209 |

**Footnotes**

1 Reported consumptive use for individual users may 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 (Reclamation) began deducting unmeasured return flows from the diversions by individual divertors. Prior to this time, Reclamation only deducted the total amount of unmeasured return flow from the total Lower Basin diversions.

3 The entitlement amounts do not include 72,000 acre-feet for the Ak-Chin (50,000 acre-feet) and Salt River-Pima Maricopa Indian (22,000 acre-feet) water rights settlements. This water is delivered by the Central Arizona Project to the Ak-Chin and Salt River- Pima Maricopa Indian Communities.

4 The Imperial National Wildlife Refuge spans an area in the Parker and Lower Gila basins. The consumptive use has been prorated based on the percentage of land in each basin.

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

Entitlement Priority Levels

Rights to Colorado River water include the following several priority levels:

a. 1st Priority: Satisfaction of Present Perfected Rights as defined in the Arizona v. California decree
b. 2nd Priority: Satisfaction of Secretarial Reservations and Perfected Rights established prior to September 30, 1968
c. 3rd Priority: Satisfaction of entitlements pursuant to contracts between the United States and water users in Arizona executed on or before September 30, 1968 (2nd and 3rd priority are coequal)
d. 4th Priority: i) Contracts, Secretarial Reservations and other arrangements between the U.S. and water users in Arizona entered into after September 30, 1968, for a total quantity not to exceed 164,652 acre-feet of diversions annually and ii) contract No. 14-06-W-245, dated December 15, 1972, as amended, between the United States and the Central Arizona Project (CAP). Entitlements having a 4th priority as described in (i) and (ii) are coequal.
e. 5th Priority: Unused entitlement
f. 6th Priority: Surplus water

In general, the lower priority entitlements will be the first to be impacted when the Secretary declares a shortage on the Colorado River system. Within the planning area, entitlement holders with a first priority or present perfected rights include the Cocopah Indian Reservation, Colorado River Indian Tribes Reservation, Fort Yuma Indian Reservation, Yuma County Water Users' Association, North Gila Valley Irrigation District, Unit "B" Irrigation and Drainage District, the City of Yuma and the Town of Parker. Second and third priority entitlement holders (which are coequal), include the Ak-Chin Indian Community, Imperial and Cibola National Wildlife Refuges, Yuma Proving Grounds, the Marine Corps Air Station–Yuma, Wellton-Mohawk Irrigation and Drainage District and others. Information on Colorado River entitlements in the Lower Colorado River Planning Area is provided in Appendix B. Entitlements may be transferred under certain conditions. Within the planning area, the Cibola Valley Irrigation and Drainage District has assigned a portion of its entitlement to the Mohave County Water Authority (MCWA, Priority 5 and/or 6), to the Hopi Tribe (Priority 4, 5 and 6) and to Cibola Resources for municipal use at Ehrenberg. More information on entitlement transfers is in Appendix C.

Coordinated Operations and Shortage Criteria

In December 2007, Reclamation issued a Record of Decision (ROD) on interim operating criteria (2008-2026) including the coordinated operation of Lake Powell and Lake Mead and criteria for implementing shortage reductions in the Lower Basin. Historically, the reservoirs were operated independently; annual Lake Powell water releases were determined based on applicable law and relevant factors contained in the Long-Range Operating Criteria. The ROD adopted four key elements: 1) establishes rules for shortages; 2) allows coordinated operation of Lake Powell and Lake Mead to avoid Lower Basin shortages and avoid curtailment of Upper Basin water use; 3) establishes rules for surpluses; and 4) address ongoing drought by encouraging new initiatives for water conservation. If regional drought conditions continue, shortage operations could begin as early as 2011. The ROD could have implications for water supply availability in the planning area.

Colorado River Water Supply Distribution System

In the Lower Colorado River Planning Area, dams on the Colorado River were constructed primarily for the purpose of regulating river flow and creating storage to facilitate water diversions to Arizona, California and Mexico via canals pursuant to decrees, international treaties and other legal agreements. Figure 7.0-11 shows the location of major dams, water delivery and diversion structures, and other features along the Colorado and Gila Rivers in the planning area. The agricultural and municipal water delivery systems are discussed in the cultural water demand section (7.0.6). The Colorado River system is described briefly below, from north to south.

*Parker Dam*

Parker Dam, at the northern edge of the planning area in the Parker Basin, is a concrete arch structure 320 feet high and 856 feet long at its crest. It is the deepest dam in the world with 73 percent of its structural height below the original riverbed. Completed in 1938, it impounds Lake Havasu and provides a desilting basin and forebay for diversion of Colorado River water. The Metropolitan Water District of Southern California pumps water into its Colorado River Aqueduct from the forebay, conveying it 242 miles west to Lake Mathews near Riverside, California. On the Arizona side, water is pumped from the forebay into the CAP canal for use in central Arizona. (USBOR, 2007c) The dam includes a powerplant that is integrated with the Davis and Hoover powerplants, providing power to Arizona and southern California. The powerplant is remotely operated from the Hoover Control Center. (USBOR, 2006)

*Headgate Rock Dam*

Downstream of Parker Dam, irrigation water for the Colorado River Indian Tribes Reservation near Parker is diverted at Headgate Rock Dam. This dam was constructed in 1942 to stabilize the river channel and provide reliable irrigation supplies. (USBOR, 2007d) A levee system protects areas downstream from flooding.

*Palo Verde Diversion Dam*

Palo Verde Diversion Dam is located about 44 miles downstream of Headgate Rock Dam. It maintains a sufficiently high, constant water surface elevation at the Palo Verde Irrigation District canal headwork for delivery of irrigation water to the west side of the Colorado River near Blythe, California. The dam is a semipervious barrier of sand, gravel and rockfill, 46 feet high and 1,850 feet long. (USBOR, 2007e)

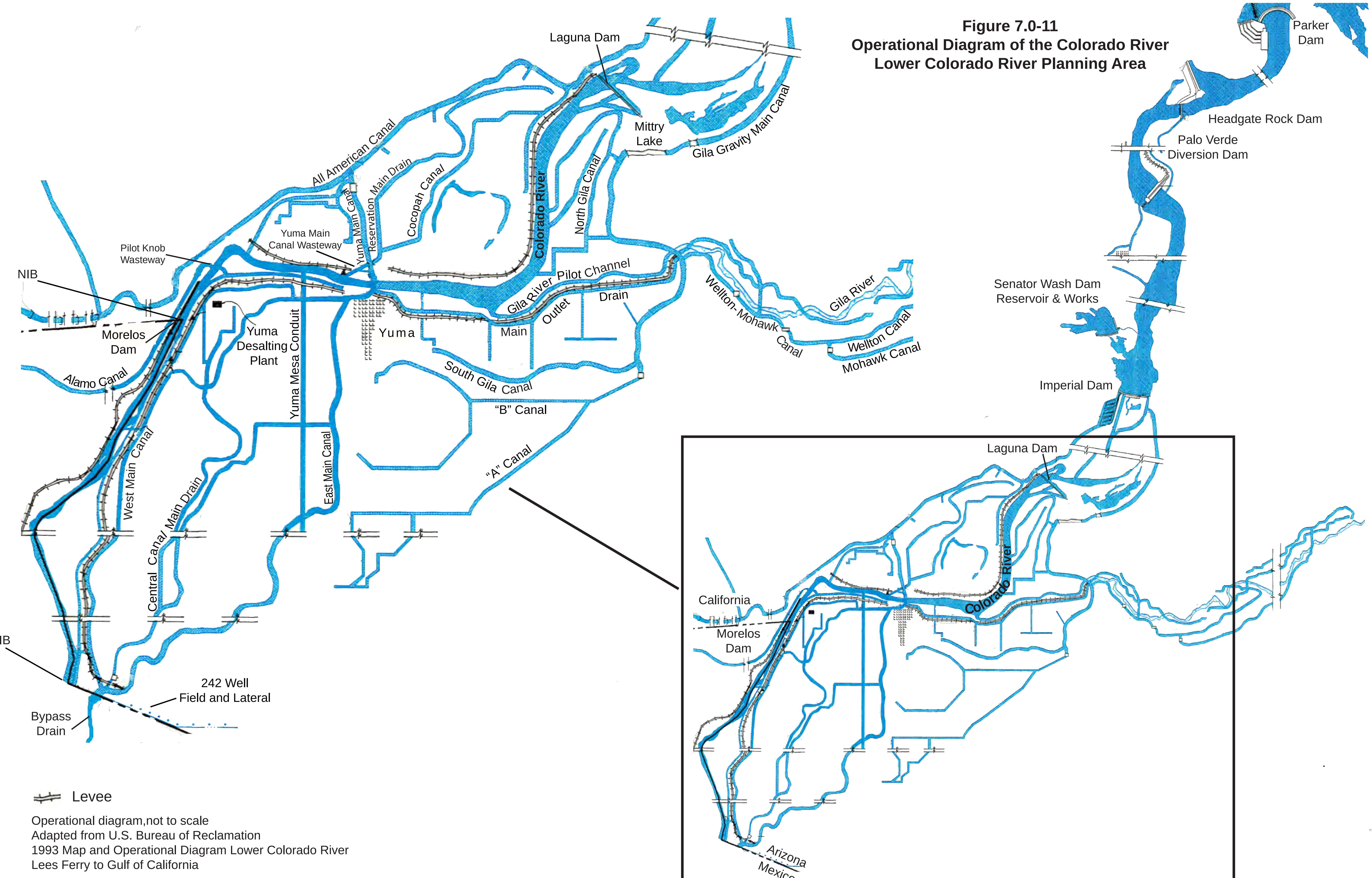
*Senator Wash Dam*

Senator Wash Dam and Reservoir is an offstream pumping facility located on the California side of the river about two miles upstream from Imperial Dam. This structure improves water scheduling by downstream users by storing part of the riverflow upstream of Imperial Dam when it is not needed, releasing it to the river for downstream use when needed. Without the dam it would take three days for water released at Parker Dam to reach Imperial Dam. The dam is an earth embankment structure 2,342 feet long with a height of about 94 feet. Other works include three dikes, a spillway and a pumping plant. (USBOR, 2007d)

*Imperial Dam*

Imperial Dam is a major diversion point for both Arizona and California. The dam raises the water

**Figure 7.0-11**
**Operational Diagram of the Colorado River**
**Lower Colorado River Planning Area**




Operational diagram,not to scale
Adapted from U.S. Bureau of Reclamation
1993 Map and Operational Diagram Lower Colorado River
Lees Ferry to Gulf of California

surface about 25 feet, allowing controlled gravity flow into the All American Canal and the Gila Gravity Main Canal. The All American Canal system diverts water from the California side of the dam and serves Imperial Irrigation District, Coachella Valley Water District, the Yuma Project in Arizona and California, and the City of Yuma. The Gila Gravity Main Canal system diverts water from the Arizona side of the dam and serves the north and south Gila Valley, Yuma Mesa, and the Wellton-Mohawk Irrigation District area. Imperial Dam is also used to regulate water deliveries to Mexico required by international treaty. (USBOR, 2007b)

*Laguna Dam*
From Imperial Dam to the Northerly International Boundary between the U.S. and Mexico, the entire channel of the Colorado River is bounded by a system of levees. Laguna Dam, located five miles downstream of Imperial Dam serves as a regulating structure for Colorado River water. (USBOR, 2007b) Because of upstream diversions and dams, from Laguna Dam to Morelos Dam the river consists of a small active channel located within a broad, older riverbed entrenched below the historic level of the unregulated river (USBOR, 2007d).

*Yuma Desalting Plant, Main Outlet Extension and Bypass Extension*
Utilizing Colorado River water for domestic and agricultural purposes has steadily increased the salinity of its waters. In the 1960s crops in the Mexicali Valley were damaged by the high salinity of the Colorado River water used for irrigation. An amendment to the 1944 treaty with Mexico (Minute 242) guaranteed that the treaty water delivery would be no more than 115 ppm (+/- 30 ppm) more saline than the water diverted at Imperial Dam.

Nine miles downstream from Laguna Dam the Gila River enters the Colorado. Along the Gila River, extensive agricultural irrigation with Colorado River water in the Wellton-Mohawk Irrigation and Drainage District (WMIDD) has made it necessary to install drainage wells to pump excess irrigation water to keep salts from accumulating in the root zone. About 120,000 acre-feet of brackish groundwater is pumped annually. If this water was directly returned to the river it would increase salinity levels above the international treaty standard and could not be counted towards Mexico's Colorado River apportionment of 1.5 million acre-feet per year. To desalinate the drainage water so that it could be returned to the mainstem and counted toward the apportionment, Reclamation constructed the Yuma Desalting Plant (YDP). Completed in 1992, the YDP is designed to treat up to 96,000 acre-feet of water per year. It operated briefly in 1993 and was then put on standby status until a recent "demonstration run" in 2007. WMIDD drainage water is discharged to the Main Outlet Drain Extension (MODE) and its bypass extension in Mexico and delivered to the Santa Clara Slough (Cienega de Santa Clara). (WMIDD, 2004)

*California and Pilot Knob Wasteways*
Four miles downstream from the mouth of the Gila River, the Yuma Main Canal wasteway returns water to the river to comply with the treaty obligation to Mexico. In addition, a portion of the water scheduled to be delivered to Mexico is diverted at Imperial Dam, conveyed by the All American Canal, and returned to the river through the Pilot Knob Wasteway west of Yuma. (USBOR, 2007b)

*Northerly International Boundary (NIB) to Southerly International Boundary (SIB)/Morelos Dam*

The 23.7 mile long reach of the Colorado River between the NIB and the SIB is referred to as the limitrophe section. Levees have been constructed on both sides of the river. About 1.1 miles downstream of the NIB, Morelos Diversion Dam acts as a diversion control structure for the Alamo Canal, which conveys water to Mexico. Other infrastructure includes wasteways, bypass channel, levees, etc. (USBOR, 2007b) Below Morelos Dam, operation of a dredge in Mexico at the head of the Alamo Canal, deposits a considerable amount of sediment into the river. In addition, river flow is reduced in this section due to diversions by Mexico into the Alamo Canal, and the channel is overgrown with vegetation. As a result, the flood capacity of the channel has been reduced, posing a threat to the safety of the Valley Division of the Yuma Project. (USBOR, 2007d)

*242 Well Field and Lateral*

The 242 well field and lateral is located east of San Luis in a 5-mile wide strip of land consisting of 21 wells. The well field intercepts part of the groundwater flow, including irrigation drainage water that moves south into Mexico from the Yuma Mesa. Water pumped from the well field is delivered at the SIB to Mexico through the 242 Lateral and other laterals to meet international treaty obligations for Colorado River water deliveries. (USBOR, 2007a)

### Central Arizona Project Water

Colorado River water is withdrawn at Lake Havasu at the Mark Wilmer Pumping Plant to the Central Arizona Project Aqueduct system. It crosses the Parker, Ranegras Plain and Harquahala basins via the Hayden-Rhodes Aqueduct to the CAP service area in central Arizona (Maricopa, Pima and Pinal counties).

CAP water is used both directly and stored underground in the planning area pursuant to the Department’s Recharge Program. Storage facilities in the planning area are shown in Table 7.0-7. The Vidler Water Company Underground Storage Facility (USF) is located near Centennial in the Harquahala Basin where it is permitted to recharge up to 100,000 acre-feet of CAP water annually. Harquahala Valley Irrigation District (HVID), located in the southern part of the Harquahala Basin holds a groundwater savings facility permit (GSF). It receives excess (uncontracted) CAP water which it uses “in-lieu” of groundwater. The Arizona Water Banking Authority (AWBA) holds water storage permits to store excess CAP water at both facilities. HVID has been using CAP water since 1986 and it has replaced groundwater as the major water supply in the basin. As a result of this storage and direct use, groundwater levels have risen in the vicinity of Vidler and HVID. A long-term storage account was established for the McMullen Valley Water Conservation & Drainage District (Vicksburg Farms) in 2000 in anticipation of the accrual of long term storage credits from storage of CAP water via two injection wells. However, a water storage permit was never issued and no water has been stored.

### Table 7.0-7 Storage facilities in the Harquahala Basin

| Permit Type/No. (Duration) | Permit Holder | Project Description | Associated Water Storage Permit No's and Permit Holder |
|---|---|---|---|
| USF 71-576699.0004<br><br>(09/03/04 to 09/30/20) | Vidler Water Storage Company | Vidler Water Company Recharge Project: Annual recharge up to 100,000 acre-feet of CAP via basins and vadose zone wells. | 73-576699.01: Vidler<br><br>73-576699.02: AWBA |
| GSF 72-593304.0000<br><br>(03/06/06 to 03/06/11) | Harquahala Valley Irrigation Dist. | Indirect recharge up to 50,000 acre-feet per annually of in lieu water. | 73-593304; AWBA |

### *Surface Water*

The Gila River in the Gila Bend Basin is the only major surface water supply in the planning area in addition to the Colorado River. The river is intermittent or ephemeral in the planning area and the volume available for use is a mixture of upstream releases of water from dams, storm runoff from precipitation events, irrigation return flows and effluent flows from the 23rd Avenue and 91st Avenue Wastewater Treatment Plants (WWTPs) located in the Phoenix AMA. The 91st Avenue WWTP, located near the confluence of the Salt, Gila and Agua Fria Rivers, has a current treatment capacity of 179 mgd (over 200,000 acre-feet/year). In typical years, most if not all water in this reach of the river is wastewater effluent (ADWR, 1994a). Flow is extremely variable in the river with annual flows varying from 0 to more than 5.6 maf at the gage below Gillespie Dam at the northern edge of the Gila Bend Basin. Median flow at the gage is about 43,000 acre-feet per year.

The waters of the Gila are designated as “impaired” due to elevated concentrations of organic compounds that exceed the designated use standard for fish consumption from it’s point of entry into the planning area to Painted Rock Dam. Below Painted Rock Dam the Gila is impaired due to dissolved oxygen, organics, selenium and boron concentrations that exceed fish consumption or aquatic and wildlife uses (see Tables 7.2-7 and 7.4-7).

### *Groundwater*

In basins without access to Colorado River or CAP water, groundwater is the primary water supply. Groundwater is a relatively abundant and dependable water supply throughout the planning area with relatively large volumes of groundwater in storage and high well yields in many basins. Well yields typically exceed 1,000 gpm, and often exceed more than 2,000 gpm, in almost all basins in the planning area. In groundwater dependent basins, estimates of water in storage are as high as 61 maf in the Gila Bend Basin, 15 maf in the McMullen Valley Basin and 27 maf in the Ranegras Plain Basin. However, groundwater levels declined in many of these basins between 1990-1991 and 2003-2004. Water levels declined by more than 30 feet in several wells in the northern part of the Gila Bend Basin during this period and wells near Salome-Wenden in the McMullen Valley Basin and in the central part of the Ranegras Plain Basin show similar declines (see Figures 7.2-6, 7.5-6 and 7.7-6). There are widespread instances of fluoride and arsenic levels that equal or exceed drinking water standards and high salinity levels in many agricultural areas. As mentioned previously, importation of Colorado River water in the Lower Gila and Yuma Basins has locally raised groundwater levels and changed groundwater flow directions, requiring drainage wells and exportation of water out of the basins.

In general, the Groundwater Transportation Act of 1991 restricts the transportation of groundwater from non-AMA groundwater basins to AMAs. However, there are three basins in the planning area from which groundwater may be withdrawn and transported outside of the basin: Butler Valley, Harquahala and McMullen Valley. General statutory provisions governing groundwater transportation from these basins are discussed below. Withdrawal and transportation of groundwater may cause groundwater level declines and impact the groundwater supply available for use within the basins.

Pursuant to A.R.S. § 45-553, groundwater may be withdrawn from the Butler Valley Basin and transferred to an initial AMA from State land or land owned by a political subdivision of the State (e.g. counties, cities and special districts). There are no limits on the volume of groundwater that may be transported from the basin. Groundwater may be withdrawn from historically irrigated lands in the McMullen Valley Basin that were owned by a city or person prior to January 1, 1988 and transported to the Phoenix AMA. (A.R.S. § 45-552) Qualified groundwater importers are cities, towns, private water companies and replenishment districts for their use or use by the AWBA. The City of Phoenix owns 14,000 acres of agricultural lands in the basin. The annual volume that may be withdrawn is limited to an average of 3 acre-feet per irrigated acre with a total limit of 6 million acre-feet. If this water is used for an assured water supply demonstration in an AMA, only water withdrawn above 1,000 feet at a rate not to exceed 10 feet per year over the 100 year period will be considered. In the Harquahala Basin, A.R.S. § 45-552 allows the transportation of groundwater pumped from historically irrigated lands owned by a political subdivision of the state and transported for its use in an AMA or use by the AWBA. The volumetric limit is 6 acre-feet per acre per year or 30 acre-feet per acre for any period of ten consecutive years. The director of ADWR may establish an alternative volume as long as it will not unreasonably increase damage to residents and other water users. Groundwater may not be withdrawn below 1,000 feet nor at a rate that cause declines of more than an average of ten feet per year during the one hundred year evaluation period. The City of Scottsdale has applied to the Department to export 3,645.24 acre-feet of groundwater per year from 1,215.08 acres of historically irrigated lands in the Harquahala Basin. As of 12/27/07 the application was still pending.

In order to better understand the water supply situation in areas of the state where data are lacking, the Department has established automated groundwater monitoring sites that record water levels in wells. This information is available through an interactive map on the Department's website to allow access to local information for planning, drought mitigation and other purposes (www.azwater.gov/dwr/). These devices were located based on areas of growth, subsidence, type of land use, proximity to river/stream channels, proximity to water contamination sites or areas affected by drought.

Figure 1-18 of Volume 1 of the Atlas shows the location of automatic water-level recording sites as of 2005. At that time there were a total of ten sites in the Lower Colorado River Planning Area, consisting of ADWR and USGS sites. Of these, there are seven ADWR sites located in the Butler Valley, Gila Bend, Harquahala, Lower Gila, McMullen Valley and Ranegras Plain basins.

Index well hydrographs, which display historic water level behavior, are available through an interactive map at the same website for 174 index wells in the planning area. Index wells are located in all basins except for San Simon Wash, most of which is covered by the Tohono O'odham Indian Reservation.

Information on major aquifers, well yields, estimated natural recharge, estimated water in storage, aquifer flow direction, and water level changes are found in groundwater data tables, groundwater conditions maps, hydrographs and well yield maps for each basin in Sections 7.1-7.11.

### Effluent

Effluent, or reclaimed water, is a little used resource in the planning area with less than 700 acre-feet used annually as a partial water supply for six golf courses in the Yuma Basin and one golf course in the Parker Basin. Golf course irrigation demand is higher in the summer, but effluent production is higher in the winter when the area population increases due to winter visitors. The water supply at Foothills Executive, Foothills Par 3 and Las Barrancas Golf Courses is about 90% effluent in the winter and 90% groundwater in the summer (personal communication, T. Holyk, 11/07). Effluent discharged to the Gila River from the Phoenix AMA is an agricultural water supply in the Gila Bend Basin, but the volume used is not quantified.

Approximately 16,300 acre-feet of effluent are treated in the planning area, and 79% of that (12,800 acre-feet) is generated in the Yuma Basin. Approximately 153,000 people or 79% of the total planning area population is served by a sewer system. Most of this potential water supply is discharged to evaporation ponds or to infiltration basins after treatment. A number of basins including, Butler Valley, Harquahala, McMullen Valley, Ranegras Plain, and Tiger Wash, have no record of a wastewater treatment plant. Use of septic tanks appears to be widespread throughout the entire planning area.

### Contamination Sites

Sites of environmental contamination may impact the use of some water supplies. An inventory of Department of Defense (DOD), Resource Conservation and Recovery Act (RCRA), Superfund (Environmental Protection Agency designated sites), Water Quality Assurance Revolving Fund (state designated WQARF sites), Voluntary Remediation Program (VRP) and Leaking Underground Storage Tank (LUST) sites was conducted for the planning area. Of these various contamination sites, DOD, Superfund, WQARF and VRP sites are found in the planning area. Table 7.0-8 lists the contaminant and affected media and the basin location of these sites. The location of all contamination sites in the planning area is shown on Figure 7.0-12.

**Table 7.0-8 Active contamination sites in the Lower Colorado River Planning Area**

| SITE NAME | MEDIA AFFECTED AND CONTAMINANT | GROUNDWATER BASIN |
|---|---|---|
| **Voluntary Remediation Sites** | | |
| Adair Memorial Park | Soil/Lead | Yuma |
| APS Yuma Manufactured Gas Plant (MGP) | Soil/Hydrocarbons, Polycyclic aromatic hydrocarbons (PAHs) and Volatile Organic Compounds( VOCs) | Yuma |
| Chevron Ajo Bulk Plant | Soil & Groundwater/Total Petroleum Hydrocarbons (TPH) and Benzene, Toluene, Ethyl benzene, and Xylene (BTEX) | Lower Gila |
| KMEP-Yuma Marine Corps Air Station | Soil & Groundwater/Total Petroleum Hydrocarbons (TPH); Benzene, Toluene, Ethyl benzene, and Xylene (BTEX); and Polycyclic aromatic hydrocarbon (PAH) | Yuma |
| Union Pacific Railroad Former AZ Agrochemical Facility | Soil/Pesticides | Yuma |
| Union Pacific Railroad Yuma Yard Dieselville | Soil & Groundwater/Total Petroleum Hydrocarbons (TPH) and Benzene, Toluene, Ethyl benzene, and Xylene (BTEX) | Yuma |
| Western Farm Service-Yuma Plant | Soil & Groundwater/Toxaphene dieldrin, Dichloro diphenyl trichloroethane (DDT), Dichloro diphenyl dichloroethane (DDD), Dichloro diphenyl dichloroethylene (DDE), Endrin heptachor epoxide disulphate and Nitrate | Yuma |
| **Water Quality Assurance Revolving Fund (WQARF) Sites** | | |
| 20th Street and Factor Avenue | Soil & Groundwater/Tetrachloroethene (PCE) and Cyanide | Yuma |
| Tyson Wash | Groundwater/ Tetrachloroethene (PCE) and Tricholoroethene (TCE) | Yuma |
| **National Priority List (NPL) Superfund Sites** | | |
| Yuma Marine Corps Air Station | Soil & Groundwater/Trichloroethene (TCE), Dichloroethene (DCE), Tetrachloroethene (PCE) and Petroleum Hydrocarbons | Yuma |
| **Department of Defense (DOD) Sites** | | |
| Yuma Army Proving Grounds | Soil & Groundwater/Hydrocarbons, Volatile Organic Compounds (VOCs), Semi-volatile Organic Compounds (SVOCs) and Metals | Lower Gila |

**Sources:** ADEQ 2002, ADEQ 2006a, ADEQ 2006b

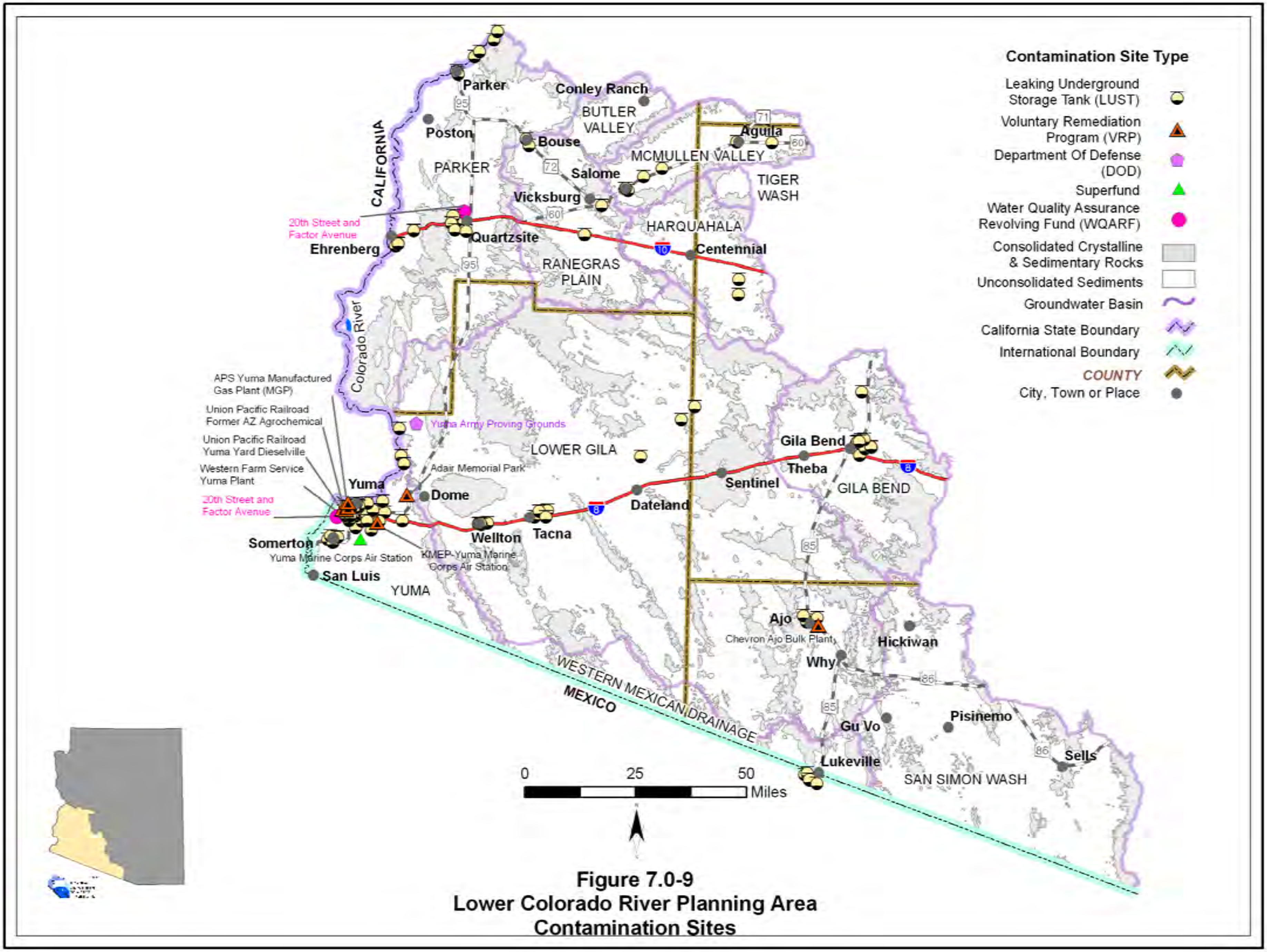



**Figure 7.0-9**
**Lower Colorado River Planning Area**
**Contamination Sites**

There are seven active VRP sites, all but one in the Yuma Basin and all primarily sites of organic compound contamination such as petroleum and pesticide products. The VRP is a state administered and funded voluntary cleanup program. Any site that has soil and/or groundwater contamination, provided that the site is not subject to an enforcement action by another program, is eligible to participate. To encourage participation, ADEQ provides an expedited process and a single point of contact for projects that involve more than one regulatory program (Environmental Law Institute, 2002).

There are two WQARF sites and one Superfund site in the Yuma Basin. All sites involve Trichloroethylene (TCE) or Tetrachloroethene (PCE) contamination. The Tyson Wash WQARF Site is located between Tyson Wash and Highway 95 north of Business Route 10 in Quartzsite. Contamination was detected in 1993 and a groundwater monitoring program began in 1995 to further investigate the extent of contamination. The upper aquifer, located about 42 to 65 feet below the land surface, has been affected. Water is being pumped and treated on site and injected back into the aquifer. (ADEQ, 2005) The 20th Street and Factor WQARF Site is located in Yuma and has cyanide contamination. Formerly the site of a motion picture laboratory and photo equipment manufacturer, wastewater was treated to recover silver and then discharged to a sump and disposal pond, to the ground, and used for landscape irrigation. Remedial actions at this site include soil removal and investigations to define the extent of a groundwater contamination plume. (ADEQ, 2007a) The Yuma Marine Corps Air Station (YMCAS) Superfund site, located at Yuma, involves multiple contaminants in groundwater as a result of disposal of materials related to military activities. Remedial actions include vertical recirculation of groundwater to contain and treat areas of relatively low contaminant concentrations, and air sparging/soil vapor extraction to treat the Area 1 Hot Spot (Source) Plume area (ADEQ, 2007b).

The Yuma Army Proving Ground Department of Defense Site is located northeast of Yuma and was first used as a military training facility during WWII. Later it became a site for testing of equipment under desert conditions. Groundwater contamination has occurred from the possible release of half a million gallons of fuel and from other actions. Environmental investigations and cleanup activities are underway and most of the contaminated areas are fenced. (ADEQ, 2007c)

There are 213 active LUST sites in the planning area. One hundred eight sites are located at Yuma, 22 at Gila Bend, 18 at Quartzsite, 13 each at Parker and Ehrenberg, and ten sites or less at Somerton, Vicksburg, Wellton, Salome, Lukeville, Tacna and Centennial Wash.

### 7.0.7 Cultural Water Demand

Cultural water demand in the Lower Colorado River Planning Area, organized by water source and water demand sector, is shown in Table 7.0-9. Total cultural water demand averaged approximately 3,038,400 acre-feet per year during the period from 2001-2003. Almost 98% of this demand is by the agricultural sector with approximately 2,974,200 acre-feet of annual demand. Agricultural demand occurs in all of the basins with the exception of Tiger Wash and Western Mexican Drainage basins. About 65% of this agricultural demand is met by surface water diverted from the Colorado River. Municipal demand is about 1.6% of the total planning area demand with an average of 49,380 acre-feet during the period 2001-2003. Municipal demand is primarily met by Colorado

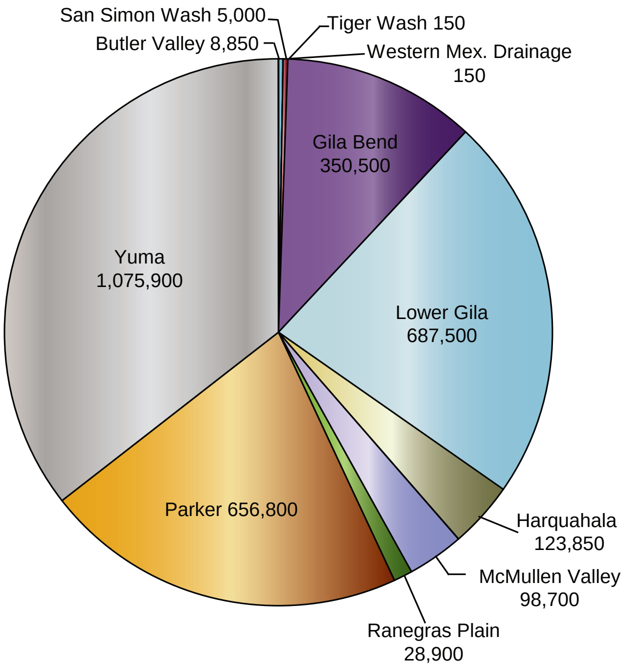
River water and the municipal sector is the only sector that utilizes effluent. Industrial demand, primarily related to dairies and feedlots, accounted for 14,850 acre-feet, 0.5% of the total demand during this period. Tribal water demand is included in these totals.

Cultural demand volumes vary substantially between planning area basins and ranges from less than 300 acre-feet per year in the Tiger Wash and Western Mexican Drainage basins to 1,075,900 acre-feet per year in the Yuma Basin (see Figure 7.0-13).

**Table 7.0-9 Lower Colorado River Planning Area average cultural water demand by sector (2001-2003)**

| Water Source/Demand Sector | Acre-feet | Percent |
|---|---|---|
| *Groundwater* | | |
| Agricultural | 999,700 | 32.93% |
| Municipal | 15,600 | 0.51% |
| Industrial | 11,398 | 0.37% |
| *Surface Water* | | |
| Agricultural | 1,974,500 | 65.03% |
| Municipal | 33,100 | 1.09% |
| Industrial | 1,382 | 0.05% |
| *Effluent* | | |
| Municipal | 680 | 0.02% |

**Figure 7.0-13 Average total basin water demand per year in acre-feet (2001-2003)**




### *Tribal Water Demand*

Tribal lands in the planning area include the Cocopah, Colorado River Indian Tribes (CRIT), Gila Bend, Fort Yuma-Quechan and the Tohono O'odham reservations. The Cocopah, Fort Yuma-Quechan and CRIT hold Priority 1 Colorado River entitlements totaling 677,573 acre-feet a year. The CRIT entitlement is 662,402 acre-feet, the largest in the state and about a third of the state's non-CAP entitlement. By comparison, the total non-tribal Priority 1 entitlement in the planning area is 290,923 acre-feet. Annual tribal demand is approximately 658,000 acre-feet a year, most of which is agricultural irrigation on the CRIT Reservation in the Parker Basin. Almost the entire San Simon Wash Basin is within Tohono O'odham Reservation boundaries.

Cocopah

The Cocopah Reservation is entirely within the Yuma Basin. The reservation has about 1,000 tribal members and consists of three parcels (East, West and North Cocopah) located south of Yuma. The tribe has approximately 2,400 acres of land under irrigation, leased to non-tribal farmers. The tribe operates a casino and a number of community facilities. (ITCA, 2003) There is no tribal water utility but the Cocopah Environmental Protection Office tests the quality of domestic wells and monitors agricultural water use to ensure that the tribe does not exceed its annual Colorado River allocation. This office also conducts weekly monitoring of groundwater levels and Colorado River water quality within the limitrophe region that crosses the boundaries of the West Reservation. (Cocopah Indian Tribe, 2006) The tribe's Colorado River entitlement is 8,821 acre-feet per year of Priority 1 rights and 2,026 acre-feet of Priority 4 entitlement for areas south of Morelos Dam.

Fort Yuma-Quechan

The Fort Yuma-Quechan Reservation is located primarily in California. Only 4% of the reservation land is in Arizona with 45 residents located just east of Yuma in the Yuma Basin. Tribal offices, RV parks and two casinos are also located in Arizona. The tribe owns a 700-acre farm which is leased to a non-Indian farmer. Some of this farm is apparently located in Arizona (ITCA, 2003).

Colorado River Indian Tribes

Most of the CRIT Reservation is located in Arizona in the Parker Basin with a small portion in California. The Colorado River Indian Tribes include the Mohave, Chemehuevi, Hopi and Navajo, and about 3,500 active tribal members. The primary tribal community is Parker, which contains non-tribal lands and Poston with about 400 tribal residents. The CRIT operate the CRIT Regional Water System (CRIT, 2005) and the CRIT Water Department serves the area outside the Parker Town limits. Tribal municipal demand is relatively small.

The primary economic activity on the reservation is agriculture. Pursuant to Arizona v. California, 99,375 acres of irrigated land were decreed with an associated annual Colorado River entitlement of 662,402 acre-feet. According to the 2006 Lower Colorado Accounting System, actual irrigated lands in Arizona totaled 72,610 acres, including land irrigated by lessees. The amount of irrigated acreage in Arizona reportedly averages between 72,000 to 80,000 acres. CRIT Farms manages over 15,000 acres of alfalfa, cotton, durum wheat and other crops (CRIT, 2005).

Other economic activities on the reservation include recreation, gaming, governmental services and light industry. The tribe operates two sand and gravel facilities, one at Parker and one north of Ehrenberg. These facilities supply concrete ready mix, asphalt and sand and gravel products to La Paz County and to neighboring counties in California. (CRIT, 2005)

Tohono O'odham

Water demand on the Tohono O'odham reservation is primarily related to municipal/domestic uses in the tribal communities, particularly at Sells, and farming in the southern part of the San Simon

Wash Basin at Papago Farms. The Tohono O'odham Utility Authority Water Department serves a total of about 3,200 customers and has 1,676 wastewater customers on the entire reservation which stretches into the Pinal and Tucson Active Management Areas. The Water Department is working to connect small systems into a single system that can be maintained in a central location. There are currently seven such systems in operation. (TOUA, 2007a) In the planning area there are plans to connect two community systems south of Gu Vo and connect another community with a regional system by the end of 2007. The water supply for the reservation comes from 73 wells located in and around the reservation. (TOUA, 2007b)

<u>Gila Bend</u>
The Gila Bend Reservation (San Lucy District) is part of the Tohono O'odham Nation but is located outside of the main reservation area north of Gila Bend. Water demand could not be determined, but based on aerial photos, it appears that there is no agricultural demand. In the Town of Gila Bend there is a multi-purpose district building and a health center that serves the district (ADOC, 2005).

### *Municipal Demand*

Municipal demand is summarized by groundwater basin and water supply in Table 7.0-10. Average annual demand during 2001-2003 was about 49,400 acre-feet. Sixty-seven percent of the municipal demand is met by surface water from the Colorado River, primarily in the Yuma Basin. In all other basins, groundwater is the primary municipal water supply. Effluent is used to meet municipal demand in the Yuma and Parker basins.

**Table 7.0-10 Average annual municipal water demand in the Lower Colorado River Planning area (2001-2003) in acre-feet**

| Basin | Groundwater | Surface Water | Effluent | Total |
|---|---|---|---|---|
| Butler Valley | <300 | | | 150 |
| Gila Bend | 950 | | | 950 |
| Harquahala | 950 | | | 950 |
| Lower Gila | 2,100 | 600 | | 2,700 |
| McMullen Valley | 550 | | | 550 |
| Parker | 3,300 | 500 | 220 | 4,020 |
| Ranegras Plain | 400 | | | 400 |
| San Simon Wash | 1,000 | | | 1,000 |
| Tiger Wash | <300 | | | 150 |
| Western Mexican Drainage | <300 | | | 150 |
| Yuma | 5,900 | 32,000 | 460 | 38,360 |
| **Total Municipal** | 15,600 | 33,100 | 680 | 49,380 |

**Sources:** USGS 2005b
**Notes:** Effluent figures are for golf course irrigation in 2006
Volume <300 acre-feet assumed to be 150 acre-feet for computation purposes

It is estimated that about 84% of the planning area population is served by a water provider. Eight water providers in the planning area served 500 acre-feet of water or more in 2003. These providers and their demand in 1992, 2000 and 2003 are shown in Table 7.0-11. In 2003, municipal utilities served the communities of Gila Bend, Wellton, Parker, San Luis, Somerton and Yuma. Municipally-owned systems have more flexible water rate-setting ability than private water companies, which are regulated by the Arizona Corporation Commission. In addition, municipal utilities have the authority to enact water conservation ordinances. This authority may enable municipal utilities to better manage water resources within water service areas. Water provider issues are discussed in Section 7.0.8.

**Table 7.0-11 Water providers serving a minimum of 500 acre-feet of water per year, excluding effluent, in the Lower Colorado River Planning Area**

| Basin/Water Provider | 1992 (acre-feet) | 2000 (acre-feet) | 2003 (acre-feet) |
|---|---|---|---|
| ***Gila Bend*** | | | |
| Town of Gila Bend | 537 | 651 | 837 |
| ***Lower Gila*** | | | |
| Ajo Improvement Company | 541 | 660 | 555 |
| Town of Wellton | NA | 158 | 638 |
| ***Parker*** | | | |
| Town of Parker | 887 | 1,049 | 1,027 |
| ***Yuma*** | | | |
| City of Somerton | 827 | 1,012 | 2,096 |
| City of San Luis | 772 | 1,904 | 2,588 |
| Far West Water and Sewer - Fortuna Foothills | 2,994 | 5,222 | 4,891 |
| Yuma Municipal Water Department | 21,680 | 32,906 | 30,016 |

**Sources:** USBOR 1991, USBOR 2000, USBOR 2003, USGS 2005

NA = Not Available

**Notes:** The Town of Ajo is served by three water providers. Ajo Improvement Company provides water to all three systems. Yuma Municipal Water Department demand are reported diversions of Colorado River water from the Bureau of Reclamation Article V Decree Accounting Reports.

Golf course demand is estimated to be approximately 12% of the total municipal demand. Estimated demand and water supply for all golf courses in the planning area is shown in Table 7.0-12. There are twelve municipal golf courses in the Yuma Basin receiving a combination of groundwater, surface water and effluent, three in the Lower Gila Basin using groundwater or surface water and one each in McMullen Valley and Parker basins.

Primary municipal demand centers are the Yuma area where the four largest communities in the planning area are located, and Parker/Parker Strip, Ajo, Quartzsite and Gila Bend. The only basins with population centers greater than 1,000 are Gila Bend, Lower Gila, Parker and Yuma basins.

Yuma Area

The total municipal demand in the Yuma Basin is about 38,400 acre-feet per year. The largest providers, City of Yuma, Far West Water and Sewer, Inc., City of Somerton and City of San Luis provided about 29,900 acre-feet of Colorado River water and groundwater to customers in 2003 (although there are accounting discrepancies as noted in Table 7.0-11). A number of wastewater treatment plants treat sewage in the Yuma area. The largest is the Figueroa Avenue Water Pollution Control Facility at Yuma. Somerton, San Luis and Far West Sewer also operate relatively large treatment plants. In its 2002 General Plan, the City of Yuma estimated that about 24% of existing housing units were not connected to a sewer system and that rapid growth in the Fortuna Foothills area has resulted in construction of on-site septic systems and private package treatment plants. (City of Yuma, 2002)

**Table 7.0-12 Golf course demand in the Lower Colorado River Planning Area (c. 2006)**

| Facility | Basin | # of Holes | Demand (acre-feet) | Water Supply |
|---|---|---|---|---|
| Ajo Country Club | Lower Gila Basin | 9 | 211 | Groundwater |
| Butterfield Golf Course | Lower Gila Basin | 18 | 441 | Surface Water |
| Coyote Wash Golf Course | Lower Gila Basin | 18 | 441 | Groundwater |
| Sunset Links Golf Club | McMullen Valley | 18 | 441 | Groundwater |
| Emerald Canyon Golf Club | Parker | 18 | 441 | Surface Water/Effluent |
| Arroyo Dunes Golf Club | Yuma | 18 | 175/175 | Groundwater/Surface Water |
| Cocopah Bend RV&GC | Yuma | 18 | 441 | Surface Water/Effluent |
| Desert Hills Golf Course | Yuma | 18 | 441 | Surface Water |
| Dove Valley Golf Course | Yuma | 18 | 441 | Groundwater |
| Foothills Executive Golf Course† | Yuma | 9 | 211 | Groundwater/Effluent |
| Foothills par 3 Golf Course† | Yuma | 9 | 211 | Groundwater/Effluent |
| Fortuna del Rey Golf Course† | Yuma | 9 | 211 | Groundwater/Effluent |
| Ironwood Golf Course | Yuma | 9 | 211 | Surface Water |
| Las Barrancas Golf Course† | Yuma | 18 | 441 | Groundwater/Effluent |
| Mesa Del Sol Golf Course† | Yuma | 18 | 441 | Groundwater/Effluent |
| Sierra Sands Golf Course | Yuma | 18 | 221 | Surface Water |
| Westwind RV & Golf Resort | Yuma | 9 | 211 | Surface Water |
| *Total Water Use Municipal Golf Courses* | | | *5,806* | |
| Yuma Golf & Country Club* | Yuma | 18 | 441 | Groundwater/Surface Water |
| *Total Water Use Industrial Golf Courses* | | | *441* | |
| **Total Water Use** | | | **6,247** | |

**Source:** ADWR 2005c
**Notes:**
* This golf course is served by its own well and is considered to be an industrial user
† These golf courses are served by Far West Water and Sewer. A total of 446 acre-feet of effluent is served for all courses.

The City of Yuma is the largest water provider, with Priority 1 and Priority 3 Colorado River water annual consumptive use entitlements totaling 50,000 acre-feet. The City can supplement its entitlement through the use of return flow credits such as water returned to the river following wastewater treatment and conversion of irrigation rights to municipal use. Colorado River water is transported to Yuma through several facilities (see Figure 7.0-11). About 97% of the City's water is transported through the All American Canal and Yuma County Water Users Association (YCWUA) facilities, including the Yuma Main Canal, to the Yuma Main Street Water Treatment Plant. The remaining three percent is delivered through the Gila Gravity Main Canal to the East Mesa treatment plant. (City of Yuma, 2002) In 2003, City of Yuma water demand was about 20,300 acre-feet. About three quarters of this demand is for residential uses. Commercial demand includes deliveries to golf courses but the precise number of courses and amount delivered is not known. (City of Yuma, 2007) The Department estimated that there are at least six golf courses served by the City of Yuma with a total annual demand of over 1,800 acre-feet. It does not appear that the City of Yuma provides effluent to meet this turf irrigation demand.

Far West Water and Sewer, Inc. serves the rapidly growing Fortuna Foothills area east of Yuma in unincorporated Yuma County. In 2003, it served about 4,900 acre-feet of water. The primary water supply is surface water from the Colorado River, delivered via the Yuma Mesa Irrigation District and "A" Canal. Groundwater is used as a back-up water supply, for irrigation water at three golf courses, and for construction. Far West operates a drinking water treatment plant, seven wastewater treatment facilities and serves about 15,000 water and 6,500 wastewater connections. (Far West Water & Sewer, Inc., 2006) About 446 acre-feet of treated wastewater, in addition to groundwater, is delivered to Foothills Executive, Foothills Par 3, Fortuna del Rey, Las Barrancas and Mesa del Sol golf courses to meet part of their annual water demand. Total annual demand of these courses is estimated at 1,525 acre-feet.

The City of Somerton, located about ten miles southwest of Yuma, is a fast growing, primarily residential community with almost 10,000 residents in 2005. In 2003, approximately 2,100 acre-feet was served to customers, including the Dove Valley Golf Course. The Somerton Municipal Water System service area is about 2.5 square miles in size and groundwater is pumped from three wells located in T9S, R24W. A fourth well is not used due to water quality problems. Depth to water is consistently about ten feet below land surface. The City is not interconnected to any other systems. It has a 2006 contract for 750 acre-feet of Priority 4 Colorado River water and is purchasing rights that are not currently being used. (City of Somerton, 2006)

Located adjacent to the international boundary, the City of San Luis is the fastest growing community in the entire planning area, growing by 33% between 2000 and 2005. The San Luis Municipal Water System served about 2,600 acre-feet in 2003. In 2006, approximately 3,400 acre-feet was withdrawn from nine wells to serve almost 5,100 customer connections. (City of San Luis, 2007)

<u>Parker/Parker Strip</u>
The Town of Parker and the Parker Strip had a combined population of about 6,400 in 2000. The Parker Strip is the area north of Parker along the Colorado River to the basin boundary. The area is growing rapidly, particularly the Parker Strip, which grew by 101% between 1990 and 2000. The Town of Parker Municipal System is the largest local water provider, serving about 3,200 residents with 1,250 service connections to the one square mile town, deeded inside the CRIT Reservation. The CRIT Water Department serves the area outside the town limits.

Parker Municipal System pumped about 1,000 acre-feet in 2003 from three wells pumping Colorado River water. The town has 630 acre-feet of Priority 1 entitlement and a combined volume of 3,030 acre-feet of 4th, 5th and 6th Priority water. Water levels in system wells vary from 75 to 90 feet and well pumpage reportedly doubles in the summer months. The system is interconnected to the CRIT water system and is used for emergency purposes. (Town of Parker, 2006) Water demand in this area is primarily for residential and commercial use.

Brooke Water LLC is the largest water provider in the Parker Strip and has an entitlement for 360 acre-feet of Priority 1 and 440 acre-feet of Priority 4 water. In 2003 Brooke Water LLC diverted 444 acre-feet of water and had a consumptive use of 297 acre-feet. Cienega Water Company, Inc. and Red Rock are smaller water providers in the Parker Strip that serve groundwater to a combined population of about 500 residents. Emerald Canyon Golf Course, located north of Cienega Springs, uses effluent from the Buckskin/Sandpiper WWTP to meet part of its irrigation demand.

<u>Ajo</u>

The Town of Ajo is the largest community in the planning area not located on or near the Colorado River. Ajo was founded by the New Cornelia Copper Company in about 1915. Phelps Dodge acquired the property in 1931 and continued to operate the mine until 1985. At that time most of the company-owned non-mining properties were sold to the residents and the unincorporated community is now a tourist and retiree destination. However, because of rising copper prices, Phelps Dodge is evaluating reopening the mine. Three water companies serve the town. (ADOC, 2007a) The largest system is the Ajo Improvement Company owned by the Phelps Dodge Corporation. It pumps water from two active wells in the Child's Well Field, seven miles north of Ajo, at a depth of 1,170 to 1,350 feet. It also provides sewer services and wastewater treatment. Effluent is not reused but is discharged to evaporation ponds. Ajo Improvement Company delivers groundwater to two other water systems: Arizona Water Company-Ajo System and Ajo Domestic Water Improvement District (DWID), neither of which operate their own wells to serve customers. (Malcolm Pirnie, 2006)

In 2003, Ajo Improvement Company served about 550 acre-feet of groundwater to 3,000 residents (1,390 service connections) and to the two other water systems. In 2006 its customer demand was about 320 acre-feet, of which 60% was residential and 40% commercial. In that year the Ajo DWID received about 40 acre-feet of water from the Ajo Improvement Company and served about 405 residents. (Phelps Dodge Corporation, 2007) In 2006, Arizona Water Company received about 180 acre-feet of water from the Ajo Improvement Company. Arizona Water Company-Ajo System serves about 686 connections, 73% residential and 27% non-residential. (Arizona Water Company, 2007) There is a nine-hole golf course in Ajo but the source of irrigation water is not known.

<u>Gila Bend</u>

The municipal water demand at Gila Bend is about 840 acre-feet a year for residential and commercial uses. Located at a transportation hub, the town has a number of gas stations, mini-marts, hotels and fast-food restaurants. In 2004, it reported 730 connections were served groundwater from three wells with water levels at 300 feet below land surface (ADWR, 2005b). About 400 acre-feet of effluent is generated at the Gila Bend Wastewater Treatment Plant and all is discharged to a watercourse.

Other municipal water demands in the northern part of the Gila Bend Basin include two large prisons, the Arizona State Prison Lewis Complex and the Eagle Point School Juvenile Corrections Facility, located on either side of Highway 85 in T2S R4W (see Figure 7.2-10). An associated Arizona Department of Corrections wastewater treatment plant generates over 400 acre-feet of effluent so water demand at the site is likely between 600 and 800 acre-feet per year. There is a small residential community located around a constructed water ski lake in the northern part of T4S R4W and another, Spring Mountain Ski Ranch, under construction in T3S R4W. These types of development are easier to construct outside of the state's active management areas since within an AMA, groundwater may not be used to fill a private lake larger than 12,320 square feet (about 0.28 acres) in area.

Wellton

Wellton is located in the middle of the Wellton-Mohawk Valley along Interstate 8 and serves as a business, service and recreation center for more than 5,000 people in the surrounding area. The Town of Wellton had a population of almost 2,000 in 2005 and grew by 72% between 1990 and 2000. The municipal water system receives Colorado River water from the Wellton-Mohawk Irrigation District and maintains one well for emergency backup. In 2003 the town served 640 acre-feet of surface water to 550 residential and commercial connections. New developments in the area, such as the master planned Coyote Wash, will increase municipal water demand. This planned community would include 2,500 homes, a condominium complex and shopping center, and an 18-hole golf course. The golf course has been completed and more than 500 lots sold. Another 18-hole course (Butterfield) at Wellton uses about 441 acre-feet of surface water annually.

Quartzsite

Although the water system for the Town of Quartzsite is not large, the community is rapidly growing with 3,600 residents in 2005. Located in the middle of the Parker Basin at the junction of Interstate 10 and U.S. 95, it is a tourist and retirement community with a population that swells in the winter with numerous gem and rock shows. There are an estimated 1.5 million annual visitors (ADOC, 2007b).

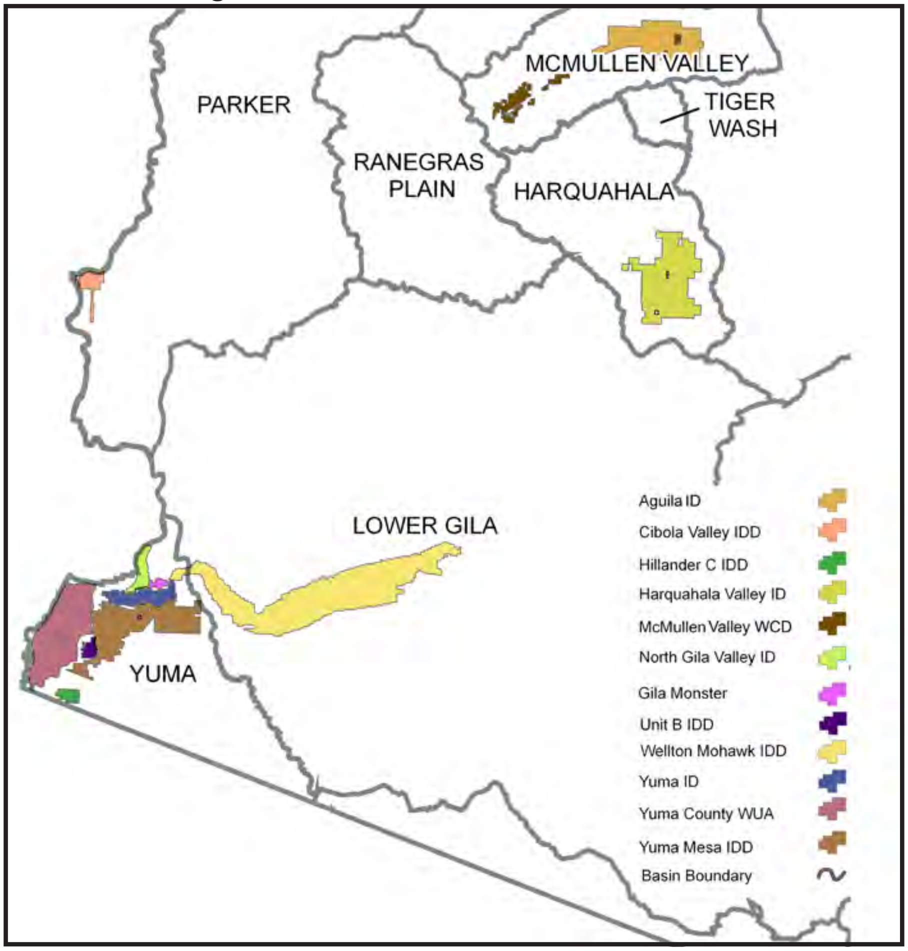
Principal water uses in the town are residential and commercial. Information on water demand is not currently available. It is known that for years, private domestic wells were the only water supply and several hundred exist within the town limits. A public water system was established in 1989 consisting of one main well with a well depth of 1,200 feet and a small, 35 gpm auxiliary well for back up. Plans are underway to drill a second large well. (Town of Quartzsite, 2003) Quartzsite has a 4th Priority Colorado River entitlement of 1,070 acre-feet but no way to convey this water to the town.

In addition to the Town of Quartzsite public water system, two, small private water companies, Desert Gardens RV Park and Q-Mountain MHP serve Quartzsite. The Q-Mountain system has 214 connections served by four wells that delivered about 43 acre-feet of water in 2003.

### *Agricultural Demand*

The planning area contains one of the largest agricultural areas in Arizona and the nation. Yuma County, which contains most of the agricultural lands in the planning area, is considered the nation's winter vegetable capital. Crops grown here include head and leaf lettuce, romaine, broccoli, cauliflower, honeydew, cantaloupe, watermelon, cabbage, spring mix, celery, endive/escarole, and citrus including lemons, oranges, grapefruit, and tangerines. Many seed crops are also grown including broccoli, cauliflower, grasses, and onions. Annual agricultural sales are reported to total over $1.3 billion. In La Paz County, upland cotton is the largest crop, followed by Durum wheat,

**Figure 7.0-14 Irrigation districts in the Lower Colorado River Planning Area**




barley, corn for grain, and alfalfa. Other crops include onions, honeydews, cantaloupe and watermelon. Annual agricultural sales are reported to total over $92 million in this county. (AZDA, 2005)

There are 13 irrigation districts in the planning area. Their general location is shown in Figure 7.0-14.

Irrigation water supply is primarily water diverted from the Colorado River. As shown in Table 7.0-13 and Figure 7.0-15, for the period 2001-2003, an average of 1,830,000 acre-feet per year was diverted from the Colorado River for use in the Parker, Lower Gila and Yuma Basins and 90,000 acre-feet was diverted via the Central Arizona Project for use in the Harquahala Basin. Gila River water and effluent averaging 54,500 acre-feet per year was used in the Gila Bend Basin. An average of 999,700 acre-feet of water withdrawn from wells was used to irrigate lands in all basins with agricultural demand.

Agricultural demand is greatest in the Yuma, Parker, Lower Gila, Gila Bend, McMullen Valley, and Harquahala basins. As shown in Figure 7.0-16, agricultural demand has steadily increased over time in most of these basins. Agricultural demand in each basin is described below.

**Figure 7.0-15 Irrigation water supply for the Lower Colorado River Planning Area, 2001-2003**

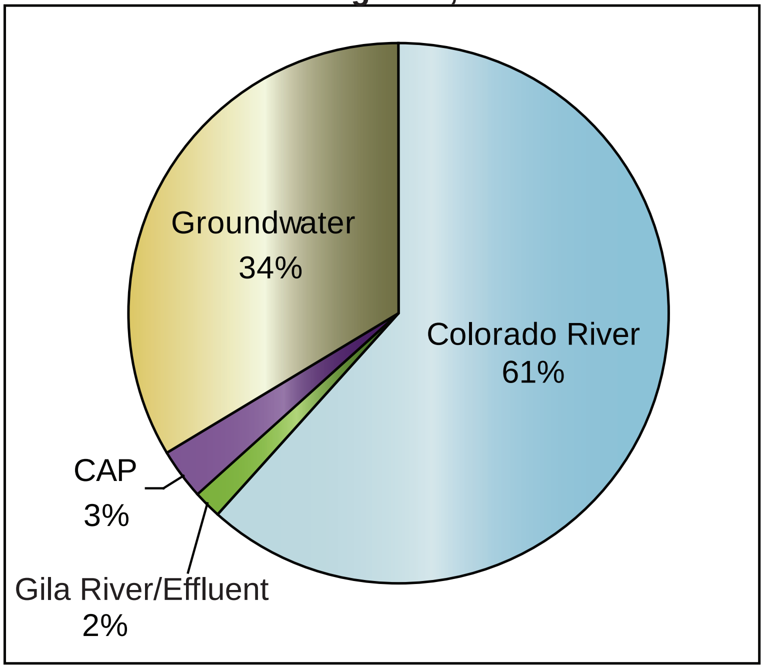


**Table 7.0-13 Agricultural demand in the Lower Colorado River Planning Area[1]**

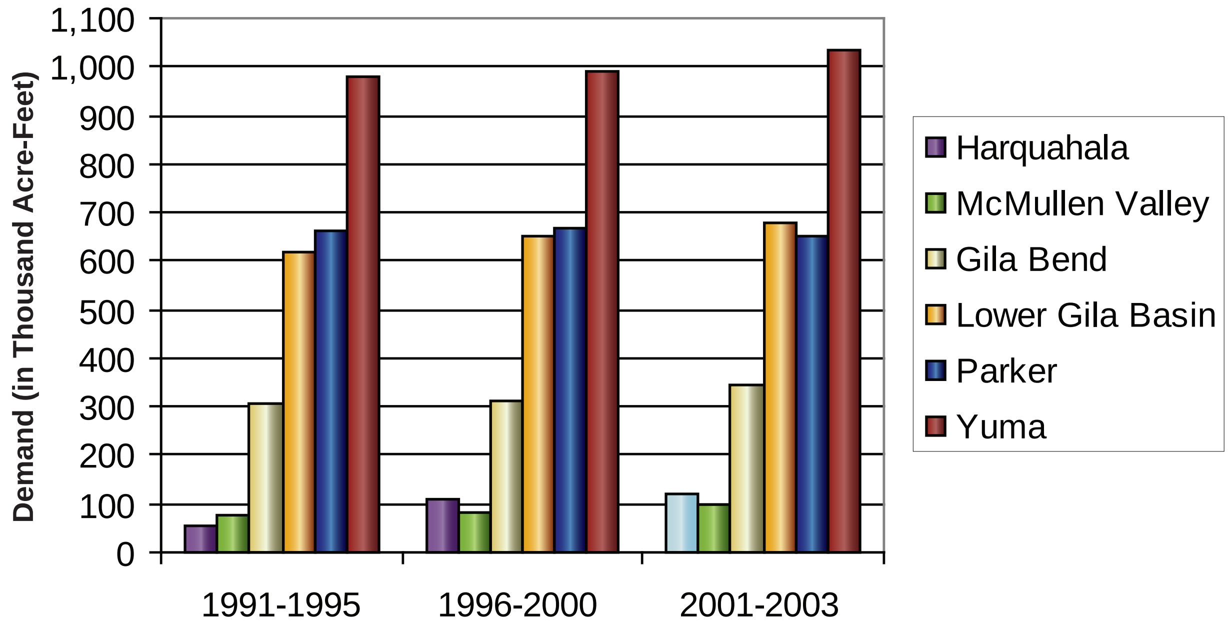
| | 1991-1995 (acre-feet) | 1996-2000 (acre-feet) | 2001-2003 (acre-feet) |
|---|---|---|---|
| *Butler Valley* | | | |
| Groundwater | 3,400 | 8,300 | 8,700 |
| Total | 3,400 | 8,300 | 8,700 |
| *Gila Bend* | | | |
| Groundwater | 237,000 | 244,000 | 291,000 |
| Surface Water[2] | 71,500 | 68,500 | 54,500 |
| Total | 308,500 | 312,500 | 345,500 |
| *Harquahala* | | | |
| Groundwater | 9,500 | 23,500 | 31,000 |
| Surface Water[3] | 47,500 | 85,000 | 90,000 |
| Total | 57,000 | 108,500 | 121,000 |
| *Lower Gila Basin* | | | |
| Groundwater | 254,000 | 261,000 | 282,000 |
| Surface Water | 365,000 | 391,000 | 399,000 |
| Total | 619,000 | 652,000 | 681,000 |
| *McMullen Valley* | | | |
| Groundwater | 77,000 | 79,500 | 98,000 |
| Total | 77,000 | 79,500 | 98,000 |
| *Parker* | | | |
| Groundwater | 1,300 | <1,000 | <1,000 |
| Surface Water | 662,000 | 667,000 | 653,000 |
| Total | 663,300 | 667,500 | 653,500 |
| *Ranegras Plain* | | | |
| Groundwater | 29,500 | 32,000 | 28,500 |
| Total | 29,500 | 32,000 | 28,500 |
| *San Simon Wash* | | | |
| Groundwater | 4,000 | 3,800 | 4,000 |
| Total | 4,000 | 3,800 | 4,000 |
| *Yuma* | | | |
| Groundwater | 206,000 | 218,000 | 256,000 |
| Surface Water | 771,000 | 771,000 | 778,000 |
| Total | 977,000 | 989,000 | 1,034,000 |
| **Total All Basins** | 2,738,700 | 2,853,100 | 2,974,200 |

**Source**: USGS 2005b
**Notes:** Volume <1,000 acre-feet assumed to be 500 acre-feet for computational purposes
[1] Unless otherwise noted, all surface water if from the Colorado River
[2] From Gila River and Effluent
[3] From Central Arizona Project water

Butler Valley Basin

Recent agricultural demand in the Butler Valley Basin is about 8,700 acre-feet a year, or 0.3% of the total agricultural demand in the planning area. Demand has more than doubled compared to the 1971-1990 time period (Table 7.1-8). Agricultural lands are located in a contiguous area in the southwest part of the basin and groundwater is the only water supply.

**Figure 7.0-16 Agricultural demand in selected basins in the Lower Colorado River Planning Area, 1991-2003**




Gila Bend Basin

Irrigation in the Gila Bend Basin is located primarily along the Gila River valley and south of the Gila River in the western part of the basin. Recent agricultural demand has been about 345,500 acre-feet per year of which 291,000 acre-feet is groundwater and 54,500 acre-feet is a mixture of Gila River surface water, agricultural drainage and effluent discharged upstream in the Phoenix AMA. Gila Bend Basin agricultural demand is 12% of the total planning area agricultural demand.

Surface water/effluent supplies are used in the northern part of the basin where they are diverted at Gillespie Dam. Until 1993, when Gillespie Dam was breached during a flood, more surface water was used. Surface water has been a less reliable supply than groundwater due to upstream dams and diversions and the unpredictability of flow even under pre-development conditions. Total agricultural demand has increased steadily from an annual average of 278,000 acre-feet during the 1986-1990 time period. However, recent demand is somewhat lower than some historical demands, for example an annual average of 376,000 acre-feet was used for agriculture during the 1976-1980 time period (see Table 7.2-8). Investigations conducted by the USGS during the summer of 2007 found about 42,900 acres are currently under irrigation and all acreage is flood irrigated. The predominant cropped acreage at that time was alfalfa/hay (81%), followed by sorghum (9%), and small areas of cotton, corn, oats, wheat and jojoba. (USGS, 2007, unpublished data)

Harquahala Basin

The number of irrigation acres allowed in the Harquahala Basin is limited because of the basin's designation as an irrigation non-expansion area, or INA. Groundwater may be pumped and transported to an AMA from agricultural lands in the basin pursuant to A.R.S. 45 § 554. In an INA farmers must report agricultural water pumpage and use on an annual basis to the Department. Recent demand has been about 121,000 acre-feet a year, the highest average demand reported since 1971 (Table 7.4-8). This demand is 4% of the total recent agricultural demand in the planning area. Non-contract CAP water began to be used in 1984 by the Harquahala Valley Irrigation District, replacing groundwater pumpage as the primary water supply in the basin. Under the Department's Recharge Program, the District is a permitted groundwater savings facility. District lands are the most extensive in the basin, covering a large area in the southeast part of the basin. All irrigation canals and laterals are concrete-lined (ADWR, 1998). Other irrigated areas exist near Centennial and south of the Buckeye-Salome Road in the northwest part of the basin. An investigation conducted by the USGS in the summer of 2007 found 26,165 acres under irrigation in the basin. At that time, about 33% of the cropped acreage was alfalfa/hay, 26% cotton, 15% vegetables, and 14% wheat. Oats, sorghum and corn were also observed. About 85% of the lands were found to be flood irrigated and 15% were drip irrigated. (USGS, 2007, unpublished data)

<u>Lower Gila Basin</u>
The Lower Gila Basin contains 23% of the recent agricultural demand in the planning area. The principal farming area is the Wellton-Mohawk Irrigation and Drainage District, whose location generally follows the Gila River Valley west of Dateland and extends into the Yuma Basin. Other irrigated areas are located north and west of Dateland, north of Hyder, near Agua Caliente (south of Hyder) and in the Dendora Valley near the eastern basin boundary. The USGS conducted a field investigation of non-district lands in the summer of 2007 and found much less land being irrigated north of Hyder than suggested by Figure 7.4-10. The USGS found 20,750 acres being irrigated on non-district lands. Principal cropped acreage observed was alfalfa/hay (34%), vegetables (24%), jojoba (11%), sorghum (10%), citrus (8%), and lesser amounts of cotton, corn, date/palm trees and oats. Irrigation methods vary in this area with 51% of the acreage flood irrigated, 21% sprinkler, 16% drip and 12% center pivot (primarily north of Dateland). (USGS, 2007, unpublished data)

Reclamation's Gila Project delivers Colorado River water to two divisions - the Wellton-Mohawk Division and the Yuma Mesa Division. The WMIDD was created in 1951 to provide a legal entity that could contract with the United States to repay the cost of the project and to operate and maintain project facilities. Lands in the area have been cultivated for many centuries. During the late 19th century, diversion structures and canals were constructed to expand agricultural lands, but periodic floods and construction of upstream reservoirs led to abandonment of the surface water system and conversion to groundwater wells. However, by the early 1930s, increasing salt concentrations in groundwater and falling groundwater levels made successful farming in the area difficult and many farms were abandoned. Area farmers approached Reclamation for delivery of Colorado River water and the project was constructed during the late 1940s and early 1950s. (WMIDD, 2004)

Water for the District is diverted at Imperial Dam into the Gila Canal, a joint-use facility shared by five Yuma Basin irrigation districts (WMIDD, 2004). The WMIDD Colorado River entitlement is diverted into the 18.5 mile long Wellton-Mohawk Canal and to its major branches, the Wellton Canal (19.9 miles long) and the Mohawk Canal (46.8 miles long). The 13-mile long Dome Canal branches off the Wellton-Mohawk Canal west of the major branches and serves the western part of the District. There are 13 small pumping plants and 227 laterals in the WMIDD. (USBOR, 2007f) Facilities include 378 miles of main canals, laterals and return flow channels, three major pumping plants, drainage wells and groundwater level observation wells. All canals and laterals are concrete-lined except for eight miles of the main canal west of the first pumping plant. There are also hundreds of domestic turnouts along the system (WMIDD, 2004).

The WMIDD has a Colorado River Priority 3 right with a current allowable consumptive use of 278,000 acre-feet per year, but diversions are significantly higher. Diversions to the District averaged 399,000 acre-feet during the 2001-2003 time period. Water pumped from drainage wells and returned to the Colorado River is deemed "return flow" that is subtracted from the District's diversions to derive its consumptive use. Demand within the WMIDD has remained relatively constant, with a slight recent increase (Table 7.4-8). Principal crops grown are alfalfa/hay, sorghum, wheat, bermuda, cotton, citrus, melons, lettuce, vegetables, nuts and safflower. A significant amount of double cropping occurs in the district with irrigation done primarily by flood. (WMIDD, 2004) Portable sprinkler systems are used for seed germination of lettuce and other vegetable crops.

Long-term irrigation with Colorado River water combined with naturally elevated salt concentrations in groundwater and soil require that salts be leached from the soil by irrigating in excess of the crop consumptive use and removal of excess groundwater to prevent waterlogging. In addition, occasional flooding on the Gila River raises groundwater levels. The District operates 90 drainage wells spaced about a mile apart with an average depth of 100 feet to control rising groundwater levels, keeping water below the root zone of crops. Three-hundred observation wells monitor groundwater levels. (WMIDD, 2004)

Because the high salinity of the WMIDD return flows increased the salinity of the Colorado River, a number of actions have been taken to achieve the salinity standards for delivery to Mexico specified in Minute 242. The drainage water is pumped into a concrete-lined channel (Main Outlet Drain and Extension, MOD/MODE), which allows it to be either diverted to the main channel of the Colorado River at the NIB above Morelos Dam, or bypassed around the dam through a canal to the Cienega de Santa Clara. WMIDD has also taken steps within the District to reduce return flows including acreage reduction, improved irrigation scheduling, land-leveling and improvements to ditches and turnouts. (WMIDD, 2004)

McMullen Valley Basin

About 3% of the recent agricultural demand in the planning area is near the communities of Aguila and Wenden-Salome in the McMullen Valley Basin. There are two irrigation districts in this basin. Neither the Aguila Irrigation District nor the McMullen Valley Water Conservation District has a consolidated distribution system and all district wells and ditches are privately owned. Both districts were formed in order to contract water and power from the Colorado River. (ADWR, 1998) Groundwater is currently the only water supply.

Since 1981, agricultural demand in the basin has been increasing with an annual average of 98,000 acre-feet of demand during the 2001-2003 time period. The USGS conducted a field investigation of the basin in the summer of 2007 and found 14,500 acres under irrigation with 80% flood irrigated and 20% drip irrigated. Cropped acres at the time of the investigation included vegetables (62%), cotton (19%) and sorghum (8%). Other crops observed were oats, guayule, orchards, alfalfa/hay and corn. (USGS, 2007 unpublished data)

McMullen Valley is one of the few groundwater basin in the state designated for out of basin transportation of groundwater. About 14,000 acres of agricultural land have already been purchased by the City of Phoenix for transport of groundwater to the Phoenix AMA (ADWR 1994b).

Parker Basin

Irrigation in the Parker Basin represents 22% of the recent agricultural demand in the planning area. The annual average Colorado River demand for the basin during 2001-2003 was 653,000 acre-feet. A relatively small amount of groundwater, less than 1,000 acre feet, was reportedly pumped for agricultural irrigation.

Irrigation occurs primarily on the CRIT Reservation and also within the Cibola Valley Irrigation and Drainage District (CVIDD). As mentioned above in the Tribal Demand section, about 72,610 acres were irrigated on the CRIT reservation in 2006. Of this total, CRIT Farms manages over 15,000 acres of alfalfa, cotton, durum wheat and other crops (Colorado River Indian Tribes, 2005).

CVIDD was formed in 1962, and in 1964 the southern half of the district was incorporated into the Cibola National Wildlife Refuge. There is an integrated canal system and all main canals are owned by the district and concrete-lined. On average about 3,550 acres of land are irrigated within CVIDD. Primary crops are alfalfa, bermuda and cotton, although a variety of other crops are grown including vegetables, wheat and barley. (ADWR, 1998) Colorado River water is the sole source of water. CVIDD has a Priority 4 Colorado River entitlement of 12,066 acre-feet and 5th and 6th Priority entitlements totaling 3,500 acre-feet.

Ranegras Plain Basin

Agricultural demand in the Ranegras Plain Basin is about 1% of the recent agricultural demand in the planning area. Average annual demand during 2001 to 2003 was about 28,500 acre-feet, all met from groundwater pumping. Since the 1986-1990 time period, average demand has been relatively stable, varying from 32,000 to 28,500 acre-feet per year (Table 7.7-8). Field investigations by the USGS in the summer of 2007 shows that agricultural activity is occurring primarily along Vicksburg road north of Interstate 10, and north of Highway 72 in the northern part of the basin. Cropped acres at that time were corn (25%), barley (21%), cotton (18%), jojoba (16%) and smaller acreages of alfalfa, guayule and sorghum. Their investigations found 99% of the irrigation was by drip systems and 1% by sprinkler. (USGS, 2007, unpublished data).

San Simon Wash Basin

Irrigation in the San Simon Wash Basin appears to be restricted to about 2,200 irrigable acres at the end of Reservation Road 21 near the international boundary. Recent average annual demand is estimated to be 4,000 acre-feet of groundwater. Historic withdrawals were higher, up to 11,300 acre-feet per year during the late 1970s. After 1980, the principal crop was alfalfa, irrigated year round (Hollett, 1985). It is not clear whether these lands are currently being irrigated.

Yuma Basin

The Yuma Basin is the largest agricultural demand center in the planning area with 35% of the recent demand, an annual average of 1,034,000 acre-feet during the 2001-2003 time period. Of this total demand, 778,000 acre-feet is water diverted from the Colorado River and 256,000 acre-feet is water pumped from wells. Annual demand has increased by over 100,000 acre-feet on average since 1991. Agricultural lands surround Yuma and extend through much of the western part of the basin from north of Fortuna Foothills to San Luis.

*Bureau of Reclamation Projects*

Two Reclamation projects serve irrigation water in the basin – the Gila Project and the Yuma Project. Water for the Gila Project is diverted at Imperial Dam and delivered via the Gila Gravity Main Canal. The project is separated into the Wellton-Mohawk Division (discussed previously) and the Yuma Mesa Division. The Yuma Mesa Division includes three irrigation districts in the basin: Yuma Mesa Irrigation and Drainage District (Yuma Mesa IDD), North Gila Irrigation District (North Gila ID) and Yuma Irrigation District (Yuma ID). (USBOR 2007g)

The Yuma Project includes lands in both Arizona and California. In Arizona, the project is divided into the Valley Division and the Yuma Auxiliary Division. The Valley Division consists of the Yuma County Water Users Association. Water for the Valley Division is diverted at Imperial Dam into the All-American Canal to the Yuma Main Canal, then through the siphon under the Colorado River at Yuma and into the Valley Division canals. Water for the Yuma Auxiliary Division, also referred to as Unit “B”, is diverted at Imperial Dam and conveyed via the Gila Project Canals to the Unit “B” Irrigation District (Unit “B” ID) (see Figure 7.0-11).

*Irrigation Districts*

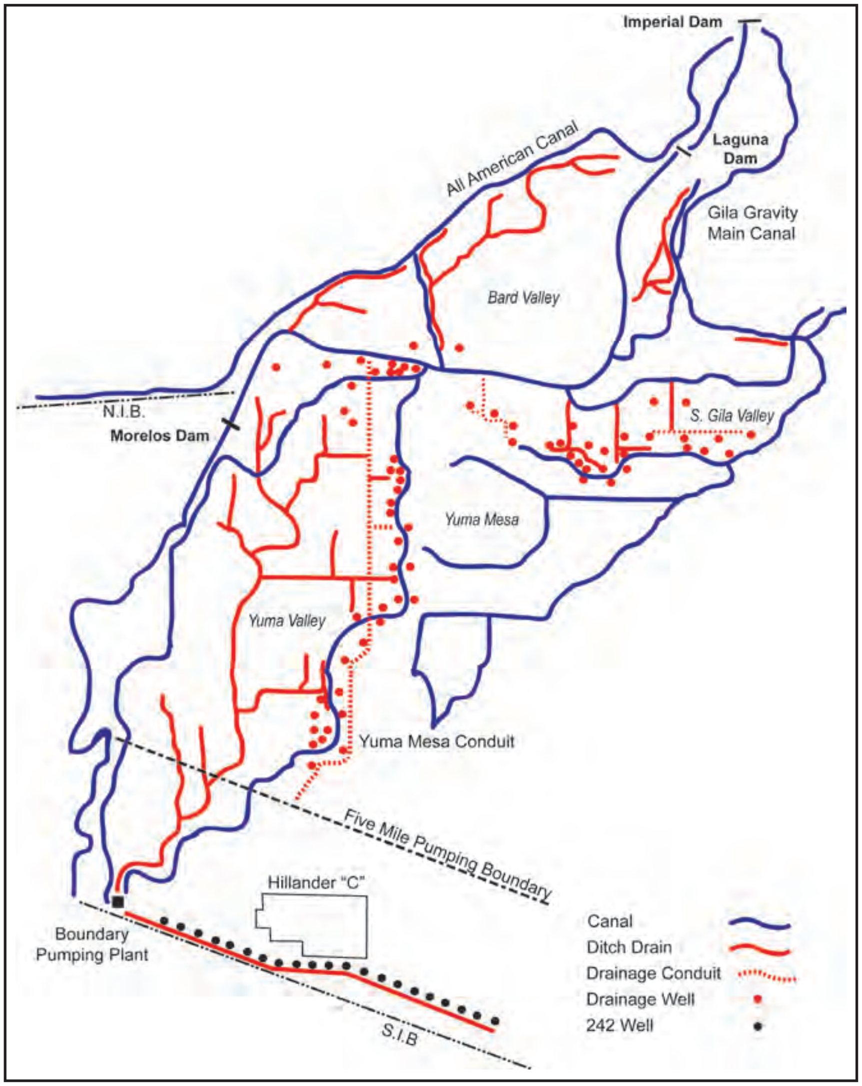
A total of eight irrigation districts operate in the basin (see Figure 7.0-14). The western part of the Wellton-Mohawk Irrigation and Drainage District extends into the basin and is discussed above in the Lower Gila Basin section. The general location of the water delivery and drainage infrastructure in the Yuma area including canals, conduits, drains and drainage wells is shown in Figure 7.0-11 and 7.0-17.

The three Gila Project/Yuma Mesa Division irrigation districts have a shared 3rd priority entitlement of 250,000 acre-feet a year on 37,187 acres. In addition, North Gila Valley ID has 1st and 2nd Priority entitlements, and Yuma Mesa IDD and Yuma ID have 2nd Priority consumptive use entitlements (see Appendix B).

Crops grown on Yuma Mesa IDD lands (the Mesa Unit) include citrus, alfalfa hay and seed, peanuts, cotton and grains. There are about 25,000 irrigated acres in the district. Crops grown on North Gila ID and Yuma ID lands (North and South Gila Units) include alfalfa, cotton, melons, citrus, winter vegetables and Bermuda grass seed (USBOR, 2007f). About 6,300 acres of the North Gila ID and 9,600 acres of the Yuma ID are irrigated (Yuma Area Ag Council, 2004). The South Gila Valley Unit of the Yuma Mesa Division consists of 24 drainage wells (Figure 7.0-17). Water is conveyed to the Gila River Pilot Channel and the Colorado River to become part of the Treaty water delivered to Mexico. (USBOR, 2007g)

Unit "B" ID is a relatively small district that operates and maintains the water distribution facilities of the Yuma Auxiliary Project. It distributes water to about 3,400 acres of land on the Yuma Mesa. Crops are almost entirely citrus including grapefruit, oranges and lemons. (USBOR, 2007h) The district has a 1st Priority diversion entitlement of 6,800 acre-feet and an unquantified 2nd priority diversion entitlement.

**Figure 7.0-17 Yuma area drainage fields and conduit systems**




Yuma County Water Users Association provides water to the Yuma Valley south of Interstate 8. It encompasses all of the Colorado River flood-plain land, approximately 53,000 acres, between the City of Yuma and the international boundary. YCWUA assumed operation and maintenance of Valley Division works of the Yuma Project in 1951 and the Siphon Drop Power Plant 1962. There are approximately 28,800 irrigable acres in the district (Yuma Area Ag Council, 2004). YCWUA has an annual Colorado River entitlement of 254,200 acre-feet or, the consumptive use for irrigation of 43,562 acres (whichever is less) of 1st and 4th Priority water. Principal crops grown are lettuce and other produce crops in the fall and winter months and wheat, cotton, hay, and melons in the spring and summer months. YCWUA recently received funding to line a number of its earthen canals to reduce seepage and conserve water. (BECC, 2003)

Excess irrigation water from the Valley Division of the Yuma Project is removed via an open drain that runs through the center of the division and terminates at the Boundary Pumping Plant at the international boundary (see Figure 7.0-17). The main drain and its branches total 56 miles in length. This drainage system is supplemented by 16 drainage wells located along the east side of the Yuma Valley that intercept groundwater flows from Yuma Mesa. YCWUA operates 11 of the wells and Reclamation operates the others. Most of this pumped water is discharged into the open drain. At the Boundary Pumping Plant, the drainage water is discharged into the bypass canal that flows into Mexico (USBOR, 2007i).

Gila Monster Farms is a relatively small operation located north of the Yuma ID and west of the Wellton-Mohawk IDD. It has 1st Priority diversion rights of 780 acre-feet a year and 3rd, 4th, 5th and 6th priority rights for a total entitlement of 9,156 acre-feet (see Appendix B). Water is delivered through the Gila Gravity Main Canal. In 2002, the total irrigated area covered 1,780 acres.

Hillander "C" Irrigation and Drainage District, located north of the international boundary east of San Luis, pumps groundwater to irrigate about 2,300 acres within the 3,440 acre district. Historic use was between 15,000 and 20,000 acre-feet per year for irrigation of citrus and asparagus. Center pivot systems in the area suggest that alfalfa or other crops may be grown. The District is located adjacent to the 242 well field and has a contract to pump up to 4,000 acre-feet of water annually from the 242 Lateral (see Section 7.0.6).

### *Industrial Demand*

Recent industrial demand in the Lower Colorado River planning area has averaged 14,850 acre-feet a year, about 0.5% of the total demand. As shown in Table 7.0-14, most demand is associated with power plants, although dairy and feedlot demand is growing, particularly in the Lower Gila Basin and more recently in the Ranegras Plain Basin. Mining activity in the Yuma Basin is associated with the Yuma Pit, a large sand and gravel operation owned by Rinker Materials in the northern part of the basin east of Highway 95. The New Cornelia Mine, a large open pit copper mining operation at Ajo, was placed on care and maintenance in 1983. There is a possibility that mining and ore processing may resume due to rising copper prices. There are several small gold mines in the planning area including the Yuma King, 30 miles east of Parker. There is also one "industrial" golf course in the Yuma Basin, Yuma Golf and Country Club. Industrial facilities are those with their own well or water supply and not served from a municipal water provider.

Table 7.0-14 shows other industrial uses in the Yuma area that use Colorado River water. Additional industrial demand in the planning area not reflected in the table, comes primarily from sand and gravel operations including at least three in the Parker Basin. Some of these operations are identified on the cultural demand maps. Water is used for aggregate washing, dust control, vehicle washing and equipment cooling. Relatively little water is consumed at these sites. Finally, north of Gila Bend, in the Gila Bend Basin, shrimp are pond grown at the Desert Sweet Shrimp operation. About 300,000 pounds of shrimp are produced annually and the shrimp effluent is applied to nearby agricultural fields. Water demand of this aquaculture operation is not known.

<u>Power Plants</u>
Panda Gila River Power Station is a 2,200 megawatt natural gas fired combined cycle plant located in Gila Bend and completed in 2003. It was approved by the Arizona Corporation Commission (ACC) in 2001 under very strict emissions requirements. The plant has zero water discharge, with concentrated brine effluent disposed to evaporation ponds. The plant used about 4,900 acre-feet of groundwater in 2003.

**Table 7.0-14 Industrial demand in selected years in the Lower Colorado River Planning Area**

| | 1991 | 2000 | 2003 |
|---|---|---|---|
| **Type** | **Water Use (acre-feet)** | | |
| **Power Plant Total** | **246** | **578** | **7,004** |
| *Gila Bend* | | | |
| Groundwater | 0 | 0 | 4,900 |
| *Harquahala* | | | |
| Groundwater | 0 | 0 | 1,700 |
| *Yuma* | | | |
| Surface Water | 246 | 578 | 404 |
| **Golf Course Total** | **441** | **441** | **441** |
| *Yuma* | | | |
| Groundwater | 220 | 220 | 220 |
| Surface Water | 221 | 221 | 221 |
| **Dairy/Feedlot Total** | **3,394** | **3,573** | **3,775** |
| *Gila Bend* | | | |
| Groundwater | 0 | 0 | 108 |
| *Lower Gila* | | | |
| Groundwater | 3,394 | 3,573 | 3,667 |
| **Mining Total** | 291 | 388 | 399 |
| *Parker* | | | |
| *Groundwater* | <300 | <300 | <300 |
| *Yuma* | | | |
| Groundwater | 141 | 238 | 249 |
| **Other Total** | 1,982 | 3,454 | 1,161 |
| *Yuma* | | | |
| Surface Water | 1,982 | 3,454 | 1,161 |

**Source**: ADEQ 2005, ASMMR 2005, ADWR 1994b, ADWR 2007, USGS 2005b

**Notes:** Volume <300 acre-feet assumed to be 150 acre-feet for computation purposes. Other category includes water use by the Yuma Desalting Plant, Union Pacific Railroad, Desert Lawn Memorial, Huerta Packing and Yuma Mesa Fruit Growers

The Harquahala Generating Project is a 1,000 megawatt gas-fired combined power facility that came on line in 2003. As a condition of approval by the ACC, the owner agreed to use CAP water as the preferable supply. Groundwater use is allowed but must meet the same siting and permitting requirements of facilities in AMAs. The facility is designed to be zero water discharge and treats and recycles water more than 130 times to minimize consumption. (PG&E Corporation, 2000) The facility used about 1,700 acre-feet of groundwater in 2003.

Arizona Public Service (APS) operates the natural gas-fueled Yucca Power Plant near Yuma. There are four combustion turbine units that produce nearly 150 megawatts of power to APS customers. The plant's other combustion turbine unit and one steam unit are owned by the Imperial Irrigation District in California. The plant provides power on an as needed basis, particularly during the summer months. (APS, 2007) The plant, which has a 1,500 acre-feet of 5$^{th}$ priority entitlement, used about 400 acre-feet of Colorado River water in 2003.

Dairy/Feedlot

There are a number of dairy and feedlot operations in the planning area and these facilities are a growing demand sector due to development pressures and land costs in more urban parts of the state. Dairies and feedlots are located adjacent to irrigated land where feed is grown and where disposal of wastes can occur.

In 2003, Citrus Valley Dairy was the only dairy operating in the Gila Bend Basin with a groundwater demand of about 100 acre-feet. Painted Rock Dairy began operation the next year and the combined demand in 2004 was 173 acre-feet for an estimated 1,600 animals.

There are two dairies in the Lower Gila Basin, G.H. Dome Valley and Hine Hettinga, with a recent demand of 152 acre-feet and 94 acre-feet respectively. These dairies house a combined total of 1,900 animals. There are also two feedlots in the basin. The Kammann Cattle Company used about 27 acre-feet of water for about 800 animals while McElhaney Cattle used about 3,394 acre-feet for an estimated 101,000 animals in 2003.

Two dairy facilities are scheduled to begin operations soon in the Ranegras Plain Basin, west of Vicksburg road. One of the facilities will be a dairy/biorefinery. The facility is designed to use cow waste products to produce energy to process corn (not grown locally) into ethanol and biodiesel. Byproducts of the fuel production will be cycled back to the biorefinery and provide feed for the cows. About 2,500 cows will initially be housed at the site with plans to eventually house about 7,500 cows. The second phase of the project involves growing algae on 2,400 acres of adjacent state land using wastewater from the dairy to produce ethanol and biodiesel. (East Valley Tribune, 2007)

### 7.0.8 Water Resource Issues in the Lower Colorado River Planning Area

Water resource issues in the Lower Colorado River Planning Area have been identified by local water users, in regional studies primary involving Colorado River water supplies, through the distribution of surveys and from other sources. There are no ADWR Rural Watershed Initiative Groups in the planning area. Colorado River and groundwater transportation issues, planning and conservation activities and results from water provider surveys are discussed in this section. Environmental protection and restoration, and local management of water resources to meet the needs of growing communities while maintaining the agricultural economy are important considerations in the planning area.

### *Colorado River Issues*

Issues involving the Colorado River system have implications for resource management and supply availability in the planning area. Issues include consequences related to compliance with the International Treaty with Mexico, agreement on management of the Colorado River system under shortage conditions in a manner equitable for all users, salinity control and water quality, entitlement transfers, and accounting surface rulemaking. Information on the “Law of the River” and more detailed discussion of some of the issues discussed below is found in Appendix C.

Mexican Treaty

Compliance with conditions of the delivery of 1.5 maf of water to Mexico under the 1944 Treaty and Minute 242 have required significant investments and actions within the U.S. and in the planning area. Actions have included rerouting agricultural return flows, construction of the 242 wellfield to return higher quality water to the Colorado River, on farm improvements and other actions.

A consequence of bypassing high salinity water around the river to the Cienega de Santa Clara in Mexico has reestablished a rich, ecologically important wetland and sparked interest in maintaining the area in its present condition. In dry years, bypassing the water to the Cienega results in Lake Mead storage decreasing by approximately 100,000 acre-feet annually since the bypassed water must be "made-up" from storage in Lake Mead. Recently, the decrease in Lake Mead storage after more than a decade of drought has increased the risk of shortage to Arizona Colorado River water users.

Actions upstream that would affect the delivery of the bypass water, including reactivation of the Yuma Desalting Plant to treat this water to a salinity level that would allow it to be discharged to the Colorado, would impact the Cienega. This is an issue with a high degree of international sensitivity. In 2005 a YDP/Cienega de Santa Clara Workgroup formed to discuss solutions that would both preserve the Cienega and offset the impact of the continued bypass of water.

Shortage Sharing

As mentioned in Section 7.0.6, Reclamation issued a Record of Decision in December, 2007 on interim operating criteria (2008-2026), including the coordinated operation of Lake Powell and Lake Mead and criteria for implementing shortage reductions in the Lower Basin. The elements of the ROD, which includes rules for shortages and surpluses, coordinated operation of Lake Powell and Lake Mead, and water conservation, have implications for water supply availability in the planning area.

The shortage recommendation implements water supply reductions when Lake Mead water storage is depleted to key elevation triggers. In Arizona, hydrologic modeling indicates that shortage reductions will impact $4^{th}$, $5^{th}$ and $6^{th}$ priority water users. The available shortage water supply is sufficient to meet all higher priority water users. However, some reductions to on-river municipal and industrial and agricultural contractors and to the CAP excess pool are expected.

Salinity and Other Water Quality Issues

Increased salinity levels in the Colorado River affect agricultural, municipal and industrial users. Damages in the United States are estimated at $330 million per year, and while economic damage in Mexico is not quantified, it is also a significant concern. The EPA approved salinity standards proposed by the Colorado River Basin Salinity Control Forum for three locations in Arizona, including two in the planning area. The water quality standards establish a flow-weighted average annual salinity standard that must be maintained on the lower Colorado River at the following locations in the planning area:

- Below Parker Dam (to Imperial Dam) - 747 mg/L
- At Imperial Dam - 879 mg/L.

In 2005, the Governor of Arizona appointed The Clean Colorado River Alliance (Alliance) stakeholder group to address water quality issues for the Colorado River. In addition to salinity, the Alliance identified several other water quality concerns including nutrients, metals, endocrine disrupting compounds, perchlorate, bacteria and pathogens, and sediment. In 2006, the Alliance issued a report titled Clean Colorado River Alliance Recommendations to Address Colorado River Water Quality. The report includes a number of recommendations to monitor and mitigate the impacts of these pollutants.

Entitlement Transfers

Arizona communities along the Colorado River that rely on the river for their water supplies have experienced rapid growth over the last decade. These communities are unique because non-Colorado River water supplies are not readily available as a supplementary water supply to meet this growing demand. As a result, some entities have acquired existing irrigation entitlements through contract assignment actions for the purpose of eventually conveying those entitlements for municipal and industrial purposes. Contract assignments involve the transfer of an entitlement for the same type of use in the same location, whereas the conveyance of an entitlement entails a change in the type and/or place of use. Non-federal Arizona contractors of mainstream Colorado River entitlements are required to consult with the Director of the Department regarding any proposed contract actions. The Department reviews proposed actions in accordance with its *Policy and Procedures for Transferring an Entitlement of Colorado River Water* and makes a recommendation to Reclamation.

Since adoption of the *Policy and Procedures* in 2004, the Department has processed three assignment and two conveyance requests. The assignments and conveyances involve partial transfers of Cibola Valley Irrigation and Drainage District's Colorado River irrigation entitlement. CVIDD, located in the southern part of the Parker Basin, assigned a portion of its entitlement to the Mohave County Water Authority (MCWA), the Hopi Tribe and Cibola Resources. Subsequent to these transactions, MCWA conveyed a majority of its entitlement to Mohave County for eventual use in Lake Havasu and Bullhead cities and assigned the remaining amount to the Arizona Game and Fjish Commission for habitat restoration purposes in Cibola Valley. Upon acquisition of its contract, Cibola Resources immediately conveyed its entitlement to B&F Investments, LLC for use by a proposed travel plaza in the Ehrenberg area (see Appendix C).

Federal Rulemaking to Establish the Accounting Surface

In August 2006, Reclamation initiated a rulemaking process to regulate the non-contract use of Colorado River water in the Lower Basin. The rulemaking is intended to ensure that all Colorado River water use is covered by an entitlement and correctly accounted for within the state's apportionment. Reclamation has contracted with the U.S. Geological Survey to document non-contract water uses in the Lower Basin. The rule will establish the methodology that Reclamation will use to determine if a well is pumping Colorado River water and will also establish an appeal process. At this time, approximately 11,500 acre-feet of unallocated fourth-priority Colorado River water is available for allocation. Some of this water will be allocated to existing uses, after currently uncontracted uses have been quantified. The inventory is expected to provide comprehensive information about existing water uses that need an entitlement. The Department will use this information to allocate the remaining supply for domestic purposes.

### Groundwater Transportation

In general, groundwater cannot be transported between groundwater basins or from a groundwater basin outside an AMA into an AMA (A.R.S. §§ 45-544 and 45-551 through 45-555). These restrictions were designed to protect hydrologically distinct groundwater supplies and rural economies by ensuring that groundwater is not depleted in one groundwater basin to benefit another. Three basins in the planning area, Butler Valley, Harquahala and McMullen Valley, are designated as basins from which groundwater may be withdrawn and transported under certain conditions. Information about the statutory provisions is found in Section 7.0.6.

As of December 2007, only the City of Phoenix has purchased agricultural land in the McMullen Valley Basin for the purpose of potentially transferring groundwater to the Phoenix AMA. In addition, the Department has received an application for transportation of groundwater from the Harquahala Basin. As competition for water supplies in AMAs increases, it is likely that additional applications will be filed. Although the rate of groundwater decline and pumping depth are regulated in the McMullen Valley and Harquahala basins, there are no specified limits for the Butler Valley Basin. Withdrawal and transportation of groundwater may cause groundwater level declines and impact the groundwater supply available for use within the basins.

### Planning and Conservation

On January 1, 2007, all large (>1,850 customers) community water systems in the state were required to submit System Water Plans to the Department. Small systems have until January 1, 2008, to submit their plans. The 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. Within the planning area plans have been submitted by the large systems of the City of Yuma, Town of Parker, Ajo Improvement Company/Phelps Dodge Corporation, City of Somerton, and Arizona Water Company-Ajo System (a small system). On June 1, 2007, 48 systems (small and large) in the planning area were required to submit an annual water use report with data on water pumped, diverted, received and delivered to customers. These data will help support water resource planning.

Local Drought Impact Groups (LDIGs) are being formed in all counties across Arizona. LDIGs are voluntary groups that will coordinate drought public awareness, provide impact assessment information to local and state leaders, and implement and initiate local drought mitigation and response actions. These groups are coordinated by local representatives of Arizona Cooperative Extension and County Emergency Management and supported by ADWR's Community Water Planning Program. To date, groups have not been formed in La Paz or Yuma counties but there are plans to organize groups within the next year.

To support the efforts of the LDIGs, professionals and residents are asked to provide monthly feedback on drought conditions throughout their county. Citizens may also participate with the LDIG by assisting with education and outreach efforts and recommending actions for drought mitigation and response. More information on LDIGs may be found at http://www.azwater.gov/dwr/drought/LDIG.html.

### Issue Surveys

The Department conducted a rural water resources survey in 2003 to compile information for the public and help identify the needs of growing communities. This survey was also intended to gather information on drought impacts to incorporate into the Arizona Drought Preparedness Plan, adopted in 2004. Questionnaires were sent to almost 600 water providers, jurisdictions, counties and tribes, and a report of the findings from the survey was subsequently completed (ADWR, 2004).

There were 15 water provider and 2 jurisdiction respondents in the Lower Colorado River Planning Area and of these, 17 numerically ranked issues. Respondents were asked to rank 18 issues, which can be grouped into three general categories: infrastructure, water supply and water quality. Issues that ranked consistently high by the most respondents are shown in Table 7.0-15. As shown, most respondents were concerned about aging infrastructure and the ability to fund improvements, and had water quality concerns. Few respondents were concerned about inadequate storage or pumping capacity to meet future demand or the need for additional water supplies.
The Department conducted another, more concise survey of water providers in 2004. This was done to supplement the information gathered in the previous year in support of developing the Arizona Water Atlas, and to reach a wider audience by directly contacting each water provider. Through this effort, 31 water providers in the Lower Colorado River Planning Area, with a total of approximately 40,200 service connections, participated and provided information on water supply, demand, and infrastructure and ranked a list of seven issues. Respondents were from the Gila Bend, Harquahala, Lower Gila, McMullen Valley, Parker and Yuma basins.

**Table 7.0-15 Water resource issues ranked by 2003 survey respondents in the Lower Colorado River Planning Area (15 water providers and 2 jurisdictions)**

| Issue | Ranked as one of the top 5 issues (out of 18) | Percent of respondents |
|---|---|---|
| Ability to meet new arsenic standards | 6 | 35% |
| Concern about proximity of wells to sources of contamination | 5 | 29% |
| Aging infrastructure in need of replacement | 11 | 65% |
| Inadequate captial for infrastructure improvement | 6 | 35% |

**Source:** ADWR 2004

With regard to a question of groundwater level trends in their service area, there were 21 respondents and most reported stable water levels as shown by basin with the corresponding number of respondents in Table 7.0-16.

**Table 7.0-16 Groundwater level trends reported by 2004 survey respondents by groundwater basin (21 respondents)**

| Basin | Rising | Stable | Falling | Variable | Don't Know |
|---|---|---|---|---|---|
| Gila Bend | | 1 | | | |
| Harquahala | 1 | | | | 1 |
| Lower Gila | 1 | 3 | | | |
| McMullen Valley | | | 1 | | |
| Parker | | 3 | 1 | | |
| Yuma | | 6 | | 2 | 1 |

**Source:** ADWR 2005c

Water providers were asked in the 2004 survey to rank seven issues from 0 to 3 with 0 = no concern, 1 = minor concern, 2 = moderate concern and 3 = major concern. There were 31 respondents that reported a concern. As shown in Table 7.0-17, infrastructure concerns ranked as important concerns, similar to the 2003 survey. This was especially of concern to providers in the Lower Gila Basin (Table 7.0-18). Unlike results from the 2003 survey, this group of respondents was comprised of more large water providers and expressed concern about storage capacity and supplies to meet future demand.

**Table 7.0-17 Water resource issues ranked by 2004 survey respondents in the Lower Colorado River Planning Area (31 respondents)**

| Issue | Moderate concern | Major concern | Total | Percent of respondents reporting issue was a major or moderate concern |
|---|---|---|---|---|
| Inadequate storage capacity to meet peak demand | 2 | 6 | 8 | 26% |
| Inadequate well capacity to meet peak demand | 1 | 2 | 3 | 10% |
| Inadequate supplies to meet current demand | 2 | 0 | 2 | 6% |
| Inadequate supplies to meet future demand | 3 | 4 | 7 | 23% |
| Infrastructure in need of replacement | 6 | 8 | 14 | 45% |
| Inadequate capital to pay for infrastructure improvements | 4 | 14 | 18 | 58% |
| Drought related water supply problems | 1 | 1 | 2 | 6% |

**Source:** ADWR 2005c

**Table 7.0-18 Number of 2004 survey respondents, by groundwater basin, that ranked the survey water resource issues a moderate or major concern (31 respondents)**

| Issue | Gila Bend (1) | Harquahala (1) | Lower Gila (11) | McMullen Valley (8) | Parker (4) | Yuma (11) |
|---|---|---|---|---|---|---|
| Inadequate storage capacity to meet peak demand | 1 | | 3 | 1 | 1 | 2 |
| Inadequate well capacity to meet peak demand | | | 1 | | | 2 |
| Inadequate supplies to meet current demand | | | 1 | | | 1 |
| Inadequate supplies to meet future demand | 1 | | 2 | 1 | | 3 |
| Infrastructure in need of replacement | 1 | | 6 | 2 | 3 | 2 |
| Inadequate capital to pay for infrastructure improvements | 1 | 1 | 6 | 2 | 2 | 6 |
| Drought related water supply problems | | | 2 | | | |

**Source:** ADWR 2005c

### 7.0.9 Groundwater Basin Water Resource Characteristics

Sections 7.1 through 7.11 present data and maps on water resource characteristics of the groundwater basins in the Western Plateau Planning Area. A description of the data sources and methods used to derive this information is found in Section 1.3 of Volume 1 of the Atlas. This section briefly describes general information that applies to all of the basins and the purpose of the information. This information is organized in the order in which the characteristics are discussed in Sections 7.1 through 7.11.

Geographic Features

Geographic features maps are included to present a general orientation to principal land features, roads, counties and cities, towns and places in the groundwater basin.

Land Ownership

The distribution and type of land ownership in a basin has implications for land and water use. Large amounts of private land typically translate into opportunities for land development and associated water demand, whereas federal lands are typically maintained for a purpose with little associated water use. State owned land may be sold or traded, and is often leased for grazing and farming. The extent of state owned lands is due to a number of legislative actions. The State Enabling Act of 1910 and the Act that established the Territory of Arizona in 1863 set aside sections 2, 16, 32 and 36 in each township to be held in trust by the state for educational purposes. Other legislation authorized additional state trust lands for specified purposes, which are identified for each basin (ASLD, 2006).

Climate

Climate data including temperature, rainfall, evaporation rates and snow are critical components of water resource planning and management. Averages and variability, seasonality of precipitation and long term climate trends are all important factors in demand and supply planning.

Surface Water Conditions

Depending on physical and legal availability, surface water may be a potential supply in a basin. Stream gage, flood gage, reservoir, stockpond and runoff contour data provide information on physical availability of this supply. Seasonal flow information is relevant to seasonal supply availability. Annual flow volumes provide an indication of potential volumetric availability.

Criteria for including stream gage stations in the basin tables are that there is at least one year of record, and annual streamflow statistics are included only if there are at least three years of record. There are different types of stations and those that only serve repeater functions were not included.

Flood gage information is presented to direct the reader to sources of additional precipitation and flow information that can be used in water resource planning. Large reservoir storage information provides data on the amount of water stored in the basin, its uses, and ownership. Because of the large number of small reservoirs, and less reliable data, individual small reservoir data is not provided. The number of stockponds is a general indicator of small scale surface water capture and livestock demand. Runoff contours reflect the average annual runoff in tributary streams. They provide a generalized indication of the amount of runoff that can be expected at a particular geographic location.

Perennial and Intermittent Streams and Major Springs

A map of perennial and intermittent streams is provided for each basin. For some basins, more than one source of information was used. Stream designations may not accurately reflect current conditions in some cases. Spring data was compiled from a number of sources in an effort to develop as comprehensive a list as possible. Spring data is important to many researchers and to the environmental community due to their importance in maintaining habitat, even from small discharges.

Groundwater Conditions

Several indicators of groundwater conditions are presented for each basin. Aquifer type can be a general indicator of aquifer storage potential, accessibility of the supply, aquifer productivity, water quality and aquifer flux. Well yield information for large diameter wells is provided and is generally measured when the well is drilled and reported on completion reports. It was assumed that large diameter wells were drilled to produce a maximum amount of water and, therefore, their reported pump capacities are indicative of the aquifer's potential to yield water to a well. However, many factors can affect well yields including well design, pump size and condition and the age of the well. Reported well yields are only a general indicator of aquifer productivity and specific information is available from well measurements conducted as part of basin investigations.

Natural recharge is typically the least well known component of a water budget. Many of the estimates in the Atlas are derived from studies of larger geographic areas and all deserve further study. Similarly, estimates of storage are based on rough estimates and considerably more studies are needed in most basins. Components of storage include aquifer depth and specific yield.

Water level data is from measured wells, usually collected during the period when the wells were not actively being pumped or only minimally pumped. Depth to water measurements are shown on mapped wells if there was a measurement taken during 2003-2004. The basin hydrographs show water-level trends for selected wells over the 30-year period from January 1975 to January 2005. Not all basins have a sufficient number of representative hydrographs.

The flow directions that are shown generally reflect long-term, regional aquifer flow in the basin and are not meant to depict temporary or local-scale conditions. However, flow directions in some basins indicate how localized pumping has altered regional flow patterns.

Water Quality

Water quality conditions impact the availability of water supplies. Water quality data was compiled from a variety of sources as described in Volume 1 Section 1.3. The data indicate areas where water quality exceedences have previously occurred, however additional areas of concern may currently exist where water quality samples have not been collected or sample results were not reviewed by the Department (e.g. samples collected in conjunction with the ADEQ Aquifer Protection Permit programs). It is important to note also that the exceedences presented may or may not reflect current aquifer or surface water conditions.

Cultural Water Demand

Cultural water demand is an important component of a water budget. However, without mandatory metering and reporting of water uses, accurate demand data is difficult to acquire. Municipal demand includes water company and domestic (self-supplied) demand estimates. Basin demand information is from several sources in order to prepare as accurate an estimate as possible. Annual demand estimates have been averaged over a specific time period. This provides general trend information without focusing on potentially inaccurate annual demand estimates due to incomplete data.

Locations of major cultural water uses are primarily from a 2004 USGS land cover study using older satellite imagery that may not represent recent changes. The cultural demand maps provide only general information about the location of water users.

Effluent generation data was compiled from several sources to provide an estimate of how much of this renewable resource might be available for use. However, effluent reuse is often difficult both logistically and economically since a potential user may be far from the wastewater treatment plant.

Water Adequacy Determinations

Information on water adequacy and inadequacy determinations for subdivisions, with the reason for the inadequacy determination provides information on the number and status of subdivision lots. Listing the reason for the inadequacy identifies which subdivisions have a demonstrated physical or legal lack of water or may have elected not to provide the necessary information to the Department. Briefly, developers of subdivisions outside of AMAs are required to obtain a determination of whether there is sufficient water of adequate quality available for 100 years. If the supply is determined to be inadequate, lots may still be sold, but the condition of the water supply must be disclosed in promotional materials and in sales documents.

In addition to these subdivision determinations for which a water adequacy report is issued, water providers may apply for adequacy designations for their entire service area. If a subdivision is to be served water from one of these water providers, then a separate adequacy determination is not required. (See Appendix A, Volume 1 for more information about the Adequacy Program).

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