Basin & Range AMAs Planning Area

Background

The Basin and Range AMAs Planning Area is contiguously located in the central and south central part of the State and is comprised of the Phoenix AMA, Pinal AMA, Tucson AMA, Santa Cruz AMA, Cienega Creek, and San Rafael Groundwater Basins. The Planning Area contains portions of Yavapai, Maricopa, Pinal, Pima, Santa Cruz, and Cochise counties. The Planning Area contains the State's largest population centers, including the greater Phoenix metropolitan area, the greater Tucson metropolitan area, as well as Casa Grande, Patagonia, and Nogales. At the time of the 2010 census, 81 percent of the State's 6.3 million residents lived in the Planning Area. There are six Indian reservations within the Planning Area including the Tohono O'odham, Pascua Yaqui, Ak-Chin, Gila River, Fort McDowell Yavapai, and the Salt River Pima-Maricopa.

Land ownership in the Planning Area varies by Basin, however, the Planning Area includes the largest contiguous areas of private lands in the State (*see Figure P.A. 3-1*). The Basin and Range AMA Planning Area is also comprised of significant acres of State Trust Lands primarily for agricultural production, livestock grazing, and recreation. Federal land ownership is dominated by the six Indian Reservations and USDA Forest Service (Forest Service) lands, including portions of the Tonto and Coronado National Forests. Two US Air Force bases are within the Planning Area: Luke and Davis-Monthan Air Force bases, located within the Phoenix and Tucson AMA basins, respectively. A portion of the Barry M. Goldwater Air Force Range is located in the Pinal AMA Basin. Smaller Federal land holdings in the Planning Area include US Bureau of Land Management (BLM) and US Fish and Wildlife Service (FWS). Local county and municipal holdings make up less than one percent of the remaining land holdings in the Planning Area.

Water Supply Conditions

Groundwater

The Basin and Range AMAs Planning Area is located in the Basin and Range Physiographic Province. This Province is characterized by long broad alluvial valleys separated by mountain ranges, with thick productive regional alluvial aquifers. The Planning Area includes large groundwater reserves and sedimentary deposits that are ideal for artificial underground water storage. Nomenclature varies between the basins and is presented in more detail in Table P.A. 3-1, below.

The Phoenix AMA Basin is the largest of the groundwater basins in the Planning Area and contains seven sub-basins. The primary source of groundwater in the Phoenix AMA Basin is basin-fill sediments. Three distinct water bearing units are identified in most of the sub-basins: an upper alluvial unit, a middle fine-grained unit, and a lower conglomerate unit. Although conditions and circumstances vary across the Basin, most groundwater is pumped from the middle unit. Bedrock, consisting of metamorphic and igneous rock, underlies the basin-fill sediments and is not generally water bearing. Groundwater occurs under generally unconfined conditions throughout most of the Basin. Natural groundwater recharge occurs along the mountain fronts and stream channels. Groundwater inflow into the Phoenix AMA Basin occurs as groundwater flows north from the Pinal AMA Basin into the East Salt River Valley Sub-basin, and from the north and east. Groundwater exits the Basin at Gillespie Dam, located where the Gila River exits the Basin to the southwest.

In general, between the early 1990s and mid-2000s, water levels rose in the eastern part of the Phoenix AMA Basin, declined in the central part and, while dynamic, were generally stable in the western part of the Basin (*see Figure P.A. 3-2*). Well yields throughout the Basin are high, with median values of over 1,400 gallons per minute reported. A high degree of variability in groundwater production is present across the Basin and between the major aquifer units. Where saturated, wells completed in the upper alluvial unit typically have the highest production potential.

Table P.A. 3-1. Basin and Range AMAs Aquifer Unit Description

AMA	Recent Stream Alluvium and Upper Basin Fill	Middle Basin Fill	Lower Basin Fill
Phoenix	Upper Alluvial Unit (UAU)	Middle Alluvial Unit (MAU)	Lower Alluvial Unit (LAU) Includes Red Unit
Pinal	Upper Alluvial Unit (UAU)	Middle Silt and Clay Unit (MSCU)	Lower Congolomerate Unit (LCU)
Tucson	Upper Alluvial Unit - Unit A	Upper Alluvial Unit - Unit B	Lower Alluvial Unit (Units C & D) and Pantano
Santa Cruz	Younger Alluvium (YAL)	Older Alluvium (OAL)	Nogales Fm
General Description of Lithology and Depositional Environments	Recent stream alluvium and basin fill deposits, generally composed of coarser grained sediments (sand and gravels) but finer grained silts and clays may also be present. Generally deposited by through-flowing stream sytems. Deposits generally range from a few feet to a few hundred feet in thickness.	Intermediate age basin fill deposits, generally composed of fine-grained sediments (silts and clays) but coarser grained sands and gravels may occur locally. Interbedded volcanics and evaporatites also found in some basins. Generally deposited in closed drainage systems. Deposits may exceed several thousand feet in thickness near basin centers and thin or pinch-out toward basin margins.	Older basin fill deposits, generally composed of medium (fine sand/silt) to fine-grained sediments (clay) that are often more consolidated and/or cemented (conglomerate) than younger basin fill deposits.nts (silts and clays) but coarser grained sands and gravels may occur locally. Generally described as pre-basin and range to early basin and range deposits that were deposited under closed drainage conditons. Deposits may exceed several thousand feet in thickness near basin centers and thin or pinch-out toward basin margins.
Hydrology	Generally groundwater is encountered under unconfined (water table) conditions in these deposits. Intermediate to high well yields (100s to 1000s gpm) are generally obtained where this unit has significant saturated thickness.	Generally groundwater is encountered under confined to semi-confined conditions in these deposits, however unconfined conditons may exist where the overlying basin-fill deposits are unsaturated. Low well yields (10s to low 100s gpm) are obtained where mainly fine-grained deposits are encountered but intermediate to high yields may be obtained where the unit is coarser-grained and has several hundred feet of saturated thickness. Artesian (confined) wells producing from massive volcanic deposits in the Prescott area can produce several hundred to several	Generally groundwater is encountered under confined to semi-confined conditions in these deposits, however unconfined conditons can exist where the overlying basin-fill deposits are unsaturated. Low well yields (10s to low 100s gpm) are obtained where mainly fine-grained or cemented deposits are encountered but intermediate to high yields may be obtained where cemented strata are fractured or where the unit has several hundred feet of saturated thickness.

The second largest Basin in the Planning Area is the Pinal AMA Basin, which contains five sub-basins. The most productive groundwater-bearing units are in the Maricopa-Stanfield and Eloy sub-basins, consisting of unconsolidated sands, gravels, silts, and clays deposited by the ancestral Gila and Santa Cruz Rivers. Demand for water by irrigated agriculture has drained much of the upper alluvial unit in both sub-basins and has altered historic groundwater flow direction in some parts of the Pinal AMA Basin. Natural recharge is primarily from underflow into the Basin and from streambed infiltration along the Gila and Santa Cruz Rivers, which produce relatively large volumes of runoff from upstream Basins outside the AMA following heavy rains. Water levels have generally risen between the early to mid-1990s and mid-2000s in many wells due to significant volumes of artificial recharge with Central Arizona Project (CAP) Water by the Arizona Water Banking Authority (AWBA), although areas of historic decline are found near the communities of Florence and Coolidge, southwest of Picacho and in the vicinity of Casa Grande (*see Figure P.A. 3-2*).

The Tucson AMA Basin contains two parallel sub-basins, the Upper Santa Cruz and Avra Valley sub-basins. These sub-basins consist of relatively deep alluvial basins filled with layered sediments bordered

by mountains. Groundwater enters the Tucson AMA Basin from the south from the Santa Cruz AMA Basin and from the bordering mountains and then flows to the north-northwest. Natural recharge also occurs along stream channels (primarily the Santa Cruz River and its major tributaries). About 84 percent of the total net natural recharge in the Tucson AMA Basin is estimated to occur within the Upper Santa Cruz Valley Sub-basin. During the period from the mid-1990s to the mid-2000s water levels rose in the northern half of the Avra Valley Sub-basin due to retirement of agricultural lands and importation of CAP water for artificial recharge activities (*see Figure P.A. 3-2*). Similar widespread water level rises have not been noted in the Upper Santa Cruz Sub-basin with the exception of an area north of Sahuarita, where CAP water is being artificially recharged at the Pima Mine Road Underground Storage Facility (USF). Elsewhere in the Sub-basin, water levels have generally declined over this timeframe.

The Santa Cruz AMA is generally viewed as a single Basin with isolated, relatively deep, water bearing formations. However, the younger alluvium along the Santa Cruz River also houses a locally important aquifer system within a series of relatively shallow and narrow "micro basins" that are interconnected and dominated by the flows and recharge in the Santa Cruz River and pumping to supply a portion of the demands of the City of Nogales. These floodplain alluvial units are quickly replenished when surficial flows are available in in the Santa Cruz River, but have limited long-term storage capacity. When this shallow aquifer system is insufficient to meet its demands, the City of Nogales shifts its pumping to a deeper aquifer system west of the City, the Potrero Well Field. Water levels have generally declined in wells measured between the mid-1990s to the mid-2000s throughout the Basin, with declines ranging from 1 to 15 feet (*see Figure P.A. 3-2*).

The Cienega Creek Basin consists of a narrow northeast trending alluvial valley, drained by Cienega and Sonoita creeks, and surrounded by fault-block mountains. There is a surface water divide southwest of Sonoita, with Cienega Creek flowing northeast and Sonoita Creek flowing to the south and west. Groundwater recharge comes from mountain front recharge and streambed infiltration along Cienega and Sonoita creeks and their tributaries.

The San Rafael Basin consists of a broad north-trending valley surrounded by the Canelo Hills and Patagonia Mountains, drained by the Santa Cruz River whose headwaters are in the northern portion of the Basin. Groundwater is found in both the stream alluvium along the Santa Cruz River and its tributaries and in the basin-fill, which occupies most of the valley and is composed of clay, silt, sand and gravel. Water levels are relatively shallow (25 feet below land surface or less) in the streambed alluvium and generally at depths in excess of 100 feet below land surface in the basin-fill.

Groundwater reserves within the Basin and Range AMA Planning Area are an important supply and, because of the generally deep alluvial aquifers, are available in significant volumes throughout much of the Planning Area. The Arizona State Legislature adopted the Groundwater Code in 1980, which established the four initial Active Management Areas to manage water supplies in some of these Basins and to stabilize declining groundwater levels and unsustainable groundwater consumption then practiced in these basins. The original AMA's were the Prescott, Phoenix, Pinal, and Tucson AMA's. Shortly thereafter a fifth AMA, the Santa Cruz AMA, was created for a basin originally part of the Tucson AMA that was dominated by the surface water of the Santa Cruz River (the San Rafael and Cienega Creek basins are not included in the AMAs).

Total groundwater in storage in the AMA Basins of the Planning Area is estimated to be in excess of 166 MAF. However, not all of this supply is readily available due to hydrologic conditions, water quality conditions, and legal constraints as a portion of this estimated volume includes water that has been

artificially recharged by, and for the benefit of, specific parties. While included within the Basin and Range AMA Planning Area, the Cienega Creek and San Rafael basins are not within an AMA (although the water management strategies presented below may be applicable to these basins). Groundwater in storage in the Cienega Creek and San Rafael basins is estimated to be 5.1 MAF and 4 MAF, respectively.

Due to historical groundwater withdrawals, areas of land subsidence have occurred within portions of the Planning Area (See *Figure P.A. 3-2*). Land subsidence occurs when large amounts of groundwater have been withdrawn from certain types of aquifers such as those containing fine-grained sediments. These sediments are held up because the open pore spaces between the soil particles contain groundwater. When the water is withdrawn, the sediments collapse – causing in some cases the land surface to collapse. In some systems, when large amounts of water are pumped, this can result in a permanent reduction in the total storage capacity of the aquifer system. Uneven compaction of the soils overlying aquifer systems can lead to the formation of earth fissures (large cracks). Earth fissures form underground and can express themselves on the surface. The impacts of land subsidence include: damage to linear utilities and flood conveyance infrastructure; earth fissuring; and loss of aquifer storage capacity through compaction. The rate and magnitude of land subsidence is highly variable across the basins in the Planning Area and are dependent upon historical volumes of groundwater withdrawal and geologic conditions. Historically, land subsidence as great as 19 feet has been observed in the Phoenix and Pinal AMA basins and three to five foot drops have been observed in the Tucson AMA Basin. Rates of land subsidence peaked in the 1970's but have lessened as groundwater reliance has been reduced in response to factors including passage of the Groundwater Code and importation of CAP water, permitting groundwater levels to recover.

Due to historical industrial and military activities within the Basin and Range AMA Planning Area, there are sites with soil and groundwater contamination above State and/or federal action levels. There are a total of 40 locations that are either a Federal National Priority List (Federal Superfund) site, Department of Defense site, or State Superfund (WQARF) site within the Planning Area. Most of these are within the Phoenix and Tucson AMA basins. Most of these sites have been defined and are subject to active remedial activities. Remediation of groundwater contamination is typically conducted through "pump and treat" systems, where contaminated groundwater is pumped to the surface for treatment. This remediated water is sometimes returned to the aquifer and can be part of a plume migration control system or, where appropriate, can be made available for potable or non-potable use.

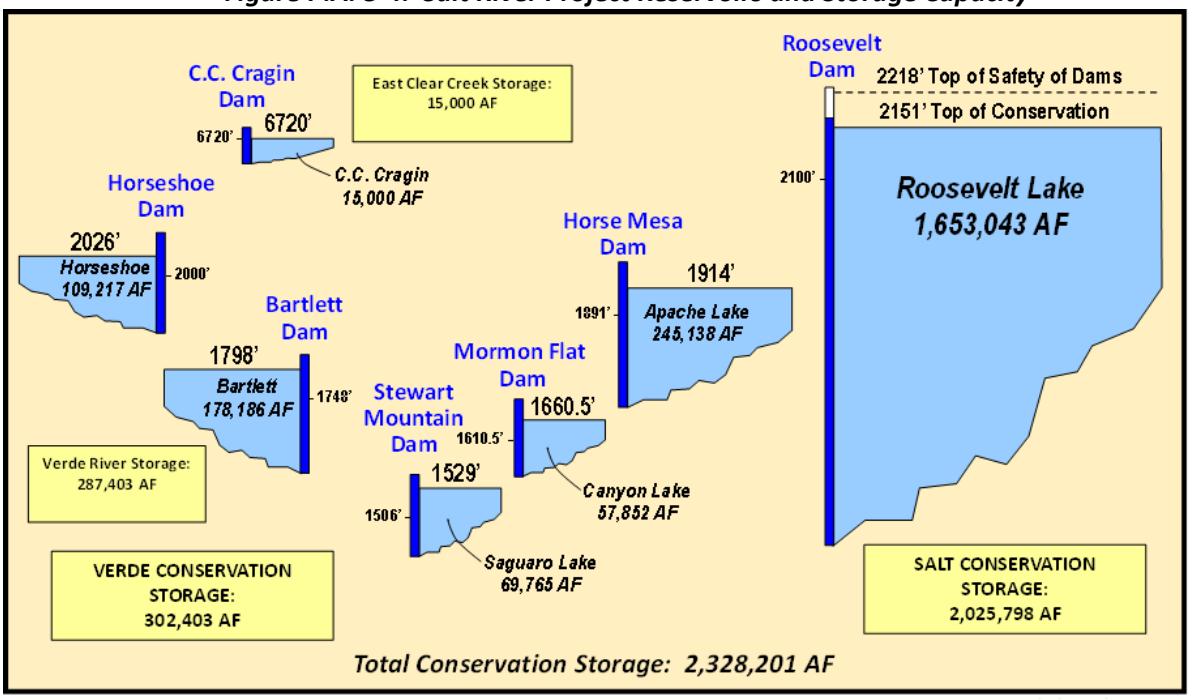
Largely as a consequence of historic agricultural land use practices, the upper aquifer units in many locations within the Planning Area contain high TDS or brackish groundwater, which is also commonly associated with nitrate (NO_3) in concentrations above drinking water standards. These aquifers are not typically used for potable water supplies due to the increased costs associated with treatment. In addition, there is a water logged area in the Phoenix AMA Basin approximately 35 miles long along the Gila River from roughly the its confluence with the Salt River to the outfall of the Basin at Gillespie Dam. Within this region, irrigators have to dewater the brackish water to sustain the agricultural activities in the area. This water is currently discharged to the Gila River channel and flows southwest into the Gila Bend Planning Area.

<u>Surface Water</u>

Six rivers in Arizona contribute water supplies to the Basin and Range AMA Planning Area (*see Figure P.A. 3-3*). These include the Agua Fria, Gila, Salt, Verde, Santa Cruz, and Colorado Rivers. The Colorado River, while not physically tributary to the Planning Area, is included as it contributes water supplies to the Planning Area through importation via the Central Arizona Project (CAP) Canal.

Reservoir storage within the Salt and Verde River system (*see Figure P.A. 3-4*), while not within the Planning Area, is of great importance to the Phoenix AMA Basin. There are six major storage reservoirs in this system managed by the Salt River Project. These reservoirs are located within other Planning Areas (Verde and Roosevelt Planning Areas), but these reservoirs are managed to supply water to certain water right holders within portions of the Phoenix AMA Basin. There are four reservoirs on the Salt River: Roosevelt, Apache, Canyon, and Saguaro Lakes. Two major reservoirs, Bartlett and Horseshoe Lakes, are located on the Verde River. Combined, these reservoirs have over 2.3 MAF of storage capacity and also provide hydroelectric power and flood control, as well as serving recreational and environmental benefits. Lake Pleasant, formed by New Waddell Dam on the Agua Fria River in the northwest portion of the Phoenix AMA, impounds water for the benefit of downstream water right holders that are within the Maricopa Water District. It also is an integral element of the CAP water delivery system, providing regulatory storage and significantly increasing operational flexibility within the system. Other surface water resources in the Phoenix AMA Basin include Cave Creek, Skunk Creek, and the reclaimed water discharges in the Salt and Gila rivers, downstream of the 23rd Ave and 91st Ave Wastewater Treatment Plants (WWTP).

Figure P.A. 3-4. Salt River Project Reservoirs and Storage Capacity



Courtesy of Salt River Project

Water from the Gila River is diverted into the San Carlos Irrigation Project at the Ashurst-Hayden Diversion Dam near Florence in the Pinal AMA Basin. This dam is a diversion works project and has no storage capacity. In the southern portion of the Pinal AMA Basin the Santa Cruz River flows ephemerally northwest through the basin. Saint Clair Reservoir, with a maximum capacity of 375,000 acre-feet, is the largest reservoir in the Pinal AMA but currently lacks infrastructure to fill the reservoir.

Perennial streams within the Tucson AMA Basin include Romero, Sabino, Cienega, and Sycamore creeks. An approximately nine-mile reach of the Santa Cruz River is perennial downstream of discharges from Pima County's Roger and Ina Road water reclamation facilities.

In the Santa Cruz AMA Basin, the Santa Cruz River is the central hydrologic feature of the AMA. The Santa Cruz River headwaters begin in Arizona in the San Rafael Basin in the Patagonia Mountains and Canelo Hills in southeastern Arizona. The River then flows south, traversing a 35-mile reach in Mexico before turning north and flowing into Arizona, crossing the international border east of Nogales, Arizona. There is a 12-mile perennial reach of the Santa Cruz River in the Santa Cruz AMA Basin downstream of the reclaimed water discharges from the Nogales International WWTP, operated by the International Boundary and Water Commission (IBWC), which treats sewage from both Nogales, Sonora, Mexico and Nogales, Arizona. Small intermittent streams are present within the Cienega Creek Basin, but there is no known direct surface water use. As stated above, the San Rafael Basin contains the head waters of the Santa Cruz River.

Colorado River Water/CAP

The CAP first began importing Colorado River water into the Phoenix, Pinal, and Tucson AMA Basins in 1985. The CAP Canal lifts Colorado River water from Lake Havasu at the Mark Wilmer Pumping Plant, then travels 336-miles, bisecting the Colorado River Mainstem South and West Basins Planning Areas, to the CAP Service Area in central and southern Arizona to its terminus just south of the City of Tucson, a total elevation rise of 2,400 feet (*See Figure P.A. 3-5*). Average annual water deliveries are approximately 1.5 MAF to three main categories of water users: non-Indian municipal and industrial (M&I), non-Indian agricultural (NIA) and Indian (Note: This supply is not available in the Santa Cruz AMA, nor the Cienega Creek or San Rafael basins).

Figure P.A. 3-5. Central Arizona Project Canal and Service Area

Courtesy of Central Arizona Project

Reclaimed Water

Reuse of reclaimed water is common within the Basin and Range AMA Planning Area both directly and indirectly. Direct use, such as irrigation for landscaping, and agriculture, and by industry, including cooling at power plants, occurs within the Planning Area. Indirect use in the Planning Area commonly occurs where reclaimed water is recharged for later recovery by municipal water systems. An estimated 469,000 acre-feet of reclaimed water is currently generated in the Planning Area. A total of 214,034 acre feet (about 46 percent) is reused in some manner within the Planning Area, either through direct deliveries or through underground storage and recovery. The largest direct user of reclaimed water (over approximately 70,000 acre-feet annually for cooling) is the Palo Verde Nuclear Generating Facility (PVNGS), owned and operated by Arizona Public Service Corporation, west of Phoenix. Extensive effluent distribution systems have also been constructed in the Planning Area for turf irrigation. Notable examples include the City of Scottsdale's Reclaimed Water and Irrigation water distribution systems (RWDS and IWDS, respectively) and Tucson's distribution system along the Catalina Foothills. No known water reuse occurs within the San Rafael or Cienega Creek basins.

Ecological Resources

The occurrence and composition of riparian vegetation has changed along many of the watercourses in the AMA Planning Area, including the Santa Cruz River in the Santa Cruz and Tucson AMAs, the Gila River in the Pinal and Phoenix AMAs, and the Salt and Verde rivers in the Phoenix AMA. Sustained surface water flows are present in the northeast portion of the Phoenix AMA Basin. These include the Verde River below Bartlett Dam (Bartlett Lake) and the Salt River from below Stewart Mountain Dam (Saguaro Lake) to the Granite Reef Diversion Dam which is located within the Basin. This has supported important riparian habitat. Reclaimed water discharges to stream channels have created several riparian areas throughout the Planning Area. Among these is in the Santa Cruz River below the Nogales International WWTP, extending approximately 12 miles. There have also been several restoration projects in the Planning Area where reclaimed or other water supplies have been used to intentionally establish or enhance riparian and surface water sources for wildlife conservation (*see Figure P.A. 3-3*). A short riparian area has developed due to reclaimed water releases in the Sonoita Creek south of Patagonia in the Cienega Creek Basin. The Nature Conservancy (TNC) has acquired property in the Cienega Creek Basin for habitat protection establishing the Patagonia-Sonoita Creek Preserve. Significant riparian areas supporting diverse species exists along the Santa Cruz River in the San Rafael Basin.

Water Demands

Table P.A. 3-2 below, illustrates the baseline and projected demands in the Basin and Range AMAs Planning Area. Water use and development in the Planning Area was largely spurred by irrigated agricultural. Currently, water demands in the Planning Area total nearly 3.7 MAF per year for municipal, industrial and agricultural uses (nearly 50 percent of the total water use in the state). Of this demand, 33 percent is groundwater supplied, 33 percent served by CAP water (either directly or indirectly), 28 percent by surface water, and five percent is met with reclaimed water (either directly or indirectly).

The Basin and Range AMA's Planning Area collectively house over 80 percent of the State's total population. The Planning Area represents 84 percent of the State's total municipal water demand; 61 percent of the State's total industrial water demand; and 39 percent of the State's total agricultural demand, which has declined as urban growth has displaced historic agricultural uses. The Planning Area contains 14 thermoelectric power plants; whose demands are accounted for in the industrial sector. Eighty five percent (85%) of the State's total gross domestic product (GDP) is derived from within the Basin and Range AMA's Planning Area and has the largest projected municipal and industrial growth through the planning period.

While, the Planning Area is still home to significant agricultural activity, primarily in the Phoenix and Pinal AMA Basins – combined contributing approximately 50 percent of total cash receipts from Arizona agricultural production (crop and livestock), continued municipal and industrial growth in this Planning Area are expected to displace a large portion of the agricultural land use, but not entirely.

Table P.A. 3-2. Projected Water Demands (in acre feet) - Basin and Range AMAs Planning Area

Sector	2010	2035	2060
Agriculture	2,029,432	1,716,697	1,373,909
Dairy	18,590	18,480	8,000
Feedlot	3,091	3,091	3,091
Municipal	1,381,251	2,319,897	2,959,583
Other Industrial	16,132	40,922	40,922
Mining	34,905		
High		117,500	117,500
Low		58,300	58,300
Power Plants	72,337		
High		184,026	230,952
Low		133,838	160,330
Rock Production	15,603		
High		103,244	132,069
Low		43,019	55,029
Turf	76,649		
High		102,524	116,389
Low		89,536	116,569
Total (High)	**3,647,990**	**4,606,381**	**4,982,415**
Total (Low)	**3,647,990**	**4,423,780**	**4,775,733**

Characteristics Affecting Projected Water Demands and Supply Availability

General Stream Adjudication

The general stream adjudications are judicial proceedings to determine or establish the extent and priority of water rights in the Gila and Little Colorado River systems. Over 84,000 claimants and water users are joined in the Gila River Adjudication that will result in the Superior Court issuing a comprehensive final decree of water rights. Until that process is complete, uncertainty regarding the extent and priority of water rights in the Basin and Range AMA Planning Area will make it difficult to identify strategies for meeting the projected water demands.

Unresolved Indian Water Rights Claims

While much progress has been made over the last two decades, resolution of the outstanding claims of the Indian communities throughout the State of Arizona has the potential to affect the water supplies to this Planning Area. While some of these are being discussed in settlement negotiations, others have yet to begin. Until these claims are quantified and settled, uncertainty regarding the extent and priority of

water rights in the Basin and Range AMAs Planning Area will make it difficult to identify and execute strategies for meeting the projected water demands.

Water Management

Water use within the AMA Basins is some of the most intensively managed in the country. Water use tracking and reporting; mandatory water conservation requirements; recharge and recovery programs; as well as stringent requirements for new growth to have a 100-year renewable water supply, place water management requirements in the AMAs well above any comparable metropolitan area in the US. Continual achievement of increased water use efficiencies have stretch limited water supplies far longer than was previously imagined. While existing groundwater uses were grandfathered in 1980, as land use practices changed over time, new subdivided growth is required to use renewable supplies. These land use changes are dominated by the urbanization of agricultural lands. In a rapidly growing area such as central Arizona, this systematic conversion has kept economic conditions stable while allowing for the orderly transformation from groundwater dominated uses to renewable supply use.

Underground Storage and Recovery

There are a total of 63 permitted underground storage facilities within the Planning Area. These include constructed (which includes recharge basins and vadose zone and injection wells), managed (discharges into streambeds for infiltration), and in-lieu (arrangements where groundwater use is curtailed and renewable supplies are used on agricultural fields) facilities. Renewable water supplies stored in these facilities include CAP, surface water, and reclaimed water. Artificial storage and recovery provides an alternative to the need to develop infrastructure for storage and direct use of renewable water supplies. Water that is stored in aquifers can be subsequently recovered in any part of the same groundwater basin (consistent with permit conditions and water management goals). Through these facilities, there is permitted capacity to capture and store a total of 1.9 MAF per year of renewable water supplies in the Planning Area. At present, a total of 7.2 MAF is currently stored, through artificial recharge, in the aquifers within the Planning Area.

Strategies for Meeting Future Water Demands

Resolution of Indian and Non-Indian Water Rights Claims

Efforts to complete the Tohono O'odham – Sif Odak, Navajo, Hopi, San Carlos Apache and other Indian community water rights claims as well as resolution of the Gila River General Stream Adjudication are essential to not only provide a secure water supply for the tribes, but also to provide long-term certainty for water users in the Planning Area. A comprehensive focus on what is needed to complete the Adjudication is essential and could help provide guidance to ADWR so adequate funding can be identified and obtained to complete the necessary technical work to support completion of this process.

Continuation of Water Conversation Programs

The mandatory conservation programs implemented through the Management Plan under the Groundwater Code and complementary voluntary water conservation efforts have resulted in significant increases in water use efficiency throughout the Planning Area. Continuation and expansion of these efforts to further and continuously increase water use efficiency will be an important element of leveraging existing available supplies and increasing the relative yield of water augmentation alternatives.

Watershed/Forest Management

Watershed management practices aimed at increasing watershed yield have been evaluated in Arizona and exhibit promise for success. Due to the significant acreage of forested land in the contributing watershed to this Planning Area, continuation of this process and implementation of safe and effective strategies are important to maximizing water yields. Combining efforts with other management initiatives (such as the Four Forest Restoration Initiative) may be a cost-effective way to advance this option and may provide multiple benefits to local communities and residents within both the planning areas that house these forests and water users in the Basin and Range AMAs Planning Area dependent on these water supplies. The Four Forest Restoration Initiative (4FRI) is a collaborative effort to restore forest ecosystems on portions of four National Forests - Coconino, Kaibab, Apache-Sitgreaves, and Tonto - along the Mogollon Rim in northern Arizona. The vision of 4FRI is restored forest ecosystems that support natural fire regimes, functioning populations of native plants and animals, and forests that pose little threat of destructive wildfire to thriving forest communities, as well as support sustainable forest industries that strengthen local economies while conserving natural resources and aesthetic values[1].

Weather Modification

Weather modification, or cloud seeding, is a potential strategy to either augment local water supplies or mitigate the impacts of groundwater development. Weather modification strategies in the areas that supply water to this Planning Area should be explored further.

Reclaimed Water Reuse

Reclaimed water has been, and will be an increasingly important source of supply in this Planning Area. Continued focus on maximizing direct reuse of reclaimed water for non-potable uses, and indirect reuse for potable and non-potable purposes through recharge/recovery, will be required in the Basin and Range AMAs Planning Area. Additionally, exploring options for direct potable reuse will also provide a more long-term secure water supply. Some jurisdictions are experiencing challenges in reusing this supply due to increases in salinity impacting end uses. Salinity management at the local and regional level may be required to maximize use of this endemic renewable supply.

Some isolated areas within the Planning Area are still reliant on septic systems, which reduce the amount of water that could be reclaimed and reused. Moving customers currently on septic systems, where practical, to centralized reclaimed water systems, converting lagoon-based mechanical treatment, and using artificial recharge in the winter months to store excess reclaimed water supplies will help to meet future water needs.

Brackish Groundwater

The southwest portions of the Phoenix AMA along the Gila River exhibit shallow brackish groundwater conditions that negatively impacts agricultural practices within the St. Johns, Buckeye, and Arlington irrigation districts. Successful agricultural practices within these areas require leaching of salts from the soil profile and drainage of this shallow groundwater to depths below crop root zones. This is accomplished through an extensive gravity drainage system and operation of dewatering wells, both of which discharge to the Gila River. These flows leave the AMA and do not contribute to its available water supplies.

Capture, treatment and direct use of this locally available resource can serve to augment the water supplies in the southwest portions of the Phoenix AMA. Highly saline brine will be a by-product of the

[1] http://www.4fri.org/

treatment required to reuse this supply. Development of a cost-effective brine disposal method will greatly enhance the viability of this supply augmentation alternative.

Firming of Low Priority Water Supplies

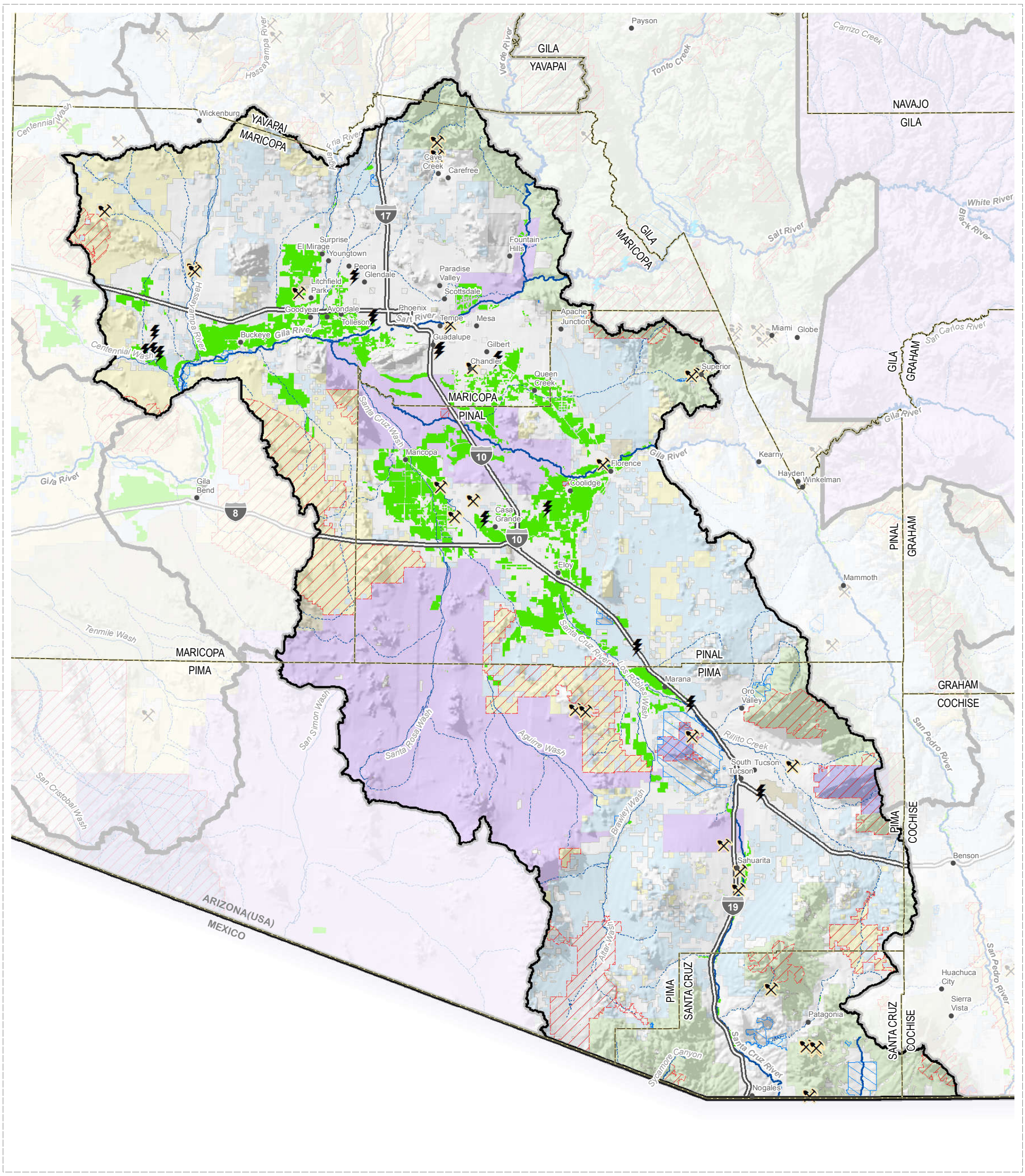
Water supply availability during shortages on the Colorado River is a concern for communities in this Planning Area with CAP supplies. One of the duties of the Arizona Water Banking Authority (AWBA) is to store water within the CAP service area for the benefit of M&I subcontractors during declared shortages on the Colorado River. To date, the AWBA has stored 1.97 MAF of excess CAP supplies towards its 2.67 MAF M&I firming goal in the CAP service area. The AWBA should continue to evaluate the long-term shortage probabilities to ensure that sufficient supplies are being stored such that supplies will be available to meet the needs of these communities and to ensure that adequate funding is available to meet these firming goals.

Importation

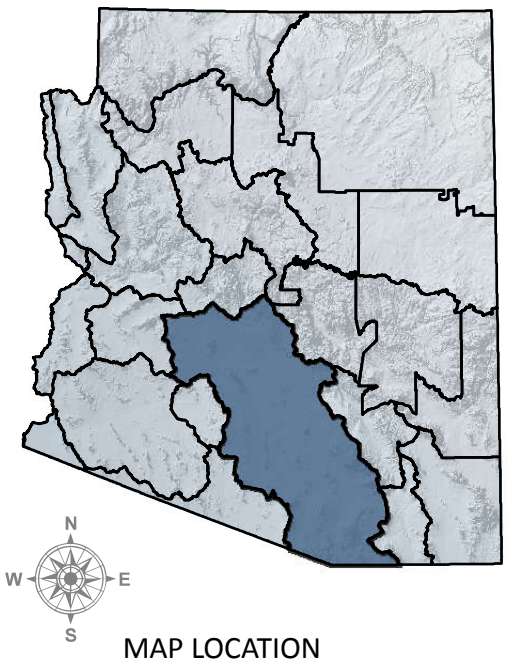
The projected growth in the Basin and Range AMAs Planning Area will continue to put stress on the existing water supplies. While continued conservation practices and maximizing the use of reclaimed water will alleviate some of this pressure, augmentation of water supplies through importation of water from outside of this Planning Area will be required to meet the water demands associated with growth projections.

Participation in a seawater desalination plant, either on the Pacific Ocean or the Sea of Cortez, represents a potential permanent water supply solution for the Basin and Range AMAs Planning Area. This supply could be developed in conjunction with an exchange of Colorado River supplies with an entity that is entitled to receive water from the Colorado River and is located in close proximity to the Pacific or the Sea of Cortez. The exchanged Colorado River supply could then be delivered into the Planning Area through the CAP canal or an alternative conveyance constructed into the Planning Area. Additional alternatives could include partnering with Mexico and constructing a transmission line from a desalination facility sited on the Sea of Cortez to the Santa Cruz River and delivering water from the south into the US, serving uses along the pipeline route in Mexico and delivering supplies to Nogales and the Tucson metropolitan area, providing not only municipal and industrial water supplies but preserving and enhancing riparian habitats in the southern portion of the Planning Area.

NOTE: Because GIS data for this project were acquired from multiple sources employing different land base grids and varying accuracy standards, some inconsistencies were encountered.
The user is responsible for understanding the accuracy limitations of GIS data layers and is responsible for the results of any application of the data for other than their intended purpose.



Miles
0 30 60



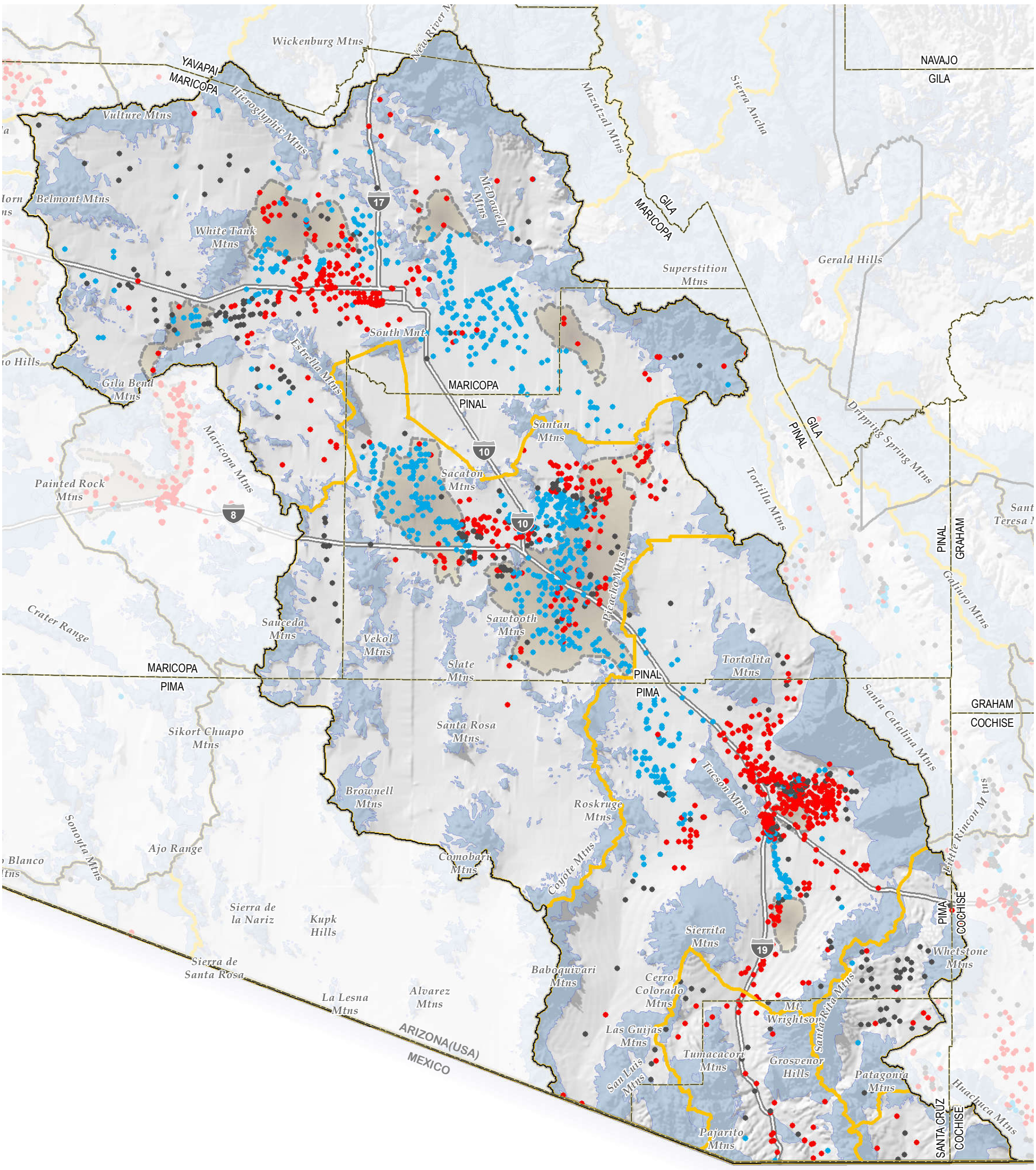
MAP LOCATION
(Planning Area Boundaries)

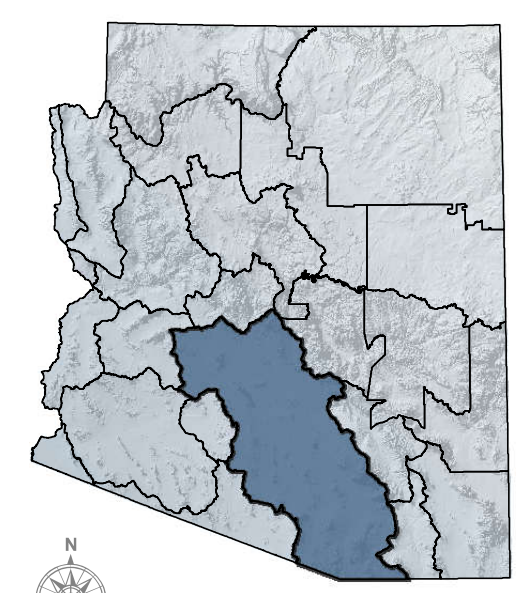
- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- River or Stream (ASLD)
- Interstate (ADOT)
- Population Center (GNIS)
- Mine (ADMMR, ADWR)
- Hydroelectric Power Plant (ADEQ, ADWR)
- Thermoelectric Power Plant (ADEQ, ADWR)
- Agriculture (SWReGAP, 2004)
- Federal Conservation Land (USFS, BLM, NPS)
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

Figure P.A.3-1

Basin and Range AMAs Land Ownership

NOTE: Because GIS data for this project were acquired from multiple sources employing different land base grids and varying accuracy standards, some inconsistencies were encountered.
The user is responsible for understanding the accuracy limitations of GIS data layers and is responsible for the results of any application of the data for other than their intended purpose.





MAP LOCATION
(Planning Area Boundaries)

- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- Groundwater Basin (ADWR)
- Area of Active Land Subsidence (ADWR)
- Hard Rock Geology (AZ Bureau of Mines, UofA)
- Interstate (ADOT)

Recent Water Level Change * (1990's through 2000's)

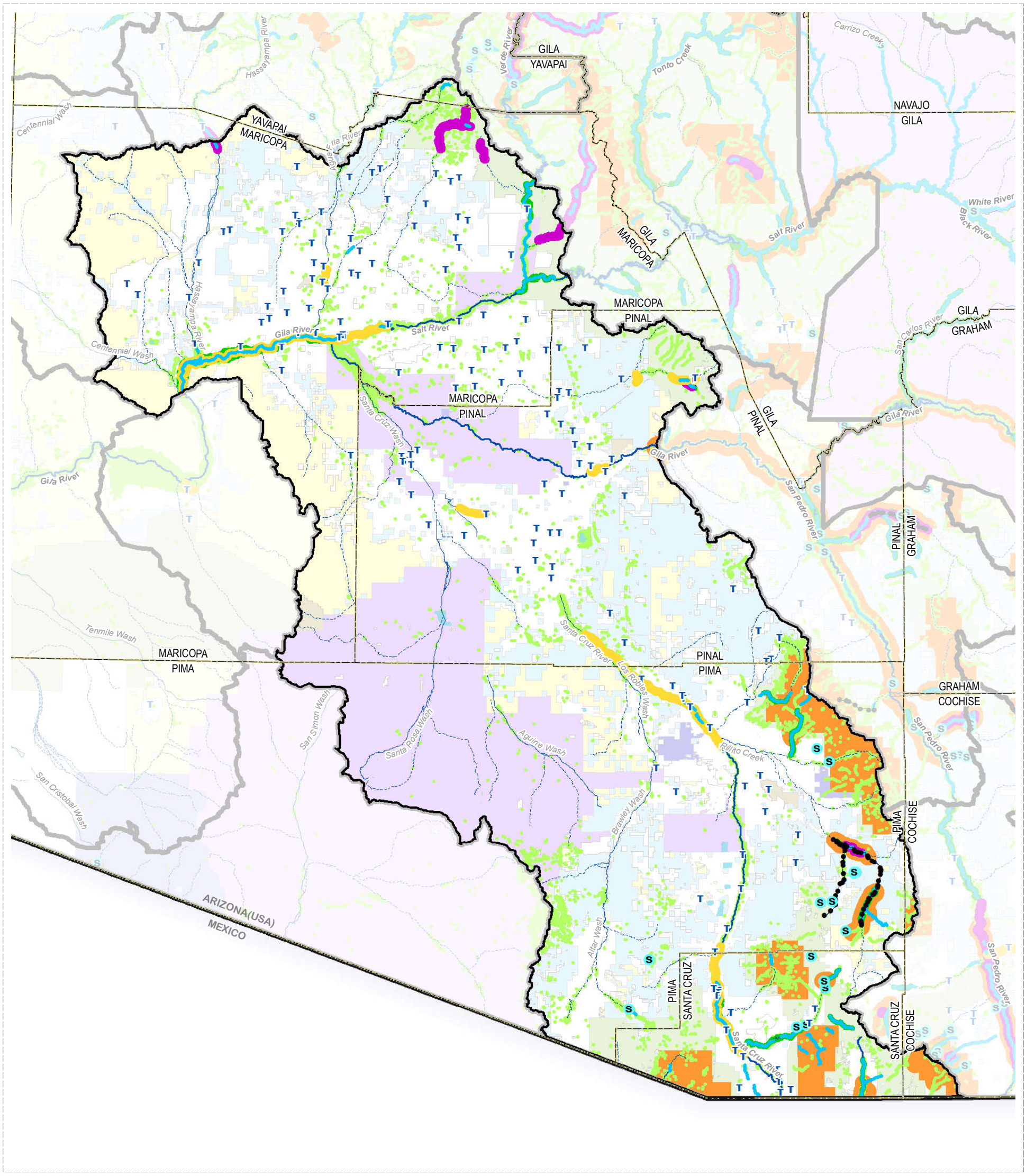
- Minor WL Change +5' to -5'
- Negative
- Positive

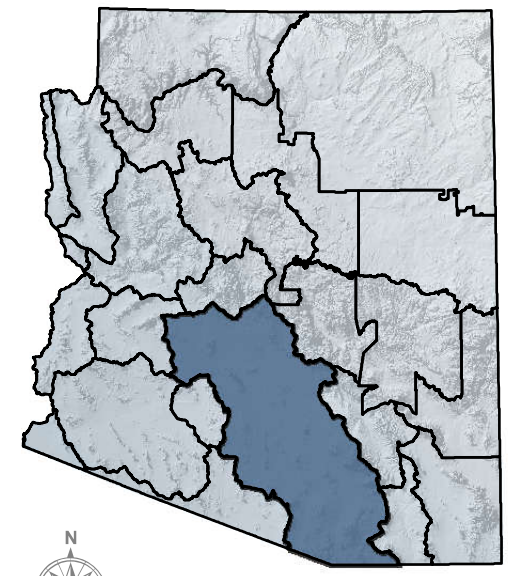
* Data provided by ADWR

Figure P.A.3-2

Basin and Range AMAs Groundwater Hydrology

NOTE: Because GIS data for this project were acquired from multiple sources employing different land base grids and varying accuracy standards, some inconsistencies were encountered.
The user is responsible for understanding the accuracy limitations of GIS data layers and is responsible for the results of any application of the data for other than their intended purpose.





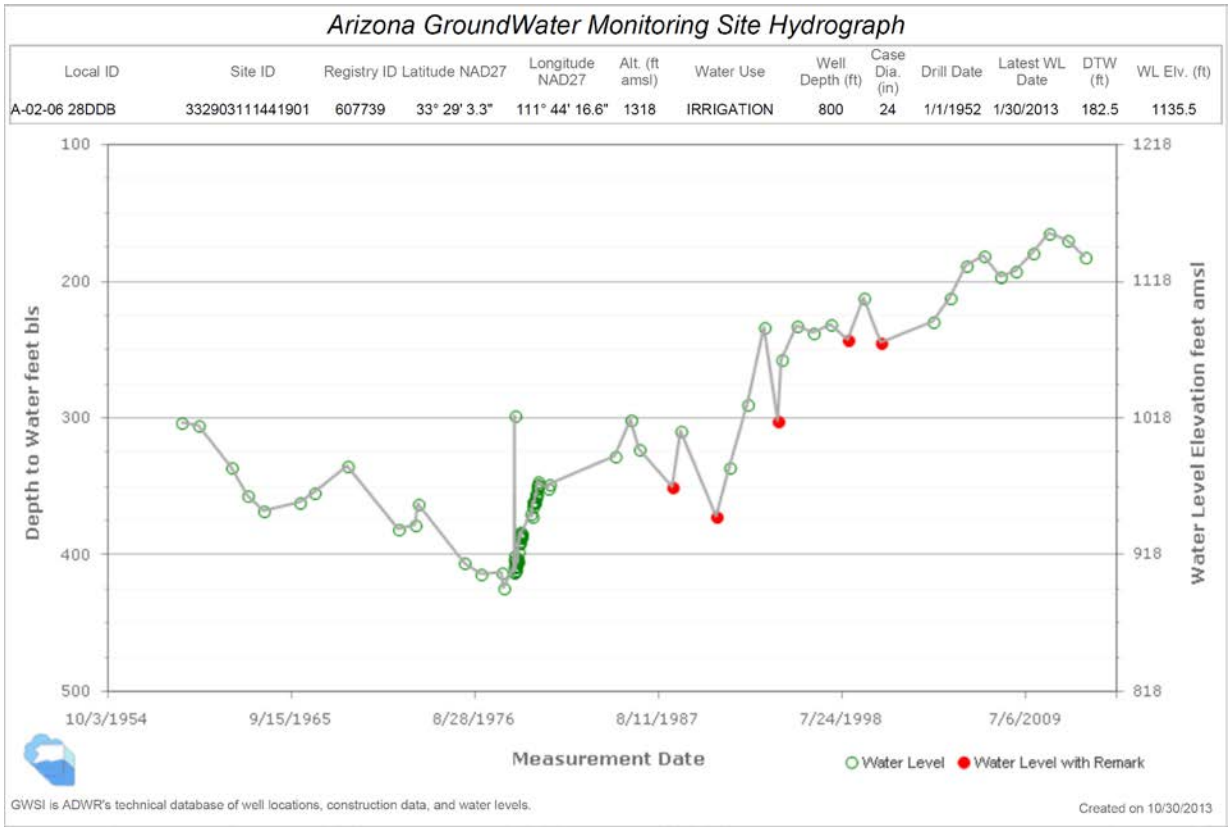
MAP LOCATION
(Planning Area Boundaries)

- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- Reservoir or Lake (NHD)
- Waste Water Treatment Plant (ADEQ)
- Major Spring (ADWR, Pima County)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ASLD)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- Instream Flow Certificate (ADWR)
- 1993 Riparian Inventory (AZGFD)
- Modeled Riparian Habitat (AZGFD)
- Designated ESA Critical Habitat (USFWS)
- Proposed ESA Critical Habitat (USFWS)
- Federally Designated Wild and Scenic River (USFS)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

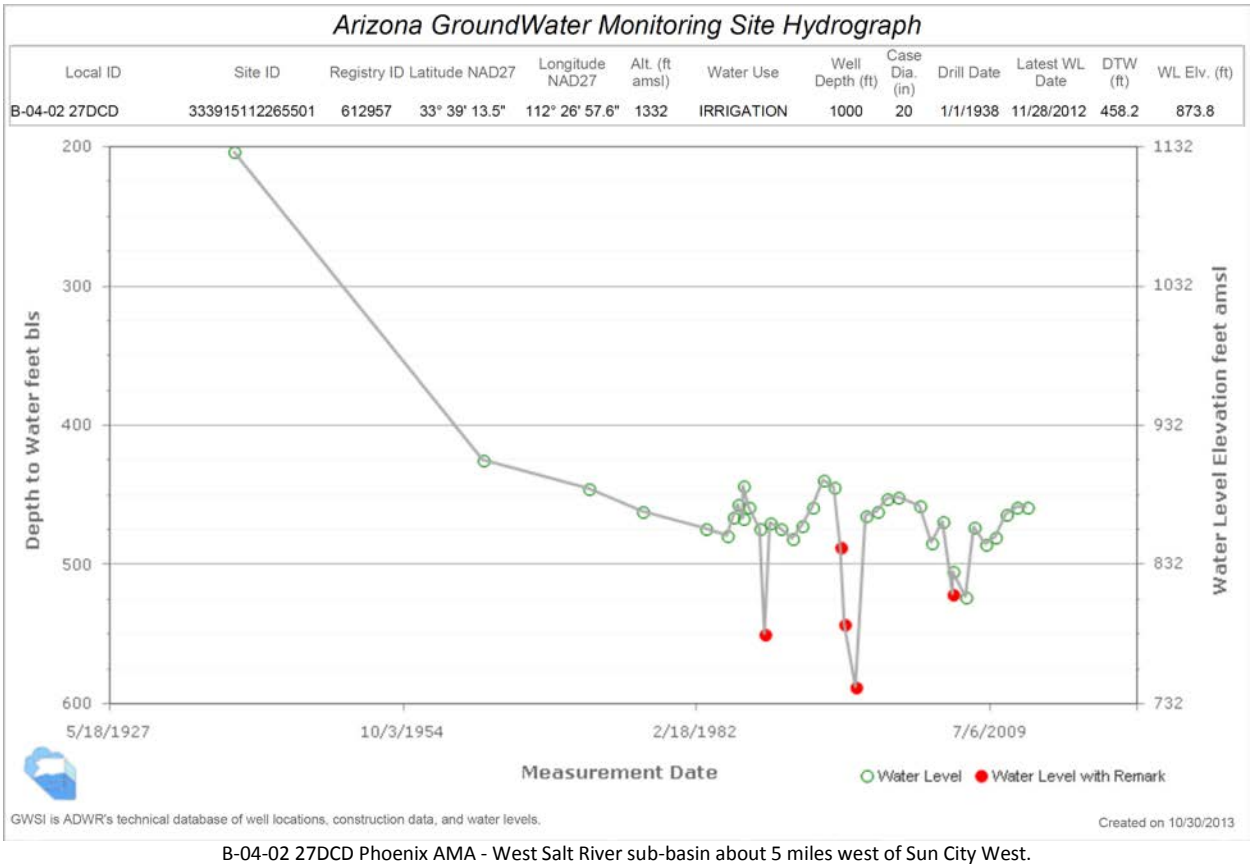
Figure P.A.3-3

Basin and Range AMAs
Surface Water and Natural Features

Phoenix AMA- Basin and Range AMA's

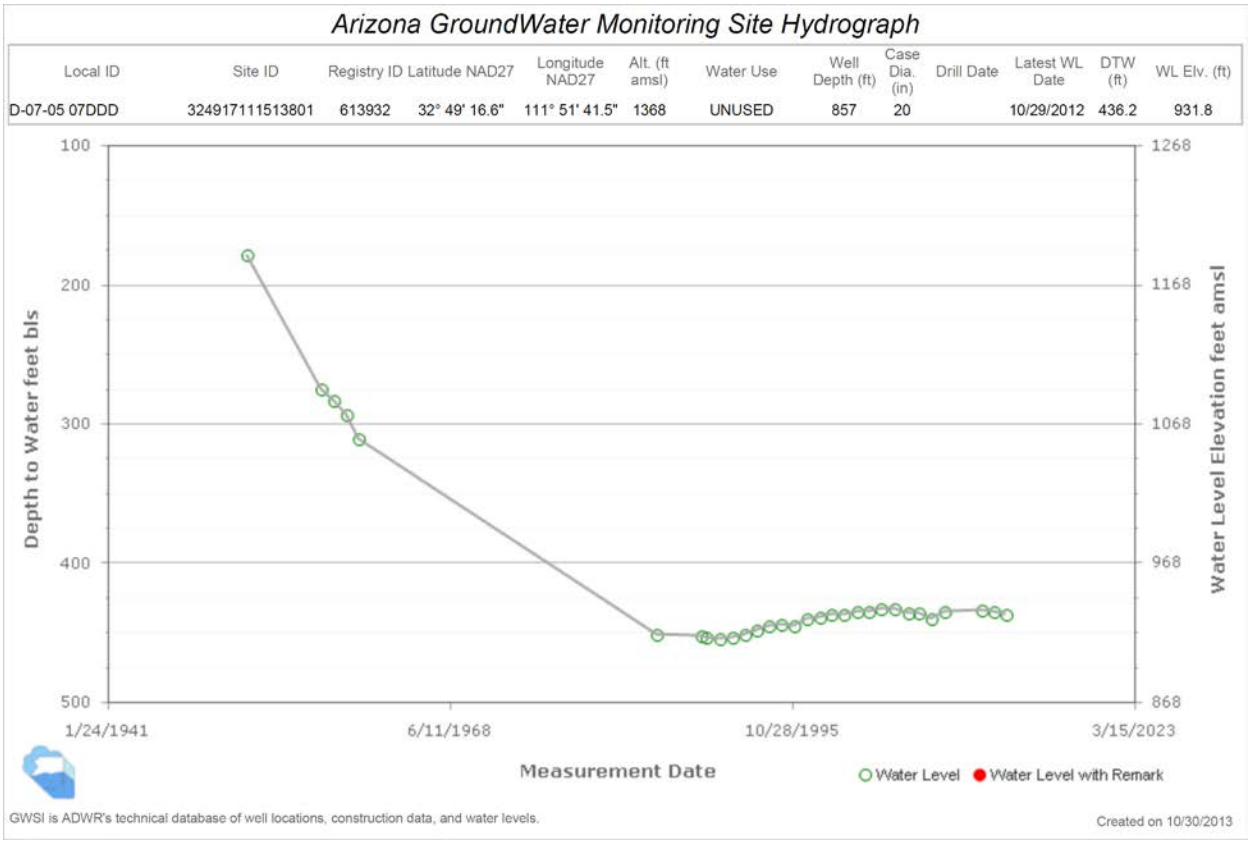


A-02-06 28DDB Phoenix AMA – East Salt River Valley sub-basin east Mesa area just south of Salt River near GRUSP recharge facility.

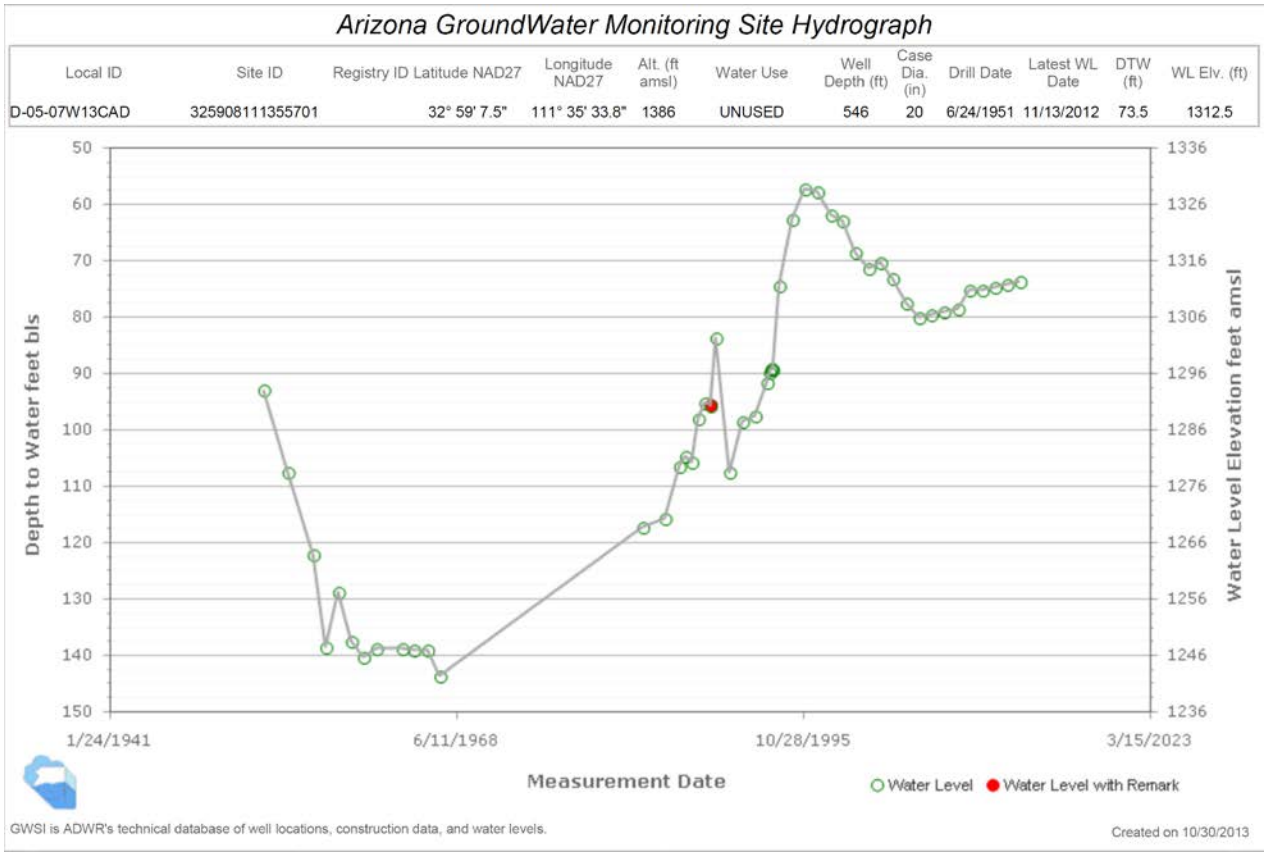


B-04-02 27DCD Phoenix AMA - West Salt River sub-basin about 5 miles west of Sun City West.

Pinal AMA- Basin and Range AMA's

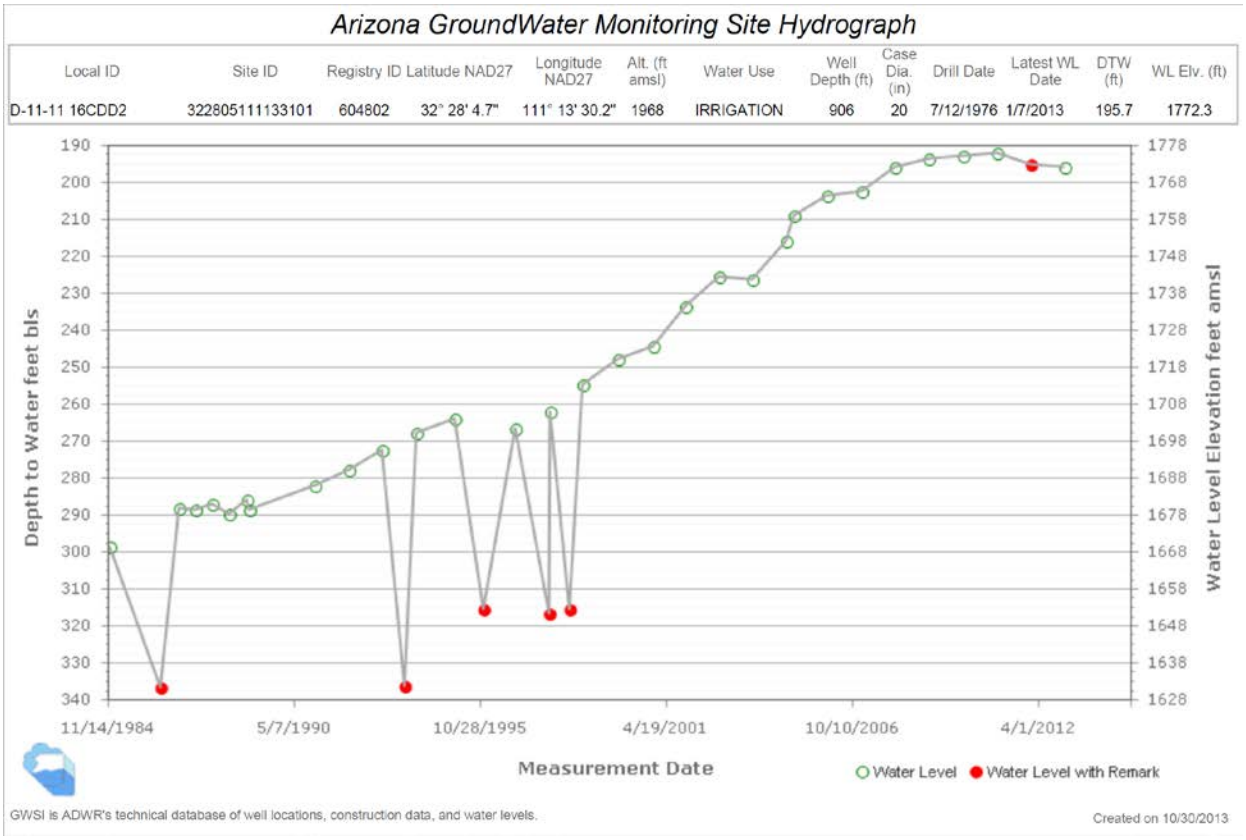


D-07-05 07DDD Pinal AMA – Maricopa-Stanfield sub-basin southern eastern Maricopa Stanfield Irrigation and Drainage District (MSIDD or MARSTAN) area.

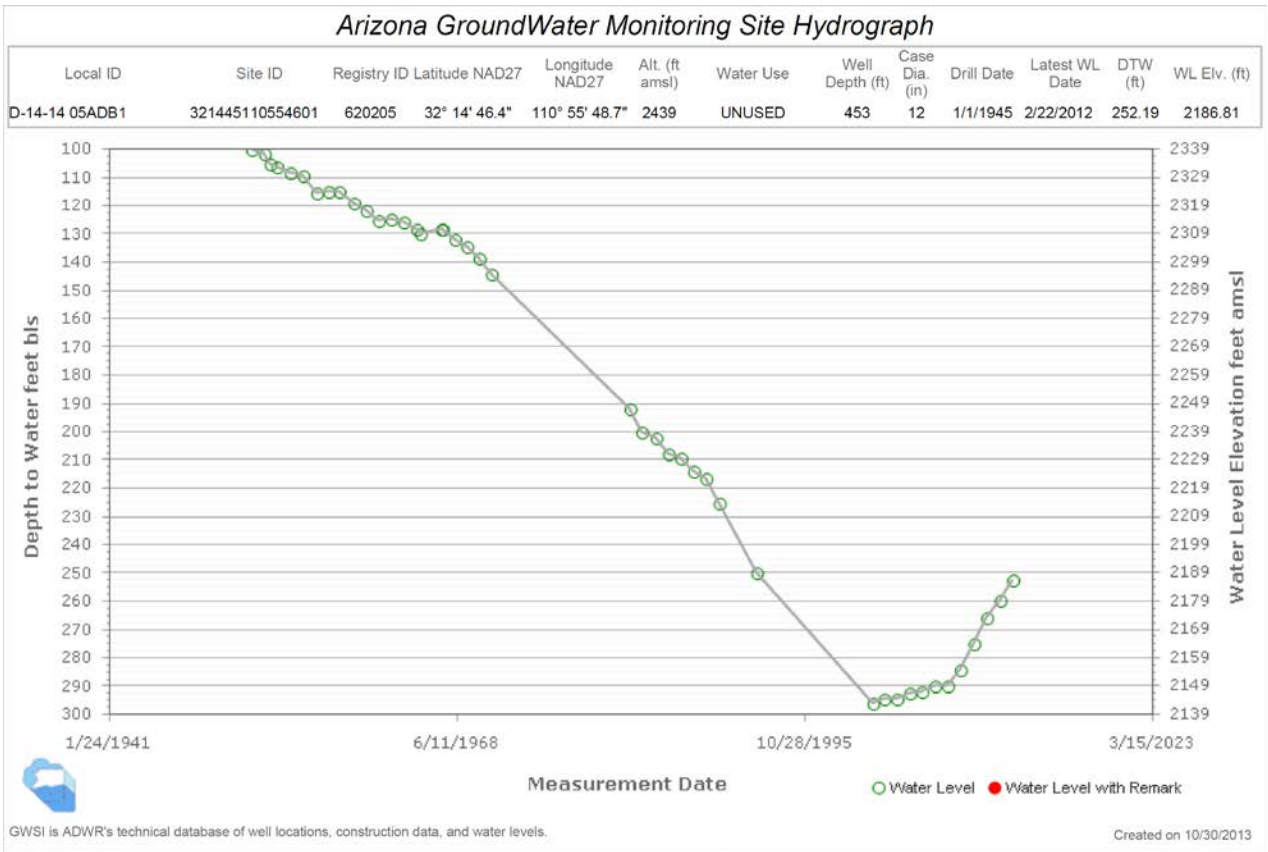


D-05-07W13CAD Pinal AMA – Eloy sub-basin NW Hohokam IDD area near GRIC.

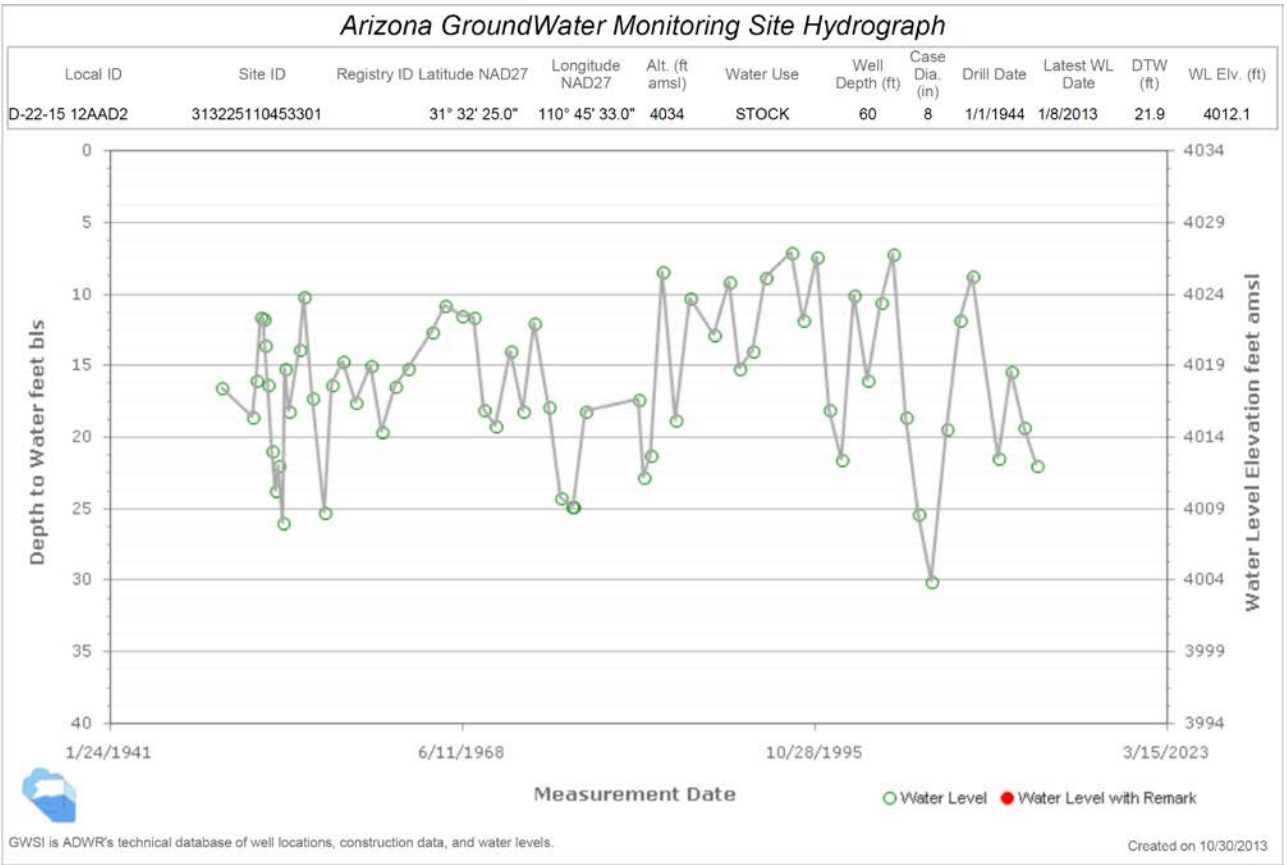
Tucson AMA- Basin and Range AMA's



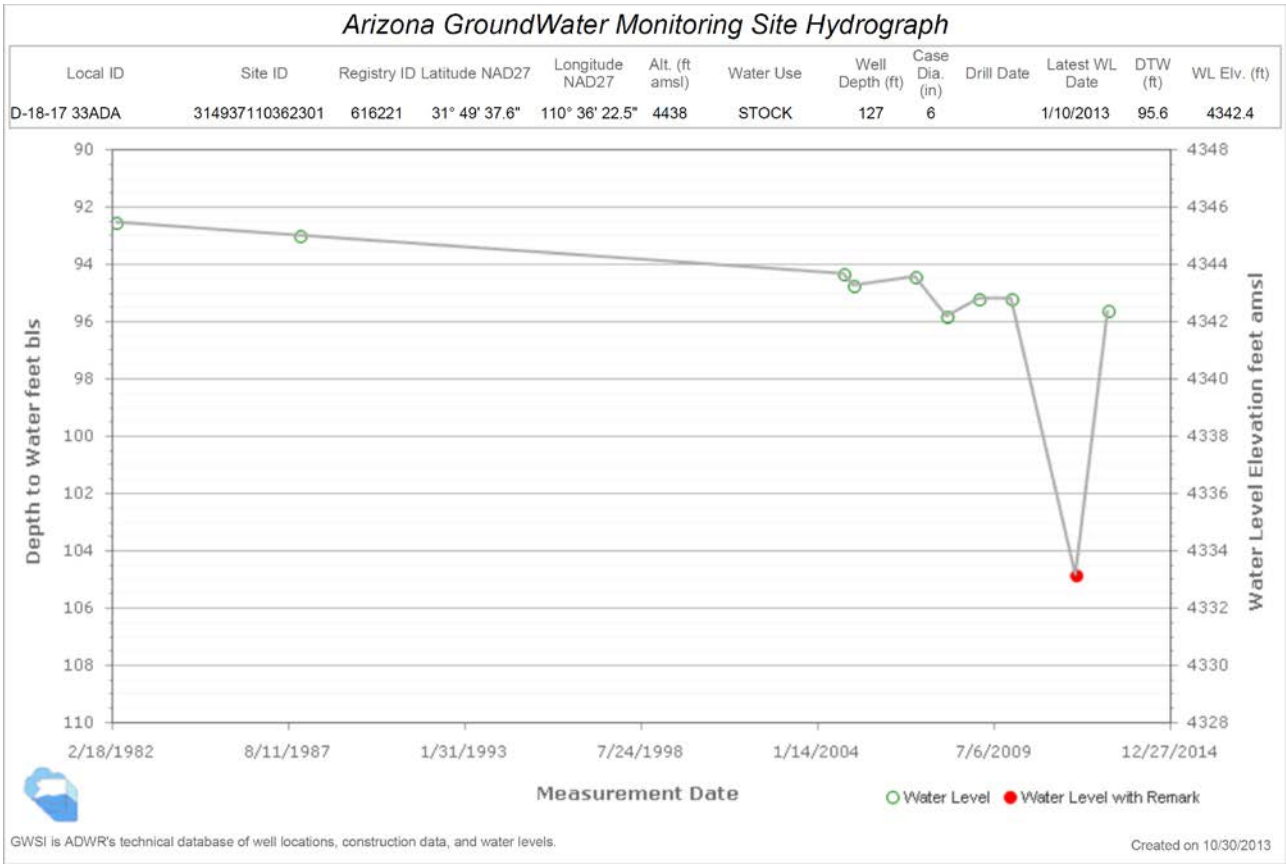
D-11-11 16CDD2 Tucson AMA – Avra Valley sub-basin about 1 mile NW of Marana.



D-14-14 05ADB1 Tucson AMA – Upper Santa Cruz sub-basin City of Tucson Central well field area about 1 mile NE of U of A.

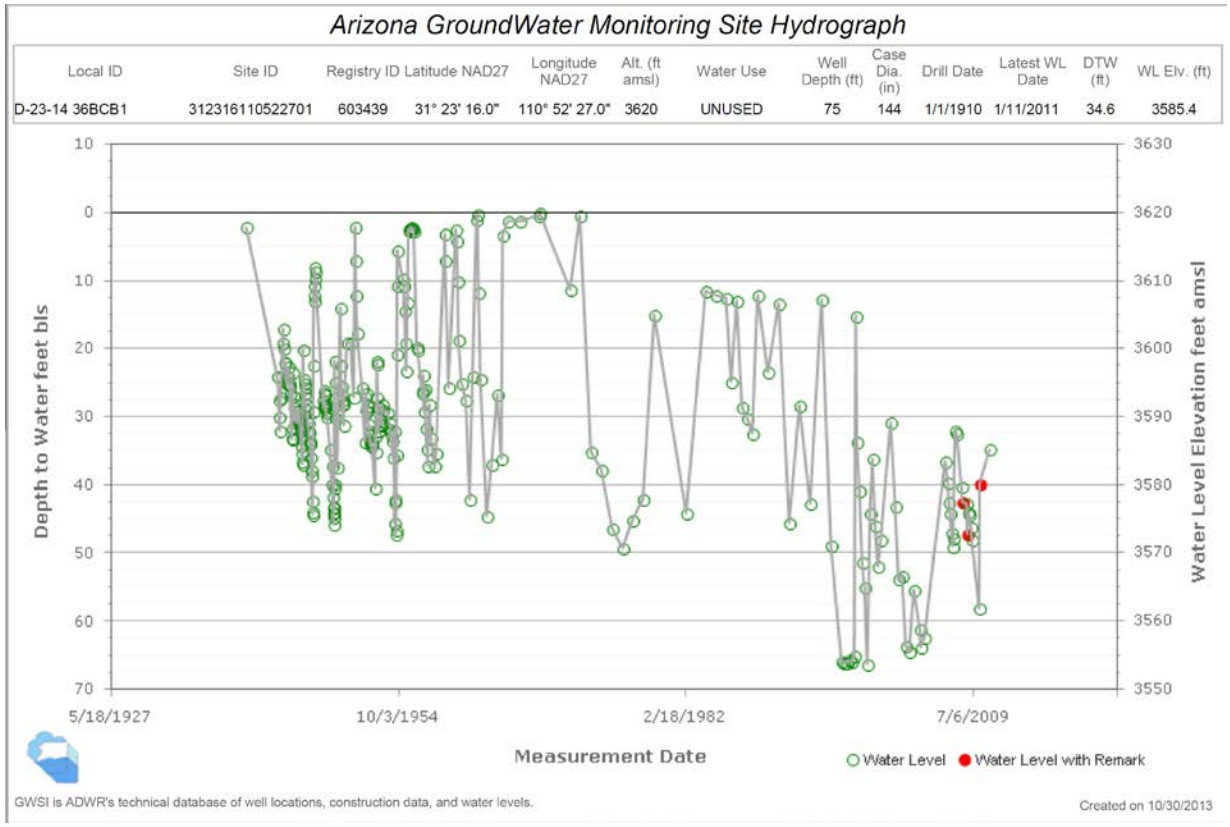


D-22-15 12AAD2 – Cienega Creek basin near Patagonia and Sonoita Creek.

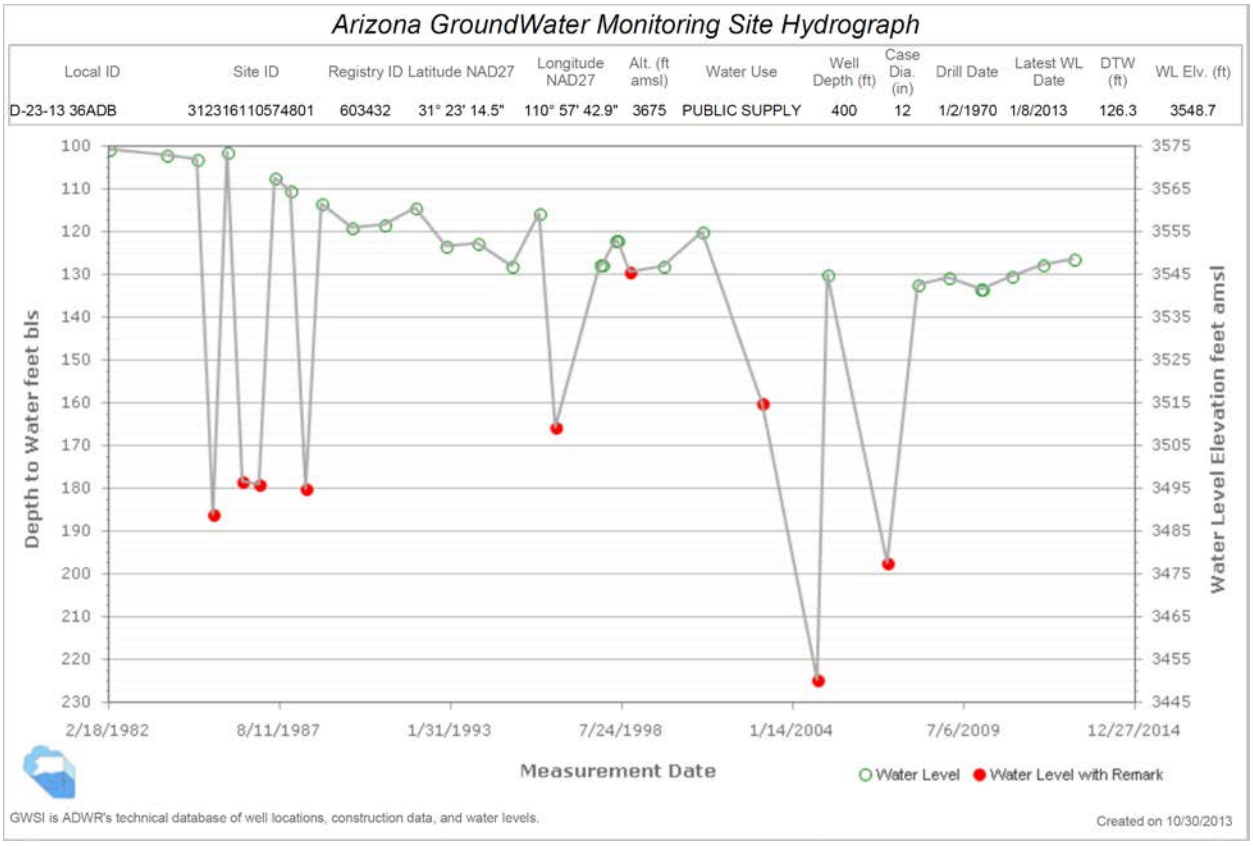


D-18-17 33ADA – Cienega Creek basin about 10 miles north of Sonoita just west of Cienega Creek.

Santa Cruz AMA- Basin and Range AMA's



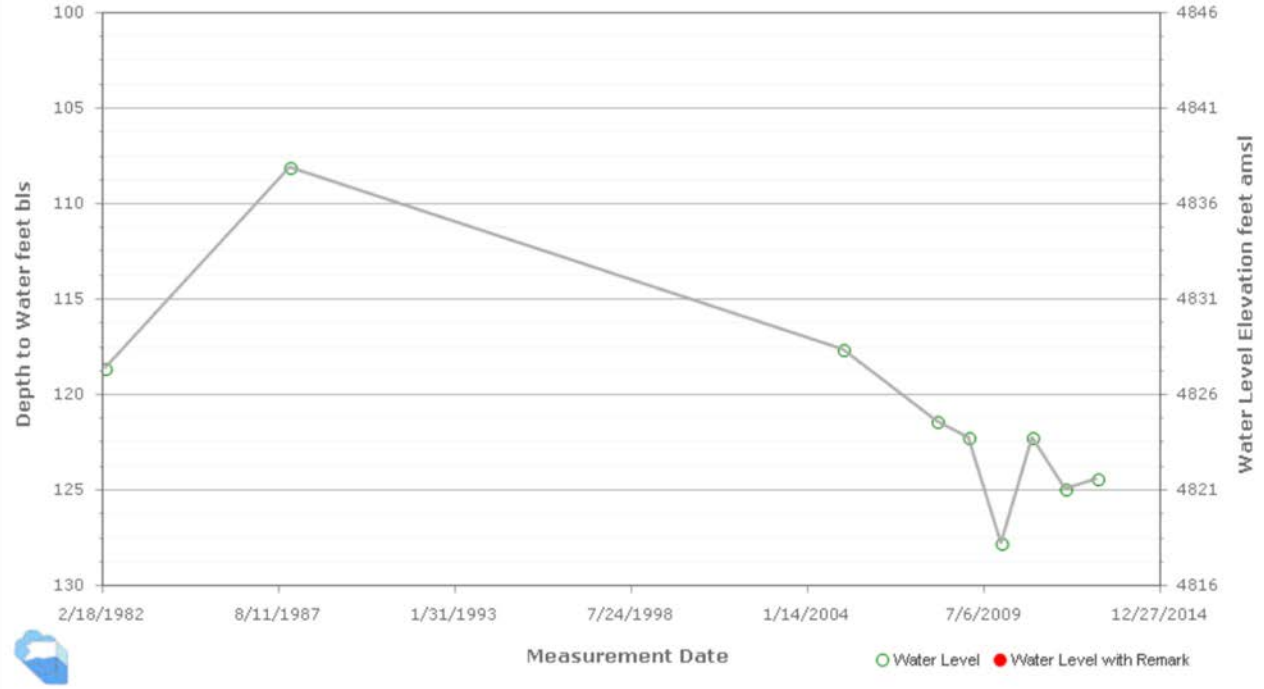
D-23-14 36BCB1 Santa Cruz AMA along Santa Cruz River at Highway 82 well field.



D-23-13 36ADB Santa Cruz AMA Portero Canyon well field area.

Arizona GroundWater Monitoring Site Hydrograph

Local ID	Site ID	Registry ID	Latitude NAD27	Longitude NAD27	Alt. (ft amsl)	Water Use	Well Depth (ft)	Case Dia. (in)	Drill Date	Latest WL Date	DTW (ft)	WL Elv. (ft)
D-23-17 10CBC2	312647110364101	624898	31° 26' 45.4"	110° 36' 40.7"	4946	STOCK	100	6		1/9/2013	124.4	4821.6



GWSI is ADWR's technical database of well locations, construction data, and water levels.

Created on 10/30/2013

D-23-17 10CBC2 -- San Rafael basin about 7 miles north of Lochiel and 1 mile west of Santa Cruz River.