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of Water Resources
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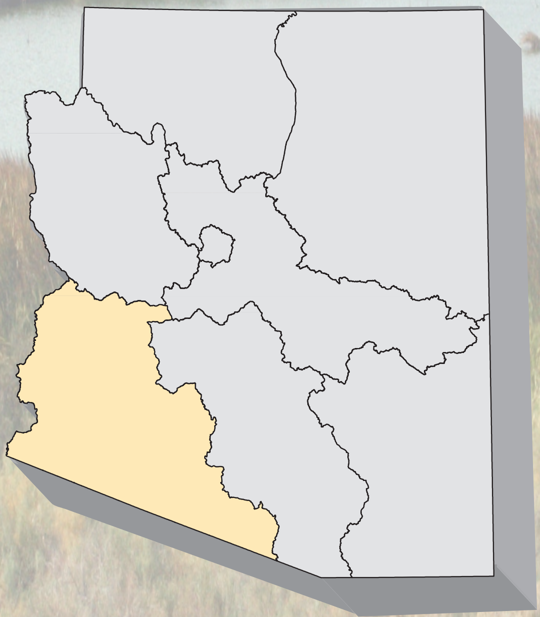
ARIZONA WATER ATLAS

VOLUME 7

LOWER COLORADO RIVER PLANNING AREA



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The Atlas is wide in scope and it is not possible to mention all those who helped at some time in its production, both inside and outside the Department. Our sincere thanks to those who willingly provided data and information, editorial review, production support and other help during this multi-year project.

Special note about the Atlas Team
Completion of the Atlas would not have been possible without the dedicated professionals that compose the Atlas Team. Most have been involved with the project from its inception in 2003 and their contributions to the success of the project cannot be overstated.

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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 also indicates where data are lacking and further investigation may be needed.

The Atlas divides Arizona into seven planning areas (Figure 7.0-1). There is a separate Atlas volume for each planning area, an executive summary volume composed of background information, and a resource sustainability 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 the State. Large expanses 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 (CRIT), 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 91,000 residents in 2006. Other population centers include Fortuna Foothills and San Luis located near Yuma, Parker/Parker Strip, Ajo, Gila Bend and Quartzsite.

During 2001-2005 an average of over 2,899,700 acre-feet of water was used annually in the planning area for agricultural, municipal and industrial uses (cultural water demand) – approximately 42% of the state's total demand

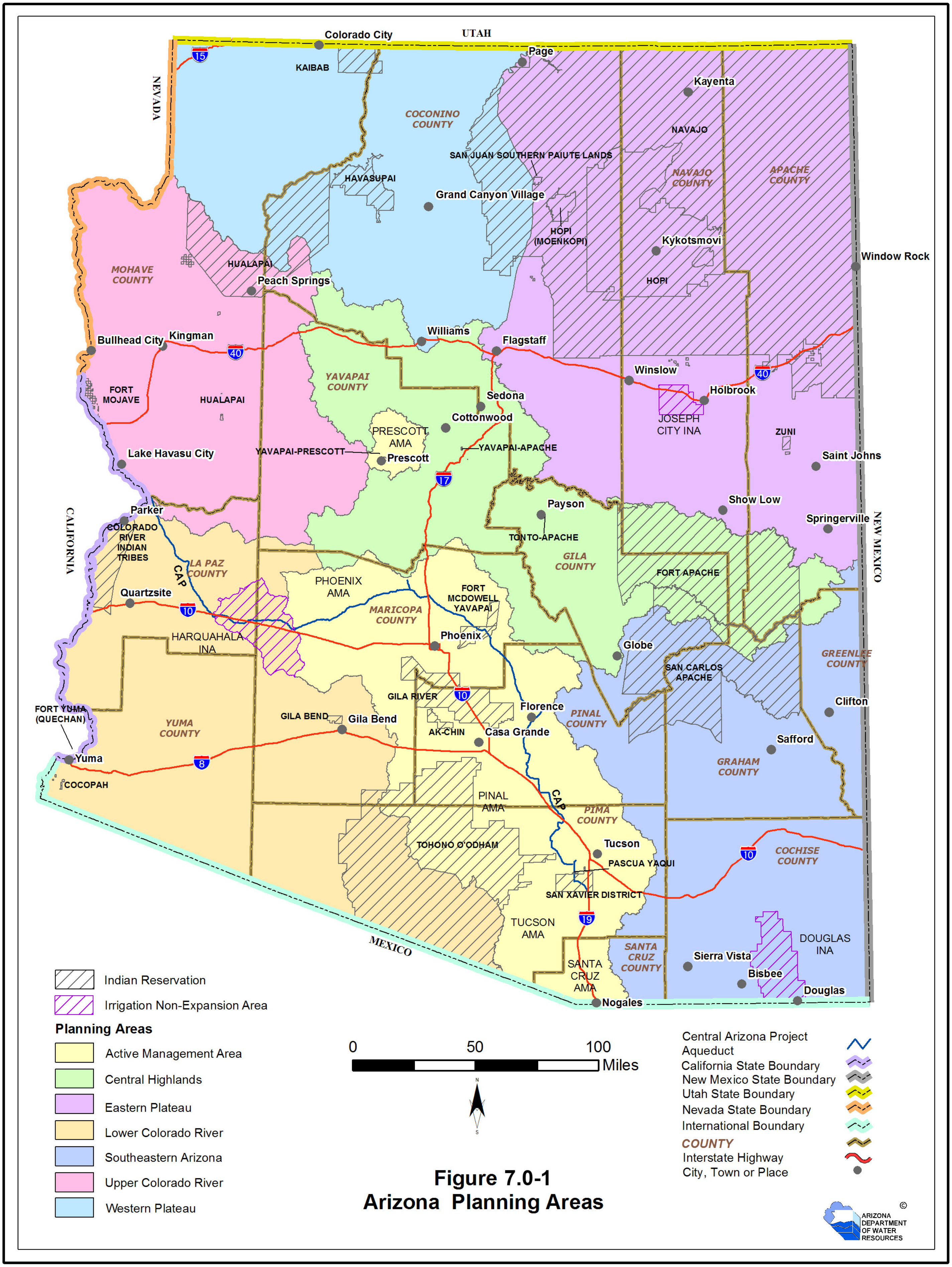


Figure 7.0-1
Arizona Planning Areas

during that period. Of the total planning area demand, approximately 964,670 acre-feet was well pumpage, 1,934,390 acre-feet was surface water diversions from the Colorado River, Gila River and the Central Arizona Project and about 680 acre-feet was effluent reuse. The agricultural demand sector was by far the largest with approximately 2,835,100 acre-feet of demand a year – 98% of the total demand. Average annual municipal sector demand was about 51,000 acre-feet a year (AFA) and industrial demand was about 13,560 AFA.

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

Figure 7.0-2 Lower Colorado River Planning Area

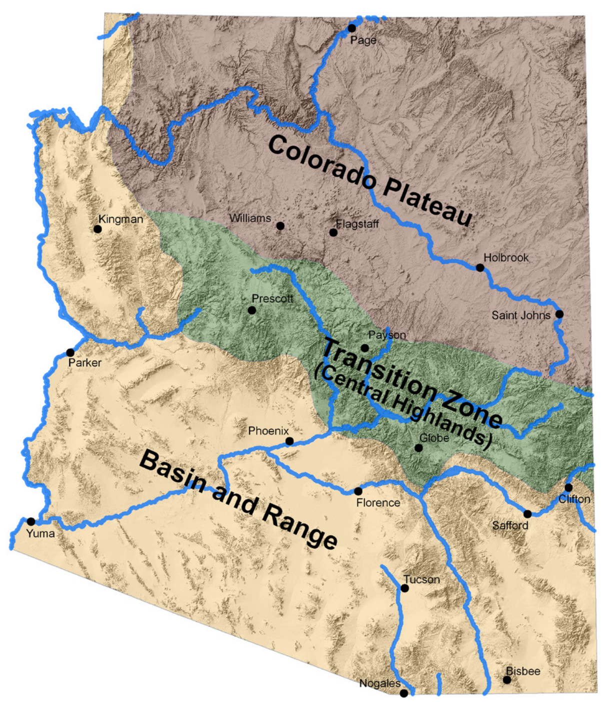
Upper Colorado River Planning Area, on the east by the Phoenix, Pinal and Tucson Active Management Areas (AMA), on the south by the international boundary with Mexico and on the west by the State of California and the international boundary.

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 CRIT, 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 (Figure 7.0-3). 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 its aridity, 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 (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

Figure 7.0-3 Physiographic Regions of Arizona



Data source: Fenneman and Johnson, 1946 and others, 1997). Broad sandy washes are the main surface water feature in the planning area, flowing only in response to significant precipitation events

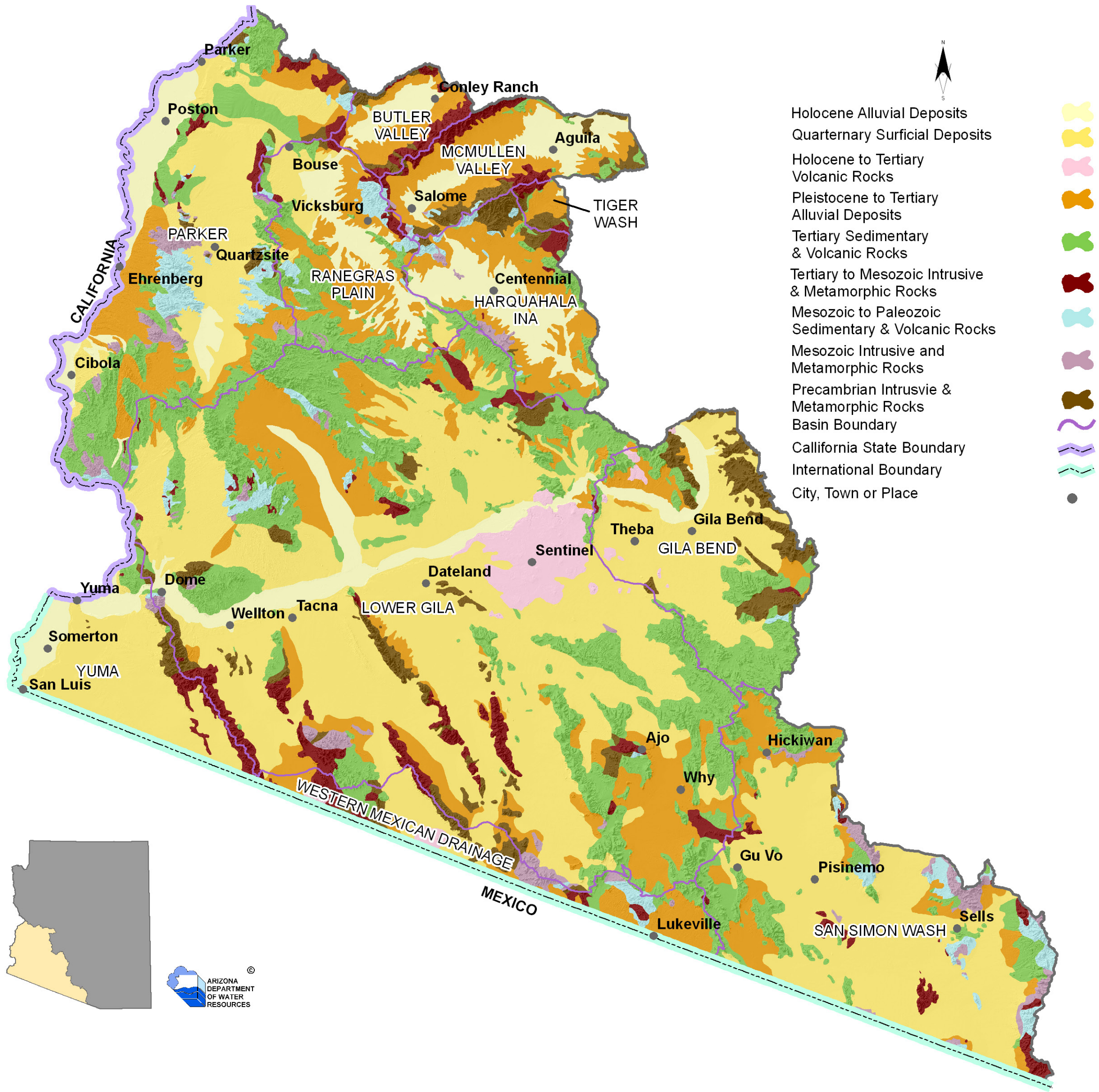
7.0.2 Hydrology[1]

Groundwater Hydrology

The groundwater basins of the Lower Colorado River Planning Area contain alluvial valleys with significant volumes of groundwater in storage. As shown in Figure 7.0-4 much of the basin is covered by Quarternary surficial deposits and Holocene to Tertiary alluvial deposits. The basin fill can have very productive water-bearing units.

Basins adjacent to the Colorado River were categorized by Anderson and others (1992) as Colorado River Basins. Colorado River infiltration was historically the main source of recharge to aquifers in these basins. Other basins in the planning area receive minimal groundwater recharge due to the aridity of the area. These other basins were categorized by

Figure 7.0-4 Surface Geology of the Lower Colorado River Planning Area
(Based on Reynolds, 1988)



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

Anderson and others (1992) as West Basins. The geology of the Colorado River Basins and West Basins are also somewhat different and each are summarized 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, partially consolidated 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 and others, 1992)

Parker Basin

The Parker Basin is composed of three sub-basins; La Posa Plains in the eastern portion, Cibola Valley in the southwest, and Colorado River Indian Reservation in the northwest.

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

Parker Basin, Colorado River. Along the Colorado River groundwater occurs under confined conditions in the Bouse Formation and fanglomerate unit and under unconfined conditions in alluvial deposits.

deposits is hydraulically connected to the river. In the La Posa Plains sub-basin groundwater is found in relatively small amounts under unconfined conditions. In this area, groundwater flows toward the Colorado River along stream courses (Figure 7.6-6). In the Cibola Valley and CRIT sub-basins, groundwater flows parallel to the Colorado River or away from it.

Pre-development groundwater recharge is approximately 241,000 AFA. Estimates of groundwater in storage range from 14 million acre-feet (maf) to 24 maf. The median well yield reported for 75 large diameter (>10 in.) wells was 100 gallons per minute (gpm) (Table 7.6-6). Water levels declined in most wells measured between 1990-'91 and 2003-'04 (Figure 7.6-6).

Groundwater quality is generally good in the Parker Basin although arsenic, fluoride, nitrate and organic compounds have been measured at concentrations exceeding the Drinking Water Standard in some wells (Table 7.6-7). Many water quality measurements have been made in the Quartzsite area where septic tanks have caused nitrate contamination of groundwater.

Yuma Basin

Tertiary and Quaternary 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 it. The middle, coarse-gravel zone is the principal water producing unit. 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 (bls) 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. 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 direction 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 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

Yuma Basin, Colorado River. Prior to development, nearly all groundwater recharge was from the Colorado and Gila Rivers through direct channel infiltration and annual flooding mound and rising groundwater levels in the Yuma area have affected groundwater flow patterns as shown on Figure 7.11-7. 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 still 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 and others, 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, with higher water levels west of the fault (USBOR, 2009).

Groundwater levels in the basin are also influenced by water management activities. The “242 Well Field and Lateral” located east of San Luis is a 5-mile wide regulated zone consisting of 35 wells that intercept part of the groundwater flow moving south into Mexico from Yuma Mesa (see Figure 7.0-9). 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).

Pre-development groundwater recharge was approximately 213,000 AFA. Groundwater storage estimates range from 34 to 49 maf. The median well yield reported for 327 large diameter (>10 in.) wells is among the highest in the State at 2,456 gpm. Water levels in wells are generally less than 100 feet bls in most wells measured in 2003-’04 (Figure 7.11-7). As shown in hydrographs of selected wells (Figure 7.11-8), water levels in most wells are relatively stable.

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 activity (Overby, 1997).

<u>West Basins</u>

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 relatively small in these basins and there are no perennial streams. Groundwater inflows consist of minor amounts of mountain front recharge and stream infiltration. The basins are contain 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 Gila River and elsewhere and may be locally productive water-bearing sediments (Anderson and others, 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 to nearly 1,500 feet thick in the central portion of the basin. The valley is bordered 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 recharge is approximately 1,000 AFA or less. Groundwater storage estimates range widely from 2.0 to 20 maf (Table 7.1-3). The median well yield reported for 17 large diameter (>10 in.) wells is 2,200 gpm. Water levels declined in most wells measured between 1990-'91 and 2003-'04, with the recent water level measurements generally ranging from 100 to 500 feet bls (Figure 7.1-5).

Groundwater quality is generally good with locally elevated fluoride and arsenic concentrations measured in wells located in the western part of the basin (Figure 7.1-8).

Gila Bend Basin
Basin-fill material is the principal aquifer in the Gila Bend Basin. Groundwater generally occurs under unconfined conditions, but there are several areas where fine-grained layers in the alluvium create either overlying perched water-table conditions as a result of percolation of irrigation water or underlying confined conditions. Confined conditions occur in the upper basin fill immediately upstream from Painted Rock Dam (Rascona, 1996).

West of Gila Bend, significant clay layers ranging from 150 to 500 feet thick are found at various depths and depth to water increases southward. North of Gila Bend, unconfined groundwater occurs primarily in the sands and gravels of the basin fill and may also occur in interbedded volcanics. The Sil Murk Formation is one of the principal water-bearing formations in the lower basin fill in this area. It is comprised of pebble to boulder-sized conglomerates with thin interbedded volcanics near the top. (Rascona, 1996)

Gillespie Dam, Gila Bend Basin. Groundwater is recharged primarily from infiltration of surface flows from the Gila River and its tributaries, and when river water is impounded behind Painted Rock Dam.

In the area north of Gila Bend, groundwater flow direction is generally from the Gila Bend Mountains east to the Gila River. In the center of the basin, groundwater flow is toward the southwest (see Figure 7.2-6).

Groundwater is recharged primarily from infiltration of surface flows from the Gila River and its tributaries, and when river water is impounded behind Painted Rock Dam. Some recharge also occurs from infiltration of irrigation water and underflow from the Hassayampa sub-basin of the Phoenix AMA (<1,000 AFA) (Rascona, 1996). Annual recharge estimates range from 10,000 to 37,000 AFA. Groundwater storage estimates range widely from 17 to 61 maf. The median well yield reported for 242 large diameter (>10 in.) wells is high with 2,700 gpm (Table 7.2-6).

Water levels in wells measured in 2003-'04 ranged from 34 feet in a well along the mountain front to almost 640 feet east of Gila Bend. 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 declines are still significant (>30 feet) in wells in this area and almost all wells measured between 1990-'91 and 2003-'04 showed some decline.

Groundwater quality is generally poor across the basin with several 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 locally 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 bls. (Hedley, 1990) Reportedly, the best well yields occur from this alternating sequence in the west-central part of the basin.

Prior to the 1950s groundwater moved from northwest to southeast and exited where Centennial Wash leaves the basin. As shown in Figure 7.3-5, groundwater flow in the south central part of the basin has been impacted by agricultural pumpage that caused severe overdraft from the 1950s through the mid 1980s, resulting in large water level declines and formation of a cone of depression.

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. Estimated annual recharge was less than 1,200 AFA. Groundwater storage estimates range from 13 to 27 maf. The median well yield reported for 157 large diameter (>10 in.) wells is 1,620 gpm (Table 7.3-5).

Introduction of CAP water in the late 1980s replaced a significant volume of groundwater pumping, allowing groundwater levels to rise by more than 30 feet in a number of wells in the south central part of the basin. Storage of CAP water at the Vidler Recharge facility has also caused local groundwater levels to rise. Elsewhere, water levels have generally declined (see Figure 7.3-5). The Harquahala Basin was designated 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 many wells require treatment to meet drinking water standards (see Table 7.3-6).

Lower Gila Basin

The Lower Gila Basin is composed of the Wellton-Mohawk sub-basin, the Dendora Valley sub-basin in the northeast and the Childs Valley sub-basin in the southeast (Figure 7.4-6). Groundwater 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. 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.

Prior to development, groundwater flow was from north and southeast toward the Gila River and then downstream to the southwest. Groundwater flow has been impacted by irrigation pumpage at some locations in the basin, where cones of depression exist (see Figure 7.4-6). Historically, cones of depression occurred in irrigated areas north of Hyder, east of Dateland and in the Palomas Plain west of Hyder. Infiltration of irrigation water in the western part of the basin has created groundwater mounds in the floodplain aquifer that also affect groundwater flow.

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 groundwater recharge. Estimates of natural groundwater recharge ranging from 9,000 to 88,000 AFA.

There is a significant volume of groundwater in storage with estimates ranging from 100 to 246 maf. The median well yield reported for 597 large diameter (>10 in.) wells is 1,600 gpm (Table 7.4-6). Well yields exceeding 2,000 gpm are commonly found near the Gila River, southeast of Dateland and north of Hyder.

Groundwater levels in the Gila River floodplain in the western part of the basin historically ranged from 10 to 20 feet bls 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.

Agriculture in the Wellton-Mohawk Irrigation District. In the far western part of the basin, infiltration of excess irrigation water is the largest source of recharge.

Historic groundwater level declines were as much as 15 feet per year in irrigated areas north and west of Hyder and east of Dateland. Few water level change measurements are available for the period 1990-'91 to 2004-'05 but several measured wells in the western part of the basin show relatively stable water level conditions (see Figure 7.4-6).

Groundwater quality varies in the eastern part of the basin with elevated fluoride concentrations measured in 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 perched aquifers. Stream alluvium has been deposited by Centennial Wash and its tributaries and is composed of silt, sand and clay. This unit ranges from 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 bls and is largely unexplored.

Eagle Eye Peak, McMullen Valley Basin. The principal aquifer in the McMullen Valley basin is alluvial-fan deposits in the basin fill.

An estimated 1,000 acre-feet of groundwater recharge occurs annually. Groundwater storage estimates range from 14 to 15.1 maf. The median well yield reported for 167 large diameter (>10 in.) wells is 1,500 gpm (Table 7.5-5).

Water levels in measured wells are generally more than 300 feet bls. As shown in Figure 7.5-5, water levels declined in all wells measured between 1990-'91 and 2003-'04, with significant declines (>30 feet) in a well east of Aguila and in five wells in the western half of the basin.

Fluoride and arsenic concentrations exceeding drinking water standards are found at wells throughout the basin with elevated nitrate concentrations measured in a number of wells near Salome (see Table 7.5-6).

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. The thickness of the basin-fill deposit is not well known but is at least 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 irrigation wells groundwater withdrawals have created a cone of depression southwest of Vicksburg (see Figure 7.7-5).

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) Annual recharge estimates range from less than 1,000 acre-feet to more than 6,000 acre-feet. Groundwater storage estimates range from 9.0 to 27 maf. Although yields in some wells are relatively low due to the presence of clays, yields reported for 68 large (>10 in.) diameter wells reach 4,000 gpm with a median yield of 1,150 gpm (Table 7.7-3).

As shown in Figure 7.7-5, water levels declined in almost all wells measured between 1990-'91 and 2003-'04, with significant declines (>30 feet) east of Vicksburg Road.

New Water Mountains in the Ranegras Plain Basin. Natural groundwater recharge in this basin is from infiltration of runoff in Bouse Wash, Cunningham Wash and along mountain fronts.

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).[2] Water quality measurements taken between 1979 and 2000 also show a number of wells with elevated fluoride and arsenic concentrations (Table 7.7-4).

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 basin-fill units have been identified. 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 relatively high. Lakebed deposits consisting of thick sequences of fine-bedded silts and clays extend to depths of more than 1,000 feet. Groundwater occurs under unconfined conditions in the basin. Groundwater flow is generally toward the southwest, then south into Mexico. (Hollett, 1985)

There is relatively little grounwater data available for the basin, which is almost entirely within the Tohono O'odham Nation. Natural recharge is estimated at 11,000 AFA and ground-

2 Listed TDS exceedences indicate "mineralized water" that contains over 3000 milligrams per liter (mg/l) of TDS and would require special well construction procedures (A.A.C. R12-15-812(B)). The secondary drinking water standard for TDS is 500 mg/l.

water storage estimates range widely from 6.7 to 45 maf. Well yield estimates range from less than 50 to 3,000 gpm (Table 7.8-5). Hollett (1985) reported that wells drilled into the lake-bed deposits in the center of the basin generally yield less than 50 gpm and well yields appear to be highest at depths of 400 to 700 feet. Depth to water averaged about 300 feet bls (Hollett, 1985).

Elevated arsenic concentrations are found across the basin and fluoride concentrations that equal or exceed drinking water standards occur in the area around Papago Farms and the international boundary (Table 7.8-6).

Tiger Wash Basin
Tiger Wash Basin is a relatively small, shallow basin composed of heterogeneous deposits of clay, silt, sand and gravel that are likely less than 1,000 feet thick. 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) (Figure 7.9-5).

Natural recharge is estimated to be less than 1,000 AFA. Groundwater in storage estimates range from 700,000 acre-feet to 2.0 maf. Measured well yield data are not available for the basin. Anning and Duet (1994) estimated a maximum yield of 500 gpm. Two wells measured in 2003-’04 had water levels of 29 feet and 219 feet bls (Figure 7.9-6).

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 7.9-4).

Western Mexican Drainage Basin
The Western Mexican Drainage Basin contains broad alluvial-filled valleys containing unconsolidated gravel, sand, silt and clay deposits that make up the main water-bearing unit. Groundwater flow is toward Mexico.

Tiger Wash, Tiger Wash Basin. Tiger Wash Basin is a small, shallow, alluvial basin composed of heterogeneous deposits of clay, silt, sand and gravel that are likely less than 1,000 feet thick.

Natural recharge is estimated to be 1,000 AFA. Groundwater in storage estimates range from 3.0 to 4.1 maf. The median well yield reported for three large (>10 in.) diameter wells was 50 gpm (Table 7.10-4).

Water levels varied from 27 to 237 feet bls at wells measured in 2003-‘04 and levels appear to be declining near Lukeville, likely due to development in the Sonoyta area of Sonora, Mexico (Figure 7.10-6). 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 7.10-5).

Surface Water Hydrology

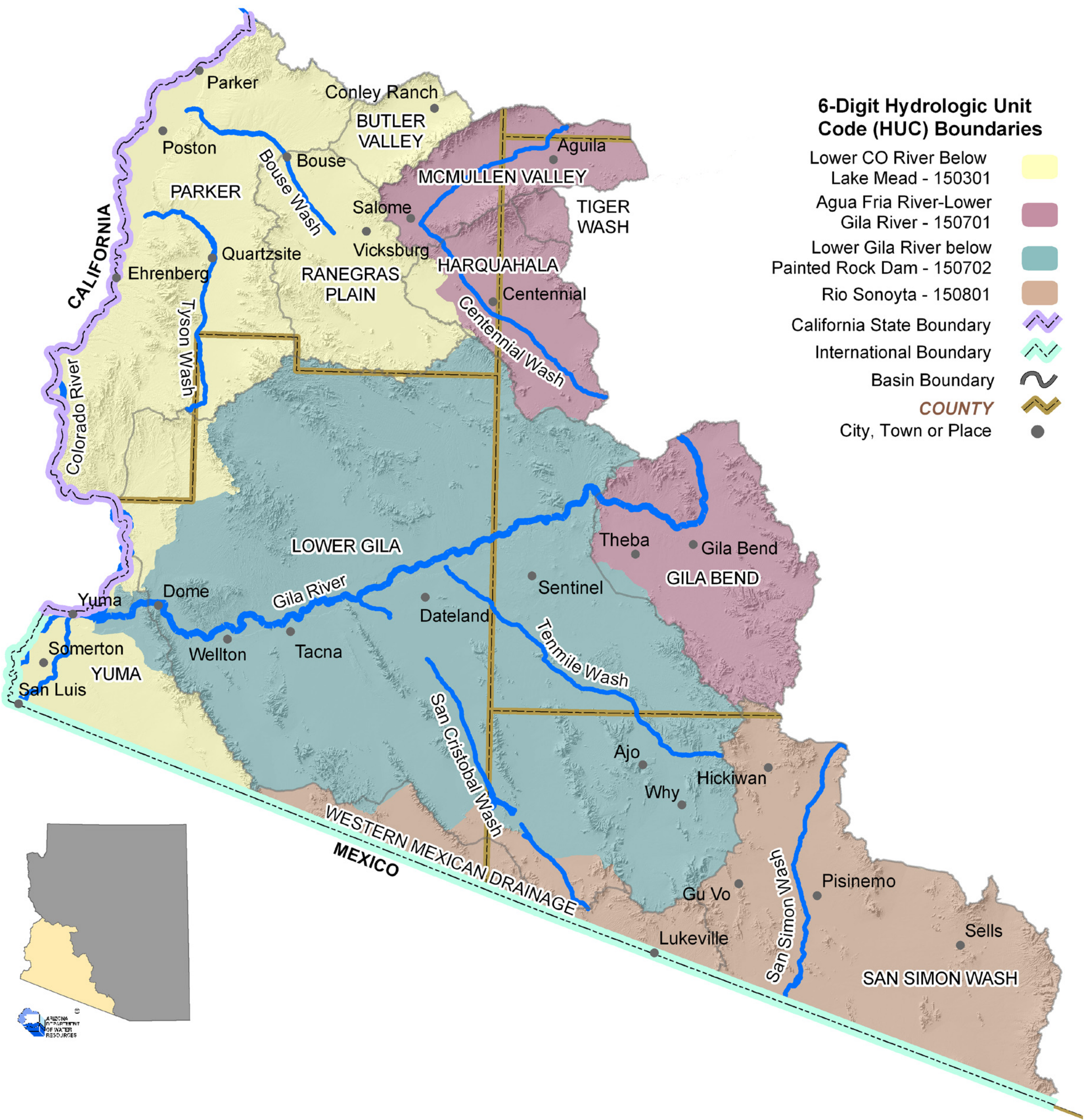
The U.S. Geological Survey (USGS) divides and subdivides the United States into successively smaller hydrologic units based on hydrologic features. These units are classified into four levels. From largest to smallest these are: regions, subregions, accounting units and cataloging units. A hydrologic 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; Agua Fria River-Lower Gila River; and the Rio Sonoyta (Figure 7.0-5). 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 Watershed

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 4.0-5). 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

Figure 7.0-5 Lower Colorado River USGS Watersheds
(USGS, 2005)

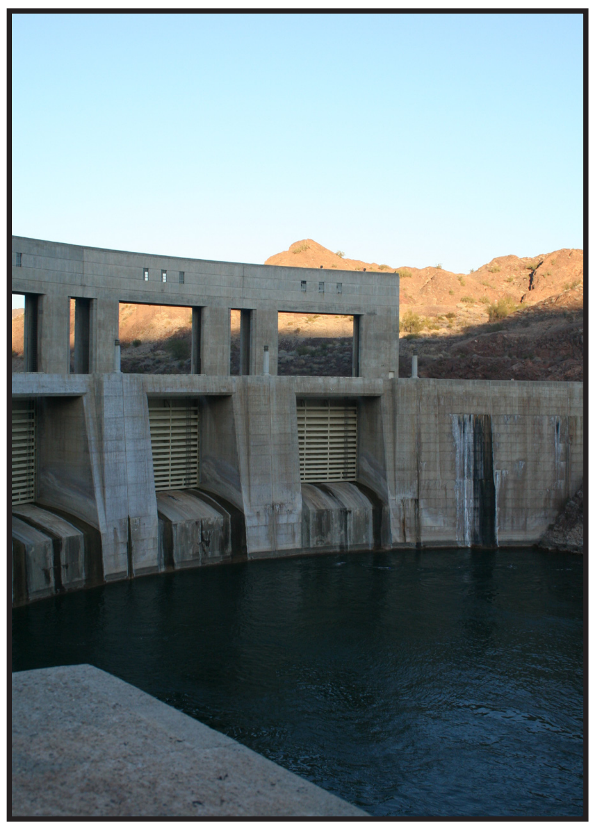


several dams along the Colorado River. Dams include Imperial, Laguna and Morelos. There are major diversions from Imperial Dam to the All-American Canal, which delivers agricultural water to California and to the Gila Gravity Canal for use in Arizona. Drainages to the Colorado River in the planning area 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 and others, 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 and others, 2004)

There are streamflow records for eight Colorado River streamgages in the watershed. Of these, five are currently in operation and four are real-time gages. There are two active gages in the Parker Basin, one in the Lower Gila Basin and two in the Yuma Basin. The active gages in the Parker Basin portion of the watershed report similar median and mean flows (Table 7.6-2). Median flow at the gage below Parker Dam is 7.2 maf and the mean is 8.9 maf. The highest maximum annual flow (20.4 maf) in the watershed was reported at this gage in 1984. The three operating downstream gages (located below the major California diversion structures)



Parker Dam.

report mean flows substantially greater than median flows. For example, the gage on the Colorado River below Laguna Dam reports a median flow of 0.39 maf and a mean flow of 1.8 maf. The highest maximum annual flow among the three downstream gages was 15.4 maf at the Colorado River at the NIB above Morelos Dam gage (Table 7.11-2)

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.

A 28-mile reach of the Gila River (from Coyote Wash to Fortuna Wash) is designated as "impaired" due to elevated concentrations of boron and selenium that exceed the designated use standard for aquatic and wildlife uses (Tables 7.4-7 and 7.11-6).

Lower Gila River Below Painted Rock Dam Watershed

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 7.0-5).

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 its 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 and others, 1997).

Historically, the Gila River flowed in the planning area in the spring due to winter rain and snowmelt and in the summer following monsoon storms. Construction of dams resulted in loss of flows and water supplies downstream. 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. Prior to construction of the Painted Rock Dam, an average of approximately 6 AFA of groundwater was forced to the surface by the volcanic rocks of the Painted Rock Mountains and rock outcrops in the river channel at Painted Rock Narrows (Rascona, 1996). 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.

In the planning area, the Gila River now 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

Gila River at Gillespie Dam in January 1993.

gage below Gillespie Dam and the gage below Painted Rock Dam were over 5 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 has recorded annual median flow of less than 4,800 acre-feet.

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. Centennial Wash is the major tributary 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 (mentioned above), 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.

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

Ephemeral flow in Centennial Wash, McMullen Valley Basin.

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).

Rio Sonoyta Watershed

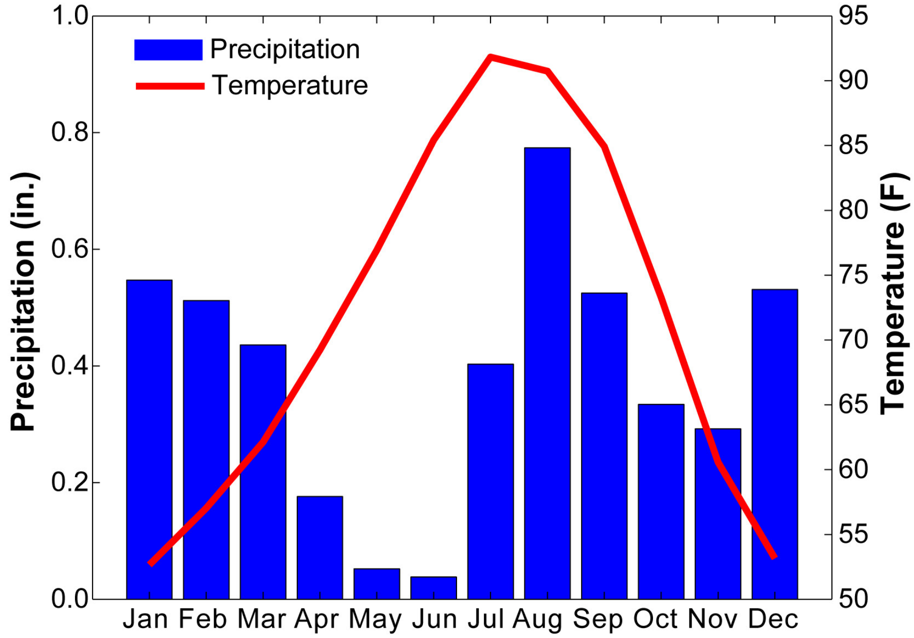
The Rio Sonoyta Watershed in Arizona includes the San Simon Wash and Western Mexican Drainage basins and the south central portion of the Lower Gila Basin. Major drainages in the San Simon Wash Basin, all ephemeral, are Hickiwan Wash, San Simon Wash and Vamori Wash (Figure 7.8-4). Vamori Wash flows northwest 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 on 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 (Figure 7.10-4).

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 spring 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 developed and diverted into a man-made 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 about 74°F), and slightly brackish. The two minor springs in the planning area are located nearby. In total there are about 20 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 considerably higher in mountainous areas 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 7.0-6); however, the northwestern part of the planning area, near Parker, exhibits a stronger late winter peak, more typical of the Mohave Desert.

Figure 7.0-6 Average monthly precipitation and temperature from 1930-2002



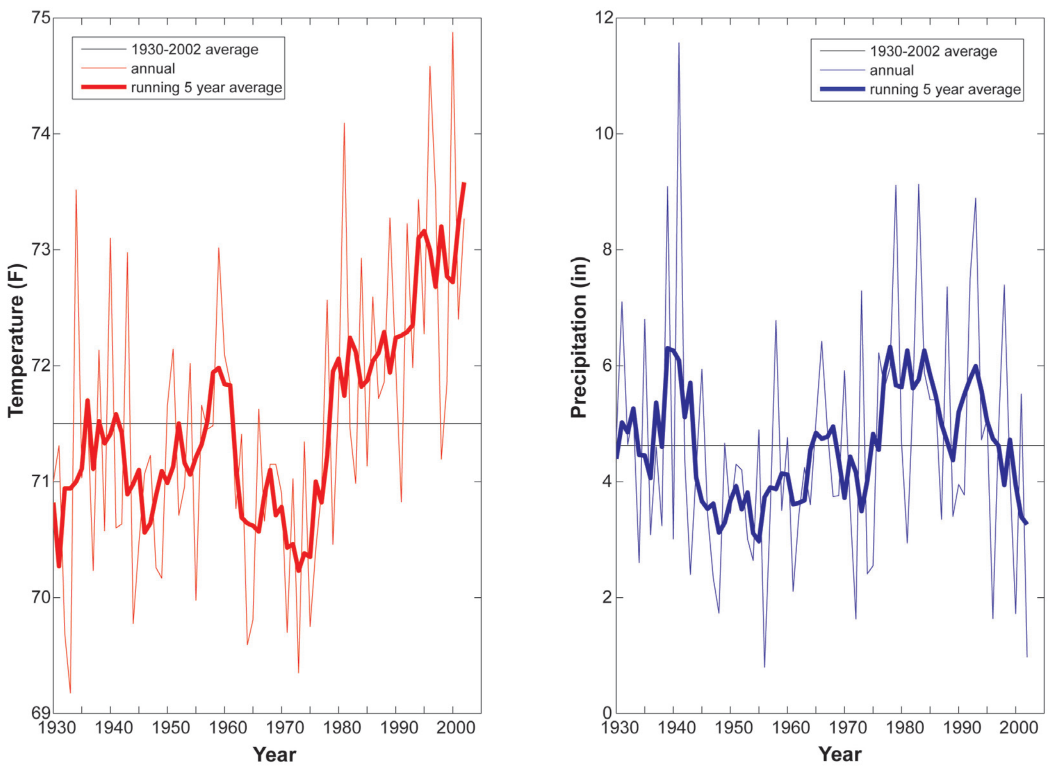
Data are from the Western Regional Climate Center. Figure author: CLIMAS.

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

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 7.0-7). 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 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 7.0-7). 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.

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 7.0-8). A climate

Figure 7.0-7 Average annual temperature and total annual precipitation for the Lower Colorado River Planning Area from 1930-2002



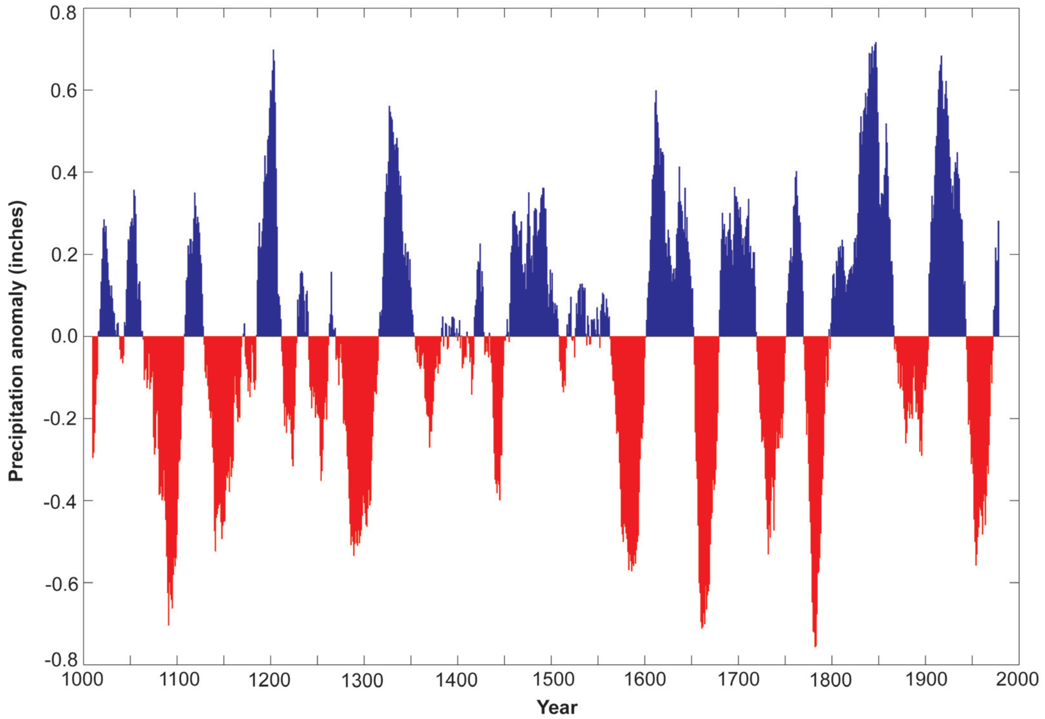
Horizontal lines are average temperature (71.5 °F) and precipitation (4.6 inches), respectively. Light lines are yearly values and highlighted lines are 5-year moving average values. Data are from the Western Regional Climate Center. Figure author: CLIMAS.

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.

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.

Figure 7.0-8 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: CLIMAS.

Vegetation

Information on ecoregions and biotic (vegetative) communities in the planning area are shown on Figure 7.0-9. 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 transitioning to semidesert grassland at lower elevation. Cacti of the semidesert grassland may extend well into the woodland. (Brown, 1982)

Interior chaparral occupies mid-elevation foothills, mountain slopes and canyons in small areas along the boundary of McMullen Valley and Butler Valley basins 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.

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 along the Lower Gila/Western Mexican Drainage/San Simon Wash basin boundaries, and near Aguila in the 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 subdivision and the Arizona Upland subdivision. The Lower Colorado River 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

Lower Colorado River Desertscrub in the Gila Bend Basin.

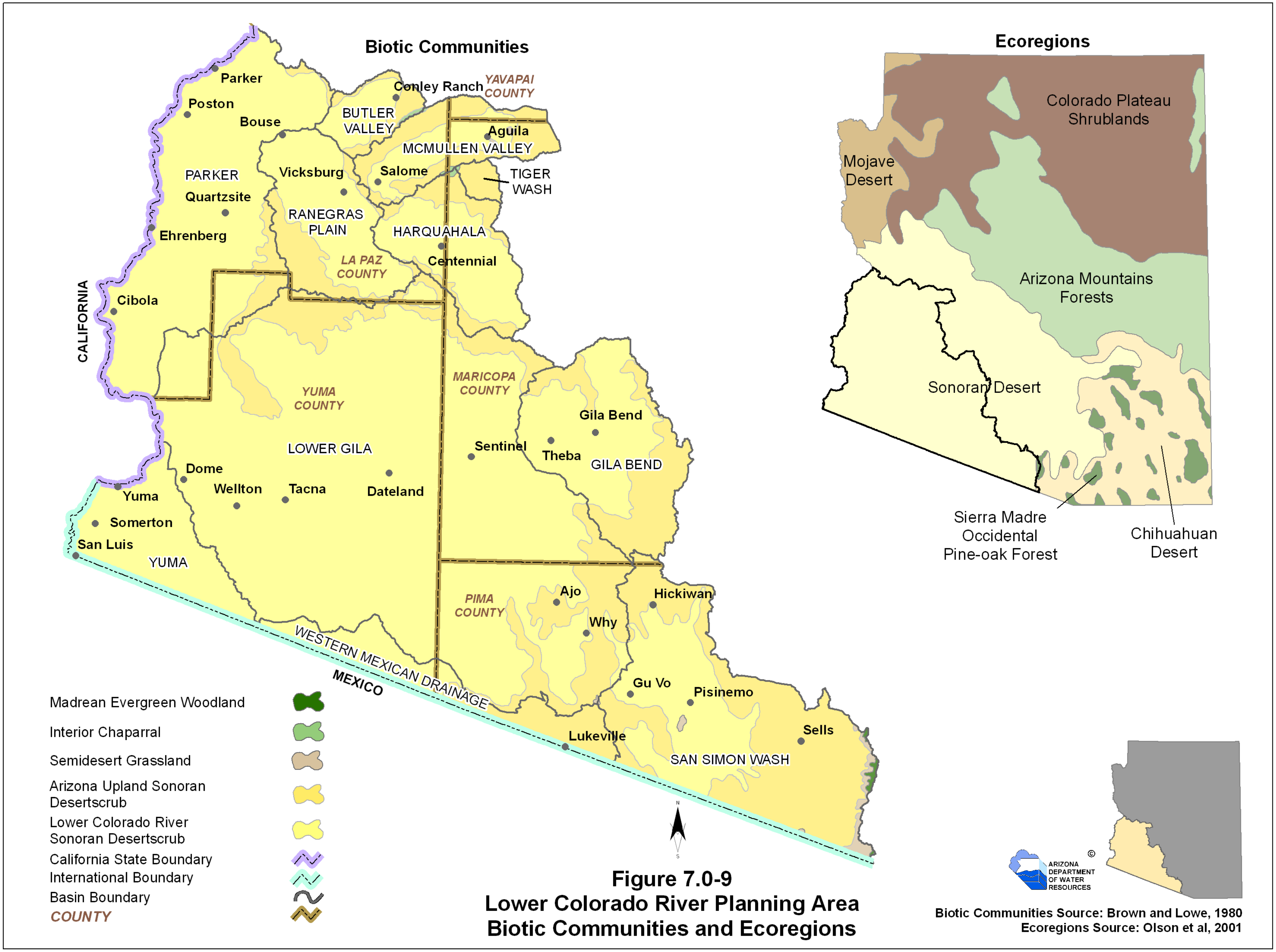


Figure 7.0-9
Lower Colorado River Planning Area
Biotic Communities and Ecoregions

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

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 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)

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, unlike native species (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).

Riparian vegetation exists at locations along the Colorado and Gila rivers as shown on Figure 7.0-10. Along the Gila River in the vicinity of Gillespie Dam, primarily tamarisk, but also cattail, occurs. Downstream from Gillespie Dam to Painted Rock Reservoir, irrigated agriculture adjacent to the river may support native and nonnative riparian vegetation. Below Painted Rock Dam, the Gila River is mostly dry until irrigation return flows within the Wellton-Mohawk Irrigation District add some flow to the river. In the area near Dome, return flow supports riparian vegetation consisting of a narrow line of cottonwood along the channel with dense tamarisk behind (Webb and others, 2007)

Lower Gila Basin, Colorado River.

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). Although the river has been altered by dams and water delivery infrastructure, riparian ecosystems exist along most of the reach of the Colorado upstream of Imperial Dam. Floods no longer occur so the composition of woody riparian vegetation has changed with native species and tamarisk predominant.

Downstream from Parker Dam, non-native date palm, giant reed and fan palm are found with mesquite and arrowweed found further from the river. Downstream of Headgate Rock Dam (Figure 7.6-5), the river corridor widens. Riparian vegetation in this area was mapped in 1962 and covered 108,000 acres of primarily mesquite bosque with some reaches of native riparian vegetation among stands of tamarisk. The All American Canal at Imperial Dam diverts much of the flow of the Colorado River to California. Black willow, cottonwood and tamarisk are found in the abandoned river channel in this area. Through Yuma, flood control and bank protection have narrowed the river channel but has also provided more stable hydrologic conditions, resulting in an increase of riparian vegetation, primarily arrowweed. (Webb and others, 2007)

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 and others, 2004).

Figure 7.0-10 Riparian Areas in the Lower Colorado River Planning Area

Riparian Data Source: AZGF 1993

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. Twelve restoration projects in the Lower Colorado River Planning Area had been funded by the AWPF through 2008. Ten projects were funded in the Yuma Basin for wetland, habitat and watershed restoration, exotic species control, research and revegetation. Two projects in the Parker Basin 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 2008 are found in Appendix A. A description of the program, a complete listing of all projects funded, and a reference map are found in Volume 1.

Threatened and Endangered Species[4]

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 2008 are shown in Table 7.0-1. Presence of a listed species may be a critical consideration in water resource 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.

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

Restoration project on Colorado River in the Yuma area.

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, power and wildlife interests created the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). The LCR MSCP is a cooperative, Habitat Conservation Program that identifies specific measures to address the needs of 26 threatened, endangered and other species that rely on habitat associated with the lower Colorado River (USDOI, 2004). 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 7.0-11.

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

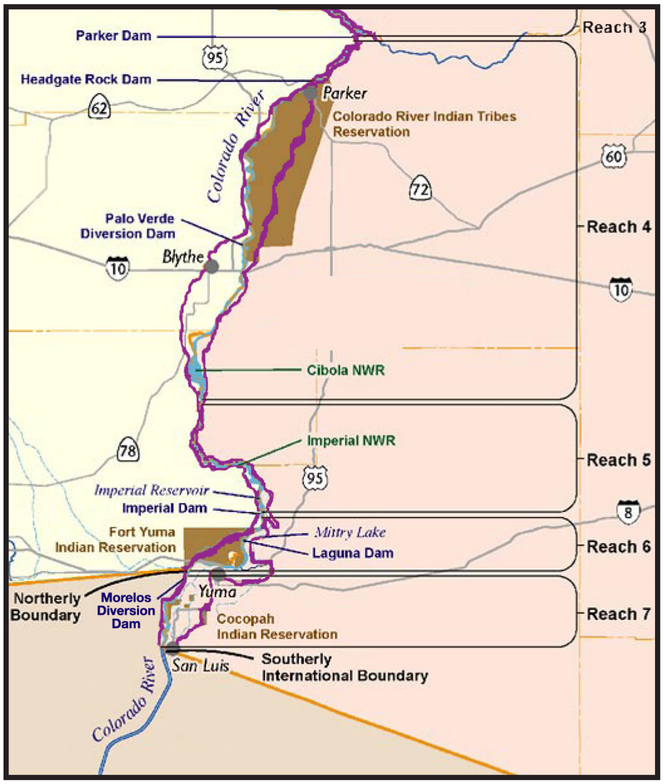
[4] An "endangered species" is defined by the USFWS as "an animal or plant species in danger of extinction throughout all or a significant portion of its range," while a "threatened species" is "an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant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

Table 7.0-1 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 2008

Figure 7.0-11 MSCP Reaches in the Lower Colorado River Planning Area



Source: U.S. Department of the Interior, 2004

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).[5]

Implementation of the LCR MSCP began in 2005. The program area extends from the full pool elevation of Lake Mead to the Southerly International Boundary 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 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 7.0-12). Both

[5] 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])

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

Figure 7.0-12 Wilderness Areas in the Lower Colorado River Planning Area
(Wilderness Data Source: National Atlas of the United States 2005, Land Ownership Data Source: ALRIS 2004)

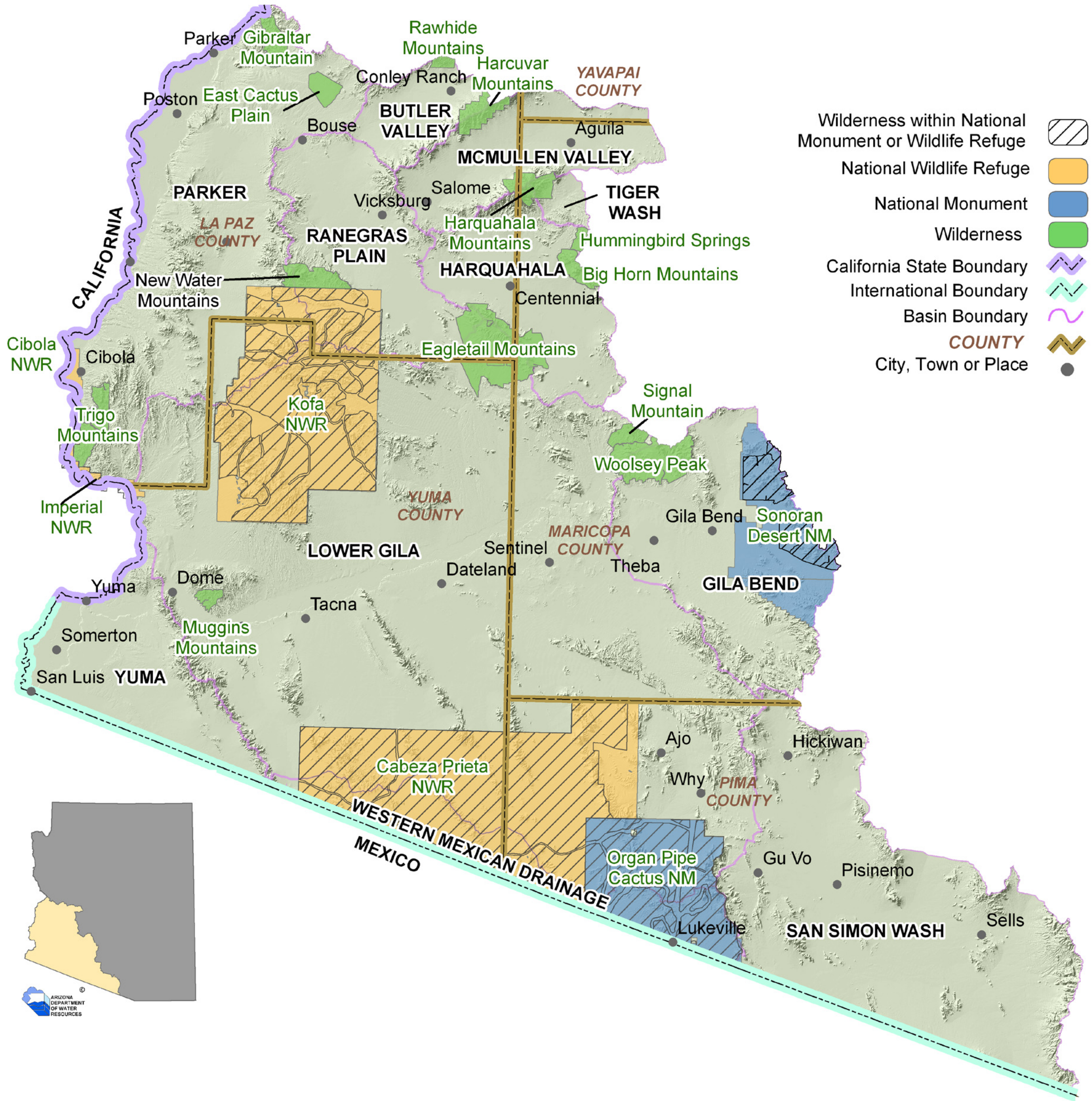


Table 7.0-2 Wilderness areas in the Lower Colorado River Planning Area

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, including many 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.

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 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 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 intact 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)

Kofa Mountains in the Kofa National Wildlife Refuge. The Lower Colorado River Planning Area contains 2.3 million acres of protected federal lands, accounting for 21% of the land area

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, flow in 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 and others, 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 2000 Census populations for each basin and Indian reservation, from highest to lowest, are listed in Table 7.0-3. The most populous basin is the Yuma Basin with 79% of the total planning area population in 2000. Three basins have population totals less than 100 residents. The 2005 estimated population of the Yuma Basin was 181,600 and Arizona Department of Economic Security (DES) population projections forecast 305,900 residents by 2030. Historic, current and projected basin populations are shown in the basin cultural water demand tables (Sections 7.1-7.11).

The planning area is growing rapidly with a 44% population increase between 1990 and 2000. Census data for 2000 show about 194,100 residents and DES population projections forecast that the population will double by 2030, to about 388,400 residents (Table 7.0-4).

Listed 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 and a 29% growth rate between 2000 and 2006. Yuma, Fortuna Foothills and Quartzsite experience a large 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 7.0-3 2000 Census population in the Lower Colorado River Planning Area

Basin/ *Reservation*	2000 Census Population
Yuma	152,928
Cocopah	*1,025*
Fort Yuma (Quechan)	*45*
Parker	16,155
Colorado River Indian Tribes (CRIT)	*3,389*
Lower Gila	11,297
San Simon Wash	5,837
Tohono O'odham	*5,833*
Gila Bend	4,256
Gila Bend	*600*
McMullen Valley	3,426
Ranegras Plain	905
Harquahala	608
Western Mexican Drainage	33
Butler Valley	15
Tiger Wash	<10

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. Only 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. 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 must be submitted each year by the systems that includes information on water pumped, diverted and received, water delivered to customers, and

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	2006 Pop. Estimate	Percent Change 2000-2006	Projected 2030 Pop.
City of Yuma[1]	Yuma	54,923	77,515	41%	91,033	15%	136,305
Fortuna Foothills	Yuma	7,737	20,478	165%	28,827	29%	57,224
City of San Luis[1]	Yuma	4,212	15,322	264%	24,485	37%	55,651
City of Somerton[1]	Yuma	5,282	7,266	38%	10,258	29%	20,433
Town of Ajo	Lower Gila	2,919	3,705	27%	4,118	10%	6,266[2]
Town of Quartzsite[1]	Parker	1,876	3,354	79%	3,650	8%	4,748
Parker Strip	Parker	1,646	3,302	101%	3,802	13%	5,660
Town of Parker[1]	Parker	2,897	3,140	8%	3,308	5%	3,933
Town of Gila Bend[1]	Gila Bend	1,747	1,980	13%	1,805	-10%	5,609[2]
Town of Wellton[1]	Lower Gila	1,066	1,829	72%	1,998	8%	2,565
Town of Ehrenberg[1]	Parker	1,226	1,357	11%	1,397	3%	1,543
Total >1,000		85,531	139,248	63%	174,681	20%	299,937
Remainder of <1,000		49,096	54,814	12%	63,034	13%	88,418
Total		**134,627**	**194,062**	**44%**	**237,715**	**18%**	**388,355**

Sources: DES 2006, U.S. Census Bureau 2006
[1] Incorporated communities
[2] Derived by ADWR from MAG and PAG projections

effluent used or received. The System Water Plan must 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. By January 1, 2008, all systems were required to submit plans.

Plans have been submitted by 37 community water systems in the planning area including the City of Yuma, Town of Parker, Ajo Improvement Company/Phelps Dodge Corporation, City of Somerton, and Town of Gila Bend and were used to prepare this document. Annual water report information and a list of water plans are found in Appendix B.

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. To date, only Yuma County and Cochise County have adopted the provision.

Subdivision adequacy determinations (Water Adequacy Reports), including the reason(s) for inadequate determinations, are provided in basin tables and maps and are summarized for each basin in Table 7.0-5. As listed on the table, a

Table 7.0-5 Water adequacy determinations in the Lower Colorado River Planning Area as of 12/2008

Basin	Number of Subdivisions	Number of Lots[1]	Lots w/ Adequate Determ.	Lots w/ Inadequate Determ.	Approx. Percent of Lots w/ Inadequate Determ.
Butler Valley	1	76	0	76	100%
Gila Bend	6	222	43	179	81%
Harquahala	4	301	201	100	33%
Lower Gila	30	3,087	2,756	331	11%
McMullen Valley	10	2,137	2,030	233	11%
Parker	28	≥1,575	≥1,145	≥430	27%
Ranegras Plain	8	280	26	254	91%
San Simon Wash	none	none	none	none	none
Tiger Wash	none	none	none	none	none
Western Mexican Drainage	none	none	none	none	none
Yuma	262	29,264	27,523	1,741	6%
Total	**348**	**≥36,942**	**≥33,724**	**≥3,218**	**9%**

Source: ADWR 2008a
Notes:
[1] Data on number of lots are missing for some subdivisions; actual number may be larger (≥)

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.

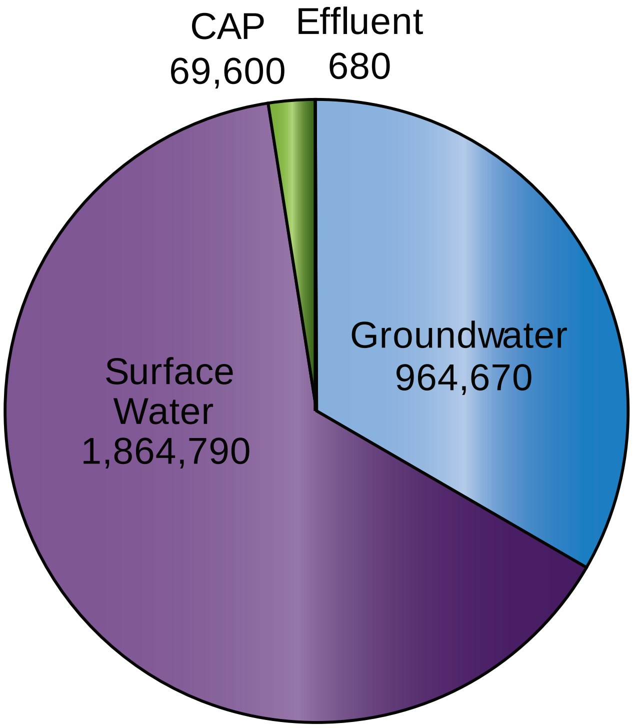
Also shown in the basin sections are approved applications for an Analysis of Adequate Water Supply (AAWS). This application is typically associated with large, master planned communities.

The service areas of two water providers in the planning area, Town of Parker and City of Yuma, have been designated as having an adequate water supply for their entire service area. If a subdivision is served by one of these designated water providers, a separate adequacy determination is not required.

7.0.6 Water Supply

Water supplies in the Lower Colorado River Planning Area include groundwater, surface water, Central Arizona Project (CAP) water and effluent. As shown on Figure 7.0-13, most water used is surface water. 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 Bend 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 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.

Figure 7.0-13 Average Annual Water Supply Utilized in the Lower Colorado River Planning Area, 2001-2005 (in acre-feet)



Colorado River Water

<u>Decree Accounting</u>

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

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	2001-05 [2]	Entitlement [3]
Parker								
Agricultural	334,058	354,197	338,033	407,512	425,204	429,193	389,668	693,486
Industrial	0	0	0	0	0	0	0	0
Municipal	829	1,070	1,770	1,815	1,891	2,339	1,876	8,004
Environmental [4]	148	13,128	8,768	11,822	19,719	18,368	11,785	56,238
Lower Gila								
Agricultural [5]	309,367	209,015	258,612	312,237	241,267	278,826	260,818	272,980
Industrial	0	0	0	0	0	0	0	0
Municipal	2	5	6	7	19	62	80	265
Environmental [4]	40	59	22	743	1,800	1,773	665	6,262
Yuma								
Agricultural [4]	676,165	631,711	564,313	571,245	543,251	560,581	457,679	582,257
Industrial	1,046	1,021	839	610	469	2,250	674	1,772
Municipal	13,272	10,146	12,174	13,137	15,255	21,625	21,296	54,945
Environmental	0	0	0	0	0	0	0	0
TOTAL	1,334,927	1,220,352	1,184,538	1,319,126	1,248,876	1,315,019	1,144,541	1,676,209

Footnotes

[1] Consumptive use for individual users may not cover an entire 5 year period, the average shown 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, which is delivered by the Central Arizona Project to reservations.

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

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

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 1,144,541 acre-feet annually for the 2001-2005 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 July 16, 2008, Reclamation proposed to develop a rule for Regulating Non-Contract Use of Colorado River Water in the Lower Basin (73 Federal Register 40916 et seq.) 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. The proposed rule would establish a methodology that Reclamation would use to determine if a well pumps Colorado River water and a process for a water user to appeal a subsequent finding (USBOR, 2008). As of October 2009, Reclamation had not adopted a rule.

Because of the complexity of the accounting system and its unique methodology that includes return flow and other considerations, the surface water and groundwater discussions in this overview section and the cultural water demand tables in sections 7.4, 7.5 and 7.11 (those basins that utilize this supply), reflect the amount of water pumped from wells and diverted from streams. This approach is comparable to that used for other planning areas. The tables do not attempt to distinguish whether the water is used pursuant to the entitlement system.

<u>Entitlement Priority Levels</u>

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; and

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 1st 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. 2nd and 3rd 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 C. 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, 5th and/or 6th), to the Hopi Tribe (Priority 4t^{h}, 5th and 6th) and to Cibola Resources for municipal use at Ehrenberg. More information on entitlement transfers is in Appendix D.

<u>Coordinated Operations and Shortage Criteria</u>

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.

<u>Colorado River Water Supply Distribution System</u>

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 7.0-14 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 (7.0.7). 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

Parker Dam. Water is pumped to canals for use in both California and Arizona from the dam's forebay.

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 CRIT 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.

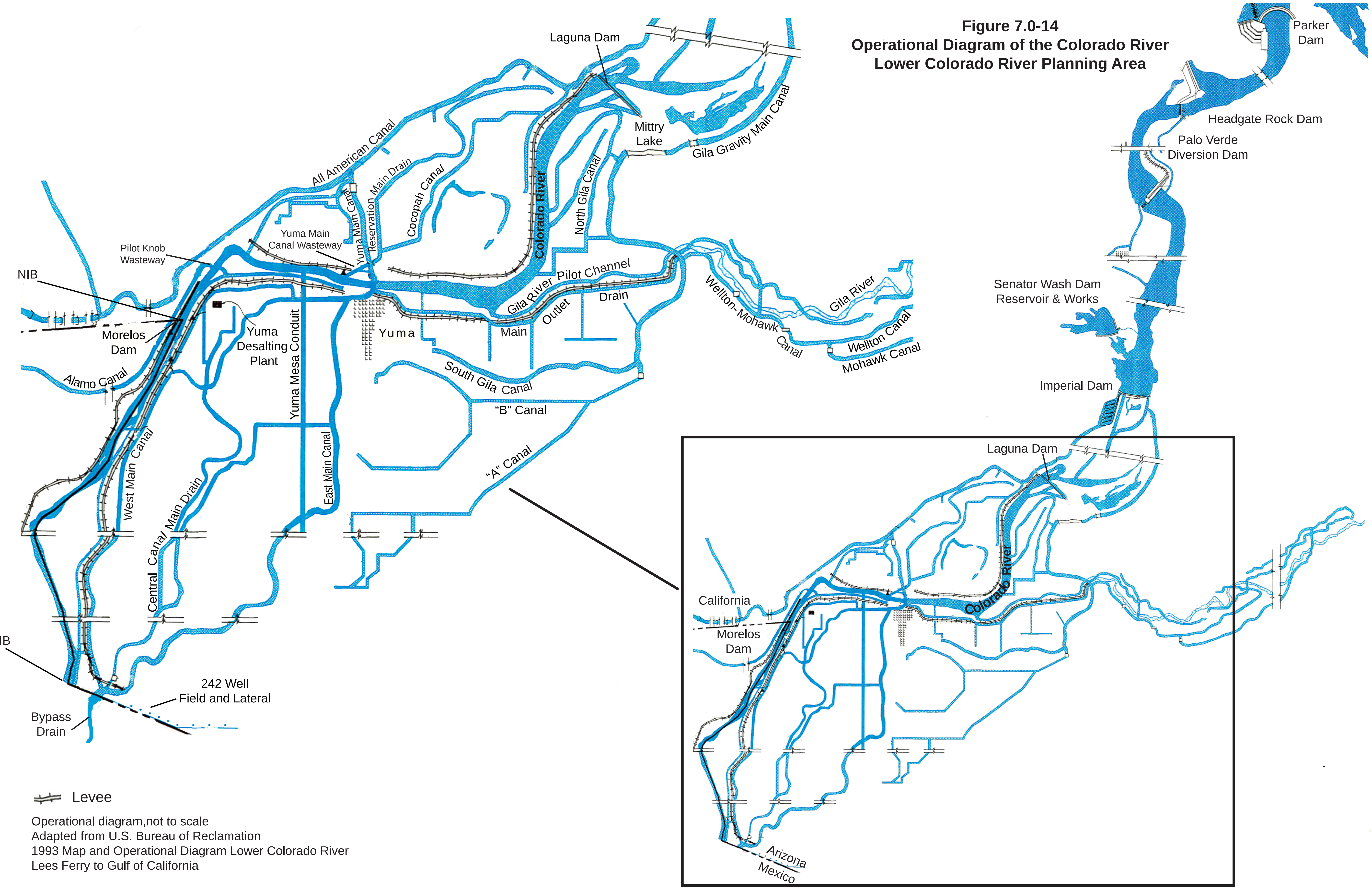
Palo Verde Diversion Dam

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 off-stream 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.

Figure 7.0-14
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

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 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.

Yuma Desalting Plant.

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 AFA.

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 AFA. It operated briefly in 1993 and was then put on standby status until a 90-day demonstration run in 2007. Currently, 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)

To desalinate the drainage water so that it could be returned to the mainstem and counted toward the apportionment, Reclamation constructed the Yuma Desalination Plant (YDP). Completed in 1992, the YDP is designed to treat up to 96,000 AFA. It operated briefly in 1993 and was then put on standby status until a 90-day demonstration run was conducted in 2007. Currently, Wellton-Mohawk Irrigation and Drainage District (WMIDD) drainage water is discharged to the Main Outlet Drain Extension and its bypass extension in Mexico and delivered to the Santa Clara Slough (Cienega de Santa Clara). (WMIDD, 2004) In May 2010, a year-long pilot run of the YDP at one-third capacity is scheduled to begin. The purpose of the pilot run is to assess the suitability of the treatment process and define its long-term design. The pilot run will include a monitoring program that evaluates impacts to the wildlife and habitat associated with the Cienega.

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. River flow is reduced in this section due to diversions by Mexico into the Alamo Canal and because the channel is overgrown with vegetation. In addition, sediment buildup around the spillway has caused loss of dam function. 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
Title I of the Colorado River Basin Salinity Control Act authorized the Protective and Regulatory Pumping Unit, consisting of the 242 well field and lateral. The unit is located east of San Luis in a 5-mile wide protected and regulated zone consisting of 35 wells, the 242 Lateral and other connecting laterals (Figure 7.0-21). 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 into 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 listed on 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-

Table 7.0-7 Storage facilities in the Harquahala Basin

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

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.

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 AFA). In typical years, most if not all water in this reach of the river is wastewater effluent (ADWR, 1994a). An average of 54,000 AFA of this water supply is used for irrigation in the basin.

Legal availability of a surface water supply is also an important consideration. The following discussion applies to non-Colorado River surface water. As described in detail in Appendix E, the legal framework and process under which surface water right applications and claims are administered and determined is complex. Rights to surface water are subject to the doctrine of prior appropriation which is based on the tenet "first in time, first in right". This means that the person who first put the water to a beneficial use acquires a right that is superior to all other surface water rights with a later priority date. Under the Public Water Code, beneficial use is the basis, measure and limit to the use of water. Each type of surface water right filing is assigned a unique number as explained in Appendix E and shown in Table 7.0-8. On the other hand, the act of filing a statement of claim of rights to use public waters (36) does not in itself create a water right. A Certificate of Water Right (CWR) may be issued if the terms of the permit to appropriate water (3R, 4A, or 33, and in certain cases 38), are met. CWRs retain the original permit application number.

Surface water rights may also be determined through judicial action in state or federal court in which the court process establishes or confirms the validity of the rights and claims and ranks them according to priority. Court decreed rights are considered the most certain surface water right. A court decree, Arizona v. California 373 U.S. 546 (1963), confirmed the apportionment of waters from the mainstem of the Colorado River to the Lower Basin States, set Arizona's allotment of Colorado River water at 2.8 maf and reserved irrigation water for reservations along the river including the CRIT, Cocopah and Quechan (Fort Yuma) reservations in the planning area.

Arizona has two general stream adjudications in progress to determine the nature, extent and priority of water rights across the entire river systems of the Gila River and the Little Colorado River. The adjudications will recognize existing water right settlements and decrees (see discussion below) and adjudicate all remaining water rights claims in the river systems. Pertinent to the Lower Colorado River Planning Area, the Gila River Adjudication is being conducted in the Superior Court of Arizona in Maricopa County. The Gila Adjudication was initiated by petitions filed by several parties in the 1970's, including Salt River Project, Phelps Dodge Corporation and the Buckeye Irrigation Company. The petitions were consolidated in 1981 into a single proceeding. The Gila Adjudication includes seven adjudication watersheds - Upper Salt, San Pedro, Agua Fria, Upper Gila, Lower Gila, Verde, and Upper Santa Cruz. Only the Lower Gila Adjudication Watershed is within the planning area boundaries (see Figure 7.0-15). This watershed includes all of the Gila Bend, McMullen Valley and Tiger Wash basins,

Table 7.0-8 Inventory of surface water right and adjudication filings in the Lower Colorado River Planning Area[1]

Basin	Type of Filing							Total
	BB[2]	3R[3]	4A[3]	33[3]	36[4]	38[5]	39[6]	
Butler Valley	0	0	4	0	15	8	0	**27**
Gila Bend	0	0	5	16	26	23	343	**413**
Harquahala	0	1	2	8	35	46	332	**424**
Lower Gila	0	1	11	25	104	57	845	**1,043**
McMullen Valley	0	23	11	18	78	136	484	**750**
Parker	0	0	9	6	37	5	0	**57**
Ranegras Plain	0	0	4	4	6	15	0	**29**
San Simon Wash	0	0	0	3	11	5	0	**19**
Tiger Wash	0	0	2	3	4	9	30	**48**
Western Mexican Drainage	0	0	0	1	1	0	0	**2**
Yuma	0	1	0	2	38	0	289	**330**
Total	**0**	**26**	**48**	**86**	**355**	**304**	**2,323**	**3,142**

Notes:

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

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

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

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

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

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

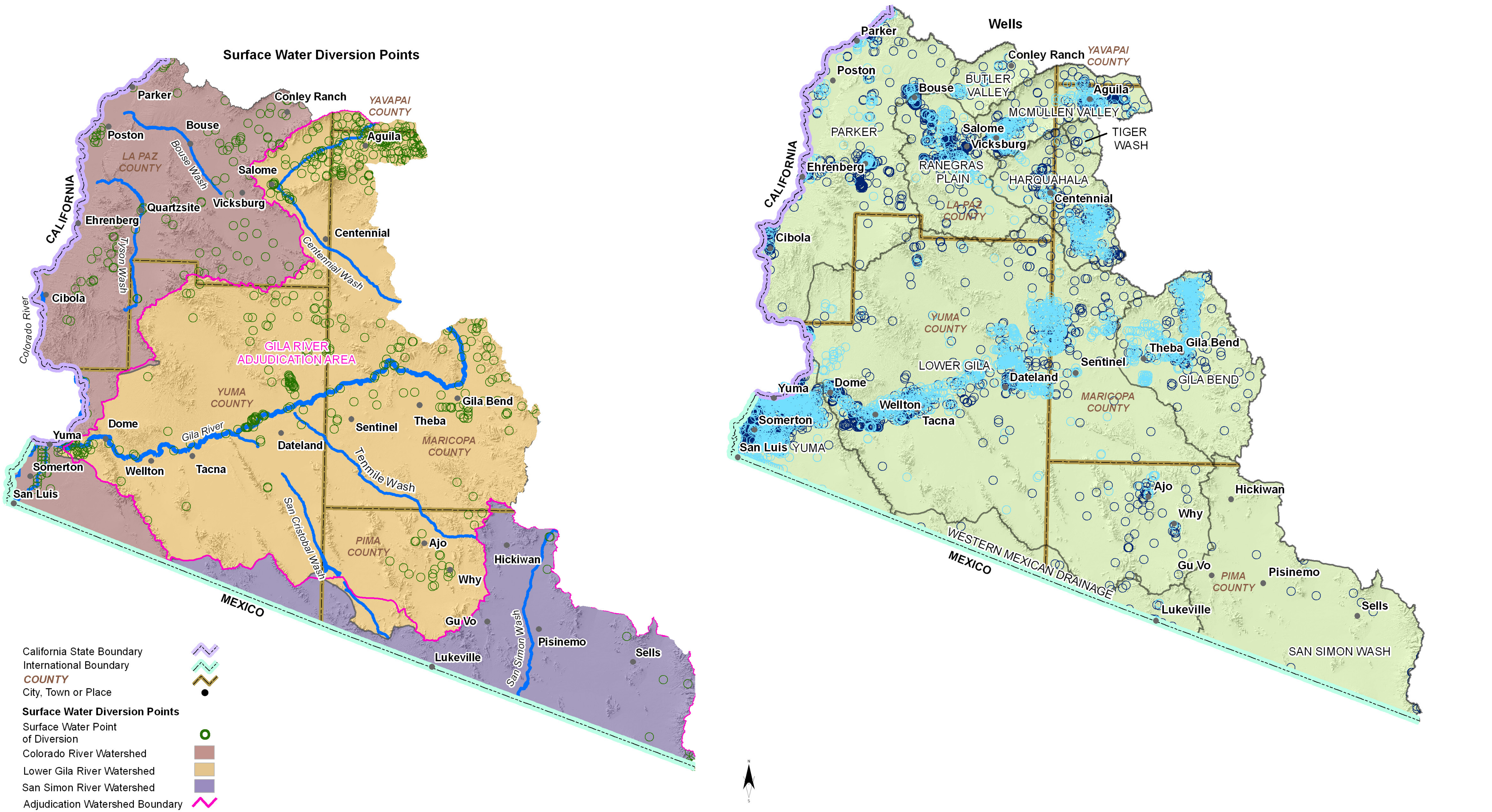


Figure 7.0-15
Lower Colorado River Planning Area
Registered Wells and Surface Water Diversion Points

most of the Lower Gila and Harquahala basins and a small part of the Yuma Basin. These watersheds do not coincide with the 6-digit HUC watersheds discussed previously and shown in Figure 7.0-5. The entire Gila Adjudication includes over 24,000 parties.

Table 7.0-8 summarizes the number of surface water right filings in the planning area. The methodology used to query the Department's surface water right and statement of claimant (SOC) registries is described in Appendix E. Of the 3,142 filings that specify surface water diversion points in the planning area, 108 CWRs have been issued to date. Most of these (46) are located in the McMullen Valley Basin. Figure 7.0-15 shows the general location of surface water diversion points listed in the Department's surface water rights registry. The numerous points reflect the large number of stockponds and reservoirs that have been constructed in the planning area as well as diversions from streams and springs. Locations of registered wells, many of which are referenced as the basis of claim in SOCs are also shown in Figure 7.0-15.

The location of surface water resources are shown on surface water condition maps and maps showing perennial and intermittent streams and major springs for each basin, and in basin tables that contain data on streamflow, flood ALERT equipment, reservoirs, stockponds and springs.

Groundwater

In basins without access to Colorado River or CAP water, groundwater is the primary water supply. Groundwater is an 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 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-'91 and 2003-'04. During this period, water levels declined by more than 30 feet in several wells in the northern part of the Gila Bend Basin, in wells near Salome-Wenden in the McMullen Valley Basin and in the central part of the Ranegras Plain Basin (see Figures 7.2-6, 7.5-5 and 7.7-5). There are widespread occurances of fluoride and arsenic levels in groundwater that equal or exceed drinking water standards and high salinity levels in many agricultural areas. As mentioned previously, importation of Colorado River water to areas in the Lower Gila and Yuma basins has locally raised groundwater levels and changed groundwater flow directions, requiring drainage wells and exportation of groundwater 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

McMullen Valley Basin. Groundwater an abundant and dependable water supply throughout the planning area with relatively large volumes of groundwater in storage and high well yields in many basins.

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 maf. If this water is used for an assured water supply demonstration in an AMA, only water withdrawn above 1,000 feet below land surface (bls) 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 bls nor at a rate that cause declines of more than an average of ten

Agriculture and power plant in the Harquahala Basin. in general the transportation of groundwater from non-AMA groundwater basins to AMAs is restricted. 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.

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. This application is currently still under review.

The Department's Groundwater Site Inventory (GWSI) database, the main repository for statewide groundwater well data, is available on the Department's website (www.azwater.gov). The GWSI database includes records for over 42,000 wells and over 210,000 ground-water level measurements statewide. GWSI contains spatial and geographical data, owner information, well construction and well log data, and historic groundwater data including water level, water quality, well lift and pumpage records. Included are hydrographs for statewide Index Wells and Automated Groundwater Monitoring Sites (Automated Wells), which can be searched and downloaded to access local information for planning, drought mitigation and other purposes. Approximately 1,700 wells have are designated as Index Wells statewide out of over 43,700 GWSI sites. (GWSI sites are primarily well sites but include other types of sites such as springs and drains). Typically, Index Wells are visited once each year by the Department's field staff to obtain a long-term record of ground water level fluctuations. Approximately 200 of the GWSI sites are designated as Automated Wells. These systems measure water levels 4 times daily and store the data electronically. Automated groundwater monitoring sites are established to better understand the water supply situation in areas of the state where data are lacking. These devices are 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.

Volume 1 of the Atlas shows the location of Index Wells and Automated Wells as of January 2009. At that time there were a total of 167 Index Wells and eight ADWR automatic water-level sites in the planning area located in the Butler Valley, Gila Bend, Harquahala, Lower Gila, McMullen Valley and Ranegras Plain basins. Index wells are located in all basins except for San Simon Wash, most of which is covered by the Tohono O'odham Indian Reservation. Updated well maps may be viewed at the Department's website.
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.

Automated well in the Harquahala Basin.

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 precise volume used is not quantified.

Approximately 16,300 acre-feet of wastewater is 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, LUST, DOD, Superfund, WQARF and VRP sites are found in the planning area. Table 7.0-9 lists the contaminant and affected media and the basin location of all but the LUST sites. The location of all contamination sites in the planning area is shown on Figure 7.0-16.

Seven active VRP sites are located in the planning area and all but one is in the Yuma Basin. All are 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).

Two WQARF sites and one Superfund site exist in the Yuma Basin. All sites involve Trichloroethylene (TCE) and 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 bls, has been affected. Water is being pumped and treated on site and injected back into the aquifer. (ADEQ, 2005a) The 20th Street and Factor WQARF Site is located in Yuma and also 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 DOD 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.

Table 7.0-9 Contamination sites in the Lower Colorado River Planning Area

SITE NAME	MEDIA AFFECTED AND CONTAMINANT	GROUNDWATER BASIN
Voluntary Remediation Program 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); BTEX; and PAHs	Yuma
Union Pacific Railroad Former AZ Agrochemical Facility	Soil/Pesticides	Yuma
Union Pacific Railroad Yuma Yard Dieselville	Soil & Groundwater/TPH and 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/ PCE and Tricholoroethene (TCE)	Yuma
National Priority List (NPL) Superfund Sites		
Yuma Marine Corps Air Station	Soil & Groundwater/TCE, Dichloroethene (DCE), 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

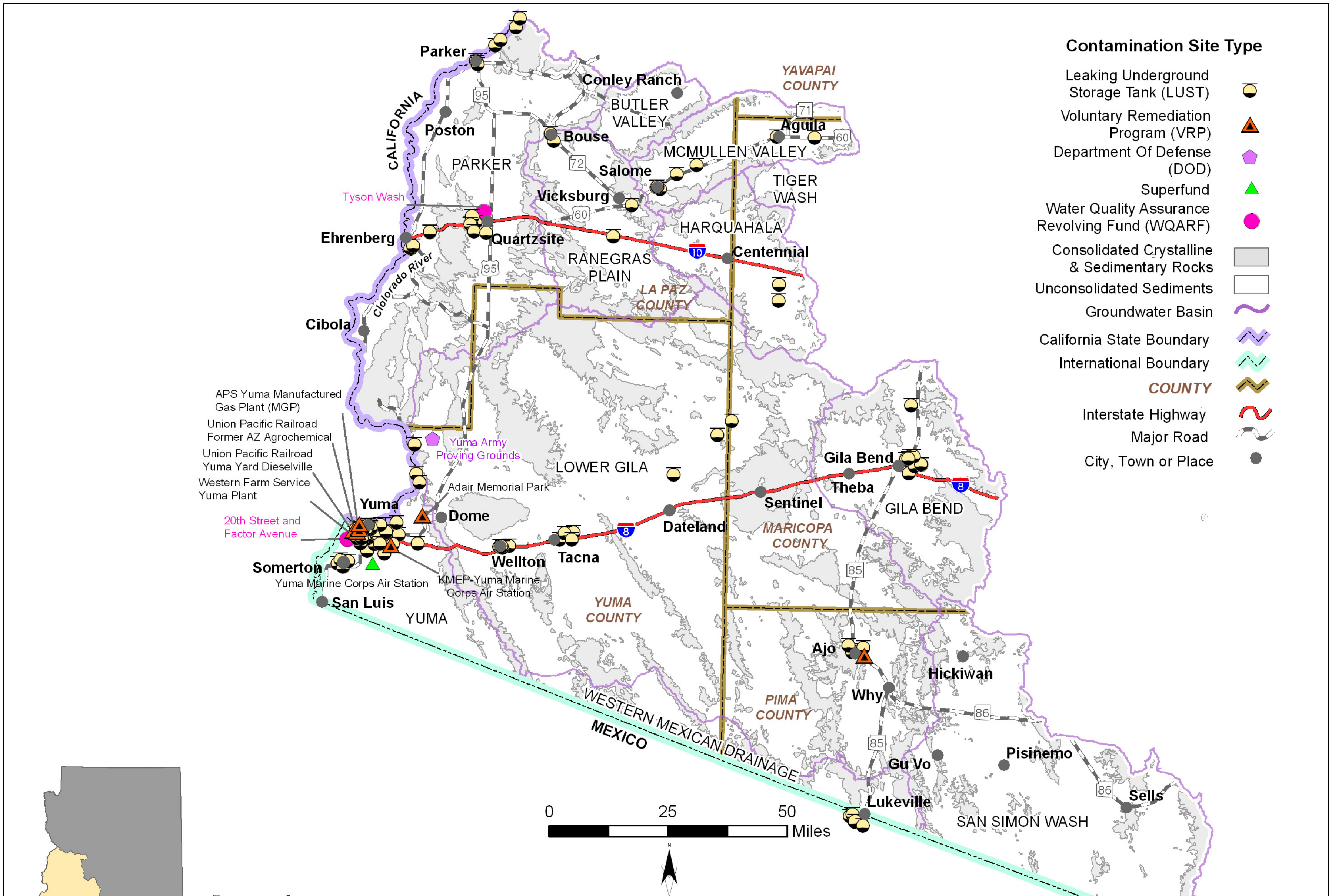


Figure 7.0-16
Lower Colorado River Planning Area
Contamination Sites

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 7.0-10. Total cultural water demand averaged approximately 2,899,700 AFA during the period from 2001-2005. Almost 98% of this demand is by the agricultural sector with approximately 2,835,100 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 66% of the agricultural demand is met by surface water of which all but 3% is Colorado River water. Municipal demand averaged 51,000 AFA during the period 2001-2005. 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, averaged 13,560 AFA during this period. Tribal water demand is included in these totals. As shown on Figure 7.0-17, cultural demand volumes vary substantially between planning area basins.

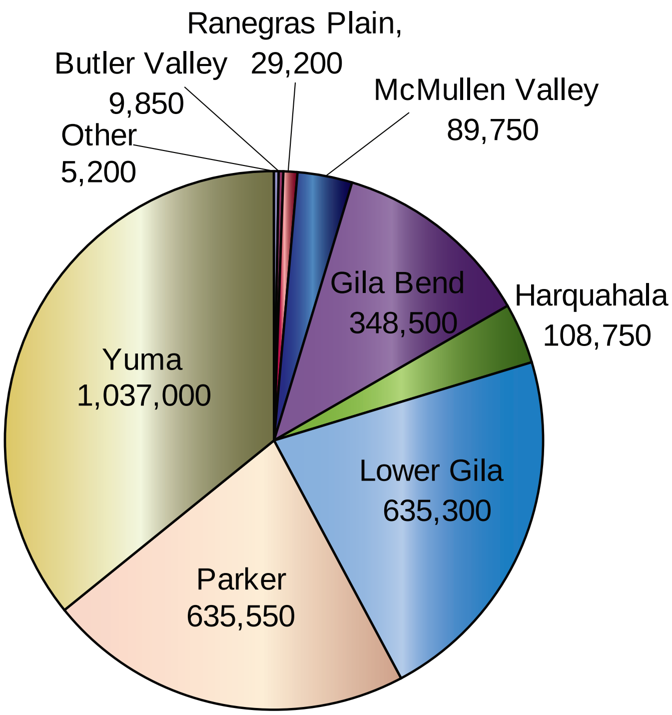
Tribal Water Demand

Tribal lands in the planning area include the Cocopah, CRIT, Fort Yuma-Quechan, Gila Bend and the Tohono O'odham reservations. The Cocopah, Fort Yuma-Quechan and CRIT hold Priority 1 Colorado River entitlements totaling 677,573 AFA. 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 AFA, 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.

Table 7.0-10 Lower Colorado River Planning Area average cultural water demand by sector (2001-2005)

Water Source/ Demand Sector	Acre-feet	Percent
Groundwater		
Agricultural	935,700	32.27%
Municipal	17,400	0.60%
Industrial	11,570	0.40%
Surface Water		
Agricultural	1,899,400	65.50%
Municipal	33,000	1.14%
Industrial	1,990	0.07%
Effluent		
Municipal	680	0.02%

Figure 7.0-17 Average Annual Basin Water Demand, 2001-2005 (in acre-feet)



<u>Cocopah</u>
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 AFA 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 about 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 consist of 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)

Gila Bend

The Gila Bend Reservation (San Lucy District) is part of the Tohono O'odham Nation but is located on 10,409 acres north of Gila Bend and divided by the Gila River. Completion of Painted

Rock Dam resulted in flood damage to district lands including destruction of a 750-acre farm and the necessary relocation of tribal members from Sil Murk Village to the 40-acre San Lucy Village just north of Gila Bend. Approximately 600 tribal members reside in the district (TON, 2007). The village includes residential dwellings, tribal offices and library. The Gila Bend Indian Reservation Lands Replacement Act (P.L. 99-503), enacted in 1986, authorizes the Tohono O'odham Nation to purchase up to 9,880 acres of private lands in Pima, Pinal or Maricopa counties to replace the reservation lands that were rendered unusable for economic development due to flooding. In 2003, the Nation acquired a 135-acre parcel in Glendale to construct a Casino in order to provide needed services to its members. (TON, 2009)

Municipal Demand

Municipal demand is summarized by groundwater basin and water supply in Table 7.0-11. Average annual demand during 2001-2005 was about 50,930 acre-feet. Sixty-five percent of this municipal demand was 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.

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 2006. These providers and their demand in 1992, 2000 and 2006 are shown in Table 7.0-12. In 2006, 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.

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

Table 7.0-11 Average annual municipal water demand in the Lower Colorado River Planning Area, 2001-2005 (in acre-feet)

Basin	Groundwater	Surface Water	Effluent	Total
Butler Valley	<300			150
Gila Bend	800			800
Harquahala	<300			0
Lower Gila	2,000	500		2,500
McMullen Valley	500			500
Parker	3,800	500	220	4,520
Ranegras Plain	400			400
San Simon Wash	1,000			1,000
Tiger Wash	<300			150
Western Mexican Drainage	<300			150
Yuma	8,300	32,000	460	40,760
Total Municipal	17,400	33,000	680	50,930

Sources: USGS 2007

Notes: Effluent figures are for golf course irrigation in 2006

Volume <300 acre-feet assumed to be 150 acre-feet for computation purposes than 1,000 are Gila Bend, Lower Gila, Parker and Yuma basins.

Yuma Area

The total municipal demand in the Yuma Basin averaged 40,760 AFA during 2001-2005. The largest providers, City of Yuma, Far West Water and Sewer, Inc., City of Somerton and City of San Luis provided about 31,850 acre-feet of Colorado River water and groundwater to customers in 2006. 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)

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 7.0-14). About 97% of the City's Colorado River 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 2006, City of Yuma water demand was about 20,400 acre-feet of which 4,240 was well pumpage and 16,180 was Colorado River water. About 60% of this demand is for residential

Table 7.0-12 Water providers serving 450 acre-feet or more of water per year in 2006, excluding effluent, in the Lower Colorado River Planning Area

Basin/Water Provider	1992 (acre-feet)	2000 (acre-feet)	2006 (acre-feet)
Gila Bend			
Town of Gila Bend	537	651	557[1]
Lower Gila			
Ajo Improvement Company[2]	541	660	543
Town of Wellton	NA	158	314
Parker			
Town of Parker	887	1,049	988
Yuma			
City of Somerton	827	1,012	1,403
City of San Luis	772	1,904	3,366
Far West Water and Sewer - Fortuna Foothills	2,994	5,222	6,660
Yuma Municipal Water Department[3]	21,680	32,906	20,421

Sources: USBOR 1992, USBOR 2000, USGS 2007, Community Water System Annual Reports 2006 and 2007

NA = Not Available

[1] Demand for 2006 not available, demand from 2007 shown.

[2] The Town of Ajo is served by three water providers. Ajo Improvement Company provides water to all three systems.

[3] Yuma Municipal Water Department demand in 1992 and 2000 are reported diversions of Colorado River water from the Bureau of Reclamation Article V Decree Accounting Reports.

Fortuna Foothills in the Yuma Basin. Rapid growth in the Fortuna Foothills area has resulted in construction of on-site septic systems and private package treatment plants.

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 2006, it served about 6,660 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 AFA of treated wastewater, in addition to groundwater, was 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 was 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 10,260 residents in 2006. In 2006, approximately 1,400 acre-feet was served to customers, of which 93% were residential customers. 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 37% between 2000 and 2006. In 2006, approximately 3,400 acre-feet was withdrawn from nine wells to serve almost 5,100 customer connections. Of the volume withdrawn, 1,079 acre-feet was delivered to residential customers and 948 acre-feet to non-residential customers of which 414 acre-feet was delivered to turf (City of San Luis, 2007). In 2007 the City reported only ten acre-feet delivered to turf.

<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 has grown 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 almost 1,000 acre-feet in 2006 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) In 2006 it delivered 470 acre-feet to residential customers, 285 to commercial customers and 89 acre-feet to turf.

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 2006 Brooke Water LLC-Lakeside diverted 163 acre-feet of Colorado River water and delivered 136 acre-feet to residential customers. Emerald Canyon Golf Course, located north of Cienega Springs, uses effluent from the Buckskin/Sandpiper WWTP to meet part of its irrigation demand.

Ajo

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. 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. These wells are at depths between 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 2006, Ajo Improvement Company served 543 acre-feet of groundwater to 3,000 residents (1,390 service connections) and to the two other water systems. Its customer demand was about 300 acre-feet, of which 184 acre-feet was residential and 120 acre-feet was 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 184 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.

Gila Bend

Located at a transportation hub, the Town of Gila Bend has a number of gas stations, mini-marts, hotels and restaurants in addition to residential housing The municipal water demand was 557 acre-feet in 2007 (2006 data were not available) served to 733 residential and 66 commercial connections. Groundwater was pumped from two wells with water levels at 300 feet bls. An emergency source of water is water trucked from Lewis Prison or Paloma Ranch (Town of Gila Bend, 2008). 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 AFA of effluent so water demand at the site is likely between 600 and 800 AFA. 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 2006 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 2006 the town received 314 acre-feet of surface water and served 214 acre-feet to residential customers and 97 acre-feet to commercial connections. New developments in the area, such as the master planned Coyote Wash, will increase municipal water demand. This planned community is anticipated to include 2,500 homes, a condominium complex and shopping center, and two 18-hole golf courses. By 2009, a 9-hole golf course had been completed and more than 500 lots sold. Another 18-hole course (Butterfield) is located at Wellton. (see Table 7.0-13)

Quartzsite

Although the water system for the Town of Quartzsite is not large, the community is rapidly growing with 3,650 residents in 2006. 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).

In 2007, Quartzsite withdrew 439 acre-feet of water from two wells and served 340 acre-feet to residential customers, primarily in the area

Town of Quartzsite in the Parker Basin.

north of Interstate 10. Water levels in wells were reported at 390 feet and 442 feet. Plans are underway to drill a production well on the south side of the Interstate (Town of Quartzite, 2008). Prior to 1989, private domestic wells were the only water supply and several hundred exist within the town limits (Town of Quartzsite, 2003). Quartzsite has a 4th Priority Colorado River entitlement of 1,070 acre-feet but no way to currently 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 (ADWR, 2004).

Municipal golf course demand is estimated to be approximately 11% of the total municipal demand in the planning area. Estimated demand and water supply for all golf courses in the planning area is shown in Table 7.0-13. There are eleven 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. Two other golf courses in the

Table 7.0-13 Golf courses in the Lower Colorado River Planning Area (c. 2008)

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
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			*5,365*	
Dove Valley Golf Course*	Yuma	18	441	Groundwater
Yuma Golf & Country Club*	Yuma	18	441	Groundwater/Surface Water
Total Water Use Industrial Golf Courses			*882*	
Total Water Use			**6,247**	

Source: ADWR 2008b
Notes:
* Golf course 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.

Yuma Basin are believed to have facility wells that serve the course and are considered industrial golf courses and discussed below.

Agricultural Demand

The planning area contains one of the largest agricultural areas in Arizona. 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, barley, corn for grain, and alfalfa. Other crops include onions, honeydew, cantaloupe and watermelon. Annual agricultural sales are reported to total over $92 million in this county. (AZDA, 2005)

There are 12 irrigation districts in the planning area. Their general location is shown in Figure 7.0-18 and described below.

Irrigation water supply is primarily water diverted from the Colorado River. As shown in Table 7.0-14 and Figure 7.0-19, for the period 2001-2005, an average of about 1,775,800 AFA was diverted from the Colorado River for use in the Parker, Lower Gila and Yuma Basins. An additional 69,600 acre-feet was diverted via the Central Arizona Project for use in the Harquahala Basin. Gila River water and effluent averaging 54,000 AFA was used in the Gila Bend Basin. During this period an average of 935,700 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 7.0-20, agricultural demand has steadily increased over time in most of these basins. Agricultural demand in each basin is described below. Included are findings from a USGS agricultural field survey conducted of the Butler Valley, Gila Bend, Harquahala, Lower Gila, McMullen Valley and Ranegras Plain basins in the summer of 2007, which are summarized in Table 7.0-15.

Figure 7.0-18 Irrigation districts in the Lower Colorado River Planning Area

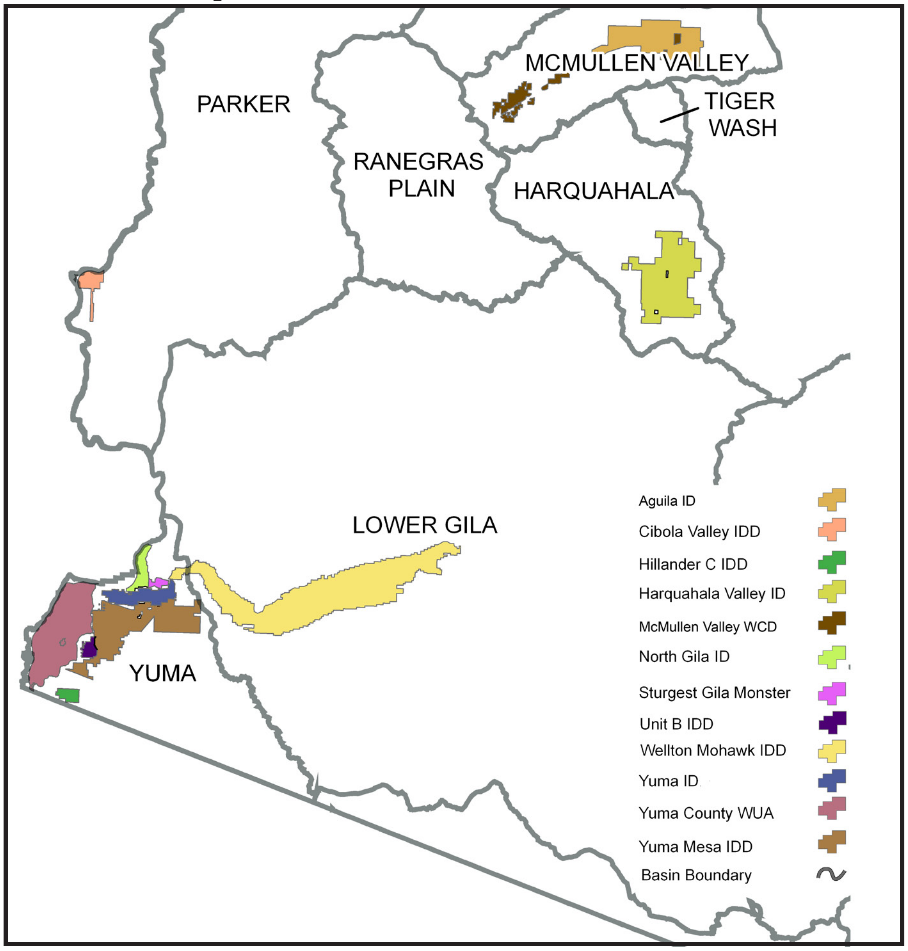


Table 7.0-14 Agricultural water demand in the Lower Colorado River Planning Area

	1991-1995 (acre-feet)	1996-2000 (acre-feet)	2001-2005 (acre-feet)
Butler Valley			
Groundwater	3,400	8,300	9,700
Total	3,400	8,300	9,700
Gila Bend			
Groundwater	237,000	244,000	289,000
Surface Water[2]	71,500	68,500	54,000
Total	308,500	312,500	343,000
Harquahala			
Groundwater	9,500	23,500	36,500
Surface Water[3]	47,500	85,000	69,600
Total	57,000	108,500	106,100
Lower Gila Basin			
Groundwater	254,000	261,100	246,000
Surface Water	365,000	391,000	383,200
Total	619,000	652,100	629,200
McMullen Valley			
Groundwater	77,000	79,500	89,100
Total	77,000	79,500	89,100
Parker			
Groundwater	1,300	<1,000	<1,000
Surface Water	662,000	667,000	630,600
Total	663,300	667,500	631,100
Ranegras Plain			
Groundwater	29,500	32,000	28,800
Total	29,500	32,000	28,800
San Simon Wash			
Groundwater	4,000	3,800	3,900
Total	4,000	3,800	3,900
Yuma			
Groundwater	206,000	218,000	232,200
Surface Water	711,000	771,000	762,000
Total	917,000	989,000	994,200
Total All Basins	2,678,700	2,853,200	2,835,100

Source: USGS 2007

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

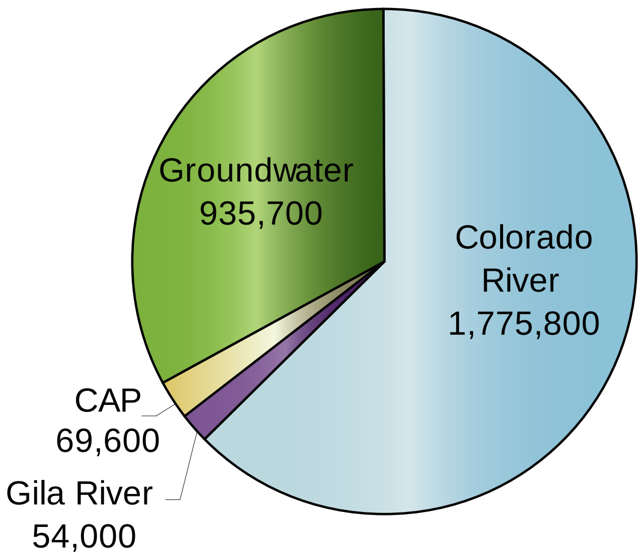
Butler Valley Basin

Agricultural demand in the Butler Valley Basin averaged 9,700 AFA during 2001-2005. Demand has more than doubled compared to the 1971-1990 time period (Table 7.1-5). Agricultural lands are located in a contiguous area in the southwest part of the basin and groundwater is the only water supply. In 2007 the USGS found 1,352 acres of irrigated alfalfa/hay, all center pivot irrigated. (USGS, 2009)

Gila Bend Basin

Irrigation in the Gila Bend Basin is located primarily along the Gila River valley and south

Figure 7.0-19 Irrigation Water Supply for the Lower Colorado River Planning Area, 2001-2005 (acre-feet)



of the Gila River in the western part of the basin. Agricultural demand averaged 343,000 AFA during 2001-2005, of which 289,000 acre-feet was groundwater and 54,000 acre-feet was a mixture of Gila River surface water, agricultural drainage and effluent discharged upstream in the Phoenix AMA. Gila Bend Basin agricultural demand was 12% of the total planning area agricultural demand. Agricultural demand has increased steadily from an annual average of 308,500 acre-feet during the 1991-1995 time period (see Table 7.2-8).

Surface water/effluent supplies are used in the northern part of the basin where they are diverted at Gillespie Dam through the Gila Bend Canal and Enterprise Canal. Prior to 1993, when Gillespie Dam was breached during a flood, more surface water was diverted. 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. As shown on Table 7.2-8, the proportion of groundwater used has increased since the 1990s. Investigations by the USGS found about 43,400 acres under irrigation and all acreage was flood irrigated. (Table 7.0-15) The predominant cropped acreage at that time was alfalfa/hay (76%), followed by sorghum (8%), wheat (7%) and smaller amounts of cotton, corn, jojoba, grasses and nursery plants. (USGS, 2009)

Harquahala Basin

The number of irrigation acres in the Harquahala Basin is limited due to the basin's designation

Figure 7.0-20 Agricultural Demand in Selected Basins in the Lower Colorado River Planning Area 1991-2005 (in acre-feet)

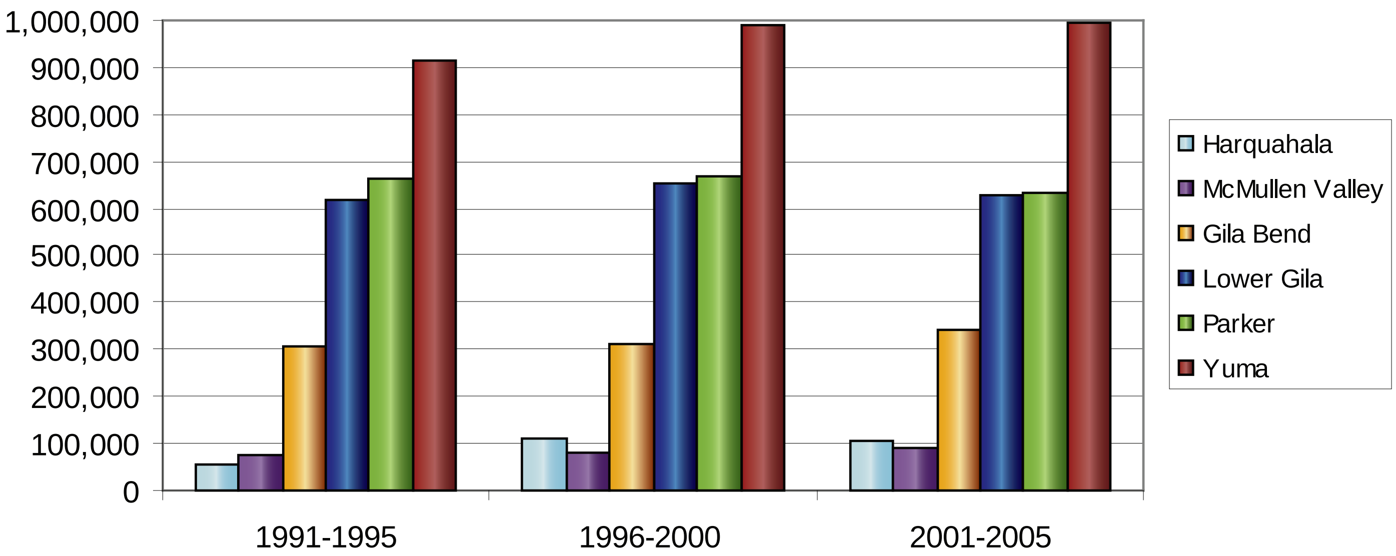


Table 7.0-15 Agricultural acreage, crop type and irrigation type in selected basins in 2007

Basin	Butler Valley	Gila Bend	Harquahala	Lower Gila		McMullen Valley	Ranegras Plain
				Wellton-Mohawk	Other		
2007 Irrigated Acreage	*1,352*	*43,434*	*25,951*	*85,876*	*17,132*	*14,668*	*6,878*
Crop Type							
Alfalfa/Hay	100%	76%	33%	29%	39%	2%	8%
Barley				<1%			17%
Corn		1%	5%	<1%	5%	<1%	26%
Cotton		4%	25%	11%	8%	19%	19%
Grasses		<1%	2%	6%	2%		
Jojoba		1%			13%		17%
Melons			13%	3%	5%	60%	
Sorghum		8%	4%	<1%	6%	8%	5%
Vegetables				32%	9%	3%	
Wheat		7%	14%	16%			
Other		2%	4%	<1%	13%	7%	8%
Irrigation Type							
Center Pivot	100%				13%		
Drip			13%		13%	20%	99%
Flood		100%	86%	NA	15%	79%	
Furrow						1%	
Sprinkler					17%		<1%
Unknown			1%		42%		

Source: USGS 2009
NA - Not Available

as an irrigation non-expansion area, or INA. In an INA farmers must report annual agricultural water pumpage to the Department. Demand averaged 106,100 AFA, during 2001-2005, representing 4% of the agricultural demand in the planning area (Table 7.3-7). Non-contract CAP water began to be used in 1984 by the Harquahala Valley Irrigation District (HVID), replacing groundwater pumpage as the primary water supply in the basin. Under the Department's Recharge Program, HVID is a permitted groundwater savings facility. (See Section 7.0.6, Central Arizona Project)

HVID lands are the most extensive in the basin, covering a large area in the southeast portion. 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. The USGS found 25,951 acres under irrigation in the basin in 2007. At that time, about 33% of the cropped acreage was alfalfa/hay, 25% cotton, 14% wheat,13% melons and lesser amounts of corn, sorghum, grasses, oats and nursery trees. About 86% of the lands were found to be flood irrigated and 13% were drip irrigated. (Table 7.0-15) (USGS, 2009)

<u>Lower Gila Basin</u>

The Lower Gila Basin contained 22% of the agricultural demand in the planning area during the 2001-2005 time period. Demand within the basin averaged between 619,000 acre-feet during 1991-1995 to a high of 652,000 acre-feet from 1996-2000. Demand declined during 2001-2005 to an average of 629,000 AFA. Colorado River water (surface water) comprises about 60% of the water supply (Table 7.4-8).

The principal farming area is the Wellton-Mohawk Irrigation and Drainage District (WMIDD), whose location generally follows the Gila River Valley west of Dateland and extends into the Yuma Basin (see Figure 7.0-18). 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.

Crop type and estimated irrigated acres in the WMIDD during 2007 are shown in Table 7.0-15. Principal crops grown were vegetables, alfalfa/hay, wheat, cotton, grasses (bermuda) and melon. A significant amount of double cropping occurs in the district (WMIDD, 2004). The irrigation method for each crop type was not available but flood irrigation is the primary irrigation method for most crops, with a few center pivots. Vegetables are irrigated with a combination of sprinkler (for seed germination) and flooding and melons are most likely irrigated with drip irrigation (personal communication, S. Tadayon, 2009).

The USGS field investigation of non-district lands in the summer of 2007 found much less land being irrigated north of Hyder than suggested by Figure 7.4-10. The USGS found 17,132 irrigated acres on non-district lands. Principal cropped acreage observed was alfalfa/hay (39%), jojoba (13%), vegetables (9%), cotton (8%) and sorghum (6%). Citrus comprised 5% of the "other category" with lesser amounts of date/palm trees and oats. Irrigation methods vary in this area with 15% of the acreage flood irrigated, 17% sprinkler, 13% drip and 13% center pivot (primarily north of Dateland). The irrigation method was unknown on 42% of the acreage. (Table 7.0-15) (USGS, 2009)

Agriculture in the Wellton-Mohawk Irrigation District.

Reclamation's Gila Project delivers Colorado River water to two divisions in the planning area - 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 Gila 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 Gravity Main 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) (See Figure 7.0-14). 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 AFA, but diversions are significantly higher. Diversions to the District averaged 408,258 AFA during the 2001-2005 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.

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 increase 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 but 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.

Agricultural demand in the basin has been increasing with an annual average of 89,100 acre-feet of demand during the 2001-2005 time period. (Figure 7.5-7) The USGS field investigation in 2007 found approximately 14,700 acres under irrigation with 79% flood irrigated and 20% drip irrigated. Cropped acres at the time of the investigation included melons (60%), cotton (19%) and sorghum (8%). Other crops observed were vegetables (chilis), oats, alfalfa/hay, corn, guayule, pistachio, palm and oats (Table 7.0-15). (USGS, 2009)

McMullen Valley is one of the few groundwater basins in the state designated for out of basin

Agriculture near Salome, McMullen Valley Basin. Agricultural demand in the basin has been increasing with an annual average of 89,100 acre-feet of demand during the 2001-2005 time period.

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 represented 22% of the agricultural demand in the planning area in 2001-2005. The annual average Colorado River demand for the basin during that period was 630,600 acre-feet. A relatively small amount of groundwater, less than 1,000 acre feet, was reportedly pumped for agricultural irrigation (Table 7.6-8).

Irrigation occurs primarily on the CRIT Reservation and also within the Cibola Valley Irrigation and Drainage District (CVIDD). As mentioned 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 (CRIT, 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 have been 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. The USGS did not visit agricultural lands in the Parker Basin in 2007.

Ranegras Plain Basin

Agricultural demand in the Ranegras Plain Basin averaged 28,800 acre-feet during 2001-2005, all met with groundwater pumping. Agricultural demand has been relatively stable since 1991 (Table 7.7-5). In 2007, the USGS found about 6,900 irrigated acres 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 (26%), cotton (19%), barley (17%), jojoba (17%) and smaller acreages of alfalfa/hay, guayule and sorghum. Their investigations found 99% of the irrigation was by drip systems and 1% by sprinkler (Table 7.0-15). (USGS, 2009)

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. Average annual demand was estimated to be 3,900 acre-feet of groundwater during 2001-2005. Historic withdrawals were higher, up to 11,300 AFA during the late 1970s (Table 7.8-7). After 1980, the principal crop was alfalfa, irrigated year round (Hollett, 1985). It is not known how many acres 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 994,200 acre-feet during the 2001-2005 time period. Of this total demand, 762,000 acre-feet was water diverted from the Colorado River and 232,200 acre-feet was water pumped from wells. Annual demand has increased by over 77,000 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 (Table 7.0-16). The location of canals and associated irrigation districts is shown on

Figures 7.0-14, 7.0-18 and 7.0-21. 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 2007f)

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 (YCWUA). 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 7.0-14).

Irrigation Districts
A total of eight irrigation districts operate in the basin (see Figure 7.0-18). 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 7.0-14 and 7.0-21.

The three Gila Project/Yuma Mesa Division irrigation districts have a shared 3rd priority entitlement of 250,000 AFA 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 C).

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 7.0-21). Water is conveyed to

Table 7.0-16 Bureau of Reclamation project areas in the Yuma Basin

YUMA PROJECT (AZ) (Imperial Dam Diversion)		**GILA PROJECT (Imperial Dam)**			
Valley Division (Yuma Main Canal)	**Yuma Auxilary Division (Gila Project Canals)**	**Wellton-Mohawk Division (Wellton-Mohawk Canal)**	**Yuma Mesa Division (Gila Gravity Main Canal)**		
↓	↓	↓	↓	↓	↓
YCWUA	**Unit “B” I.D.**	**Wellton-Mohawk I.D.**	**Mesa Unit**	**North Gila Valley Unit**	**South Gila Valley Unit**
			↓	↓	↓
			Yuma Mesa ID	**North Gila ID**	**Yuma ID**

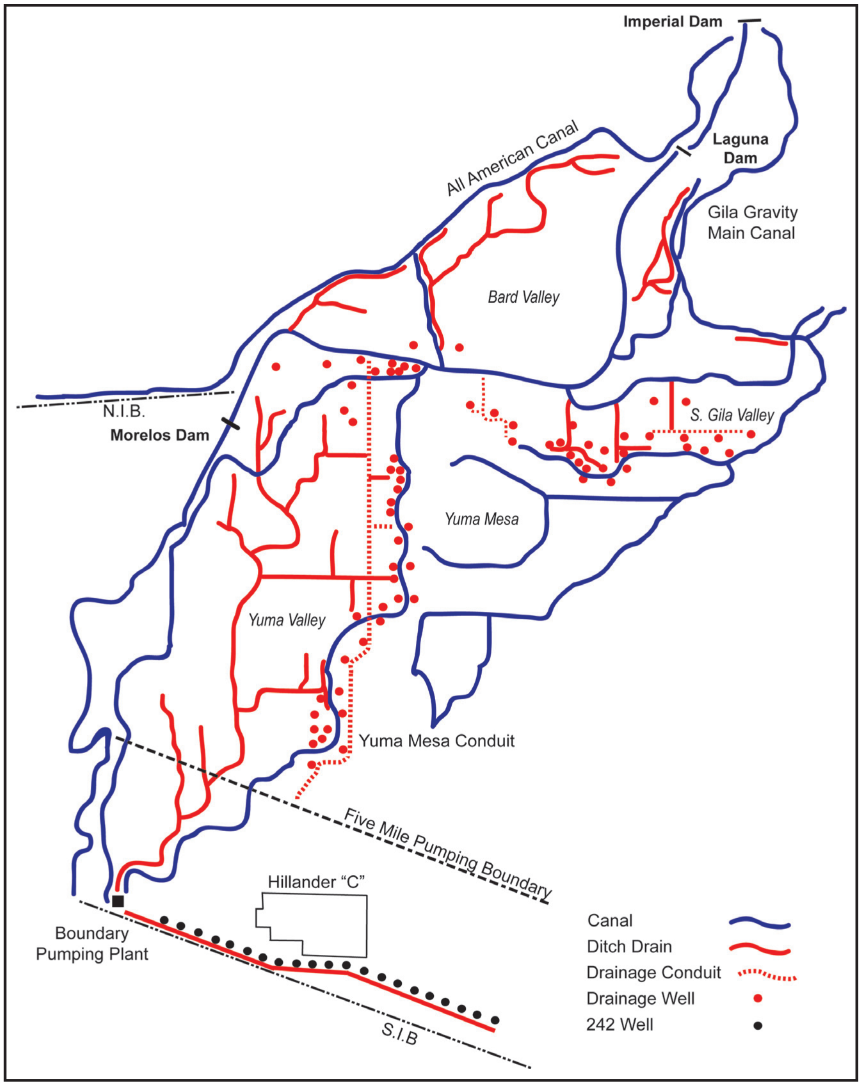
the Gila River Pilot Channel and the Colorado River to become part of the Treaty water delivered to Mexico. (USBOR, 2007g)

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.

YCWUA 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 in 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. In 2003, YCWUA 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 7.0-21). 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).

Figure 7.0-21 Yuma area drainage fields and conduit systems



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 AFA and 3rd, 4th, 5th and 6th priority rights for a total entitlement of 9,156 acre-feet (see Appendix C). Water is delivered through the Gila Gravity Main Canal. In 2006, the total irrigated area covered 2,090 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 AFA 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

Industrial demand in the Lower Colorado River planning area averaged 13,560 AFA during the 2001-2005 time period, about 0.5% of the total demand. As shown in Table 7.0-17, most demand is associated with power plants, although dairy and feedlot demand is growing, particularly in the Lower Gila Basin.

Mining activity in the Yuma Basin is associated with sand and gravel operations including the large-scale Cemex Highway 95 facility and BLT Company facility in the northern part of the basin. 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 if copper prices increase enough. There are several small gold mines in the planning area including the Yuma King, 30 miles east of Parker. Two "industrial" golf courses are located in the Yuma Basin: Yuma Golf and Country Club and Dove Valley Golf Course. Industrial facilities are those with their own well or water supply and not served from a municipal water provider.

Table 7.0-17 shows "other" industrial uses in the Yuma area that use Colorado River water (surface water). These other uses include the

Table 7.0-17 Industrial water demand in the Lower Colorado River Planning Area

	1991-1995	1996-2000	2001-2005
Type	**Water Use (acre-feet)**		
Power Plant Total	**285**	**700**	**7,670**
Gila Bend			
Groundwater	0	0	4,600
Harquahala			
Groundwater	0	0	2,500
Yuma			
Surface Water	285	700	570
Golf Course Total	**440**	**440**	**440**
Yuma			
Groundwater	220	220	220
Surface Water	220	220	220
Dairy/Feedlot Total	**3,400**	**3,500**	**3,700**
Gila Bend			
Groundwater	0	0	100
Lower Gila			
Groundwater	3,400	3,500	3,600
Mining Total	**350**	**380**	**550**
McMullen Valley			
Groundwater	<300	<300	<300
Parker			
Groundwater	0	0	<300
Yuma			
Groundwater	200	230	250
Other Total	**2,600**	**2,900**	**1,200**
Yuma			
Surface Water	2,600	2,900	1,200
Total	**7,075**	**7,920**	**13,560**

Source: ADEQ 2005b, ADWR 2008b, USGS,2007
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

Yuma Desalting Plant, cemetery irrigation and produce packing companies. There are other industrial demands in the planning area not reflected in the table, 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 at sand and gravel facilities. 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 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 4,400 acre-feet of groundwater in 2005.

The Harquahala Generating Project is a 1,000 megawatt natural gas 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 750 acre-feet of groundwater and CAP water in 2005.

Arizona Public Service (APS) operates the natural gas Yucca Power Plant near Yuma. There are four combustion turbine units that

Panda Gila River Power Station, Gila Bend Basin.

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 5th priority entitlement, used about 350 acre-feet of Colorado River water in 2005.

<u>Dairy/Feedlot</u>
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 2005 was approximately 170 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 2005 demand of 152 acre-feet and 94 acre-feet respectively. These dairies house a combined total of 1,900 animals. There are also two

Painted Rock Dairy, Lower Gila Basin.

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 2005.

A biorefinery was planned to open in 2008 near Vicksburg in the Ranegras Plain Basin. Plans included a 7,500-cow dairy, a corn fractionation mill, a biodiesel plant and a waste-to-energy conversion plant. While the facility has been substantially constructed, the project has been delayed with a focus on development of algae biomass as an alternative to corn and grains for biofuels. (AZFB, 2008) As of October 2009, the facility had not commenced operation.

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 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 that is equitable for all users, salinity control and water quality, entitlement transfers, and the development of accounting surface rules. Information on the "Law of the River" and more detailed discussion of some of the issues described below are found in Appendix D.

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. In the 1960s, salinity associated with irrigation return flows from the Wellton-Mohawk Irrigation and Drainage District (WMIDD) to the Colorado River coupled with reduced flows in the river system developed into a major international issue. To address this issue, Minute 242 to the Treaty was negotiated. This Minute requires that the Treaty water delivered to Mexico will be of nearly the same quality as that which is diverted at Imperial Dam and delivered to U.S. water users. To comply with this requirement, the U.S. implemented a number of measures including re-routing drain water from the WMIDD to the Cienega de Santa Clara in Mexico. The U.S. also built a $250 million dollar desalination plant in Yuma to treat WMIDD drain water, so that it could be returned to the mainstream for delivery to Mexico. The facility was completed in 1992, operated briefly in 1993 and then placed in standby status.

Imperial Dam and Colorado River, Lower Gila Basin.

A consequence of continuing to annually bypass the approximately 100,000 acre-feet of saline irrigation return flow to the Cienega de Santa Clara was the reestablishment of a rich, ecologically important wetland in the Mexican Delta. Currently, there is significant interest on both sides of the border to continue to maintain the area in its present condition. However, bypassing this water to Mexico each year without crediting it against the U.S. Treaty obligation requires the U.S. to release an equal amount of water from storage in Lake Mead. As a result, the risk of shortage is increased, particularly to the Central Arizona Project and other equal priority water users in Arizona. After more than a decade of drought, the potential for shortage has been further amplified.

Reactivation of the Yuma Desalination Plant to treat and discharge this water to the Colorado River to meet U.S. Treaty obligations with Mexico, would impact the Cienega. In recognition of this concern, the Yuma Desalination Plant/Cienega de Santa Clara Workgroup was formed in 2004 to identify and discuss potential solutions that would preserve the Cienega and make the treated bypass flows available for use under the Treaty. Workgroup recommendations were released in April, 2005.

In 2007, Reclamation conducted a pilot run of the Yuma Desalting Plant by operating it at about ten percent capacity for three months. The purposes of the run were to test new equipment, acquire current operational data, and identify design deficiencies to better determine whether the facility could reliably and efficiently be operated on a long-term basis. Results from this study were favorable. However, it was determined that to obtain more conclusive information, the plant needed to be operated at a scale and for a duration which covers seasonal variations associated with chemical use and power consumption. As a result, Reclamation will conduct a second pilot run of the facility. During this pilot run, which is scheduled to be initiated in May 2010, the plant will operate at up to one-third capacity for 365 operating days during a 12- to 18-month period. Components of the project will include a commitment to offset the reduced bypass flows with up to 30,000 acre-feet of Colorado River water and an extensive monitoring program for the Cienega.

Shortage Sharing

As mentioned in Section 7.0.6, Reclamation issued a Record of Decision (ROD) in December, 2007 on interim operating criteria (2008-2026). The elements of the ROD, which include 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 surface water level elevations. In Arizona, hydrologic modeling indicates that shortage reductions will impact 4th, 5th and 6th priority water users, including on-river municipal, industrial and agricultural contractors and to the Central Arizona Project excess pool. During a shortage, the available water supply is sufficient to meet all higher priority water users.

Currently, Arizona and the other Colorado River Basin States, Reclamation and federal and state water organizations in Mexico have been engaging in discussions regarding the development of cooperative, innovative and holistic measures that will ensure that the Colorado River will continue to be able to meet environmental, agricultural and urban water demands in both countries. To further this effort, the U.S., Mexico and the Basin States are working to develop a policy framework.

Salinity and Other Water Quality Issues

Increased salinity levels in the Colorado River affect agricultural, municipal and industrial uses. Damages in the U.S. are estimated at $330 million per year, and while economic damage in Mexico is not quantified, it also poses 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 and 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.

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 from the City of Scottsdale to transport groundwater from the Harquahala Basin. As competition for water supplies in AMAs increases, it is likely that additional applications will be filed. Under the transportation statutes the rate of groundwater decline and pumping depth are regulated in the McMullen Valley and Harquahala basins, but 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

As mentioned in section 7.0-5, all community water systems in Arizona are required to submit a water system plan as part of the State's Drought Preparedness Plan. The system water plan includes a water supply plan, water conservation plan, and drought preparedness

Big Horn Mountains, Harquahala Basin.

plan. Water providers are required to develop the plan to ensure they reduce their vulnerability to drought and prepare to respond to potential water shortage conditions.

Local Drought Impact Groups (LDIGs) are county-level voluntary groups created to 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 Statewide Drought Program. To date, LDIG groups have not been formed in La Paz or Yuma counties. 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 all numerically ranked a list of 18 issues. Issues that ranked consistently high by the most respondents are shown in Table 7.0-18. As shown, most respondents were concerned about the need for infrastructure replacement 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 almost all ranked a list of seven issues. Respondents were from the Gila Bend, Harquahala, Lower Gila, McMullen Valley, Parker and Yuma basins.

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 30 respondents that ranked issues. As shown in Table 7.0-18, infrastructure concerns ranked as important concerns, similar to the 2003 survey. This was especially of concern to providers in the Lower Gila Basin. Water quality issues were not included in the issues list but a separate question asked the respondent to indicate contaminant concerns. Of the 31 respondents, 6 indicated concerns about arsenic and one indicated a concern about proximity to a source of contamination. Unlike results from the 2003 survey, this group of respondents was

Table 7.0-17 Water resource issues ranked by survey respondents in the Lower Colorado River Planning Area

Issue	Percent of 2003 respondents that ranked issue as one of the top 5 (of 18)	Percent of 2004 respondents reporting issue was a moderate or major concern
Inadequate storage capacity to meet peak demand	NR	26%
Inadequate well capacity to meet peak demand	NR	10
Inadequate water supplies to meet current demand	NR	6
Inadequate water supplies to meet future demand	NR	23
Infrastructure in need of replacement	65%	45
Inadequate capital to pay for infrastructure improvements	35	58
Drought related water supply problems	NR	6
Ability to meet arsenic standard	35	NA
Concern about proximity of wells to sources of contamination	29	NA

Source: ADWR, 2004; ADWR, 2005

Note: 2003 respondents consisted of 15 water providers and 2 jurisdictions. 2004 respondents included 30 water providers

NR=not reported as a top 5 issue

NA= respondents were not asked to rank the issue

comprised of more large water providers and expressed concern about storage capacity and supplies to meet future demand.

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.

<u>Geographic Features</u>

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.

<u>Land Ownership</u>

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.

Surface water maps display runoff contours and the location of reservoirs and gages. Also shown are 1st and 2nd order streams, and 3rd order streams with gages. The stream order used is the Cartographic order, similar to 'stream level' used by the USGS to categorize streams in its National Hydrography Dataset (NHD). This method assigns Level 1 to the principal stream in a drainage area, major tributaries are assigned Level 2, minor tributaries are assigned Level 3, etc.

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 Section 7.0-5).

Developers of large, master-planned communities outside of AMAs may apply for an Analysis of Adequate Water Supply (AAWS). This type of application is generally used to prove that water will be physically available for the master-planned community. AAWS are issued based on the development plan or plat. If an AAWS is issued for groundwater, it reserves a specific volume of water for 10 years (for purposes of further adequacy reviews) only for the specific property that is the subject of the AAWS.

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