Arizona's Next Century:
A Strategic Vision for Water Supply Sustainability

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

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[SECTION 1: INTRODUCTION]

Thanks to careful planning and continued leadership, Arizona has been successful in the management of its water resources for more than a century. Without the vision and foresight of early Arizonans like Carl Hayden and John Rhodes, we would not have the quality of life that we enjoy today. Following in that tradition of strategic planning and action, Arizona now must face its next challenge in water supply security and management.

As Arizona's 22nd Governor, I have built my policies on my "Four Cornerstones of Reform" to position Arizona as "a magnet for business relocation, and capital formation; a catalyst for the creation of new business and new jobs; a breeding ground for intellectual and educational achievement; a welcome home for future generations of committed Arizonans seeking to build their dreams; and a safe environment where families and individuals can enjoy life without undo fear for their personal safety." The cement that holds this all together is a firm foundation of long-term secure water supplies and a sound water management strategy that attracts and sustains Arizona's economic sectors and provides a stable and predictable environment in which to live.

To ensure Arizona's competitive advantage in the region, I have asked the Director of the Arizona Department of Water Resources to create a Strategic Vision for Water Supply Sustainability that will provide a solid foundation for Arizona's economic growth in its next Century, just as our great leaders did before us.

- ***Governor Janice K. Brewer***

FOREWORD

Arizonans should be proud of our long history of confronting our water supply challenges and successfully meeting the needs of our agricultural, industrial and domestic water users. Arizona has long demonstrated the resolve to take the necessary actions to ensure that sufficient and dependable water supplies are available for its long-term economic stability. While diverse, these actions have shared a common premise of being solution-oriented to meet not only the immediate needs of the state, but more importantly address future challenges the state would face.

Over the last five years, the Arizona Department of Water Resources (ADWR), in partnership with many in Arizona's water community has participated in the development of a comprehensive water supply and demand analysis for Arizona through the Water Resources Development Commission (WRDC). At the same time, ADWR and its partners have also been actively working with the U.S. Bureau of Reclamation (Reclamation) and the other six Colorado River Basin States (Basin States) to identify projected supply and demand imbalances on the entire Colorado River system, culminating in the *Colorado River Basin Water Supply and Demand Study* (Basin Study). Through the work of the WRDC and the Basin Study, we have identified long-term imbalances, which may result if no action is taken. Given the strong growth in the region, particularly in Arizona, these imbalances are not surprising. Even with the recent economic downturn, vibrant economic growth is expected to continue in the southwest. Our challenge is to explore and develop viable solutions to address these projected imbalances.

The process to meet these challenges has already begun on two fronts. First, in cooperation with Reclamation and the Basin States, ADWR (along with several Arizona stakeholders) is actively participating in a process to identify and analyze multiple Basin-wide strategies, including: demand management; reuse of reclaimed or recycled water; the viability of water transfers; alternative water management strategies (e.g., Water Banking in the Upper Basin); watershed management; and importation of water supplies from outside of the Colorado River Basin. Secondly, thanks to the foresight and leadership of Governor Brewer, we have initiated a parallel process within Arizona - starting with the development of this Strategic Vision - that identifies possible strategies and projects similar to those described in the Basin Study. While we will all have a part to play, much of what needs to be done to meet these imbalances is beyond the scope of what any individual may be able to accomplish alone. This Strategic Vision creates the framework for analysis of potential strategies and provides context for maximizing them to address the needs of multiple water uses.

This Strategic Vision for Arizona is the necessary next step in this process. We have completed the initial analysis of the problems we face and have organized the State into solution oriented "Planning Areas." The next logical step is to identify possible strategies to address the imbalances, not just walk away and leave it to individuals, industries and local communities to meet their future water needs in a vacuum. While many of the mechanisms necessary to address our future imbalances are available today, there are still limited supplies. As currently structured, it is largely left to individual entities and communities to try to obtain the supplies and finance the necessary infrastructure to put these to use. Additionally, increased competition for water supplies may lead to much higher costs to water users and rate payers and possible negative impacts to the areas from which supplies are derived. A comprehensive Strategic

Vision that identifies viable strategies will assist all water users in Arizona to come together to address many needs, as opposed to a less constructive and potentially divisive piecemeal approach.

However, just addressing the needs is not enough. As Arizona's policy leaders, we must also identify the priorities of the State in the arena of water development including, whether in-state supplies are to be the limit of Arizona's development, or if we should explore larger-scale importation (new water supplies from outside of Arizona) that has the potential to meet the water demands of multiple water users and secure our state's economy and quality of life into the future. Putting this strategy together gives policy makers an opportunity to comprehensively explore what is possible, and the pros and cons of a combination of efforts, rather than addressing these issues across the state on a project-by-project basis. This Strategic Vision is not intended to be a regulatory tool. Instead, it is intended to serve as a guide for our policy leaders to make informed decisions about: (1) where we want to focus our efforts, (2) if we want to further explore a suite of potential strategies, and (3) the potential economic consequences of action or inaction. The purpose of this Strategic Vision is to help guide Arizona through the coming decades on steps that Arizona can take to secure water supplies to meet current and anticipated demands and provide a stable economy for our future.

Sandy Fabritz-Whitney
Director
Arizona Department of Water Resources

EXECUTIVE SUMMARY
Arizona's Next Century: A Strategic Vision for Water Supply Sustainability

The Challenge

For over a century, Arizonans have faced challenges in ensuring that there are sufficient and sustainable water supplies and have successfully developed water supplies for agricultural, industrial and domestic uses. Arizona has aggressively taken the actions necessary to ensure that sufficient and dependable water supplies are available for its long-term economic stability. While diverse, these actions have shared a common premise of being solution-oriented, meeting not only the immediate needs of the State, but more importantly addressing the future challenges Arizonan's would face. Following in that tradition of strategic planning and action, Arizona now must face its next challenge in water supply security and management. We are at the crossroads of having to decide what actions we will take to meet those challenges.

Over the last five years, the Arizona Department of Water Resources (ADWR), in partnership with many in Arizona's water community has participated in the development of a comprehensive water supply and demand analysis for Arizona through the work of the Water Resources Development Commission (WRDC). At the same time, Arizona has also been actively working with the U.S. Bureau of Reclamation ("Reclamation") and the other six Colorado River Basin States (collectively, the "Basin States"), *(see Figure ES-1)* to identify projected supply and demand imbalances on the entire Colorado River system, culminating in the Colorado River Basin Water Supply and Demand Study ("Basin Study"). Through the work of the WRDC and the Basin Study, we have identified a long-term imbalance between available supplies and projected water demands over the next 100 years of up to 3 million acre-feet. Our challenge is to explore viable solutions to address this projected imbalance and initiate the action necessary to develop those solutions.

Figure ES-1. Colorado River Basin Study Area (Reclamation, 2012)

The process to meet these challenges has already begun on two fronts. First, in cooperation with Reclamation and the other Basin States, ADWR (along with several Arizona stakeholders) is actively participating in a process to identify multiple Basin-wide solutions including: demand management; reuse of reclaimed or recycled water; analyzing the viability of water transfers; analysis of alternative

water management strategies (e.g., Water Banking in the Upper Basin); watershed management; and importation of water supplies from outside of the Colorado River Basin. Secondly, at the request of Governor Jan Brewer, ADWR has initiated a parallel process within Arizona to develop a Strategic Vision that identifies possible strategies and projects to pursue to reduce these imbalances. This Strategic Vision creates the framework for analysis of potential strategies and provides context for maximizing them to address the needs of multiple water uses across the State.

This Strategic Vision for Arizona is a necessary first step in this process. We have completed the initial analysis of the challenges faced by Arizonans and have organized the State into twenty-two solution oriented "Planning Areas" *(see Figure ES-2)*. The next logical step is to identify possible strategies to address projected imbalances. While many of the mechanisms necessary to address our future imbalances are available today, there are still limited supplies. A comprehensive Strategic Vision that identifies viable strategies will assist all water users in Arizona to come together to address our needs.

Figure ES-2. Strategic Vision Planning Areas

History

While we reside in what some perceive as a harsh environment, those with great vision and leadership have harnessed the natural resources needed to support a thriving Arizona economy. This vision started well before statehood. First, beginning with the passage of the 1902 National Reclamation Act and the efforts of the Salt River Valley Water User's Association (SRP), over 200,000 acres of private ranching and farm lands in the Phoenix area was pledged as collateral for the construction of Roosevelt Dam in 1903, with a reservoir storage capacity of nearly 1.4 million acre-feet[1] (MAF) *(see Figure ES-3).* At the same time Central Arizona was harnessing the Salt River, development of the waters of the Colorado River was also taking shape, culminating over 50 years later, after a series of legal and political struggles, in the authorization of the Central Arizona Project (CAP) in 1968 (*see Figure ES-4*).

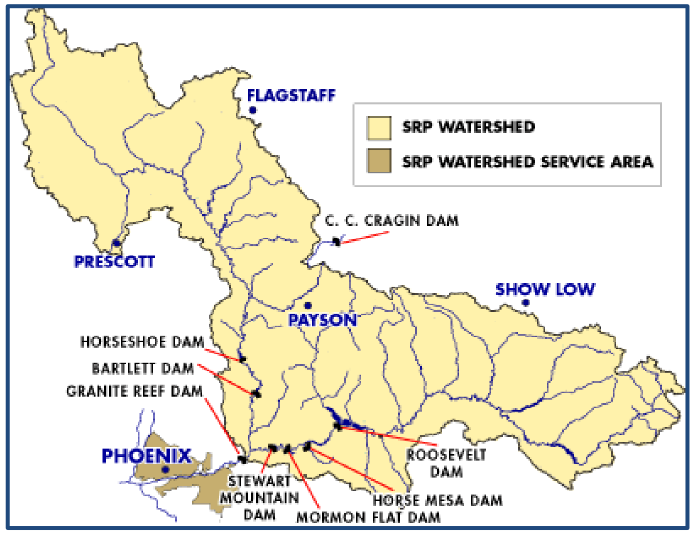

Figure ES-3. Salt River Project Reservoir System and Service Area (Courtesy of SRP)

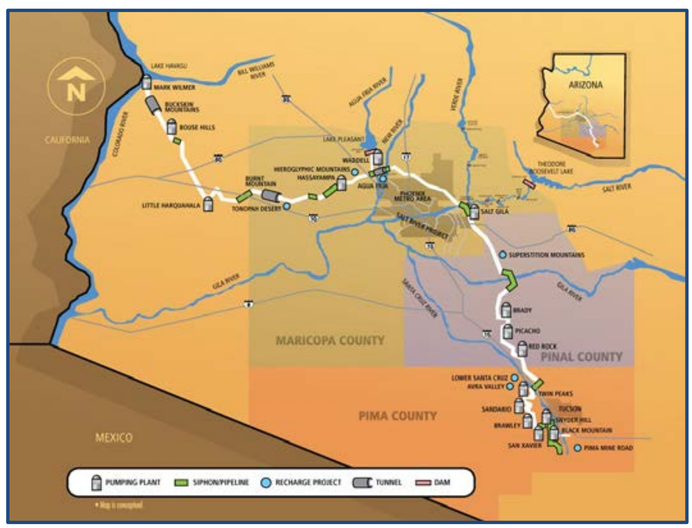

Figure ES-4. Central Arizona Project System (Courtesy of CAP)

For decades Arizona's groundwater supplies were managed through the Court's until 1980, when the Arizona Legislature adopted one of the most comprehensive groundwater management strategies in the U.S. – the 1980 Groundwater Management Act (GMA). The framework of the GMA is intended to protect existing water users and serve new uses with non-groundwater supplies, preserving the groundwater supply as for future shortages. The GMA established a timeline for reduction and elimination of groundwater pumping in certain areas of the State; designating Active

[1] From 1989 to 1996, the dam was modified by the US Bureau of Reclamation. In addition to raising the dam's height 77 feet in elevation, the modification included construction of two new spillways, installation of new outlet works, and power plant modifications, increasing its water conservation storage capacity by 20 percent.

Management Areas (AMA) and Irrigation Non-Expansion Areas (INA) to facilitate this process (*see Figure ES-5*).

Addressing the needs of Arizona's tribal communities was also an important part of Arizona's water management history. The State of Arizona and non-Indian water users have been working for decades to develop equitable distribution of Arizona's water supplies in cooperation with its tribal communities through settlement of these claims.

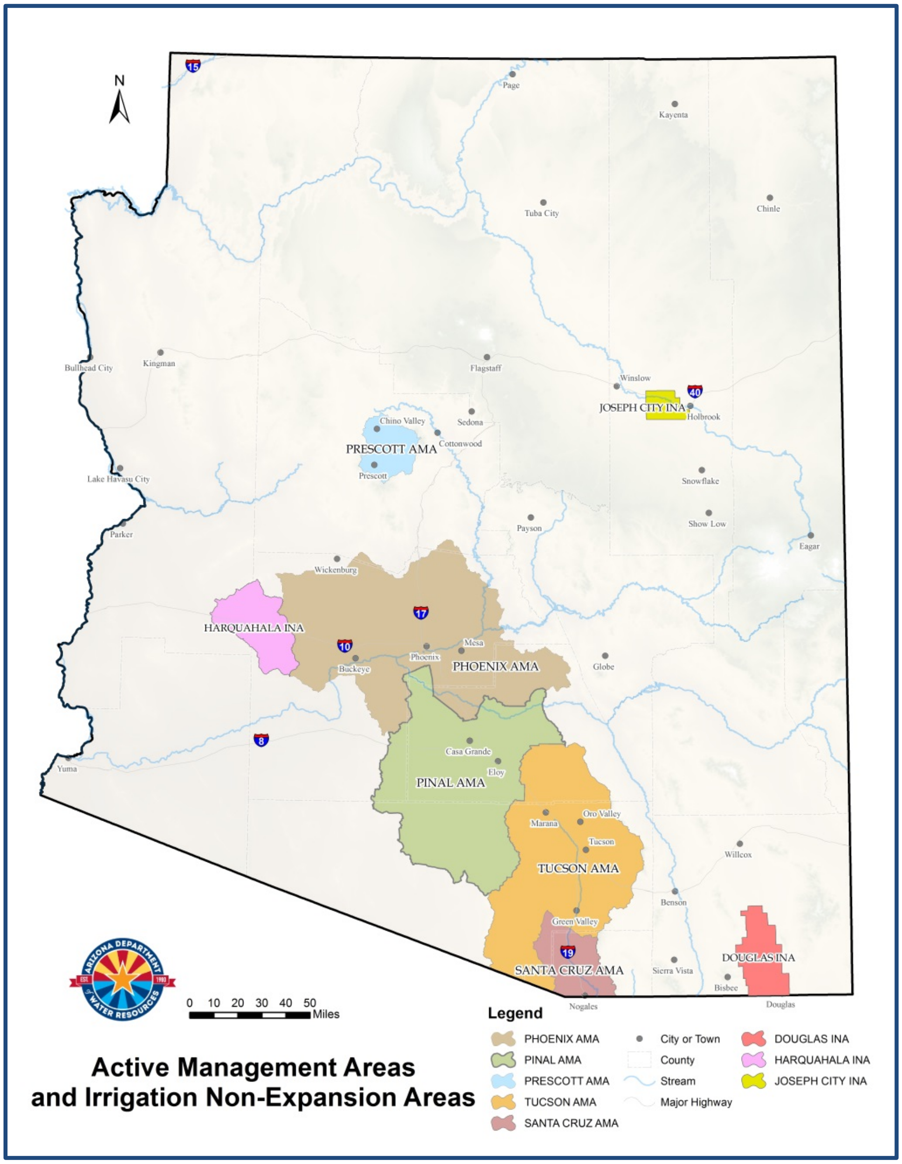

Figure ES-5. Active Management Areas and Irrigation Non-Expansion Areas

Water conservation and reuse of water supplies is the cornerstone of Arizona's water use history. Arizona leads the nation in water conservation and the reuse of treated wastewater (reclaimed water). Water conservation continues to be the foundation of Arizona's water management strategy. The State of Arizona and its citizens have achieved unparalleled water supply improvements through

implementation of conservation measures and practices that serve as a model for water managers throughout the world. Since the adoption of the GMA in 1980 and subsequent refinements to its mandatory water conservation requirements, Arizona has seen significant improvement in water use efficiencies, as illustrated in Figure ES-6, below.

Arizona, along with California, Florida, and Texas, also leads the nation in utilization of reclaimed water[2]. A significant portion of the reclaimed water produced in Arizona is reused for landscape irrigation, agricultural irrigation, power generation, irrigation of parks and schools and artificially recharged into groundwater aquifers. A portion of the reclaimed water is also discharged into the beds of rivers and streams, benefiting the environment by providing habitat for wildlife and adding aesthetic and economic value to Arizona's landscape.

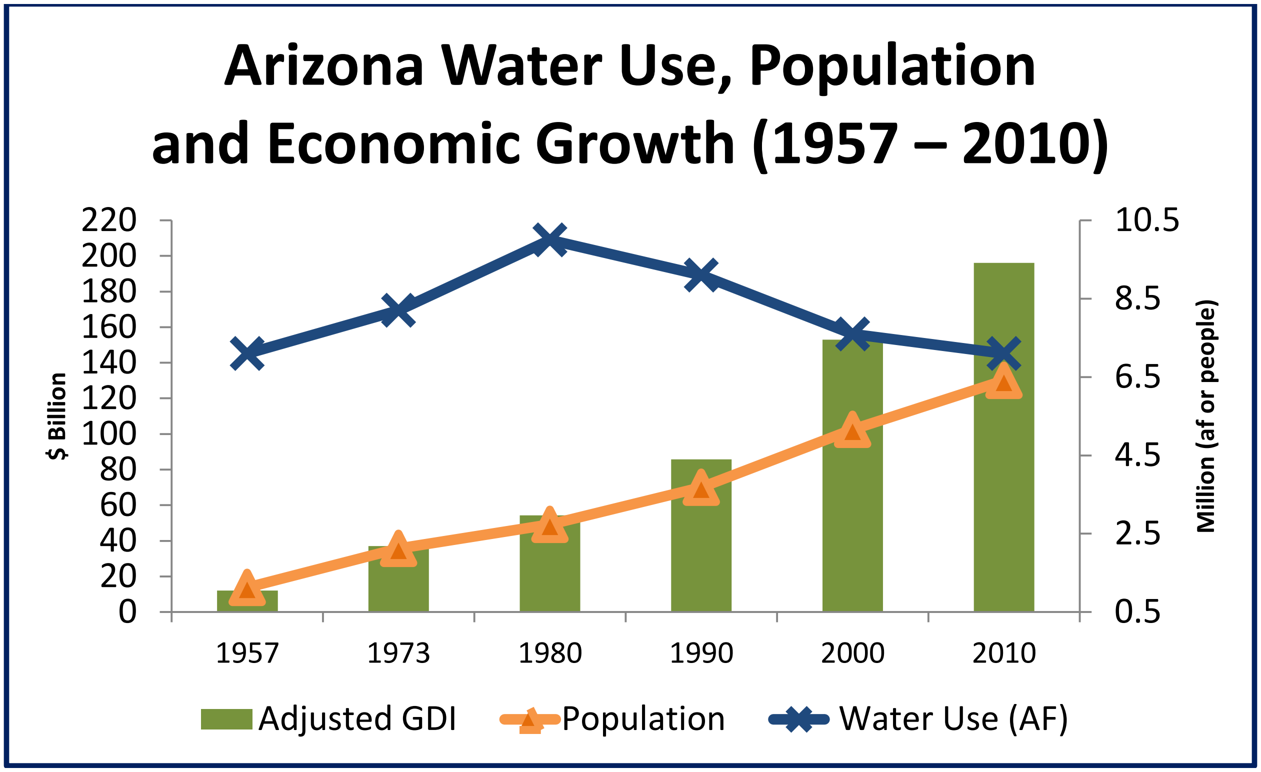

Figure ES-6. Arizona Water Use, Population and Economic Growth 1957 - 2010 (ADWR, 2013)

As development expanded throughout Arizona and as the State moved closer to full utilization of its diverse water portfolio, Arizonans adopted dynamic water management strategies to address the issues they encountered, including Underground Storage and Recovery and Water Banking of unused supplies, adoption of 100-year Assured Water Supply Rules for all new development, and the creation of the Central Arizona Groundwater Replenishment District (CAGRD) to meet the needs of communities without direct access to renewable water supplies.

[2] Water and Wastes Digest @ http://www.wwdmag.com/EPA-Releases-Updated-Version-of-Guidelines-for-Water-Reuse-article6636

The achievements outlined above serve as a guide for future planning as they are the result of strong commitments and significant investments in time and money to realize the benefits of the projects. Establishing and pursuing a vision for water security for future generations of Arizonans must begin well in advance of the need in order to ensure orderly development, avoid economic disruption, and protect the unique and precious environment that we all enjoy. Many of the elements of Arizona's water development history were shaped by creative public/private partnerships. Such arrangements are likely to become more common and necessary, as the federal government's role in water development projects continues to evolve.

Future Water Supplies & Demands

The current challenge facing Arizona is that, although the State has an existing solid water management foundation, water demands driven by future economic development are anticipated to outstrip existing supplies. Additionally, the availability of surface water supplies have been reduced in recent years as drought conditions have been experienced locally and throughout the Colorado River Basin. Questions about future climate conditions add additional uncertainty to our ability to maintain an appropriate balance between demands and supply. Water resource planning efforts are instrumental in the identification and evaluation of these challenges. Arizona has been actively evaluating future water supply and demand conditions for decades.

Every ten years, consistent with State statute, ADWR assesses water supply and demand conditions in each of the State's AMAs, primarily to evaluate the ability to achieve the management goals identified by the Legislature for each AMA under the GMA. In 2009 and 2010, in anticipation of the next Management Plan, ADWR developed a demand and supply assessment for each of the five AMAs to: (1) evaluate its current status and ability to achieve the statutory water management goals for these five areas and (2) to frame the discussions for alternative management strategies needed to meet and maintain those goals. Additionally, ADWR also produced the *Arizona Water Atlas* (Atlas) in 2010 providing water-related information on a local, regional and statewide level to frame and support water planning and development efforts. The development of the Atlas also spurred the development of a statewide water resources data repository housed at ADWR, which is continuously updated as water use information is reported and collected. These are on-going efforts that allow both for focus on specific regions of the State and provide past and present water use information.

Since 1980, Arizona has also developed, or partnered in, comprehensive and prospective statewide and multi-state planning efforts (a list of these efforts is identified in Appendix III of the Strategic Vision). More recently, the WRDC was an Arizona-only effort identifying projected future statewide water demands and available water supplies for the next 100 years. Estimates for population growth in Arizona for the years 2035, 2060 and 2110 are 10.5, 13.3 and 18.3 million people, respectively. Annual water demand is expected to grow from current levels of 6.9 MAF to between 8.2 and 8.6 MAF in 2035; between 8.6 and 9.1 MAF in 2060 and between 9.9 and 10.5 million acre-feet per year in 2110.

The Basin Study was developed to define current and future imbalances between projected demands and Colorado River water supply availability in the Colorado River Basin and the adjacent areas that receive water from the Colorado River, through 2060. This extensive study estimated that population within the study area is projected to increase from about 40 million people in 2015 to between 49.4 million and 76.5 million people under the slow growth and a rapid growth scenario, respectively. As a

result of this increased population, and factoring in Mexico's 1.5 MAF 1944 Treaty allotment and losses due to evaporation and system operations, projected demands in the Basin are anticipated to range between 18.1 MAF (slow growth scenario) and 20.4 MAF (rapid growth scenario). Over the past 10 years, the Colorado River's yield has averaged about 15.3 MAF annually. Comparing the median water demand projections to the median water supply projections, the long-term projected Basin-wide imbalance is estimated to be 3.2 MAF by 2060. The actual imbalance may be much larger, or could be slightly smaller, depending on the availability of water and actual growth experienced in the region.

Opportunities & Challenges

Arizona is characterized by widely diverse geographic zones, ranging from forested mountains to arid deserts. These areas have dissimilar climates and precipitation regimes, resulting in great variability in, and accessibility to, surface water supplies. Arizona is also geologically complex, which impacts the availability, quality and accessibility of groundwater supplies. Arizona is also unique in its land ownership patterns. Less than 18 percent of the land within the State is under private ownership. State Trust Land, administered by the Arizona State Land Department (ASLD) comprises almost 13 percent of the land, with the remaining 69 percent in either Federal or Indian ownership (*see Figure ES-7*). This ownership is also often fragmented, with Federal, State, and private land holdings assembled in a "checkerboard" fashion that further complicates the development and execution of comprehensive and cohesive land and water management strategies.

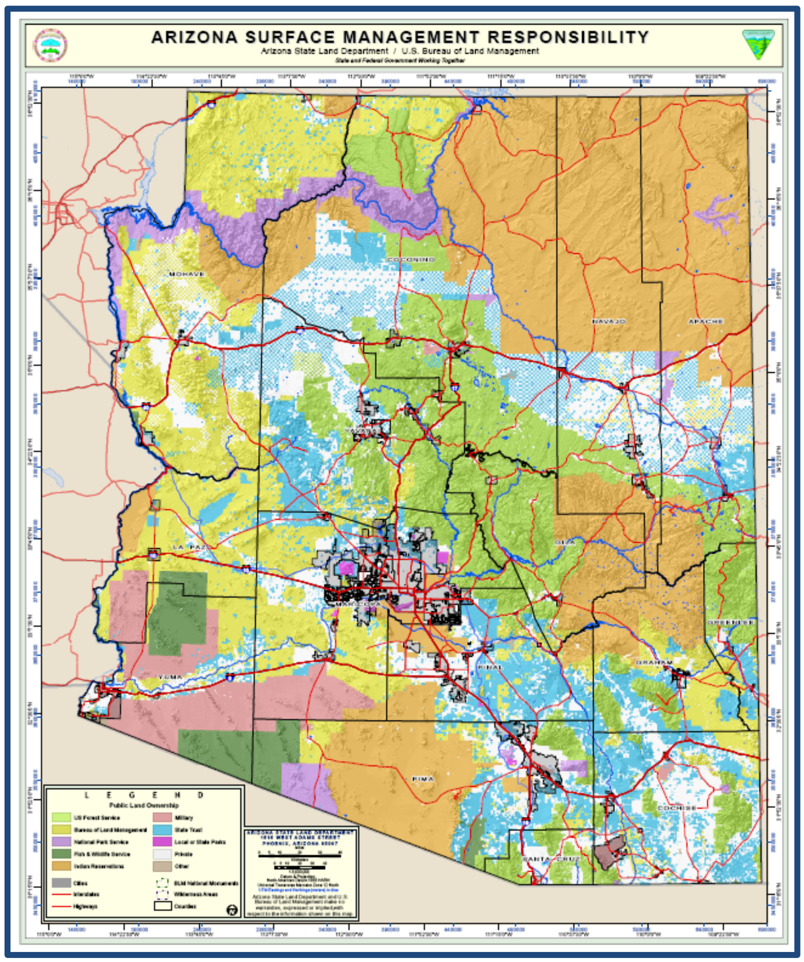

Figure ES-7. Arizona Land Ownership (Courtesy ASLD)

Another factor in the complexity of developing water supplies is the Arizona water law system, a complex mixture of State and federal laws, with groundwater and surface water largely regulated under separate statutes and rules. While the groundwater management system primarily applies inside designated AMAs and INAs, the surface water system (except for Colorado River supplies) is administered statewide. Colorado River supplies are managed in cooperation with the State, but contracts for Colorado River water are initiated through the US Secretary of the Interior and

administered by Reclamation. Reclaimed water is managed under a completely different set of regulations and policies, and its management framework was significantly influenced by case law[3]. This legal complexity adds to the challenge of ensuring that adequate supplies exist to meet the demands across the state.

Further adding to the legal complexities within the State are the on-going general stream adjudications of the Gila and Little Colorado Rivers. General stream adjudications are judicial proceedings to determine or establish the extent and priority of water rights. The Gila River and the Little Colorado River adjudications were initiated in 1974 and include water uses and claims by both state and federal entities. The State parties include municipalities, mines, utility companies, private water providers, water users' associations, conservation districts, irrigation districts, state agencies and individual water users that rely on water diverted from streams, lakes, springs, stored in reservoirs or stockponds, and withdrawn from wells. Within these proceedings, water rights are also being adjudicated for water uses on Indian reservations and federal lands including military installations, conservation areas, parks and forests, monuments, memorials, and wilderness areas. These water uses may include both surface water (non-Colorado River) and groundwater in certain instances. As of July 2013, there are 83,244 surface water claims in the Gila River Adjudication and 14,522 claims in the Little Colorado River Adjudication. While progress on the adjudication process has been complicated by the diversity of water users and claimants, the State has made significant progress in reducing uncertainty through execution of Indian Settlements resolving in whole or in part 13 of the 22 tribal claims through Court Decrees or negotiations culminating in Congressionally authorized settlements.

Over the next 25 to 100 years, Arizona will need to identify and develop an additional 900,000 to 3.2 MAF of water supplies to meet the projected water demands. While there may be viable local water supplies that that have not yet been developed, water supply acquisition and/or importation will be required for some areas of the State to realize their growth potential. Examples of these potential supplies are:

1) Non-Indian Agricultural Priority CAP water;
2) Reclaimed water/water reuse for which there is not yet delivery or storage infrastructure constructed to put it to direct or indirect use;
3) Groundwater in storage (both potable & brackish supplies);
4) Water supplies developed from revised watershed management practices;
5) Water supplies developed through weather modification;
6) Water supplies developed from large-scale or macro rainwater harvesting/stormwater capture; and
7) Importation or exchange of new water supplies developed outside of Arizona (e.g., ocean desalination).

Strategic Vision

Arizona could be facing a water supply imbalance between projected demands and water supply availability approaching 1 million acre-feet in the next 25 to 50 years. In many portions of the State, this short term imbalance can likely be solved with enhanced management of locally available water supplies. However, there is still a need to develop the financing to construct the infrastructure

[3] *Arizona Public. Service Co. v. Long*

necessary to accomplish this. The imbalance is projected to increase by an additional 2.3 MAF by the year 2110. The availability of local water supplies to meet these needs will vary based on the distribution and intensity of the demands throughout each region of the State. The stresses imposed by these imbalances would be experienced by all water using sectors in the State and would likely have undesirable environmental consequences.

Local water supplies may not be sufficient to address these longer term needs and more options must be explored and evaluated, including importation of new water supplies from outside of Arizona. Pursuit of long-term options will require sustained investment and commitment by Arizona's policy and business leaders. In order to avoid economic disruption, these efforts must begin immediately to ensure the long-term solutions are in place in advance of the need and the environment that makes Arizona unique is adequately and appropriately protected.

Regional Strategies

No single strategy can address projected water supply imbalances across the State. Instead a portfolio of strategies needs to be implemented dependent on the needs of each area of the State. It is very important to recognize the uniqueness of the various regions throughout the State and the varying challenges facing those regions. A more thorough regional overview and evaluation of the water supply needs is required for each of the twenty-two "Planning Areas" within Arizona and is contained in Section III of the Strategic Vision. These Planning Areas (*see Figure ES -2*) have been identified based on possible short-term and long-term strategies available to meet the projected water supply imbalances. Table ES-1, below, highlights the portfolio of strategies that have been identified and the applicability to each of the Planning Areas. Many of the necessary planning efforts are well underway in some regions.

Statewide Strategic Priorities

In analyzing all the strategies on a regional basis it became clear that there are specific measures that have widespread potential benefit to all Arizonans. Strategic priorities are identified below which ADWR believes will move Arizona forward through its next century. Additionally, action items have been identified for the first 10 years following the submittal of this report including a requirement for the continued review and update of this report every 10 years.

The identified statewide strategic priorities are:

1) <u>Resolution of Indian and Non-Indian Water Rights Claims</u>

Arizona has been successful in resolving, either in whole or in part, 13 of 22 Indian water rights claims, providing substantial benefits to both Indian and non-Indian water users. However, the general stream adjudications, which began in the 1970s, remain incomplete. Completion of the general stream adjudication will result in the Superior Court issuing a comprehensive final decree of water rights. Until that process is complete, uncertainty regarding the nature, extent and priority of water rights will make it difficult to identify all the strategies necessary for meeting projected water demands. ADWR believes that options need to be developed by the State to accelerate this process. Creation of a Study Committee to develop options in a short time frame 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. Development of options could initially focus on conceptualization of water rights administration in a post-adjudicated Arizona. This will streamline the Court and ADWR's effort to

collecting and evaluating only that information what will assist in administering the final water rights decrees.

2) Continued Commitment to Conservation and Expand Reuse of Reclaimed Water

Conservation is the foundation of sustainable water management in our arid State. The continued commitment to using all water supplies as efficiently as possible is necessary to stretch our existing water supplies and has delayed the need to acquire other, more expensive, supplies. Additionally, many non-potable uses are currently being met by reclaimed water including: landscape irrigation of parks and golf courses; agricultural irrigation; and streamflow augmentation benefitting ecosystems. Reclaimed water is produced consistently throughout the year, with limited seasonal fluctuation. Using reclaimed water limits use of potable water for non-potable purposes and saves potable water for drinking water supplies. However, as demands increase and water supplies become more stretched, the need to explore and invest in direct potable reuse for drinking water supplies will become necessary.

3) Expanded Monitoring and Reporting of Water Use

Metering and reporting across the State would serve to support and enhance analysis of current hydrologic conditions. However, monitoring of water use outside of the AMAs and INAs is limited. Data collection is a crucial element of the development of groundwater models, which have proven to be invaluable tools throughout the State in developing more thorough understanding of hydrologic systems and evaluating future conditions and potential impacts of new uses and/or alternative water management strategies.

4) Identifying the Role of In-State Water Transfers

A source of significant controversy across the State, in-State water transfers have been the focus of much debate throughout Arizona's history. A comprehensive analysis of water transfer is needed in Arizona. Evaluation of long-term versus short-term transfers may actually provide insight into how water transfers can be developed to protect or even benefit local communities. Lessons from other western states that have adopted more market-based water right transfer models may be worthy of review as part of this analysis.

5) *Supply Importation – Desalination*

Importation of water from outside of Arizona will likely be required to allow the State to continue its economic development without water supply limitations. Supplies derived from ocean or sea water desalination can be imported directly into Arizona to meet the water needs of municipal and industrial water users, while at the same time providing aesthetic, recreational and ecological benefits. Alternatively, desalination can be done in partnership with other Colorado River water users in exchange for water from Lake Mead. Potential partners for seawater desalination include higher priority Colorado River entitlement holders in Arizonan and California, the State of California, or Mexico. Projects of this magnitude are expensive and energy intensive, although unit capital and operating costs have significantly reduced as technology has improved and are comparable to water rates in other parts of the country. More importantly, because of the need to identify partners and develop agreements, such projects will require a significant investment of time – up to 20 years to bring to fruition. Because of the

time it takes to develop these projects, and the more pressing need for water supplies in certain parts of the State, exploration of this strategy should begin immediately.

6) <u>Develop Financing Mechanism to Support Water Supply Resiliency</u>

The strategies identified above, both statewide and regional, will require capital investment. Some areas of the State need immediate assistance in developing water projects, specifically in portions of rural Arizona. Unfortunately, these are areas where limited populations cannot finance the required water infrastructure. The Water Resources Development Revolving Fund was created by the Arizona State Legislature to provide financial backing for these communities, but has not been funded to date. Seed money for this revolving fund will be very important to meet the immediate needs of rural communities and provide long-term water supply security for many Arizonans.

Financing of large-scale projects is another issue. For many years, the water community has been attempting to develop options for funding water supply acquisition and infrastructure development. These conversations and analyses have largely been conducted in the absence of substantial financial expertise and have achieved limited success. It is time to elevate this conversation and address Arizona's future water supply needs and only Arizona's community, political, and business leaders are capable of garnering financial resources and mechanisms necessary to meet these needs. While the water supply needs may not be immediate, addressing the financing of future large-scale water projects needs to begin as soon as possible to ensure Arizona's industries and citizens have secure water supplies into the future.

10-Year Action Plan Outline

- Legislate Strategic Vision update every 10 years (Year 1)
- Begin Discussions on Ocean Desalination (Year 1)
  - Exchange Options
    - California
    - Mexico
  - Direct Options
    - Mexico
- Resolve ADOT Right-of-Way Issues for utilities (Year 1)
- Establish Adjudication Study Committee (Year 1)
- Begin Discussions on Water Development Financing (Year 2)
  - Immediate Needs for Water Resources Development Revolving Fund for rural Arizona
  - Long-Term Needs for Large-Scale water importation projects
- Remove current statutory limitation (*A.R.S. § 45-801.01(22)*) on the ability to receive long-term storage credits for recharging reclaimed water beyond 2024 (Year 2)
- Review Legal and Institutional Barriers to Direct Potable Reuse of Reclaimed water – develop and implement plan for resolution (Year 3)
- Review and implementation of Adjudication Study Committee Findings (Year 3)
- Develop and Begin Implementation of Direct Potable Reuse of Reclaimed Water Public Perception Campaign (Year 4)

- Begin discussions with New Mexico on an interstate cooperative program for watershed management/weather modification in the Upper Gila watershed (Year 4)
- Resolve Remaining Indian Settlements (Year 1 - 10)
- Resolve General stream Adjudication (Year 5 - 10)

Table ES-1. Planning Area Strategies

Strategy	Applicable Planning Area(s)*	Supply Limitation	Drought Resiliency	Implementation Challenge	Timeline**
Reclaimed Water Reuse	**1, 3, 5, 6, 9, 14, 15, 17, 18, 19, 20** *10, 16*	Derivative Supply Increases w/Growth	Yes	Low to Moderate Cost Perception of Direct Use	C/EEP to Short
Conservation	**ALL Planning Areas**	Potential Limited by Existing Programs	Yes	Low	C/EEP to Short
Weather Modification	**3, 5, 9, 16, 17,19**	Limited	Limited	High NEPA Limited Local Data	Med
Watershed/Forest Management	**1, 3, 5, 9, 14, 16, 17, 18, 19**	Limited	Some	High NEPA	Med
Expanded Monitoring & Reporting of Water Use	**ALL Planning Areas**	N/A Assists in Managing Existing Supplies	N/A	Moderate Consent of Unregulated Parties Required	Short
Resolution of Indian and Non-Indian Water Rights Claims/Settlement Implementation	**1, 3, 4, 9, 10, 12, 13, 14, 16, 17, 18, 19, 22** *5, 6*	N/A Reduces Supply Uncertainty	Supply Dependent	High Uncertain Federal Funding Consensus among Tribal Parties	Med to Long
Increased Access to Locally Available Groundwater (Potable & Brackish) & Enhanced Recharge	**1, 3, 5, 9, 14, 15, 18, 19** *4, 10*	Moderate Need Additional Studies to confirm	Yes Short Term Drought	Moderate Securing Supplies & ROW Access	Short to Med
Local Water Supply Study – Groundwater System Analysis/Modeling	**1, 2, 4, 6, 9, 10, 11, 14, 15, 17, 20, 22** *3, 5,19*	N/A Assists in Managing Existing Supplies	Gain Local Knowledge of GW/SW Link	Low - Moderate But Resources and Data Collection Needed	Short to Med
Local Water Supply Management	**6,19**	N/A	Supply Dependent	High Need Local Support	Med
Firming of Low Priority Colorado River Supplies	**3, 7, 20**	Limited by Available Resources	Yes	Low - Moderate Existing Authority But Resources Limited	C/EEP to Short
Importation – Instate SW or GW	**3, 5, 16, 19**	Limited by Available Resources	Supply Dependent	Moderate – High Some GW already avail. Public Opposition Likely	Med to Long
Importation – Desal Exchange	**3, 7,18, 19** *5*	Limited by Exchange Opportunities and Infrastructure	Exchange Supplies Limited	High Securing Supplies & ROW NEPA	Long
Importation – Desal Direct Use	**3, 18, 19** *5*	Supply Unlimited Economics will drive capacity	Yes	High Securing Supplies & ROW NEPA	Long

Planning Area Key

ID	Name
1	Apache
2	Arizona Strip
3	Basin & Range AMAs
4	Bill Williams
5	Central Plateau
6	Cochise
7	Colorado River Mainstem – North
8	Colorado River Mainstem – South
9	East Plateau
10	Gila Bend
11	Hassayampa/Agua Fria
12	Lower Gila
13	Lower San Pedro
14	Navajo/Hopi
15	Northwest Basins
16	Roosevelt
17	Upper Gila
18	Upper San Pedro
19	Verde
20	West Basins
21	West Borderlands
22	Western Plateau

Recommended Implementation Schedule:
C/ EEP = Continuation/Expansion of Existing Programs
Short = Short-Term (1-5 yrs)
Med = Medium- Term (5 – 15 yrs)
Long = Long-Term (> 15 yrs)

* Applicable Planning Area – **BOLD** are areas where strategy is recommended – *Italicized* are areas where strategy could be utilized but not a primary option.

Conclusion

Just as many of Arizona's greatest historic accomplishments have been directly linked to water, Arizona's future success is tethered to how effectively we continue to manage our water resources and develop new water supplies and infrastructure. Yet, our present success cannot sustain Arizona's economic development forever and we must continue to plan and invest in our water resources. The diversity, variability and complexity that are unique to Arizona make developing water supply strategies difficult. In some places, there may be local water supplies that that have not yet been developed. However, it is now clear that water supply acquisition and/or importation will be required for some areas of the State to realize their growth potential. While there are local areas that require more immediate action, the State as a whole has the good fortune of not facing an immediate water crisis. Now is the time to begin addressing this challenge by implementing this Strategic Vision for Arizona's water future. **The lack of an immediate problem increases the potential for inaction, running the risk of procrastination and not sufficiently motivating ourselves to plan and invest in our future.** Governor Brewer's foresight in calling for the development of a Strategic Vision for Water Supply Sustainability for Arizona is essential to guide and ensure our economic stability into the next century.

[SECTION 2: STRATEGIC VISION]

ARIZONA'S HISTORICAL SUCCESSES IN WATER MANAGEMENT

Water is the foundation, not only for long-term economic stability, but also for securing the success of generations of future Arizonans. Strong, forward-looking, leadership at the highest levels of State government on water issues is vital to ensure a stable future for our citizens. The Arizona Department of Water Resources (ADWR) is the logical leader in initiating this discussion and developing a comprehensive foundation to work from in this process.

Arizona has a long history of developing pro-active solutions to the challenges of developing water supplies in our arid state. The support and commitment of our current political leaders is crucial to continuing to meet those challenges *(see Appendix I – Timeline History of Arizona Water Management)*. While we reside in what some perceive as a harsh environment, those with great vision and leadership have harnessed the natural resources needed to support a thriving Arizona economy. This vision started well before statehood. Below is an overview of just a few of those achievements, which not only can serve as a guide for future planning, but will also provide a sense of the significant time and commitment required to realize the benefits of new projects. This is important to illustrate because although large-scale importation projects may not be needed until sometime in the future, the planning and politics of constructing such projects or water supply benefits of implementing management approaches can take decades to accomplish. Much of Arizona enjoys the benefit of secure water supplies today, in large part due to the vision and efforts of its past leaders. Establishing and pursuing a vision for water security for future generations of Arizonans must begin well in advance of the need to ensure orderly development, avoid economic disruption, and protect the unique environment that we all enjoy.

<u>Taming the Salt River</u>

In the late 1860's early settlers in the Phoenix area were dependent primarily upon the unregulated flow of the Salt River through diversions and canals to sustain agricultural development. The river was unpredictable - prone to both extreme flooding and droughts. Efforts to dam the river to provide more consistent and reliable supplies were impeded by the inability to finance the construction of a dam on the river (estimated at the time to cost approximately $5,000,000). A series of droughts in the 1890s and floods in the early part of the 20th century, however, highlighted the need to control the river.

With the passage of the National Reclamation Act of 1902[4], funding for projects with low-interest federal loans paved the way for the incorporation of the Salt River Valley Water Users' Association (SRP) the following year, becoming the first multipurpose project under the new Act. In 1903, over 200,000 acres of private ranching and farm lands in the association were pledged as collateral for the construction of Roosevelt Dam with a reservoir storage capacity of nearly 1.4 million acre-feet[5,6] (MAF), located approximately 76 miles northeast of Phoenix.

[4] Benjamin Fowler, an Arizona businessman, went to Washington D.C. to lobby for the federal government for this new law to find a way to finance the dam in Arizona.

[5] One acre-foot is 325,851 gallons or approximately enough water to provide for approximately two families of four living in a single-family home for one-year.

[6] From 1989 to 1996, the dam was modified by the US Bureau of Reclamation. In addition to raising the dam's height 77 feet in elevation which increased its storage capacity by 20 percent, the modification included construction of two new spillways, installation of new outlet works, and power plant modifications.

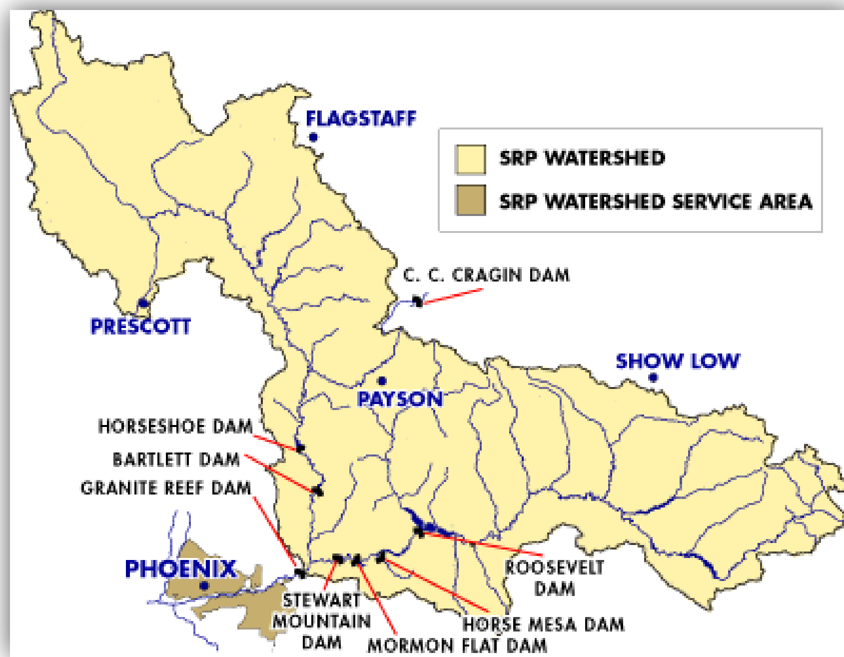

Figure 1. Salt River Project Watershed and Service Area (SRP)

Although the construction of Roosevelt Dam was SRP's most visible and costly component, an integral part of the project was also the construction and improvement of a system of canals designed to distribute the water from the Salt River among the various members living in the valley. As construction began, water rights to the Salt River in the Phoenix metropolitan area were settled in *Hurley v. Abbott (1910)*[7]. The decision, known as the Kent Decree in recognition of the presiding judge, Edward H. Kent, was a landmark in water law and still serves as an integral part of the water management structure in Arizona today. Between 1923 and 1945, five additional dams were constructed on the Salt and Verde Rivers to increase the storage capacity to greater than 2.5 MAF on the system and to generate hydropower (*see Figure 1*). Today, SRP supplies power to more than 970,000 retail customers in three Arizona counties, including most of the metropolitan Phoenix area. Integrated operation of the six reservoirs on the Salt and Verde Rivers, as well as the Granite Reef Diversion Dam and its system of canals, makes SRP an important provider of water to the Phoenix area. SRP annually delivers approximately 1 MAF of water to the Phoenix area through an extensive system of reservoirs, wells, canals and irrigation laterals and manages a 13,000-square-mile watershed. Additionally, SRP operates the C.C. Cragin Reservoir (formerly known as Blue Ridge Reservoir[8]), located on the Mogollon Rim which, in the near future, will provide renewable water supplies to the Town of Payson.

Development of the Colorado River

At the same time central Arizona was harnessing the Salt River, development of the waters of the Colorado River was also taking shape. Modern use of Colorado River water for irrigation began in the late 1800s when water was diverted for use in California's Imperial Valley. By 1901, some 100,000 acres of farmland were irrigated with Colorado River water in the Imperial Valley. As settlers and farmers in southwestern Arizona, southeastern California and the Mexicali Valley in Mexico were expanding their farming operations, rapid development in the Los Angeles basin was increasing the need for long-term water supplies. But, like the Salt River, the Colorado River was prone to highly variable and sporadic

[7] No. 4564, Decision and Decree, March 1, 1910
[8] Blue Ridge Reservoir was built by the Phelps Dodge Corporation in 1965 to provide water for its mining operations. SRP acquired the reservoir in 2005 as part of the Gila River Indian Community Water Rights Settlement approved by the 2004 Arizona Water Settlement Act to help facilitate the settlement of the Community's water rights claims.

flow regimes. From 1905 to 1907, floods impacted communities along the River, making continued reliance on its flows unpredictable.

In order to deliver Colorado River water to the Imperial Valley, water had to be diverted south of the Mexican border through an old overflow channel of the River to bypass a ridge of sand hills separating the Imperial Valley from the Colorado River. To accommodate this diversion, Mexico demanded the right to take up to one-half of the diverted water. California preferred to construct a US only canal as the solution to having to share water supplies with the Mexican farmers. Farmers in the Imperial Valley could not come up with the finances necessary for such a project and worked for years to convince Congress to construct a new aqueduct. It was not until Los Angeles got interested in augmenting its water supplies that significant progress was made. In 1920, California interests joined with Arthur Powell Davis, nephew of the famous explorer John Wesley Powell and Director of the US Interior Department's Reclamation Service (now the Bureau of Reclamation), who supported the idea of a large dam on the Lower Colorado River to help expand the west.

The year 1922 proved to be one of the most important years in the development of the Colorado River. Even before Los Angeles entered the picture, leaders in the Colorado River Basin States outside of California were becoming concerned about the rapidly expanding uses in the state that contributed the least amount of runoff to the River. In February of 1922, the US Interior Department issued the Fall-Davis Report[9], which recommended construction of an "All-American Canal", a storage reservoir "at or near Boulder Canyon," and the development of hydroelectric power to repay the cost of the dam. In April of that same year, Congressman Phil Swing from the Imperial Valley and Senator Hiram Johnson of California introduced a bill to implement the recommendations contained in the Fall-Davis Report. Then, in June of 1922, the US Supreme Court, in *Wyoming v. Colorado*, found that the doctrine of prior appropriation applied to surface water rights regardless of state lines. The doctrine of prior appropriation was the cornerstone of western water law which gave legal entitlement to the first person using water-"first in time, first in right" – and was recognized within each of the seven Colorado River Basin States as the basis for the appropriation and use of surface water[10]. Prior to this decision, it was uncertain whether the doctrine of prior appropriation applied to users in two or more states on a common river system. The outcome of this case made it clear that California, which was developing faster in both population and political power than any other area in the west, could potentially acquire rights to most of the water of the Colorado River to the detriment of the slower-growing states. As a result of the Supreme Court's decision and rapid development in California, the states in the Upper Colorado River Basin were forced to oppose all reclamation projects in the Lower Colorado River Basin until their own interests were safeguarded.

Prior to the events in 1922, Congress had already authorized the seven Basin States to negotiate a compact to divide the water between the seven states. However, representatives from each state and Secretary of Commerce Herbert Hoover, representing the federal government, were unable to reach an agreeable division between the individual states. Instead, they did reach agreement to equally divide the River [11]between the Upper and Lower Basin. The resulting 1922 Colorado River Compact (Compact) apportioned 7.5 MAF each to the Upper Basin (Colorado, New Mexico, Utah, Wyoming and a portion of

[9] The Fall-Davis Report, named for Secretary of the Interior Albert Fall and Arthur Powell Davis; who was now head of the Reclamation Bureau
[10] In 1864, the first Arizona Territorial Legislature adopted the Howell Code, which established the doctrine of prior appropriation for surface water in Arizona– "First in Time, First in Right."
[11] At this time the Colorado River was assumed to have an average annual flow of approximately 17 MAF.

Arizona) and Lower Basin (Arizona, California and Nevada) states, with a volume reserved for a future treaty with Mexico (*see Figure 2*).

While the states reached an agreement in the negotiations of the Compact, internal politics in Arizona would set the stage for years of controversy, litigation and uncertainty. The Compact faced tremendous opposition in Arizona; due in large part to the inability to secure a volumetric water supply for Arizona and political influences in Arizona who had a vision for utilization of the Colorado River which did not include sharing the River with the other states. As a result, Arizona did not adopt the Compact for 22 years. However, while Arizona sat in isolation, California continued its development of the water supplies of the Colorado River.

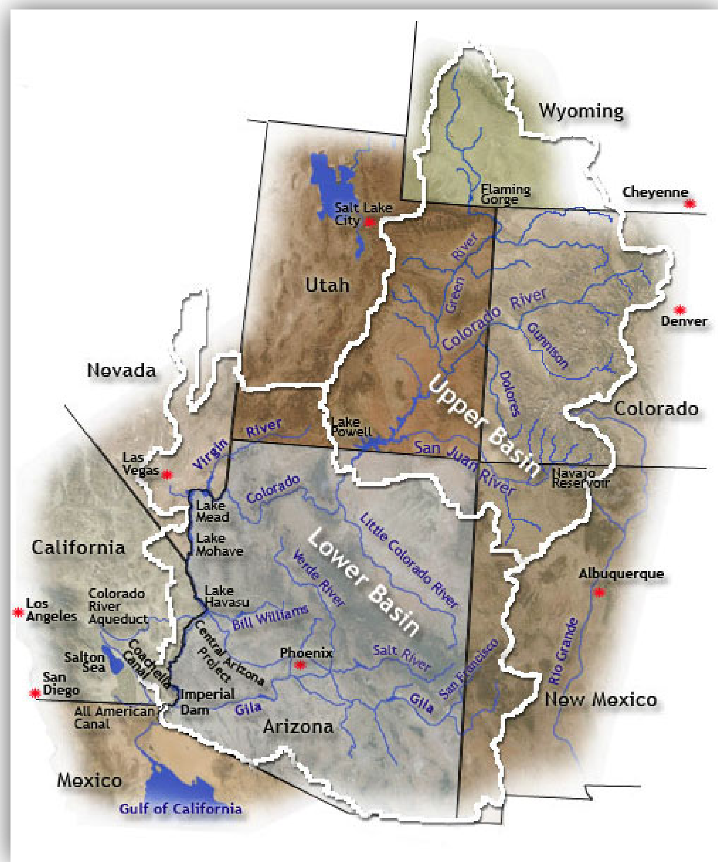

Figure 2. Colorado River Basin (Reclamation)

The Boulder Canyon Project Act was enacted in 1928 without Arizona's approval. It provided for the construction of Boulder Dam (renamed Hoover Dam after Herbert Hoover) on the Colorado River at the Arizona-Nevada border and the All-American Canal in California, paving the way for a more stable and certain future for water users in the Lower Basin.

While each state in the Colorado River Basin continued to develop their supplies, central Arizona, like Los Angeles and Denver, recognized that there was going to be a need to secure long-term water supplies from the Colorado River to ensure economic development. After years of political challenges, Arizona made application to the federal government in 1939 for a contract for the delivery of Colorado River water to secure its entitlement. This was done as Arizona realized its position was becoming increasingly tenuous as a treaty with Mexico was about to be negotiated by the US Department of State (State Department). In 1944, the US and Mexico agreed on the terms of a treaty providing 1.5 MAF of water from the Colorado River to Mexico. Arizona also promptly ratified the Colorado River Compact and signed a contract for delivery of 2.8 MAF of water allotted to the State in the Boulder Canyon Project Act of 1928.

With ratification of the Compact and execution of the delivery contract, Arizona had finally recognized the status of the Colorado River as an interstate river and the authority of the federal government to allocate its waters. These acts set the stage for development of this water supply for Central Arizona.

During this time, California was continuing to increase its use of the River and would prove to be a major hurdle to fulfillment of Arizona's vision for its future prosperity.

In 1946, the Central Arizona Project Association was formed to educate Arizonans about the need for a Central Arizona Project (CAP) and to lobby Congress to authorize its construction. Arizona Senators Ernest McFarland and Carl Hayden introduced the first bill to authorize the CAP in 1947. It would take another 21 years, including 11 years of legal battles with California, before this project would be realized. Through this entire period California continued to increase its reliance on this supply and, with its large and expanding Congressional delegation, fought the passage of a CAP bill.

Arizona filed suit in the US Supreme Court (*Arizona v. California*) in 1952 to secure its legal entitlement to Colorado River water. In the proceedings, California argued that, not only was Arizona already using its Colorado River entitlement via its tributaries, specifically the Gila River, but that because of Arizona's use of the Gila River, California was entitled to an additional 1 MAF from the mainstem of the Colorado River. After a significant shift in legal strategy, Arizona argued that its tributaries were separate from the Colorado River and the rights that Arizona had acquired to the waters of the Colorado River. Furthermore, Arizona claimed that rights to the Gila River were acquired prior to the Compact and were protected as "perfected rights"[12] under Article VIII of the Compact. Specifically, Arizona's legal argument was solidified in the language and the legislative intent of the 1928 Boulder Canyon Project Act, which recommended an allocation of 2.8 MAF of mainstem Colorado River water to Arizona *plus* the waters of the Gila River that was shared with New Mexico.

In 1963, the US Supreme Court upheld Arizona's claim[13]. The Court affirmed that the Boulder Canyon Project Act of 1928 divided the mainstem flow of the Colorado River between the Lower Basin States, with 2.8 MAF per year going to Arizona, 4.4 MAF per year going to California and 300,000 acre-feet per year going to Nevada. Further, the Court affirmed that "the tributaries are not included in the waters to be divided but remain for the exclusive use of each State[14]". This element of the decision was vital for any future CAP as there would not likely have been enough water remaining in Arizona's Colorado River apportionment to justify the construction of the project had the Court found that the use of the Gila River (approximately 1 MAF) was part of Arizona's apportionment.

With its victory in the US Supreme Court, the battle for the CAP went back to Congress. It would take eight more years to get a bill through Congress and, although Arizona's dream of a CAP would become a reality, it would come at a large cost in the face of California's political strength in Congress. Several issues arose in the ensuing years that influenced the framework of the authorizing legislation for the CAP, specifically:

1) California's ultimatum that their support of the project required receipt of its full 4.4 MAF apportionment during shortages, essentially giving California a priority over the CAP;
2) A study released by the Upper Basin States that showed insufficient water supplies available to justify the project; and
3) Growing opposition to the construction of two new dams proposed in the Grand Canyon to supply the power required for the project.

[12] Meaning the use was in place prior to 1922 when the Compact was signed.
[13] *AZ v. CA.* 373 U.S. 546 (1963)
[14] Opinion in *AZ v CA*, 1963

For many years during the discussions on the CAP, the source of power to operate the project was from two proposed dams to be located in the Grand Canyon. Ultimately bowing to pressure from the environmental and recreational communities who vehemently opposed the proposed dams, Arizona agreed to energy derived from coal mined through lease agreements with the Navajo Nation and Hopi Tribe and a thermoelectric generating facility near Page, Arizona – the Navajo Generating Station (NGS).

While these issues continued to be debated in Congress, Arizona's need for the CAP increased. Beginning in the 1950's, central Arizona's dependence on groundwater supplies increased significantly, a situation that would be solved in part by the CAP (and would later become another important component in Arizona's water management history). Through the dedication and leadership of Arizona's congressional delegation, Senator Hayden, Senator Paul Fannin and Congressmen John J. Rhodes, the Colorado River Basin Project Act was signed by President Johnson on September 30, 1968.

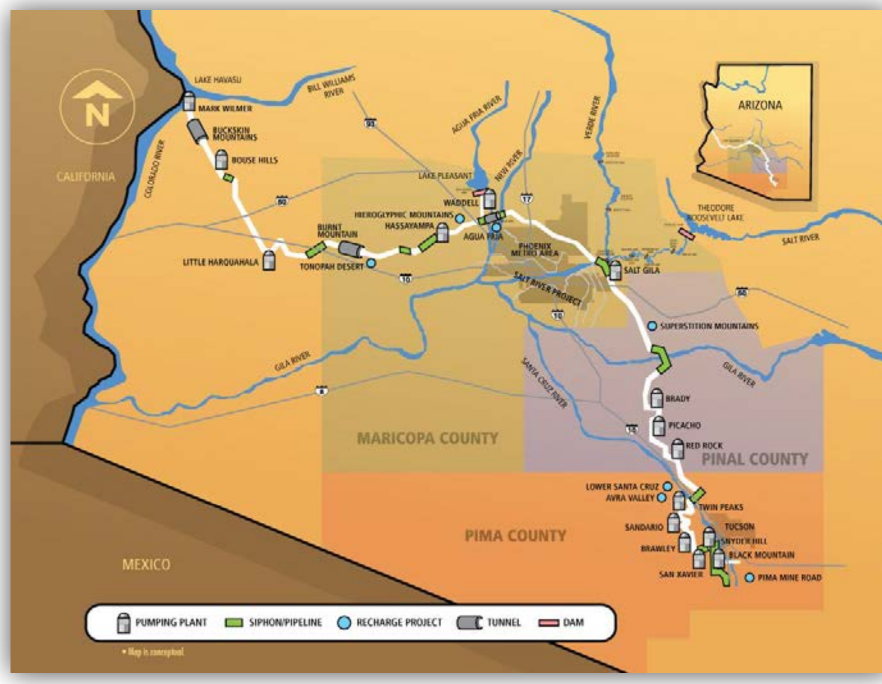

Figure 3. Central Arizona Project (CAP)

The Colorado River Basin Project Act represented a compromise for Arizona, but it did provide Arizona the project it needed to finally utilize its full Colorado River entitlement. In order to get the Act passed, Arizona agreed to a California priority of 4.4 MAF ahead of the CAP. It is important to note that this compromise on Arizona's part was with the agreement and inclusion of language in the Act that water supply augmentation would be explored by the federal government, limiting the impact of differential priority to water in the Lower Basin. To accomplish this, the Act provided for a 10-year study of water resources west of the Continental Divide in return for a 10-year moratorium on any studies aimed at bringing outside water into the Colorado River Basin (this moratorium was extended for another 10 years in 1978). The Act also identified US Bureau of Reclamation (Reclamation) as the entity to fund and construct the CAP, but authorized the Secretary of the Interior to enter into a master contract with an Arizona entity that has the power to levy assessments on real property to repay the federal government for certain costs of construction when the system was complete. In 1971, the Arizona Legislature created the Central Arizona Water Conservation District to provide a means for Arizona to repay the federal government for the reimbursable costs of construction of the CAP and to manage and operate the CAP system.

Construction began at Lake Havasu in 1973 and was completed 20 years later south of Tucson. The entire project cost over $4 billion to construct[15] (*see Figure 3*).

While presented in an extremely abbreviated fashion above, the history of the beginnings of water management on the Colorado River system is not without its controversies. The Colorado River Compact did not solve all of the issues that were to arise over the ensuing decades between the Basin States, water users, Mexico and the federal government. It has served as a platform for multiple states with very different agendas, strategies and needs coming together to solve immediate problems and is still the cornerstone of the entire "Law of the River" (*see Appendix II*), which governs the uses on the Colorado River today. Further, the history provides perhaps the most notable example of Arizonans coming together to aggressively protect and pursue their rights. The fortunes we enjoy today are directly a result of prior generations of Arizonans who envisioned bringing Colorado River water uphill into Phoenix and Tucson. The CAP was the strategic vision for Arizona from the 1940s until its completion in the early 1990s. Not without controversy, Arizona still was able to rally around the CAP, knowing that it would strengthen and bolster Arizona's future.

Private Contributions

While the development of the Salt River and Colorado River are the largest examples of Arizonan's joining efforts to develop water supplies, there are many other examples across Arizona of water users pooling their resources and expertise and developing water supplies and water storage and delivery infrastructure to the benefit of the region. A notable example is the extensive system developed by Phelps Dodge Corporation – a major mining company in Arizona (acquired by Freeport-McMoRan Copper & Gold Inc. in 2007) – to construct three large dams, reservoirs, pumping plants, pipelines and other support facilities in six different Arizona counties in cooperation with federal, state and local agencies.

With wartime efforts increasing the demand for copper in the 1940s, the need for Phelps Dodge to secure additional water supplies to increase its production was critical[16]. After extensive exploration and analysis of the water resources strategies in place at the time in Arizona, the company noted that SRP had constructed Bartlett Dam on the Verde River to regulate the flow of the Verde River in the 1930s, protecting the Phoenix area from floods and providing water for irrigation. However, the reservoir was insufficient to capture floodwaters in every year and in some years floodwaters would flow unused down the river, sometimes inundating portions of the Phoenix area. With this in mind, Phelps Dodge and SRP entered into an agreement which resulted in the construction of Horseshoe Dam in 1946 upstream from Bartlett to reduce floodflows below Bartlett and to provide SRP with additional storage for water uses in the Phoenix area. In exchange for this $2.5 million investment, Phelps Dodge secured credits for 250,000 acre-feet of water from the Black River in eastern Arizona. Intended for use at its Morenci Mine operations, the water was pumped 700 feet to the rim of Black Canyon and then gravity fed roughly six and a half miles to Willow Creek. The water was then transported another 21 miles to Eagle Creek and then another 30 miles to a diversion point near Morenci[17].

[15] http://www.cap-az.com/index.php/cap-background

[16] Prior to 1937, the company had secured rights on Eagle Creek, Chase Creek and the San Francisco River for its Morenci Mine operation.

[17] Schwantes, Charles A., *Vision & Enterprise Exploring the History of Phelps Dodge Corporation*, University of Arizona Press, 2000.

Phelps Dodge also constructed Show Low Reservoir in 1953 on the Show Low Creek tributary of the Little Colorado River, from which it delivered water 100 miles through a tributary of the Salt River, enabling a water exchange that allowed additional diversions from the Black River for the Morenci Mine. Phelps Dodge continued its water supply development efforts constructing Blue Ridge Reservoir on East Clear Creek. Water stored in Blue Ridge was pumped to the Mogollon Rim, ultimately flowing to the Verde River, where it augmented SRP supplies and allowed additional Black River diversions. These cooperative projects continue to serve as a model for advancing water resource planning and development in many portions of the Arizona.

Groundwater Management

At the same time Arizona was struggling in its efforts to develop the CAP, reliance on groundwater continued to increase. Early in Arizona's history, groundwater was identified separately from surface waters by the Courts as either flowing in underground streams or percolating through the soil beneath the land surface. Beginning as far back as 1904, the Arizona Territorial Supreme Court adopted the common law rule that percolating water was the property of the overlying land owner and not subject to appropriation as was surface water[18]. Litigation would dominate the management of groundwater in Arizona for the next 76 years.

In the 1930's, the combination of increased cotton prices, improved technology in well pumping efficiency, and the availability of inexpensive power, largely from the newly constructed hydroelectric dams on the Salt, Verde, and Colorado Rivers, led to increased groundwater pumping in central Arizona. As a result, individual well owners were experiencing declining water levels and difficulties in producing water as neighboring well owners were competing for the same groundwater supply, naturally leading to economic disruption and litigation. In response to growing concerns over increased groundwater pumping, the first commission to study groundwater was appointed by then Governor Rawghlie Clement Stanford in 1938. The sole notable accomplishment was convincing the Arizona Legislature of the need to appropriate funds to have the US Geological Survey (USGS) investigate groundwater conditions throughout the State and publish a report with regard to these investigations. The report, issued by the USGS in 1943, found that groundwater depletion would continue to increase as lands continued to be developed.

As a result of the USGS report, two bills were introduced in the 1945 regular legislative session. The first bill, originally drafted by SRP and other irrigation districts, proposed transferring groundwater from private to public ownership and requiring permits for new uses of groundwater. This would accomplish two things: 1) groundwater supplies would be quantified and appropriated amongst the existing users, setting priorities of rights, just as was done for surface water, and 2) limit or even preclude additional farming operations from locating into the State, thereby limiting competition for resources and protecting market shares for existing farmers. The second bill required the registration of all irrigation wells in the state, which would accomplish little more than identifying all well owners and their location in the State. Neither bill was approved by the Legislature.

Arizona's inability to adopt a comprehensive groundwater management strategy would not go unnoticed by the opponents to the CAP. In the first federal government salvo in moving the State towards legislative groundwater management, the US Department of Interior declared that the CAP

[18] *Howard v. Perrin*, 1904 (See Appendix I)

would not be approved until Arizona took steps to restrict groundwater irrigated agriculture. In response to this federal declaration, Governor Sydney P. Osborn reintroduced both the irrigation district bill and the well registration bill in a special session. The well registration bill, which only required the registration of all irrigation wells throughout the state, was better received than the irrigation district proposal and thus was passed by the Legislature becoming the Groundwater Code of 1945. It was immediately recognized that the 1945 Code did nothing to stop groundwater depletion and again, in 1948, the federal government threatened the future of the CAP.

A more comprehensive Groundwater Code was finally enacted in 1948. It provided for designation of ten critical areas within the State (defined as areas without sufficient groundwater to provide irrigation for cultivated lands at then current rates of withdrawal) and prohibited the expansion of groundwater irrigated agriculture within these critical areas. However, the Code did nothing to address existing pumping nor did it apportion the use of groundwater among the overlying landowners within the critical areas. The provision allowing existing groundwater pumping to continue was widely criticized, as it did nothing to stop the existing groundwater overdraft. In response, a second groundwater study commission was initiated in 1951, charged with drafting a meaningful groundwater bill. The commission introduced a bill in the 1952 legislative session that not only would have divided the State's groundwater basins into three separate management classifications, but also, and most notably, would have changed the long-held common law rule of groundwater use to a publicly-owned resource subject to appropriation. The bill was not passed by the Legislature. Instead, the Legislature passed a bill establishing yet another groundwater study commission.

In addition to the legislative efforts, these issues were being actively litigated at the time. In 1952, a case before the Arizona Supreme Court resulted in one of the most controversial decisions in the history of Arizona groundwater law. In *Bristor I*[19], the Court found that "the common-law concept that the owner of the overlying land owns the percolating waters under its surface is fallacious and that the vested rights of the users of percolating waters are more fully protected under the law of prior appropriation than under the so-called common-law rule." It was the Court's opinion that to "permit the present underground water race to continue unabated, without regulation or control, would inevitably lead to exhaustion of the underground supply and consequently to economic disaster."[20] Left unchanged, this opinion would have dramatically altered Arizona groundwater law by making the State's groundwater supplies subject to the law of prior appropriation.

The Arizona Supreme Court's opinion in *Bristor I* raised so much controversy that a rehearing was granted the following year. In 1953, the Arizona Supreme Court reversed its opinion in *Bristor I,* affirming the police power of the Legislature to regulate groundwater and reinstituting the common law rule with the addition of the doctrine of reasonable use. Under this doctrine, a landowner could pump as much water as could be put to reasonable use on the land from which it was pumped. However, no limits on the amount of water that could be reasonably used were defined, and landowners found themselves competing for the same supply. The Court's reversal in *Bristor II*[21] was seen by some as a failure to adequately allocate the State's diminishing groundwater reserves. In their dissent, Justices Phelps and Udall predicted that "the mad race to 'mine' percolating waters…will continue unabated

[19] *Bristor v. Cheatham, (Bristor I)*, 73 Ariz. 228, 240 P2d. 185 (1952)
[20] *Bristor I*
[21] *Bristor v. Cheatham, (Bristor II)*, 75 Ariz. 227, 255 P2d. 173 (1953)

until such time as these waters are declared to be public in character and suitable regulatory measures are adopted."[22]

Following the decision in *Bristor II*, the groundwater study commission introduced a bill that would: prohibit new groundwater irrigated farmland in the Salt River and Santa Cruz River Valleys; reduce groundwater use on a pro-rata basis; provide for the purchase and retirement of irrigated acreage in critical groundwater areas for municipal and industrial water supplies; and create a regulatory groundwater agency. The bill never made it out of committee. As a last ditch effort to develop meaningful groundwater legislation, Governor Howard Pyle was able to extend the commission by only one month to address what he considered the "failure… to deal effectively for more than 20 years with our continuously diminishing supplies of underground water."[23] The failure of the legislation left the resolution of groundwater issues to the courts.

Meanwhile, the State's dependence on groundwater was continuing to increase. Coupled with extended droughts on the Salt and Verde Rivers between 1942 and 1948, and again between 1953 and 1957, groundwater was legally being pumped at rates that far exceeded recharge. The concept that the water beneath the land belonged to the landowner, together with the doctrine of reasonable use, encouraged landowners to pump as much water as they needed without regard to the impact on neighboring wells. Unfortunately, natural groundwater systems act independently of legal rules and regulations. An aquifer provides a common supply for all to pump from and is not bound by land ownership or the boundaries of the critical groundwater areas. The hydrologic reality that all pumping from the common source can affect all land overlying it was still largely ignored.

Although the 1948 Code put restrictions on development of new agricultural lands (although it lacked any enforcement provisions), it was silent on obtaining water to supply new non-agricultural development. Cities and towns relied on transporting groundwater from one location to another location where the water was put to use. Although the area of pumping and the area of use were usually within the water service area of the water provider, in some instances water was being pumped from outside the service area and transported back to the urbanizing areas for domestic and industrial uses. This situation would also lead the state towards yet more complicated litigation. In fact, such transportation of groundwater was one of the issues that ultimately led to Arizona's current groundwater management structure.

In a series of decisions between 1969 and 1974, the Arizona Supreme Court tackled the issue of transportation of groundwater. In response to a lawsuit filed in 1969 (*Jarvis v ASLD I*)[24], the Court issued an injunction against the City of Tucson prohibiting the transportation of groundwater from its well fields in the Avra and Altar Valleys, which had been designated as a critical area. The Court held that the property right in percolating waters was only a right to use the water, limited by reasonable use, on overlying land, not ownership of the source. The Court ruled that a person may not transport groundwater away from the overlying land if it would cause damage to other lands. The Court found that transporting groundwater away from a critical groundwater area would inevitably damage other lands in the area.

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[22] *Bristor II*

[23] Letter from Howard Pyle, Governor of the State of Arizona to Wesley Bolin, Secretary of State, Arizona State Archives.

[24] *Jarvis v. State Land Department (Jarvis I)*, 104 Ariz. 527, 456 P. 2d. 385 (1969).

Then, in 1970 (*Jarvis v ASLD II*)[25], the Court modified its injunction on Tucson based on the surface water statute (ARS § 45-147) for determining appropriative rights, which gives preference to municipal and domestic uses over agricultural uses. The Court allowed Tucson to purchase and retire irrigated farmlands and transport the "annual historical maximum use" of groundwater that had been applied to the irrigated acreage. This allowed the City of Tucson to annually pump the highest volume of groundwater used on the acquired farms in a single year, thus allowing more pumping than ever. In 1974 (*Jarvis v ASLD III*)[26], the Court finally modified its previous decision and limited Tucson's pumping to the average of the "annual historic maximum use."

The Arizona Supreme Court's 1976 decision in *FICO v. Bettwy*[27]is often considered the single event that prompted the passage of the 1980 Groundwater Management Act. At issue were several mining companies operating south of Tucson that were pumping groundwater in the Sahuarita-Continental Critical Groundwater Area to provide water for their mining operations located several miles away outside the critical groundwater area but within the same acquifer. Farmers Investment Company (FICO), owner of approximately 7,000 acres of farmland within the critical groundwater area, sued to enjoin the mining companies from transporting groundwater away from the area, claiming that the use of the water off "the land from which the water was taken" would damage FICO's lands and therefore violated the reasonable use doctrine established in *Bristor II*.

The mines defended their actions by asserting that the phrase "the land from which the water was taken" should be defined as the land over the common source and argued that, hydrologically, the water was being used on the same land from which it was being taken because both lands overlay the same aquifer. Further, the mines argued that the transportation of groundwater does not add to the depletion of the aquifer as long as the water is used, and eventually recharged, within the same aquifer. Adding another dimension to this dispute, the City of Tucson intervened in the case, claiming that the mines were polluting the groundwater basin from which Tucson withdrew much of its water to supply its customers (although that water was being transported away from the basin by Tucson).

In its decision in *FICO*, the Court recognized that the State had been committed to the reasonable use doctrine in an earlier case (*Bristor II*) and had operated for almost 50 years in this manner. The Court held in favor of FICO, ruling that under the doctrine of reasonable use, water may not be pumped from one area and transported to another if other wells suffer injury or damage, even if both areas overlay a common source. Additionally, counter to its earlier finding in *Jarvis II*, the Court stated that it was the Legislature's and not the Court's responsibility to establish rights based on economic interest and "…if it is the State's interest to prefer mining over farming" then the Legislature would have to decide this. The Court went further in this same opinion and limited the City of Tucson's withdrawals for transportation away from the groundwater basin to amounts consistent with what was pumped before 1972, the date of its intervention in the case. In summary, the Court held that FICO was entitled to an injunction against the mines from transporting groundwater away from the critical groundwater area, and the mines were entitled to an injunction against Tucson from transporting groundwater away from the groundwater basin.

[25] *Jarvis v. State Land Department (Jarvis II)*, 106 Ariz. 506, 479 P. 2d. 169 (1970).
[26] *Jarvis v. State Land Department (Jarvis III)*, 113 Ariz. 230, 550 P. 2d. 227 (1976).
[27] *Farmer's Investment Company v. Bettwy*, 113 Ariz. 520, 558 P. 2d. 14 (1976).

The impact of this decision was a great blow to the second and third largest water use sectors in Arizona. The mines were vital to the State's economy and needed access to groundwater to do business. Additionally, some of the largest cities were transporting groundwater long distances to supply their customers with reliable water supplies. Rather than FICO pursuing enforcement of its injunction following the decision, a negotiated settlement was reached between the parties. However, the decision and settlement did not end the legal interpretation of the phrase "the land from which the water is taken" and the issue of transportation of groundwater from the critical groundwater areas and groundwater basins remained uncertain.

After years of confusion and uncertainty, it was clear that Arizona's groundwater laws would have to be addressed by the Legislature, particularly in light of the Court's conflicting opinions. In 1976, the mines and the cities formed a complex alliance. In 1977, agricultural interests were also persuaded to join this alliance to draft amendments to the 1948 Code.

Temporary amendments to the 1948 Code were adopted in the spring of 1977 and were intended to apply only until a comprehensive plan providing for groundwater use, allocation, and distribution could be enacted. The 1977 Act established a permit system allowing for the transportation of groundwater (certain transportations were allowed without a permit) and the creation of a Groundwater Study Commission charged with developing a comprehensive groundwater code for Arizona. The Study Commission was required to produce a draft report by June 30, 1979 and a final bill by December 31, 1979. Most notable was the inclusion in the 1977 Act of the provision that the Study Commission's proposed recommendations would become law if the Legislature failed to enact groundwater legislation by September 7, 1981. This provision was included to address the long-standing inability to enact effective groundwater management regulations and was designed to force the Legislature to act once and for all.

Concurrent with the discussions on groundwater management, the federal government again weighed in on the CAP. In 1979, the Carter Administration announced that the CAP would be among the water projects cut from the federal budget. Although later removed from the "hit list", US Secretary of the Interior Cecil Andrus, warned that if Arizona failed to enact a groundwater code, the CAP would be eliminated. The events that would lead to Arizona's adoption of the 1980 Groundwater Management Act were now in place.

The Groundwater Management Act (GMA) was enacted into law in a special session of the Legislature in June of 1980. No other State has a comparable groundwater management strategy that not only protects the State's economy, but ensures its future economic stability. The GMA was developed with the assistance of the three major water using sectors: agriculture, municipal and mining. The framework is intended to protect existing users and serve new uses with non-groundwater supplies, reserving the groundwater supply as a hedge against future shortages. The GMA established a timeline for reduction and elimination of groundwater pumping in certain areas of the State - designating Active Management Areas (AMA) and Irrigation Non-Expansion Areas (INA) to facilitate this process (*see Figure 4*).

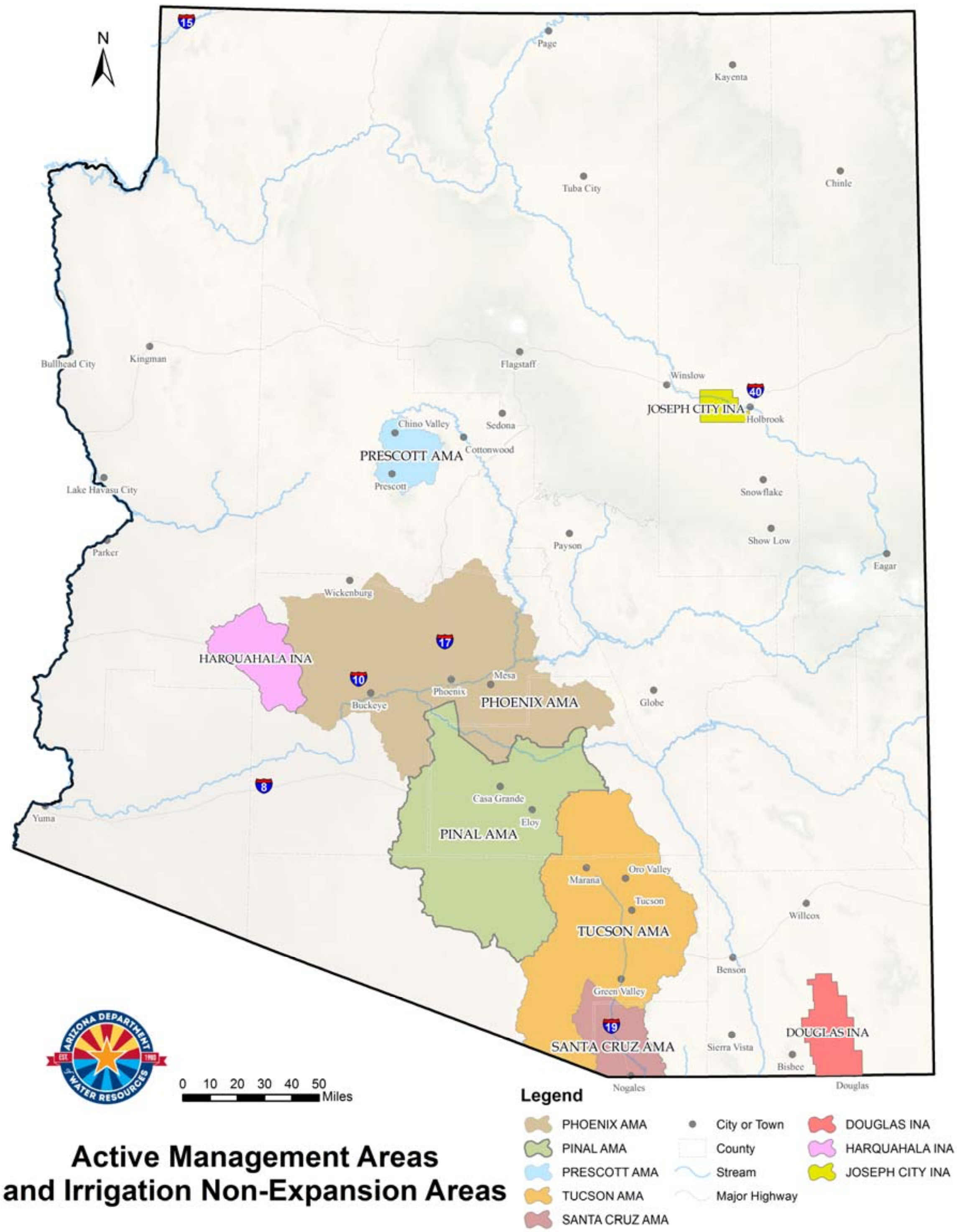

Figure 4. Active Management Areas & Irrigation Non-Expansion Areas (ADWR)

Within the AMAs, the GMA requires a "100-year Assured Water Supply" for new development and imposes mandatory water conservation requirements for agricultural, municipal and industrial groundwater users. Finally, the Act created the Arizona Department of Water Resources (ADWR) to administer and enforce Arizona's water management policies and laws for all water supplies, and to protect Arizona's Colorado River entitlement.

Subsequent significant modifications to the GMA have been enacted to: protect rural areas from groundwater transportation; encourage the use of non-groundwater supplies through the Underground Storage and Recovery Program; and allowed new subdivisions to obtain an assured water supply determination by enrolling the Central Arizona Groundwater Replenishment District (CAGRD), a district created to replenish groundwater used in excess of allowable groundwater pumping by its members. The decreasing dependence on groundwater supplies, coupled with the creation in 1996 of the Arizona Water Banking Authority (AWBA), has reduced the State's vulnerability to water supply shortages by leaving groundwater in the aquifer for use during supply shortages. The AWBA was created to store Arizona's unused Colorado River entitlement for backup water supplies and to further protect Arizona communities from water supply shortages. To date, the AWBA has stored nearly 3.5 MAF of Central Arizona Project water (CAP water) to protect against shortages, while Arizona communities and other water interests have stored an additional 5 MAF of CAP water and reclaimed water for future uses.

Resolution of Tribal Water Rights

Arizona is home to 22 Indian Reservations (*see Figure 5 - Tribal Communities in Arizona*). In 1908, the US Supreme Court held that a tribe's rights to water were established when the reservation was created and by creating the reservation, Congress implicitly reserved all the waters of the river necessary for the purposes for which the reservation was created (*Winters v. United States*)[28]. Rather than litigating these claims, water users and the State of Arizona have been working for decades to develop equitable distribution of Arizona's water supplies in cooperation with its tribal communities. The successes in this area are outlined below and include decreed rights as well as congressionally authorized water rights settlements. The remaining outstanding tribal claims are discussed in later sections.

United States Supreme Court Decreed Rights

Four Arizona Indian reservations along the Colorado River were decreed entitlements by the US Supreme Court to divert water from the Colorado River pursuant to *Arizona v. California* (1963). The reservations and their annual Colorado River entitlements are listed below:

- Cocopah – 9,707 acre-feet
- Colorado River Indian Tribes – 662,402 acre-feet
- Fort Mohave – 103,535 acre-feet
- Fort Yuma – 6,350 acre-feet

Congressionally Authorized Settlements

Ak Chin Indian Community

By Congressional action in 1978 and 1984, the Ak Chin Indian Community was provided an annual entitlement to 75,000 acre-feet of CAP water and other Colorado River water in normal and wet years (85,000 acre-feet when other surface water is available). Congress amended the 1984 Act in 1992 to

[28] 207 U.S. 564 (1908)

authorize the Community to lease any unused CAP water to off-reservation users within the Tucson, Pinal and Phoenix AMAs.

Tohono O'odham Nation

The Southern Arizona Water Rights Settlement Act (SAWRSA) was enacted by Congress in 1982 to address the water right claims of the San Xavier and Shuck Toak Districts of the Tohono O'odham Nation. SAWRSA provided the districts an annual entitlement to 37,800 acre-feet of CAP water and 28,200 acre-feet of settlement water to be delivered by the US Secretary of the Interior to the two districts. The districts may also collectively pump annually up to 13,200 acre-feet of groundwater from non-exempt wells. In addition to state and local financial contributions, the City of Tucson contributed 28,200 acre-feet annually of reclaimed water to be used by the Secretary to facilitate deliveries to the districts (through sale or exchange).

In December 2004, the Arizona Water Settlements Act amended the 1982 SAWRSA and provided a mechanism to implement the Settlement. The amendment identified Non-Indian Agricultural (NIA) Priority CAP water as the water source of the Settlement. The Nation may lease its CAP water within the CAP service area. State law was amended to provide additional protection to groundwater resources on the San Xavier Reservation, and allow the Nation to store its CAP water at a groundwater savings facility (GSF). The Nation's water right claims will not be completely satisfied until the claims of the Sif Oidak District in Pinal County, commonly known as Chui Chu, are addressed. While that district currently holds a contract for 8,000 acre-feet of CAP water, it has stated a need of an additional amount of almost 20,000 acre-feet.

Figure 5. Tribal Communities in Arizona (ADWR)

Salt River-Pima Maricopa Indian Community

The Salt River-Pima Maricopa Indian Community Water Rights Settlement Act of 1988 was enacted by Congress approving an agreement providing the Community an annual entitlement to 122,400 acre-feet

of water plus storage rights behind Bartlett and modified Roosevelt Dams. Sources of water for the Community under the settlement include the Salt and Verde Rivers, groundwater and CAP water. The Community is allowed to pump groundwater, but must achieve safe-yield[29] when the East Salt River Valley Sub-basin in the Phoenix AMA Groundwater Basin does so. The Community has leased its 13,300 acre-foot CAP water allocation to municipalities in the Phoenix metropolitan area.

Fort McDowell Yavapai Nation *(formerly Ft. Mc Dowell Indian Community)*
In 1990, Congress ratified an agreement between the Fort McDowell Indian Community and federal and State parties, including: SRP; Roosevelt Water Conservation District; the cities of Chandler, Mesa, Phoenix, Glendale, Scottsdale, and Tempe; the Town of Gilbert; CAP the United States; and the State of Arizona. Under that agreement, the Fort McDowell Indian Community is provided an annual entitlement to 35,223 acre-feet of water from the Verde River and CAP. The 18,233 acre-feet of CAP water in the Fort McDowell water budget may be leased for up to 100 years off-reservation within Pima, Pinal, and Maricopa counties. Currently, 4,300 acre-feet is being leased to the City of Phoenix. This settlement also provides for a minimum stream flow of 100 cubic feet per second (CFS) on the Lower Verde River.

San Carlos Apache Tribe
The water rights claims of the San Carlos Apache Tribe to the portion of the reservation within the Salt River Watershed were settled through Congressional enactment of the San Carlos Apache Tribe Settlement Act of 1992. The Tribe was awarded an annual entitlement of up to 71,445 acre-feet of CAP water and water from the Salt, Gila and Black Rivers. The Tribe is authorized to lease its allocation of 64,135 acre-feet of CAP water off-reservation within Pima, Maricopa, Pinal, Gila, Graham, and Greenlee counties. Groundwater may also be pumped on the reservation. The agreement also includes a 100-year lease with the City of Scottsdale for a portion of the Tribe's CAP water. The water right claims of the San Carlos Apache Tribe to the portion of the reservation within the Upper Gila River Watershed will be the subject of separate negotiations or litigation.

Yavapai-Prescott Indian Tribe
Congress enacted the Yavapai-Prescott Indian Tribe Water Settlement Act in 1994. The Act settled the Tribe's water rights claims by: 1) confirming the Tribe's right to pump groundwater within the boundaries of the reservation; 2) providing for relinquishment of the Tribe's CAP water contract, the proceeds to be used to fund a water service contract with the City of Prescott; and 3) providing that the Tribe may divert a portion of the water from Granite Creek that, at the time, was diverted by the Chino Valley Irrigation District. The Act also provided authorization to the Tribe and the City of Prescott to market their CAP water to the City of Scottsdale, which has been completed (500 acre-feet from the Tribe and 7,127 acre-feet from Prescott, respectively).

Zuni Indian Tribe
President George W. Bush signed P.L. 108-34, the Zuni Indian Tribe Water Rights Settlement Act, into law in June, 2003. The Act awards the tribe a right to annually use 5,500 acre-feet of surface water from the Little Colorado River and up to 1,500 acre-feet of underground water, both for wetland restoration

[29] Safe yield is the condition where water pumped out of the aquifer is in balance with water entering the aquifer, whether naturally or artificially.

at the Zuni Heaven Reservation. It also grandfathers existing surface and groundwater uses in the area, restricts future wells near the reservation and facilitates local environmental programs.

Gila River Indian Community

President George W. Bush signed P.L. 108-451, the Arizona Water Settlements Act, into law in December, 2004. Title II of the Act provided approval of the Gila River Indian Water Settlement Agreement. The Settlement provided the Community an annual entitlement to an average of 653,500 acre-feet of water from various sources including: CAP water, reclaimed water (through CAP water exchanges), groundwater, and surface water from the Gila, Verde and Salt Rivers. It also gave leasing authority to the Community for its CAP water as long as the water is leased within Arizona. In partial fulfillment of its obligations under the Settlement Agreement, the State enacted legislation to provide protection to certain water resources of the Community.

White Mountain Apache Tribe

Federal legislation authorizing the White Mountain Apache Tribe Water Rights Quantification Agreement became law in December 2010. The parties executed a revised settlement agreement in 2013 to conform the Agreement to the federal legislation. Other actions are required for the settlement to become final, including approval of the settlement agreement by the adjudication courts. Under the settlement agreement, the White Mountain Apache Tribe is entitled to an annual depletion totaling 27,000 acre-feet of surface water and groundwater from the Salt and Little Colorado River watersheds and 25,000 acre-feet of CAP water (23,782 of which is NIA Priority CAP water previously set aside for future Indian tribal settlements). The Tribe will lease its CAP water to several Phoenix area cities and CAP.

Water Conservation & Reuse

Water conservation is the foundation of Arizona's water management strategy and is an area where the State of Arizona and its citizens have achieved unparalleled water supply improvements that serve as a model for water managers throughout the world. The GMA created the Phoenix, Pinal, Prescott, and Tucson, and later the Santa Cruz, AMAs. A major component of the GMA is the requirement for statutorily-mandated water conservation by municipal, industrial and agricultural water users located in those areas. In addition, the programs enacted by the State's policy leaders have also spurred adoption of many voluntary conservation programs throughout the State.

The majority of Arizona's total water use, 86 percent of the state's total municipal water use and 61 percent of the state's total industrial water use, occurs in the AMAs and is subject to mandatory water conservation programs. While 39 percent of the state's agricultural water use occurs in the AMAs (and is subject to statutorily-mandated water conservation requirements), nearly 50 percent of the State's total agricultural water use is in the Yuma area where agricultural water users have voluntarily employed state-of-the-art agricultural water conservation measures to stretch the water supplies vital to that area's economy.

In addition to the statutorily-mandated water conservation requirements for AMAs in the GMA, Arizona's policy leaders went even further in 2005 with the passage of Arizona House Bill 2277[30]. Under the provisions of this bill, codified in law at A.R.S. §45-341, et. seq., water systems in Arizona that serve

[30] Arizona Revised Statutes Title 45, Chapter 1, Article 14

at least 15 connections used by year-round residents, or that regularly serves at least 25 year-round residents, must submit a water use report every year, and a system water plan every five years that contains the following:

1) A Water Supply Plan that describes the service area, transmission facilities, monthly system production data, historic water demands for the past five years, and projected water demands for the next 5, 10 and 20 years; and
2) A Drought Preparedness Plan that includes drought and emergency response strategies, a plan of action to respond to water shortage conditions, and provisions to educate and inform the public; and
3) For those communities located outside of the AMAs, a Water Conservation Plan that addresses measures to control system leaks and lost water, considers water rate structures that encourage efficient use of water, and plans for public information and education programs on water conservation.

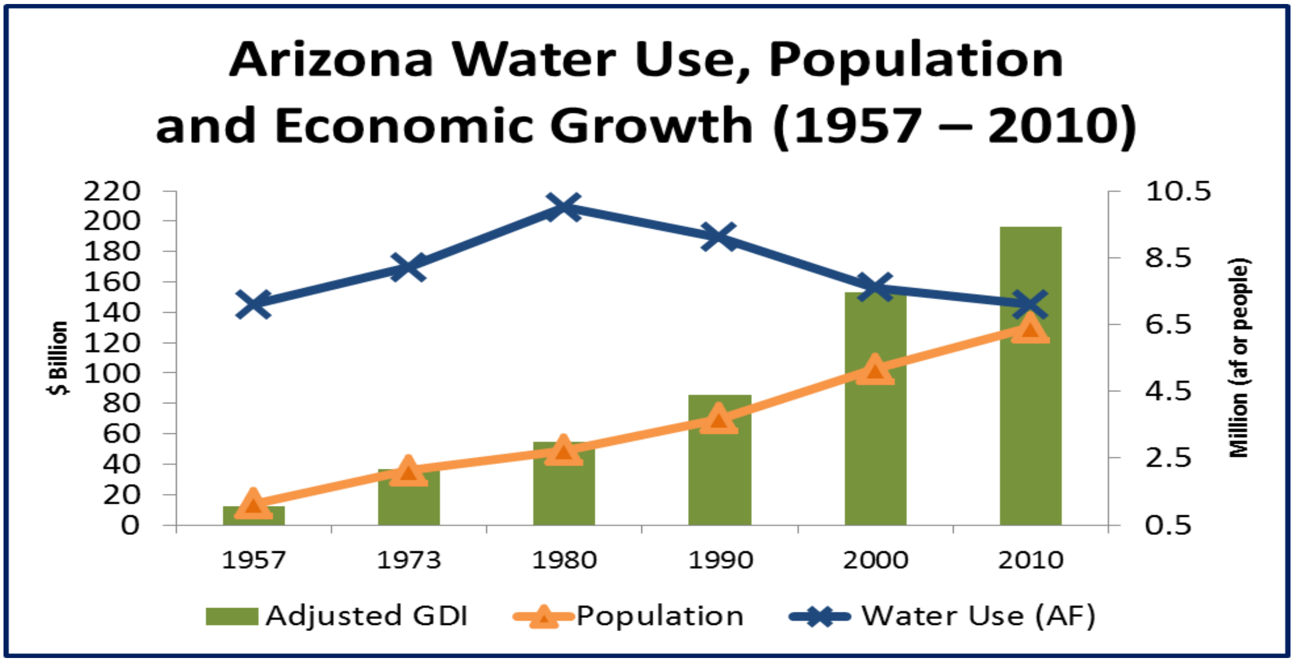

Figure 6. Arizona Water Use, Population and Economic Growth 1957 – 2010 (ADWR, 2013)

While there will continue to be potential for additional water conservation in Arizona, our past successes cannot be discounted. The GMA, along with both the passage of HB 2277 and the voluntary implementation of some very strong conservation measures across Arizona, has already resulted in significant water supply savings (*see Figure 6 - Arizona Water Use, Population and Economic Growth 1957 - 2010*). Most Arizona communities already understand the benefits of water conservation as a less expensive alternative to water supply augmentation and have taken steps to implement conservation measures.

A significant portion of the reclaimed water produced in Arizona is reused for landscape and golf course irrigation, agricultural irrigation, power generation, irrigation of parks and schools and artificial recharge

and streams, benefiting the environment by providing habitat for wildlife and adding aesthetic and economic value to Arizona's landscape. While these benefits are important locally and notable, there may be additional opportunities to further leverage these locally available supplies to replace existing uses of limited groundwater and surface water supplies, while maintaining or enhancing our natural ecosystems. A 1989 Arizona Supreme Court Decision, *Arizona Public Service Company v. Long*[31] held that reclaimed water is owned by the entity that produces it. The Court ruled that until reclaimed water is returned to the system as surface water or groundwater, it has the legal character of neither surface water nor groundwater and, therefore, a treatment plant operator that produces reclaimed water is free to use it without regard to the laws governing surface water and groundwater. This ruling creates a strong incentive for reuse by allowing those who generate reclaimed water to maintain the right to reuse or market that water.

Currently, Arizona, along with California, Florida, and Texas, leads the nation in utilization of reclaimed water[32]. Increased utilization of reclaimed water is not without challenges. For example, although the Arizona Department of Environmental Quality (ADEQ) administers a comprehensive regulatory program governing the safe use of reclaimed water, public perception of water quality limitations still remains a significant obstacle for water managers. Developing a strong recycled water program must appropriately address public health and safety concerns and the significant capital and operating costs associated with reuse infrastructure. Increased utilization of this supply is anticipated to be one of the least-cost alternatives available to Arizona to meet local water supply imbalances. Full utilization of this locally available supply has the potential to reduce future water supply imbalances by more than 50 percent in the year 2110. In order to provide a long-term sustainable water supply for the citizens throughout the State, water managers must address the challenge of long-held public perceptions and, while protecting public health and welfare, remove regulatory barriers to ensure Arizona's continued economic and environmental viability into the future.

Summary

Arizona's water management history not only highlights the motivation and vision that our past leaders have exhibited, but also the time, effort, steadfastness and political will it took to develop the water management programs and water supply projects that are the foundation of our vibrant economy and quality of life. It took nearly 50 years to secure Arizona's Colorado River entitlement and achieve deliveries of CAP water to Central Arizona. It took over 70 years of sometimes confusing and inconsistent court rulings before the Arizona Legislature proactively and meaningfully addressed groundwater management for the benefit of Arizonans and passed the Groundwater Management Act in 1980.

However, and more importantly, this history underscores Arizona's standing as a State that aggressively secures, delivers, protects and manages its water supplies, creating a viable and economically stable environment in which to live and do business. Arizona's future as an economic leader in the Southwestern US will depend on this same determination, tenacity and the willingness to do what it takes to protect and develop its water supplies for its current and future citizens.

[31] 160 Ariz. 429, 773 P.2d 988 (1989)

[32] Water and Wastes Digest @ http://www.wwdmag.com/EPA-Releases-Updated-Version-of-Guidelines-fo-Water-Reuse-article6636

ARIZONA'S FUTURE WATER SUPPLY & DEMANDS

The current challenge facing Arizona is that, although the State has an existing solid water management foundation, water demands driven by future economic development are anticipated to outstrip existing supplies. Water resources planning efforts are instrumental in the identification and evaluation of these challenges. Arizona has been actively evaluating future water supply and demand conditions for decades.

Every ten years, consistent with State statute, ADWR evaluates water supply and demand conditions in each of the State's AMAs – primarily to evaluate the ability to achieve the management goals identified by the Legislature for each AMA under the GMA. Management Plans have been developed in 1985, 1990 and 2000. In 2009 and 2010, in anticipation of the next Management Plan, ADWR developed a demand and supply assessment for each of the five AMAs to: (1) evaluate the AMAs current status and ability to achieve the management goals and (2) to frame the discussions for alternative management strategies needed to meet and maintain those goals. Additionally, ADWR also produced the *Arizona Water Atlas* in 2010 to provide water-related information on a local, regional and statewide level to frame and support water planning and development efforts. The development of the Atlas also has spurred the development of a statewide water resources data repository housed at ADWR, which is continuously updated as water use information is reported and collected. These are on-going efforts that are either aimed at specific regions of the State or provide past and present water use information.

Since 1980, Arizona has also developed, or partnered in, comprehensive and prospective statewide (see Appendix III) and multi-state planning efforts. More recently, the Water Resources Development Commission (WRDC) was an Arizona-only effort aimed at projected future statewide water demands and available water supplies for the next 25, 50 and 100 years. *The Colorado River Basin Water Supply and Demand Study* (Bain Study) was developed by Reclamation in cooperation with the seven Basin States (Arizona, California, Colorado, New Mexico, Nevada, Utah and Wyoming) to define current and future imbalances in water supply and demand in the Colorado River Basin and the adjacent areas that receive water from the Colorado River, through 2060. The findings of these large-scale prospective efforts are discussed below.

Colorado River Basin Water Supply and Demand Study

Although the Basin Study was completed after the WRDC, it will be discussed first since it only addresses a certain portion of Arizona's total water supply and only examines those areas where that supply is currently being utilized. However, some assumptions were also analyzed for the utilization of this supply to meet future growth in other areas of Arizona in excess of its 2.8 MAF entitlement to address expanded growth within Arizona, though this does not mean Arizona is seeking an increase in its entitlement.

The Colorado River system spans seven western states. It serves the municipal uses of nearly 40 million people and supplies water to irrigate nearly 5.5 million acres of land. The Colorado River is also an important resource for wildlife and recreation, and hydroelectric generation from water stored at dam sites along the Colorado River totals about 12 billion kilowatt-hours per year. The power is shared among several western states[33]. The Colorado River also flows into Mexico where it is a vital resource

[33] http://www.waterencyclopedia.com/Ce-Cr/Colorado-River-Basin.html

for agricultural and municipal water users. Reservoirs have been developed on the River to store almost four years of the natural flow of the River (60 MAF) and, while the West has been in the grips of the worst 14-year drought in the last century, the needs of these users have been fully met by this system. With the continued uncertainty of the magnitude and duration of the drought gripping the Colorado River Basin, and the need to meet the increasing demands that are anticipated in the Western States, Reclamation, in cooperation with the seven Basin States, conducted a study to determine the current and future imbalances in the Basin through 2060. The study area included the Colorado River Basin and adjacent areas dependent on this resource (*see Figure 7 - Colorado River Basin Study Area*)[34]. The Basin Study was released in December of 2012.

This extensive study estimated that population within the study area is projected to increase from about 40 million people in 2015 to between 49.4 million and 76.5 million people by under the slow growth and a rapid growth scenario, respectively. As a result of this increased population, and factoring in Mexico's 1.5 MAF 1944 Treaty allotment and losses due to evaporation and system operations, projected demands in the Basin may range between 18.1 MAF (slow growth scenario) and 20.4 MAF (rapid growth scenario) by 2060. Over the past 10 years, the Colorado River's yield has averaged about 15.3 MAF annually. Comparing the median water demand projections to the median water supply projections, the long-term projected Basin-wide imbalance is estimated to be 3.2 MAF by 2060. However, the actual imbalance may be much larger, or could be slightly smaller, depending on the availability of water and actual growth in the region.

Figure 7. Colorado River Basin Study Area (Reclamation, 2012)

[34] Source: US Bureau of Reclamation

The Basin Study process incorporated a broad range of input from the Study participants, interested stakeholders and the general public to identify possible options to address the supply and demand imbalances. These options were not extensively evaluated during the study due to time and resource constraints, however, over 150 options were submitted and were organized into four groupings:

1) Increase Supply – Options that increase Basin water supply;
2) Reduce Demand - Options that reduce Basin water demand;
3) Modify Operations – Options that focus on modifying how the River is operated; and
4) Governance and Implementation – Options that mainly focus on Basin governance and mechanisms to facilitate optional implementation.

The specific options were identified in the Basin Study, setting the framework for the next step discussions currently underway between the Basin States attempting to address these future imbalances[35]. This Strategic Vision will be a tool that will help guide ADWR in our deliberations in these discussions.

Water Resources Development Commission

Recognizing that water is essential to Arizona's prosperity, the Legislature passed House Bill 2661 in 2010 establishing the WRDC. The WRDC was tasked with assessing Arizona's water demands and available supplies to meet those demands for the next 25, 50 and 100 years. Seventeen Commission members, representing various Arizona industries and water users from a regional and geographic cross-section of the state, were selected for their knowledge about various water resources and water management issues in Arizona. Additionally, nine ex officio members representing state and federal agencies and the Governor's office participated on the Commission.

The findings of the WRDC were based on the combined work of many individuals in developing forecasted water demands for municipal, industrial, agricultural and tribal uses and current and projected water supplies to meet those demands. Additionally, the WRDC prepared an inventory of Arizona's water-dependent natural resources, providing future planning efforts valuable information on the State's water supplies and the environmental resources they support. Work was also done on identifying possible mechanisms to finance the development of additional water supplies and the associated infrastructure needed to deliver those supplies.

The WRDC found that Arizona has grown from a population of 2.7 million people with an economy of approximately $30 billion in 1980 to nearly 6.6 million people with an economy of $260 billion by 2009. Estimates for population growth in Arizona were developed for 2035, 2060 and 2110. The population estimates for these years are 10.5, 13.3 and 18.3 million people, respectively. Annual water demand is expected to grow from current levels of 6.9 MAF to between 8.2 and 8.6 MAF in 2035; between 8.6 and 9.1 MAF in 2060 and between 9.9 and 10.5 million acre-feet in 2110.

The WRDC also analyzed the availability of currently developed supplies. Baseline water supplies were catalogued within each groundwater basin in the State. These supply sources included: existing developed groundwater resources; in-state surface water diversions; existing developed reclaimed

[35] Colorado River Basin Supply and Demand Study – Executive Summary, December 2012 – Table 2: Summary of Representative Options Including Cost, Timing, Potential Yield, and Inclusion in Portfolios, p. 13

water supplies; mainstem Colorado River water; and CAP water. The total water supply that is currently developed or readily available to meet existing demands is approximately 7.7 MAF. Additional groundwater and reclaimed water supplies are also available to meet future demands. However, the availability of these water supplies may be constrained to specific water right holders, specific places of use within the State and, in the case of in-state surface water, Colorado River water and CAP water, subject to possible shortages due to drought.

OPPORTUNITIES AND CHALLENGES FOR ARIZONA

The studies described above identify the potential imbalance between available water supplies and projected demands which could limit Arizona's future economic growth if no actions are taken. Consequently, the economic future of this State, and the region, is dependent on a resource for which legal and physical complexities need to be taken into consideration and addressed.

Complexities Affecting Long-Term Water Use and Planning

Arizona is characterized by widely diverse geographic regions, ranging from forested mountain areas to arid deserts. These areas have dissimilar climates and precipitation regimes, resulting in variability in, and accessibility to, surface water supplies. Arizona is also geologically complex, which impacts the availability, quality and accessibility of groundwater supplies. Areas of water demand are also unevenly distributed across the state. Central Arizona exhibits the highest concentration of urban/municipal uses and growth. Much of this use is located on retired irrigated farmlands. Agricultural irrigation is still significant, and is the most prevalent water use sector in the State. It continues to provide a significant benefit to Arizona's economy and serves as the foundation of the local economies in many regions of the State. Important industrial sectors, such as copper mining remain regionally significant water users and economic engines in isolated portions of the State. Portions of the State also remain popular winter-time destinations and golf courses are a prevalent and important economic use throughout the State.

Land Ownership

Arizona is also unique in its land ownership patterns. Less than 18 percent of the land within the State is under private ownership. State Trust Land comprises almost 13 percent of the land, with the remaining 69 percent in either federal or Indian ownership. This variability in land ownership adds additional complexity to the water supply challenges that must be met. These challenges range from the need to appropriately involve tribal entities to ensure that Indian water supplies, demands and water right claims are accurately understood and addressed, and ensuring that the mandates of federal lands are fulfilled. This ownership is also often fragmented, with federal, state, and private land holdings assembled in a "checkerboard" fashion that further complicates the development and execution of comprehensive land and water management strategies.

Additionally, there are possible limitations on the ability to construct and develop water transmission lines across federal and tribal lands. Because 69 percent of the land in Arizona is federally controlled, there is a strong likelihood that a federal nexus will exist, and the requirement for environmental compliance under the National Environmental Policy Act (NEPA) will be triggered. As water supplies are developed and water treatment and delivery infrastructure is designed, it will be important to consider the potential financial impacts of federal environmental compliance requirements. Those impacts could also result in a longer planning horizon to provide time to secure permits or other federal approvals. In most cases, environmental compliance processes include formal public input and the opportunity for third party legal action challenging the final decision of the federal agency issuing the permit or approval. This can increase the lead time for planning and constructing projects and may introduce additional levels of uncertainty in the outcome.

Experience with the planning, design, construction and operation of existing water projects shows that complying with federal requirements can add anywhere from several months to several years to a project. Some compliance programs that may be encountered whenever there is a federal nexus associated with a project include:

1) The National Environmental Policy Act of 1969 (NEPA). NEPA became effective on January 1, 1970. In simple terms, it requires that the federal government consider all environmental factors when making a decision on a major federal action. NEPA can result in projects incorporating mitigation measures that avoid, minimize or compensate for potential adverse environmental impacts. The federal agency taking the action is responsible for administering the Act.

2) The Endangered Species Act of 1973 (ESA). The ESA became law on December 28, 1973. Generally, the Act protects species from becoming extinct, by prohibiting the take of endangered or threatened species and adverse modification of a species critical habitat. Projects and actions that fall under the umbrella of the ESA may be required to minimize and mitigate negative impacts to species and their habitat to the maximum extent practicable. The ESA is administered by the US Fish and Wildlife Service and the National Oceanic and Atmospheric Administration.

3) Section 404 of the Clean Water Act (CWA). Section 404 of the CWA regulates the dredge and fill of materials into waters of the United States. The program to administer it was established in 1972. It is intended to protect aquatic resources and to avoid or lessen degradation of waters of the United States. The permitting process encourages avoidance of impacts and may require minimizing and mitigating impacts to the environment. The program is primarily administered by the US Army Corps of Engineers with additional oversight by the US Environmental Protection Agency.

Arizona Water Law

Another factor in the complexity of developing water supplies is the Arizona water law system under which groundwater and surface water are largely regulated under separate statutes and rules. While the groundwater management system primarily applies inside designated AMAs and INAs, the surface water system (except for Colorado River supplies) is administered statewide. Colorado River supplies are managed in cooperation with the State, but contracts for Colorado River water are initiated through the US Secretary of the Interior and administered by Reclamation. Reclaimed water use is managed under a completely different set of regulations and policies and was significantly influenced by case law[36]. This legal complexity adds to the challenge of ensuring that adequate supplies exist to meet the demands across the state.

General Stream Adjudication

Adding to the legal complexities within the State are the on-going general stream adjudications of the Gila and Little Colorado river systems. General stream adjudications are judicial proceedings to determine or establish the extent and priority of water rights. Thousands of claimants and water users are joined in these judicial proceedings that will result in the Superior Court issuing a comprehensive

[36] *Arizona Public. Service Co. v. Long*, discussed earlier

final decree of water rights for both river systems[37]. The Gila River adjudication was initiated in 1974 when SRP filed a petition with Arizona State land Department (ASLD[38]), before the creation of ADWR, for the adjudication of the Upper Salt River. Thereafter, SRP, Phelps Dodge Corporation (Phelps Dodge), ASARCO and the Buckeye Irrigation Company filed petitions to adjudicate other watersheds within the Gila River Basin. The Gila River Adjudication includes much of the southern half of the state and covers the following seven watersheds: Upper Salt River, Upper and Lower Gila River, Verde River, Agua Fria River, Upper Santa Cruz River, and the San Pedro River.

The Little Colorado River Adjudication began in 1978 when Phelps Dodge filed a petition with the ASLD for the adjudication of water rights within the Little Colorado River system and source. The Little Colorado River Adjudication includes the northeastern part of the state and covers the following three watersheds: Silver Creek and the Upper and Lower Little Colorado River.

The general stream adjudications are comprehensive proceedings, evaluating water uses and claims by both State and federal entities. The State parties include municipalities, mines, utility companies, private water providers, water users' associations, conservation districts, irrigation districts, state agencies and individual water users that rely on water diverted from streams, lakes, springs, stored in reservoirs or stockponds, and withdrawn from wells. Within these proceedings, water rights are also being adjudicated for water uses on Indian reservations and federal lands including military installations, conservation areas, parks and forests, monuments, memorials, and wilderness areas. These water uses may include both surface (non-Colorado River) water and groundwater in certain instances. It is critical that the adjudication move forward in the near future to provide certainty regarding future water supply availability to the various water users throughout these watersheds, particularly during times of drought.

Outstanding Indian Water Rights Claims

While progress on the adjudication process has been complicated by the diversity of water users and the need to resolve preliminary legal issues, the State has made significant progress in reducing uncertainty through execution of Indian Settlements[39]. However, there are still Indian claims that have yet to be addressed and completion of these settlements is essential to not only provide a secure water supply for tribal communities, but also to provide long-term certainty for all water users in Arizona (*see Table 1*).

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[37] As of July 2013, there are 83,244 claims in the Gila River Adjudication and 14,522 claims in the Little Colorado River Adjudication.

[38] Upon its creation in 1980, ADWR assumed the role of administering surface water rights throughout the State. ASLD performed this function prior to ADWR's establishment.

[39] Discussed above in Section II Part III: Arizona's Historical Successes in Water Management, Resolution of Tribal Water Rights.

Table 1. Outstanding Indian Water Rights Claims

Tribe	Potentially Affected Planning Area(s) ***See Section 3***
Havasupai Tribe	*Bill Williams, Verde, Western Plateau and Central Plateau*
Hualapai Tribe	*Bill Williams, Verde, Western Plateau and Central Plateau*
Hopi Tribe	*Navajo/Hopi, East Plateau, Central Plateau, Basin & Range AMAs, Colorado Mainstem – North, and Colorado Mainstem – South*
Kaibab Paiute Tribe	*Arizona Strip*
Navajo Nation	*Navajo/Hopi, East Plateau, Central Plateau, Basin & Range AMAs, Colorado Mainstem – North, and Colorado Mainstem – South*
Pasqua Yaqui Tribe	*Basin and Range AMAs*
San Carlos Apache Tribe (On-Reservation Gila River tributary claims)	*Basin & Range AMAs*
San Juan Southern Paiute	*Navajo-Hopi*
Tohono O'odham	*Basin & Range AMAs*
Tonto Apache Tribe	*Roosevelt and Basin & Range AMAs*
Yavapai Apache Nation	*Verde and Basin & Range AMAs*

Land Subsidence

Land subsidence occurs when groundwater has been withdrawn from certain types of aquifers, such as those containing fine-grained sediments, in excess of rates of replenishment. When groundwater is withdrawn from the open pore spaces between the soil particles, the sediments can collapse – causing a lowering of the land surface. In some systems, when large amounts of water are pumped, this can result in a permanent reduction in storage capacity of the local aquifer system. Uneven compaction of the soils overlying aquifer systems can lead to the formation of earth fissures (large cracks). Earth fissures typically form underground and can express themselves on the surface. The impacts of land subsidence include: damage to linear utilities and flood conveyance infrastructure; differential settling of building foundations; 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 areas and are dependent upon geologic conditions and historical volumes of groundwater withdrawals.

Summary

The diversity, variability and complexity that are unique to Arizona make developing water supply strategies difficult. In some areas, water users have access only to surface water from rivers and streams. In others, they rely solely on groundwater. Other regions have access to both groundwater and surface water, which can be conjunctively managed to provide renewable and redundant supplies for the benefit of local water users. Some areas may have elaborate and far reaching water storage, transmission and delivery systems, while others have limited infrastructure and rely entirely on local wells. Some areas may have already experienced rapid growth and others have not. Some areas of the state have available water supplies in excess of projected demands. In others, the currently developed supplies may not be sufficient to meet projected future demands, although there may be locally available supplies that can be developed in volumes adequate to meet those needs. Absent development of supply acquisition and importation projects, some portions of this arid State will struggle to meet projected water demands with locally available supplies.

Water Supply Development Opportunities

Over the next 20 to 100 years, Arizona will need to identify and develop an additional 900,000 to 3.2 MAF of water supplies to meet its projected demands. While there may be local water supplies that have not yet been developed, water supply acquisition and/or augmentation will be required for some areas of the State to realize their growth potential. Examples of these potential supplies are:

1) Non-Indian Agricultural Priority CAP water;
2) Reclaimed water/water reuse for which there is not yet delivery or storage infrastructure constructed to put it to direct or indirect use;
3) Groundwater in storage;
4) Water supplies developed from revised watershed management practices;
5) Water supplies developed through weather modification;
6) Water transfers
7) Water supplies developed from large-scale or macro rainwater harvesting/stormwater capture; and
8) Direct importation or exchange of new water supplies developed outside of Arizona (e.g., ocean desalination).

1) Non-Indian Agricultural Priority CAP Water

The Arizona Water Settlements Act[40] (Settlements Act) was enacted on December 10, 2004. The Settlements Act ratified the Arizona Water Settlement Agreement (Agreement) between the United States, ADWR, and CAP and provided for the reallocation of 96,295 acre-feet of Non-Indian Agricultural Priority CAP water (NIA Priority CAP water) for municipal and industrial uses in the State of Arizona.

Both the Settlements Act and the Agreement required the US Secretary of the Interior (Secretary) to reallocate the 96,295 acre-feet of NIA Priority CAP water to ADWR "to be held under contract in trust for further allocation."[41] Both the Settlements Act and the Agreement also specified that the Director of ADWR shall submit a recommendation for reallocation to the Secretary, and that the Secretary shall carry out all necessary reviews of the proposed reallocation in accordance with applicable federal law[42]. The Agreement further provided that ADWR develop eligibility criteria and make the water available for reallocation "at periodic intervals, starting in 2010[43]." On August 22, 2006, the Secretary reallocated the 96,295 acre-feet of NIA Priority CAP water to ADWR acknowledging that "before the water may be further allocated the Director of ADWR shall submit to the Secretary of the Interior a recommendation for reallocation[44]."

The NIA Priority CAP water has a lower priority than Indian or Municipal and Industrial (M&I) Priority CAP water and is expected to have reduced availability, especially during times when Arizona's supplies are affected by shortage operations on the Colorado River. ADWR's analysis of the average availability of this 96,295 acre-feet of NIA Priority CAP water estimates that an average of about 64,000 acre-feet per year will be available over the next 100 years, assuming a moderate development schedule on the

[40] Public Law 108-451
[41] Settlements Act § 104(a)(2)(A); see also Agreement Paragraphs 3.1 and 9.3.1.
[42] Settlements Act § 104(a)(2)(C); see also Agreement Paragraph 9.3.4. The Department has traditionally provided recommendations of allocations of CAP water to the Secretary, consistent with its authority in A.R.S. § 45-107.
[43] Agreement Paragraph 9.3.4.
[44] *Notice of Modification to the Secretary of the Interior's Record of Decision, Publication of a Final Decision of CAP Water Reallocation*, 71 Fed. Reg. 50449, 50451 (Aug. 25, 2006).

acre-feet per year over the 100-year period after 2030 due to projected increases in use for all Colorado River water users. This means that over the next 100 years in some years this NIA water supply will be fully available, some years it will be partially available, and some years it will not be available at all. Recipients of this water will need alternate water supplies and the necessary infrastructure to use those alternate water supplies in order to meet future firm demands in years of reduced or no availability of this NIA Priority CAP water.

ADWR has divided the full reallocation volume of 96,295 acre-feet into three pools and the water will be reallocated in a tiered process, with phases starting in 2013, 2021 and, if there is any remaining water, in 2030. ADWR has initiated the reallocation process for the first pool, in the amount of 46,629 acre-feet of NIA Priority CAP water, within the three-county CAP service area (Maricopa, Pinal and Pima counties). The Director of ADWR will submit a recommendation for allocation of this volume to the Secretary by December 31, 2013. The second pool of NIA Priority CAP water (17,333 acre-feet) will be offered to water users inside of the three county CAP service area in 2021. The third pool of NIA Priority CAP water (17,333 acre-feet) will be offered to water users located outside of the three county CAP service area, also beginning in 2021.

2) Reclaimed Water/Water Reuse

Substantial volumes of reclaimed water are utilized today through underground storage and recovery and through direct use to non-potable uses such as landscaping and turf irrigation. ADWR has projected additional volumes of reclaimed water that can be generated by future populations[45]. Along the Colorado River, water users can receive return flow credits for discharge of reclaimed water back to the River, allowing them to divert above their entitlement by the volume of return flows. The current volume of reclaimed water supplies available to meet demands is over 500,000 acre-feet. In 2035, the estimated volume of reclaimed water that can be generated is approximately 745,000 acre-feet. In 2060, the volume is estimated at approximately 935,000 acre-feet and in the year 2110 the volume is estimated to be approximately 1.3 MAF.

Reclaimed water supplies are potentially available to partially offset the projected imbalances throughout the State. Significant investments will need to be made to put this water to use and to overcome the public perception associated with direct potable reuse of this supply. By using this supply more effectively, the future imbalances can be reduced by nearly 50 percent to 155,000 acre-feet in 2035 and 1.9 MAF in 2110. In addition to reducing a community's possible water supply imbalance, expanding a community's sewer collection and treatment system to customers who are dependent on septic systems can also protect local water quality.

The volumes stated above are based on production from municipal wastewater systems. Other sources of water reuse include: 1) in home grey water reuse systems, which recycle water from uses such as washing machines and dishwashers for outdoor landscape watering or toilet flushing and 2) industrial wastewater.

[45] These projections were conservatively derived by holding the current percentage of the population that is connected to a sewer system in each groundwater basin constant and applying a constant reclaimed water generation factor to the projected population.

3) Groundwater

ADWR estimates that the groundwater currently in aquifer storage within the State to a depth of 1,000 to 1,200 feet below land surface (or bedrock, whichever is higher) is just over 1.2 billion acre-feet[46]. If this groundwater were fully accessible and was utilized through 2110, without regard to the negative impacts of pumping that supply to those depths, the 100-year annual volume available would be 12.5 MAF. While at face value this would solve the water supply challenges facing Arizona, the available groundwater is not always located in the areas that have the greatest projected demands and depletion of this resource is not in the best interest of the State. For example, the adjusted estimated groundwater in aquifer storage in the Little Colorado Plateau Groundwater Basin is over 760 MAF (7.6 MAF annually for 100 years) while the projected demand in that basin in the year 2110 ranges from 300,000 to 400,000 acre-feet. Additionally, much of the groundwater basin underlays Indian reservation lands and is not likely available for off-Reservation uses.

In some areas of the State (e.g., Buckeye and Yuma), successful agricultural practices require leaching of salts from the soil profile and drainage of shallow groundwater to depths below crop root zones. This is accomplished through an extensive gravity drainage system and operation of dewatering wells, which discharge or dispose of this "brackish groundwater," typically to nearby rivers. Capture, treatment and direct use of this locally available resource can serve to augment local water supplies reducing demands on other groundwater supplies or can be transported to other areas as needed. Highly saline brine will be a by-product of the treatment required to reuse this supply. Development of a cost-effective brine disposal method will greatly enhance the viability of this supply augmentation alternative.

The potential for negative consequences associated with groundwater mining (withdrawing water from groundwater storage in excess of the rate of replenishment) is the primary reason for not relying on groundwater to meet all future water needs. These may include but are not limited to:

- Declining groundwater tables;
- Dewatering of certain areas of the basin;
- Declining well yields;
- Increased pumping depths and cost;
- Land subsidence and earth fissuring;
- Diminished water availability to water dependent natural resources; and
- Deterioration of water quality and the costs associated with treating that water.

Developing a regional analysis of the sustainable or optimal yield from Arizona's groundwater basins would provide water managers with information necessary to determine the long-term security associated with local reliance on groundwater supplies to meet current and projected water demands.

4) Watershed Management

Increasing water yields through vegetation management may be a viable option for water management for on-site or off-site uses. Vegetation management does not have to occur through extreme measures, such as clear-cutting (either wholesale clearing or type conversion), but can include strategies to decrease interception and evapotranspiration in upland areas outside of the riparian zone by reducing the numbers of trees and shrubs and replacing those species with plants that use less water, such as

[46] Arizona Department of Water Resources

native grasses. Existing soils, topography, precipitation and vegetation types are important elements in the effectiveness of this practice and will affect the timing and magnitude of potential water yields and required management practices essential to maintaining the benefits. Cost also must be weighed in determining whether to initiate and maintain such a program. The value of the water yield has to be compared to the other societal uses of the land. However, finding projects that have mutual benefits compatible with other natural resource objectives, such as increased livestock forage, recreational opportunities and reduced risks and costs of associated with wildfires may offset these costs.

Table 2. Compilation of Water Yield Data From Experiments in Arizona

(*Source: Water Yield Improvement by Vegetation Management, Ffolliott and Thorud, 1977 & Arizona Forest Resource Assessment- Arizona State Forestry Division, 2013*)

Vegetative Zone	Experimental Location	Water Yield Increase	Acreage of Traditional Forest Types in AZ	Studied Management Practice
Mixed Conifer Forests	Workman Creek – North Fork	No Change	450,221acres	Removal of riparian vegetation
	Workman Creek – North Fork	0.10 ac-ft/ac/yr		Conversion of 1/3rd of watershed, specifically moist-site vegetation immediately adjacent to stream channel
	Workman Creek – North Fork	0.45 ac-ft/ac/yr		Conversion of 1/3rd of water watershed, specifically the dry-site vegetation immed.adjacent to the moist-site conversion.
	Workman Creek – South Fork	No Change		Individual tree selection cut
	Workman Creek – South Fork	0.50 ac-ft/ac/yr		Subsequent uniform thinning of areas dominated by Ponderosa pine, and after areas dominated by Douglas-fir and White fir were cleared
Ponderosa Pine Forests	West Fork of Castle Creek	0.05ac-ft/ac/yr	4,043,854 acres	Clearing 1/6th of the overstory, with the remaining 5/6ths subject to thinning treatment
	Beaver Creek	0.20 ac-ft/ac/yr		Clearing 1/3rd of the forest overstory in uniform strips on Watershed 9 and irregular strips on Watershed 12
	Beaver Creek	0.15 ac-ft/ac/yr		Thinning of forestry overstory by group selection on Watershed 17
Pinyon-Juniper Woodlands	Beaver Creek	0.04ac-ft/ac/yr	13,420,572 acres	Aerial application of herbicides on Watershed 3
		Minimal increases		Mechanical conversion

Watershed management strategies have been explored and used in Arizona and across the West for decades to increase yields in localized settings. At a larger scale, Arizona's forests are an integral part of the watershed management strategy in this State. The Tonto National Forest, which owes its existence to the construction of Roosevelt Dam, was created in 1905 to protect the watersheds of the Salt and

Verde Rivers and, according to its web site, continues to be a central focus of the Forest[47]. Additionally, the Apache-Sitgreaves National Forests[48] include the health and restoration of the watersheds as one of their management concerns, and the Prescott National Forest[49] manages its watershed for the purpose of protecting the Agua Fria and Verde Rivers.

In the early 1960s, the Arizona Watershed Program was initiated to research integrated watershed management techniques for the purpose of increasing water yield. The program was a joint effort of the ASLD, working with the USDA Forest Service and other government agencies and cooperators. This effort was instrumental in many of the historic experimental research projects in Arizona, some exhibiting potentially promising results. The results of many of these projects were summarized in a report, *Water Yield Improvement by Vegetation Management* (Ffolliott and Thorud, 1977). The report presented the available information from experiments conducted in Arizona on water yield improvement for eight different vegetative zones. Those results are summarized above in Table 2.

ADWR recognizes that these studies are dated. New information is being developed through private and governmental organizations and should be part of the on-going analysis within Arizona to identify possible areas of focus. Combining efforts with other management initiatives (such as the Four Forest Restoration Initiative) may be a cost-effective way to advance this option and provide multiple benefits. 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[50]. Future plans, through the 4FRI effort, for landscape scale restoration activities in Arizona's national forests have the potential to increase water yield and overall forest health.

Another area that may have promise for increasing water yields is Tamarisk removal[51]. Tamarisk, commonly known as salt cedar, is a non-native shrub or tree that was introduced into the US in the 19th Century. During the Great Depression in the 1930s, tamarisk was used as a tool to fight soil erosion in the Great Plains. Tamarisks are very prolific and displace native vegetation and animals, alter soil salinity, and increase fire frequency[52]. Tamarisk is an aggressive competitor for water supplies and often develops into monoculture stands, which can negatively impact native vegetative communities. In Arizona, Tamarisk has colonized into dense stands along many water courses, altering flow regimes and reducing downstream flows. Measures to control the growth of, or eradicate, tamarisk have been attempted for the purpose of reducing vegetative water consumption, improving habitat conditions, and improving river system function. Maintaining the benefits of these measures has proven difficult, but may have promise in selection regions of the State.

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[47] http://www.fs.usda.gov/tonto
[48] http://www.fs.usda.gov/asnf
[49] http://www.fs.usda.gov/prescott
[50] http://www.4fri.org/
[51] Other areas vegetation manipulation should also be explored, such as mesquite encroachment, but we are focusing on tamarisk in this report.
[52] http://www.nps.gov/grca/naturescience/exotic-tamarisk.htm

The ability to employ watershed management practices is becoming significantly more constrained due, in part, to environmental concerns. Areas that appear to have potential for water yield improvement will also need to be evaluated not only for the vegetative, physiographic and climate potential but also social, institutional and economic factors.

5) Weather Modification

Weather modification (cloud seeding) is the application of scientific technology that can enhance a cloud's ability to produce precipitation. The technique was developed in the 1940's using small particles of dry ice and converting water droplets existing at temperatures lower than freezing (supercooled) to ice crystals. There are two types of projects that are being conducted today in parts of the US: 1) projects that increase snowpack (cold rain) and 2) projects that increase localized precipitation for range and croplands (warm rain).

The process is based on enhancing the natural formation of precipitation in the atmosphere. As wind pushes moist air over rising terrain, the rising air cools and water droplets are then formed through condensation, resulting in the formation of orographic clouds. The clouds consist of small droplets that, despite below-freezing temperatures, remain liquid. The water's purity and the lack of foreign particles in the atmosphere prevent the droplets from freezing, forming supercooled clouds. As temperatures decrease further, the droplets form ice crystals around small atmospheric particles such as dust (known as "condensation nuclei").

Cloud seeding introduces additional particles or nuclei into the atmosphere, causing more ice crystals to form. Silver iodide compounds and dry ice are the most common cloud seeding agents. Aircraft or ground-based generators are used to introduce the agents into the atmosphere. As the ice particles grow, they attract nearby water vapor and droplets, growing larger and heavier. These enlarged ice particles eventually fall as snow.

Cloud seeding experiments originally were focused largely on cumulus clouds, the most common, widely distributed cloud form, and the world's most important precipitation source. The short life span and instability of cumulus clouds complicated seeding operations. Orographic clouds, which form as air masses are forced over mountainous areas, are preferable for seeding as they typically last longer and are more predictable, allowing for more easily controlled weather modification experiments. Orographic clouds are the source of both rain and snow. In the mid-latitudes, nearly all precipitation begins as snow but, if it is much warmer than freezing below the cloud base, the snow melts and reaches the ground as rain. Freezing temperatures are required for crystallization to occur with the seeding material or agent. As a result, snow is the expected product of cloud seeding.

The West provides favorable conditions for weather modification as the mountainous terrain is generally favorable to the forming of orographic clouds. Additionally, it is an area of water scarcity, with the dependable flows of its natural streams typically fully appropriated. Therefore, the natural conditions and water supply needs suggest suitability for weather modification activities. With a large proportion of its area arid or semiarid, Arizona can be expected to benefit by weather modification, certainly to a greater extent than less arid states in the Nation.

SRP conducted some of the earliest cloud seeding operations in Arizona. During the 1950s, a time of drought in Arizona, SRP set up a series of ground-based seeders on its 13,000-square-mile watershed.

The operations relied on air masses to lift propane-burned silver iodide for seeding. SRP also contracted for aerial seeding during the 1950s and 1960s. These early efforts were suspended when drought conditions eased.

Reclamation released a study in 1974 that described the potential of weather modification to increase water resources in the region. The study estimated the average annual water augmentation potential in the Upper Colorado Basin to be about 1.4 MAF, with 300,000 acre-feet in the Lower Basin and 500,000 in adjacent basins. Most of the 300,000 acre-foot Lower-Basin yield would come from Arizona watersheds. The study found that an additional 300,000 acre-feet could be delivered to Arizona via the Central Arizona Project. The study estimated the cost of generating this new runoff to be about $2 to $5 per acre foot (1974 dollars- $9.50 to $23.75, adjusted to 2013 with CPI).

The Mogollon Rim, in central Arizona, has been identified as offering the greatest potential for in-state weather modification efforts[53]. Stretching from northwest to southeast, the Rim forms a physical barrier that forces flowing air upward to cool, a situation favorable to orographic cloud development. According to the Arizona Water Resources Research Center, about 40 percent of the water for central and northern Arizona falls as winter precipitation over this area and drains north into the Little Colorado River and south to the Verde and Salt River systems. Thus, according to the Research Center, it provides an ideal opportunity for weather modification experimentation and research.

While studies continue, weather modification still remains somewhat scientifically uncertain and raises legal and public policy concerns in need of resolution, such as:

- How is it determined that precipitation was in fact the result of weather modification?
- How is the amount of new water to be quantified for credit and distribution?
- On what basis is the new water induced by weather modification to be allocated among water users?
- How can those who pay for the weather modification be assured that they will in fact receive their share of the new water?

Also not to be neglected are the possible unintended consequences resulting from weather modification (storm damage and flooding liability). Environmental studies would also be required to determine the effects of cloud seeding. Computer modeling is capable of contributing to this effort.

Weather modification may have potential to increase water supplies in Arizona. However, studies are needed to identify areas with potential, and practical public policies must be developed to address the legal and public policy concerns to benefit and protect Arizona water users and landowners.

6) Water Transfers

There are established laws, policies and procedures for transfers of groundwater, Colorado River water and in-state surface water. They are designed to protect local interests and other water users and water right holders in the system. These protections make water transfers difficult to execute and would likely limit their utility in addressing future water supply imbalances. In other

[53] https://wrrc.arizona.edu/publications/arroyo-newsletter/weather-modification-water-resource-strategy-be-researched-tested-tri

words, transfers that are possible *under existing law* may be a helpful limited tool to enhance water supplies under the right cooperative conditions, but it is clear this is not the mechanism for dealing with more comprehensive enhancement needs around the state.

Moving water from one area of Arizona to another has the potential to create controversies, especially if the area from which the water is being transferred has existing water uses and economies built on that water supply. However, such transfers have already been accomplished in limited cases and are subject to regulation aimed at protecting local economies and water users.

The Arizona State Legislature passed the Groundwater Transportation Act in 1991, prohibiting most transfers of groundwater. The law was passed in response to some of the larger cities in Maricopa and Pima counties purchasing large farms in other areas of the State to augment their water supplies. The restrictions imposed by the Transportation Act are intended to protect hydrologically distinct groundwater supplies and the economies in rural areas by ensuring the groundwater is not depleted in one groundwater basin to benefit another. The law does, however, recognize pre-existing investments in water transfers and allows for the following limited, exceptions to these restrictions, under specific statutory conditions that are unique to each exception:

1) Butler Valley Groundwater Basin to an initial AMA;
2) Harquahala Irrigation Non-Expansion Area to an initial AMA;
3) McMullen Valley Groundwater Basin to an adjacent initial AMA;
4) Big Chino Sub-Basin of the Verde River Groundwater Basin to an adjacent initial AMA;
5) Yuma Groundwater Basin;
6) Little Colorado River Plateau Groundwater Basin (under very limited conditions); and
7) Parker Groundwater Basin (under very limited conditions).

A transfer of a Colorado River water entitlement or allocation must be approved by the Secretary. State statute authorizes the Director of ADWR to consult, advise and cooperate with the Secretary in contracting for the delivery of water from the Colorado River[54]. State statute also requires that a person proposing to transfer a Colorado River entitlement or allocation cooperate and obtain the advice of the Director of ADWR[55]. ADWR has adopted a substantive policy statement that establishes the procedures that must be followed and criteria that must be met for the Director to recommend approval of a proposed Colorado River water transfer. Importantly, this process requires the input of stakeholders who may be impacted by these transfers. This input is designed to ensure that all impacts are evaluated prior to removing these water supplies from the region of origin and is an integral component of ADWR's Transfer Policy and, if conditions are met, its recommendation to the Secretary[56].

Transfers of in-state surface water (non-Colorado River water) are also allowed under specific conditions set forth in State statute[57]. Generally, these types of transfers are limited to the same river system and do not involve trans-basin transfers. State law allows water to be transferred to another location on the river system but, depending on the type of use and location, the transferred supply may not retain the same water right priority date, which can limit its viability as a source for large-scale transfers.

[54] *A.R.S. §45-107(A)*
[55] *A.R.S. §45-107(D)*
[56] http://www.azwater.gov/azdwr/Legal/LawsRulesPolicies/documents/CR7.pdf
[57] *A.R.S. §45-172*

The role of water transfers for long-term water management strategies must be evaluated on a case-by-case basis. While certain transfers may have minimal impacts, others may not only impact local economies, but also operations of nearby and downstream irrigation districts, environmental and recreational needs, the operation of intra-state rivers for hydroelectric power, water quality, and international treaty obligations. Depending on the source of water, using transfers for long-term water supplies must take into account the long-term availability of the water supply that is subject to the transfer request, the reliance of the local area on that water supply, and the impacts to other water users in that system. In areas where the availability of the water to be transferred is limited, short-term and/or dry year options may be more suitable and beneficial to the communities.

There are established laws, policies and procedures for transfers of groundwater, Colorado River water and interstate surface water. They are designed to protect local interests and other water users and water right holders in the system. These protections make water right transfers difficult to execute and may limit their utility in addressing future water supply imbalances.

7) Large-Scale(Macro) Rainwater Harvesting/Stormwater Capture

The practice of rainwater harvesting dates back to the earliest days of civilization and refers to the technology for capturing, storing and using rainwater. This can be accomplished on a small-scale at a single residence, intercepting the precipitation that falls on impervious areas around the home or from rooftops and diverting it to cisterns or barrels for on-site uses such as landscape watering. In Arizona, rainwater harvesting is encouraged at the residential level as a water conservation best management practice and is a common, voluntarily employed, practice across the State. Some Arizona water providers offer incentives for their customers to invest in and utilize this technique. For example, Tucson Water has a program that will rebate qualifying residential rainwater harvesting systems costs up to a maximum of $2,000[58].

Larger-scale techniques for the capture of rainwater or stormwater can be used for residential subdivisions, commercial developments, industrial sites, parking lots, roads and highways. While these types of projects can utilize commercially available equipment, they can also be accomplished through design of facilities and grading land surfaces to slow down flows and enhance infiltration into the aquifer, thereby creating the potential to enhance natural aquifer recharge. Large-scale stormwater capture and recharge is managed through ADEQ's Arizona Pollution Discharge Elimination System (AzPDES) permitting process and supports compliance with ADEQ's best management practices for stormwater management.

While, stormwater capture and infiltration enhancement projects exist in Arizona, proposals to obtain underground storage credits through ADWR's Underground Storage and Recovery Program have added a new dimension to this activity. Typically, rainwater or stormwater either infiltrates into the ground, ultimately replenishing local aquifers, or flows over the land surface to rivers, streams or other surface water management systems or impoundments. Water that infiltrates into the aquifer is considered a benefit to the aquifer, the environment, and all users in that system. Allowing individual entities to accrue underground storage credits for this water would require significant monitoring of localized storm events, accounting and administration. Additionally, there are concerns from some water rights

[58] For more information see http://cms3.tucsonaz.gov/water/rwh-rebate.

holders that inhibiting flows that otherwise would have entered the surface water system may reduce their water availability. To address these issues, the Arizona Legislature passed House Bill 2363 in 2012 establishing a Joint Legislative Study Committee on Macro-Harvested Water to evaluate the issues arising from the collection and recovery of large-scale harvested water. The process to evaluate these projects will be important in determining whether or not the projects can result in significantly enhancing water supplies beyond what is currently available for future uses, and whether those local benefits can be earmarked for specific parties. Pilot projects are currently being developed to analyze this activity in the Upper San Pedro Basin in Cochise County.

8) Importation of New Water Supplies

While Arizona has local options available to meet its near-term water supply challenges, there still may be a need to explore and acquire water supplies from outside of the State. Water supply augmentation from outside Arizona will be challenging and, most likely, more costly than the in-State options. In the public discussions following the release of the Basin Study, options for importation of water supplies were generally dismissed as less desirable than local conservation and reuse.

Unfortunately for Arizona, the significant strides that have already been made in the area of conservation and reuse have been ignored by external parties perhaps due to lack of understanding of the magnitude of Arizona's efforts. While Arizona has significant potential to reduce the future imbalances using reclaimed water, and to some extent the other options described above, there may remain an imbalance between future demands and available supplies that needs to be addressed. Given the long lead time that will be required, addressing this need cannot be pushed off into the future. Acquiring and developing imported water supplies could be an exponentially more difficult task than it was to bring Colorado River water to Central Arizona through authorization of the CAP, as the supplies will likely be derived from outside the State. Several other states are in the same, or nearly the same, position as Arizona, but do not share the challenge of having a significant portion of its entitlement as the junior priority on the Colorado River. If we take a wait-and-see approach to pursuing these options, we will certainly be at a disadvantage, as other states and municipal water suppliers are actively exploring similar options. If we are choosing to pursue economic expansion, for the future of Arizona, we must begin today to actively explore opportunities to expand our water supplies to meet those needs.

The pursuit of similar opportunities by entities outside of Arizona presents both potential competition and opportunities for cooperation. Arizona has and shall maintain its stalwart protection of our Colorado River supplies. We have been able to do that while maintaining a spirit of cooperation and collaboration with our fellow Basin States and representatives of Mexico. We continue to work to solidify those relationships and can expand on those relationships to explore importation opportunities from outside the State.

Options for importation of water supplies are limited because of the distance from the supplies and in some cases, the local demands on those supplies in the area of origin. Additionally, the cost-effectiveness of developing these options (acquiring, transmission, energy and maintenance) further limits the practical application of utilizing such supplies. Some of the importation alternatives identified in the Basin Study include trans-basin importation of Mississippi River water to the Lower Basin; importation of Missouri River water to the Upper Basin; and ocean desalination. Of all the options identified in the Basin Study, seawater desalination may be the most cost-effective and politically viable

importation option available to Arizona. Desalination refers to any of several processes that remove some amount of salt and other minerals from saline water to produce fresh water suitable for human consumption or irrigation.

The cost of desalinating sea water (including the infrastructure, energy and maintenance) is generally higher than obtaining fresh water from rivers or aquifers, reusing reclaimed water, or employing water conservation practices. Options for acquiring and delivering this supply vary based on the anticipated location of delivery within the State and the ability to develop agreements with neighboring states or Mexico. Table 3, below, identifies several desalinating options identified in the Basin Study. Obviously, among the Basin States, the state of California has access to the nearest US supply of ocean water. California is a partner in the Colorado River Basin and has significant needs for dependable water supplies into the future. Arizona can explore options for exchanging California's Colorado River water entitlement for use in Arizona for the construction and operation of desalination plants on the Pacific coast of California. This option is only likely to be possible if a mutually beneficial arrangement can be struck between Arizona and California. California already has access to large volumes of seawater and currently has no incentive to share its Colorado River entitlement. Thus, while monetary incentive may present an option, it is still uncertain if California would be a willing cooperator. Exploration of this option would require significant time and effort but, if viable, could provide a mechanism to address Arizona and Nevada's needs.

Table 3. Desalination Options Identified in the Colorado River Basin Supply and Demand Study

Option Type	Option Category	Representative Option	Estimated Cost ($/AF)	Years Before Available	Potential Yield by 2035 (AFY)	Potential Yield by 2060 (AFY)
Increase Supply	Desalination	Gulf of California	2,100	20 - 30	200,000	1,200,000
		Pacific Ocean in California	1,850 – 2,100	20 -25	200,000	600,000
		Pacific Ocean in Mexico	1,500	15	56,000	56,000
		Salton Sea Drainwater	1,000	15 – 25	200,000	500,000
		Groundwater in Southern California	750	10	20,000	20,000
		Groundwater near Yuma, AZ	600	10	100,000	100,000
		Subtotal			**776,000**	**2,476,000**

Source: Reclamation, 2012

Mexico is at the end of the Colorado River system and has an annual entitlement of 1.5 MAF. Two options are available for entering into an agreement for desalination with Mexico, but would require significant capital investment and negotiations through the State Department. First, capital investment in Mexico to construct a desalination plant for Mexico on either the Sea of Cortez or the Pacific Ocean could provide Arizona with an opportunity to exchange Mexico's Colorado River entitlement for desalinated ocean water. Depending on the volume and location of delivery, this option would also

require additional transmission capacity from the Colorado River to the location of use if the volume exchanged exceeds the current CAP canal capacity, as well as a source of energy to desalinate and deliver that supply to areas in Mexico. Secondly, cooperating with Mexico on the construction of a facility on the Sea of Cortez and directly transporting that water into Arizona (and along the pipeline route in Mexico) for use would provide water to an area of need. Both of these options would require significant capital investment for construction, energy development and transmission.

To provide a general sense of the cost for a desalination project, the San Diego County Water Authority has proposed construction of the 54 million gallons per day (MGD) Carlsbad Desalination Facility (approximately 60,000 acre-feet per year) and 10 miles of 54-inch transmission line. Capital costs for the project are approximately $700 million. The annual operating costs for the facility are estimated at approximately $50 million, with 50 percent of that cost for the energy production needed to operate the facility to produce and deliver drinking water. The cost to the ratepayers is (including capital repayment, operation and maintenance) is about $2,329/acre-foot ($7.14/1,000 gals)[59].

A more local study analyzed a desalination plant located on the Sea of Cortez, just northeast of the central part of Puerto Peñasco and delivery of the water above Imperial Dam, north of Yuma, Arizona[60]. The study assumed that desalinated water conveyed to Imperial Dam could then be used to displace Colorado River water and exchanged to users in Arizona, and possibly other partnering states, which would then divert the additional Colorado River water through their existing, expanded, or new infrastructure (possibly requiring additional costs). A regional scenario that included a 1.07 Billion Gallon per Day (1.2 MAF) treatment facility and a 143-mile open canal conveyance structure was estimated to cost approximately $1,183/acre-foot ($3.63/1,000gallons), not including 500 MW energy production capacity requirement for this scenario. Replacing the open canal conveyance structure with a closed pipe system could provide more supply security but could also add as much as $4.47/1000 gallons to the overall cost. In comparison, the current rate for M&I water delivered to Phoenix through the CAP canal is approximately $0.45/1,000 gallons before treatment and approximately $5.00/1,000 gallons after treatment, depending on location and treatment technology. It is interesting to note that the cost of that same volume of water from commercial bottled water is approximately $12,736/1,000 gallons.

It is also important to note that an entity proposing a project in Mexico would need to consider supplying security to protect the project from possible terrorism, and would also need to consider environmental impacts, including disposal of the by-products of the desalination project, both of which could add to the cost.

59 http://www.sdcwa.org/sites/default/files/files/board/2012_presentations/presentations_2012_06_14.pdf

60 Investigation of Binational Desalination for the Benefit of Arizona, United States, and Sonora, Mexico – Final Report, June 5, 2009, HDR Engineering

GOING FORWARD:
CREATING AN ARIZONA STRATEGIC VISION FOR WATER SUPPLY SUSTAINABILITY

Based on the most recent study conducted by the water community in Arizona, the legislatively formed WRDC, Arizona could be facing a water supply imbalance between projected demands and water supply availability in the next 25 to 50 years of approximately 900,000 acre-feet. In many portions of the State, this short term imbalance can likely be solved with locally available water supplies. However, there is still a need for financing the infrastructure necessary to accomplish this.

The imbalance is projected to increase by an additional 2.3 MAF by the year 2110. The availability of local water supplies to meet these needs will vary based on the intensity of the demands within each region of the State. Local water supplies may not be sufficient to address these needs and more options must be explored and evaluated, including importation and transportation of desalinated seawater. Pursuit of such options will require sustained investment and commitment by Arizona's policy and business leaders. In order to avoid economic disruption, these efforts must begin immediately to ensure that long-term solutions are in place in advance of the need.

Regional Strategies

There is no single strategy that can address projected water supply imbalances across the State. Instead a portfolio of strategies needs to be implemented dependent on the needs of each area of the State. It is very important to recognize the uniqueness of the various regions throughout the State and the varying challenges facing those regions. A more thorough regional overview and evaluation of the water supply needs for each delineated "Planning Area" within Arizona is included in Section 3 of this report. These Planning Areas have been identified based on possible short-term and long-term strategies available to meet the projected water supply imbalances (*see Figure 8*). Additionally, Table 4 highlights the portfolio of strategies that have been identified and the applicability to each of the Planning Areas, as discussed in more detail in Section 3.

Statewide Strategies

In analyzing all the strategies on a regional basis it became clear that there were specific issues that have widespread potential benefit to all Arizonans. Strategic priorities are identified below which ADWR believes will move Arizona forward through its next century. Additionally, action items have been identified for the first 10 years following the submittal of this report including a requirement for the continued review and update of this report every 10 years.

Figure 8. Strategic Vision Planning Areas

Table 4. Planning Area Strategies

Strategy	Applicable Planning Area(s)*	Supply Limitation	Drought Resiliency	Implementation Challenge	Timeline**
Reclaimed Water Reuse	**1, 3, 5, 6, 9, 14, 15, 17, 18, 19, 20** *10, 16*	Derivative Supply Increases w/Growth	Yes	Low to Moderate Cost Perception of Direct Use	C/EEP to Short
Conservation	**ALL Planning Areas**	Potential Limited by Existing Programs	Yes	Low	C/EEP to Short
Weather Modification	**3, 5, 9, 16, 17,19**	Limited	Limited	High NEPA Limited Local Data	Med
Watershed/Forest Management	**1, 3, 5, 9, 14, 16, 17, 18, 19**	Limited	Some	High NEPA	Med
Expanded Monitoring & Reporting of Water Use	**ALL Planning Areas**	N/A Assists in Managing Existing Supplies	N/A	Moderate Consent of Unregulated Parties Required	Short
Resolution of Indian and Non-Indian Water Rights Claims/Settlement Implementation	**1, 3, 4, 9, 10, 12, 13, 14, 16, 17, 18, 19, 22** *5, 6*	N/A Reduces Supply Uncertainty	Supply Dependent	High Uncertain Federal Funding Consensus among Tribal Parties	Med to Long
Increased Access to Locally Available Groundwater (Potable & Brackish) & Enhanced Recharge	**1, 3, 5, 9, 14, 15, 18, 19** *4, 10*	Moderate Need Additional Studies to confirm	Yes Short Term Drought	Moderate Securing Supplies & ROW Access	Short to Med
Local Water Supply Study – Groundwater System Analysis/Modeling	**1, 2, 4, 6, 9, 10, 11, 14, 15, 17, 20, 22** *3, 5,19*	N/A Assists in Managing Existing Supplies	Gain Local Knowledge of GW/SW Link	Low - Moderate But Resources and Data Collection Needed	Short to Med
Local Water Supply Management	**6,19**	N/A	Supply Dependent	High Need Local Support	Med
Firming of Low Priority Colorado River Supplies	**3, 7, 20**	Limited by Available Resources	Yes	Low - Moderate Existing Authority But Resources Limited	C/EEP to Short
Importation – Instate SW or GW	**3, 5, 16, 19**	Limited by Available Resources	Supply Dependent	Moderate – High Some GW already avail. Public Opposition Likely	Med to Long
Importation – Desal Exchange	**3, 7, 18, 19** *5*	Limited by Exchange Opportunities and Infrastructure	Exchange Supplies Limited	High Securing Supplies & ROW NEPA	Long
Importation – Desal Direct Use	**3, 18, 19** *5*	Supply Unlimited Economics will drive capacity	Yes	High Securing Supplies & ROW NEPA	Long

Planning Area Key

ID	Name
1	Apache
2	Arizona Strip
3	Basin & Range AMAs
4	Bill Williams
5	Central Plateau
6	Cochise
7	Colorado River Mainstem – North
8	Colorado River Mainstem – South
9	East Plateau
10	Gila Bend
11	Hassayampa/Agua Fria
12	Lower Gila
13	Lower San Pedro
14	Navajo/Hopi
15	Northwest Basins
16	Roosevelt
17	Upper Gila
18	Upper San Pedro
19	Verde
20	West Basins
21	West Borderlands
22	Western Plateau

Recommended Implementation Schedule:
C/ EEP = Continuation/Expansion of Existing Programs
Short = Short-Term (1-5 yrs)
Med = Medium- Term (5 – 15 yrs)
Long = Long-Term (> 15 yrs)

* Applicable Planning Area – **BOLD** are areas where strategy is recommended – *Italicized* are areas where strategy could be utilized but not a primary option.

Strategic Priorities

M) ***Resolution of Indian and Non-Indian Water Rights Claims***

Arizona has been successful in resolving, either in whole or in part, 13 of 22 Indian water rights claims, providing substantial benefits to both Indian and non-Indian water users. However, the general stream adjudications, which began in the 1970s, remain incomplete. As of July 2013, there are 83,244 claims in the Gila River Adjudication and 14,522 claims in the Little Colorado River Adjudication by both federal and non-federal parties. These legal proceedings involve complicated technical analysis and legal issues that can often be litigated for years. Completion of a general stream adjudication will result in the Superior Court issuing a comprehensive final decree of water rights. Until that process is complete, uncertainty regarding the nature, extent and priority of water rights will make it difficult to identify all the strategies necessary for meeting projected water demands. ADWR believes that options need to be developed by the State to accelerate this process. Creation of a Study Committee to develop options in a short time frame 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. Development of options could initially focus on conceptualization of water rights administration in a post-adjudicated Arizona. This will streamline the Court and ADWR's effort to collecting and evaluating only that information what will assist in administering the final water rights decrees.

H) ***Continued Commitment to Conservation and Expand Reuse of Reclaimed Water***

Arizona leads the nation in water conservation. However, we cannot be complacent with these successes. Conservation is the foundation of sustainable water management in our arid State. A continued commitment to using all water supplies as efficiently as possible is necessary to stretch our existing water supplies and delay the need to acquire other, more expensive, supplies.

Arizona is also a leader in the reuse of reclaimed water. Reclaimed water is continually produced from residential and industrial water users and is a secure source of water, but Arizona is only taking advantage of a fraction of its potential reuse opportunities. Many non-potable uses are being met by reclaimed water including: landscape irrigation of parks and golf courses; agricultural irrigation; and streamflow augmentation benefitting ecosystems. Reclaimed water is produced consistently throughout the year, with limited seasonal fluctuation. But irrigation demands, which are the most common use for reclaimed water, fluctuate seasonally, with high demands during the summer months and lower demands in the winter. Underground storage of unused reclaimed water during times of excess supplies and recovery of those supplies during higher demand seasons is a way to ensure renewable reclaimed water is available to meet demands. Using reclaimed water limits use of potable water for non-potable purposes and saves potable water for drinking water supplies. However, as demands increase and water supplies become more stretched, the need to explore and invest in direct potable reuse for drinking water supplies will become necessary. Using this supply that is readily available also reduces or delays the need to find alternative, more expensive, water supplies. Addressing legal hurdles and ensuring the public that this is a safe source of water needs to start now to ensure that direct potable reuse of reclaimed water will be available when it is needed.

O) ***Expanded Monitoring and Reporting of Water Use***

Monitoring of water use outside of the AMAs and INAs is limited to (1) the Community Water System Reports submitted by municipal water providers and (2) Colorado River accounting reports submitted to Reclamation. Metering and reporting across the State would serve to support and enhance analysis of

current hydrologic conditions. Data collection is a crucial element of the development of groundwater models, which have proven to be invaluable tools throughout the State in developing more thorough understandings of hydrologic systems and evaluating future conditions and potential impacts of new uses and/or alternative water management strategies. Additionally, expanded exploration drilling and testing of wells throughout the State will increase knowledge of local groundwater systems in addition to potentially mitigating local pumping impacts.

n) Identifying the Role of In-State Water Transfers

A source of significant controversy across the State, water transfers have been the focus of much debate throughout Arizona's history. So much so that the 1991 Groundwater Transportation Act was adopted prohibiting (with a few exceptions) the transportation of groundwater to the AMAs in order to protect rural Arizona water supplies. However, no such statutory prohibitions exist for the transfer of Colorado River supplies and in-state surface water. The absence of a statutory prohibition on moving these supplies does not mean that transportation is easily achieved. The conflicts that have arisen result from the perception that all transfers will be harmful to local communities and economies. A comprehensive analysis of water transfer is needed in Arizona. Evaluation of long-term versus short-term transfers may actually provide insight into how water transfers can be developed to protect or even benefit local communities. Lessons from other western states that have adopted more market-based water right transfer models may be worthy of review as part of this analysis.

Assuming, upon comprehensive vetting and study, such transfers could be effected in a manner that is satisfactory to at-risk constituencies with respect to local protection and benefit, another issue in this category is the physical transportation of water throughout the state. Typical mechanisms would be through construction of water pipes or canals. The ability to move water throughout Arizona is significantly inhibited by the amount of and dispersal of federal lands. Some land management agencies are amenable to allowing water transmission works to cross their lands while others are not. Because Arizona's highway system has already been constructed, using the rights-of way of existing highways provides an opportunity for colocation of water utility infrastructure and reduces the impact to surrounding lands and ecological resources. However, because of ADOT policy, the ability to utilize these existing corridors is extremely limited. Without this access utilities may have to acquire potentially costly lands and wait for lengthy federal processes to develop much needed infrastructure. Accordingly, in terms of finding some contributing value toward dealing with supply imbalances in the vein of possible mutually desired transfers, finding a compromise to right-of-way access for infrastructure development would assist in hastening the necessary development of water supplies for many communities.

p) Supply Importation - Desalination

Importation of water from outside of Arizona will likely be required to allow the State to continue its economic development without water supply limitations. Supplies derived from ocean or sea water desalination can be imported directly into Arizona to meet the water needs of municipal and industrial water users, while at the same time providing aesthetic, recreational and ecological benefits. Alternatively, desalination can be done in partnership with other Colorado River water users in exchange for water from Lake Mead. Potential partners for seawater desalination include higher priority Colorado River entitlement holders in Arizona, the State of California, and the State of Nevada. Additionally, advancing Governor Brewer's initiative to work cooperatively with Mexico through the Arizona Mexico

Commission, developing much need water supplies for both Arizona and Mexico through desalination on the Sea of Cortez could prove most effective. Projects of this magnitude are expensive and energy intensive, although unit capital and operating costs have significantly reduced as technology has improved and are comparable to water rates in other parts of the country. More importantly, because of the need to identify partners and develop agreements, these projects will require a significant investment of time – up to 20 years to bring to fruition. Because of the time it takes to develop these projects, and the more pressing need for water supplies in certain parts of the State, exploration of this strategy should begin immediately.

c) Develop Financing Mechanism to Support Water Supply Resiliency

The proverbial elephant in the room is cost. The strategies identified above, both statewide and regional, will require capital investment. For many years, the water community has attempted to develop options for funding water supply acquisition and infrastructure development. These conversations and analyses have largely been conducted in the absence of substantial financial expertise and have achieved limited success. It is time to elevate this conversation and address Arizona's future water supply needs, and only Arizona's community, political, and business leaders are capable of garnering the financial resources and mechanisms necessary to meet these needs. Historically, large water supply projects were funded by the Federal government. These Federal options may no longer be available and, if they are, will likely come at a financial premium to Arizona as the Federal land agencies seek to leverage their missions in exchange for approval and access to project financing. A dialogue is needed, perhaps modeled off the development of the Arizona Commerce Authority, to address Arizona's future water supply needs. Evaluation of the potential role of private capital in funding water treatment and delivery infrastructure will be required as a fundamental element of this planning process.

Some areas of the State need immediate assistance in developing water projects, specifically portions of rural Arizona. Unfortunately, these are areas where limited populations cannot finance the required water infrastructure. The Water Resources Development Revolving Fund was created by the Arizona State Legislature to provide financial backing for these communities, but has not been funded to date. Seed money for this revolving fund will be very important to meet the near-term needs of rural communities and provide long-term water supply security for many Arizonans.

Other areas of the State can develop smaller projects for now and may have sufficient population to financially sustain these smaller-scale water projects. But ultimately, large-scale water projects will need to be developed to meet the needs of Arizona's growing economy. While the water supply needs may not be immediate, addressing the financing of future large-scale water projects needs to begin as soon as possible to ensure Arizona's citizens and industries have secure water supplies into the future.

10-Year Action Plan Outline

- Legislate Strategic Vision update every 10 years (Year 1)

- Begin Discussions on Ocean Desalination (Year 1)
  - Exchange Options
    - California
    - Mexico
  - Direct Options
    - Mexico

- Resolve ADOT Right-of-Way Issues for utilities (Year 1)

- Establish Adjudication Study Committee (Year 1)

- Begin Discussions on Water Development Financing (Year 2)
  - Immediate Needs for Water Resources Development Revolving Fund for rural Arizona
  - Long-Term Needs for Large-Scale water importation projects

- Remove current statutory limitation (*A.R.S. § 45-801.01(22)*) on the ability to receive long-term storage credits for recharging reclaimed water beyond 2024 (Year 2)

- Review Legal and Institutional Barriers to Direct Potable Reuse of Reclaimed water – develop and implement plan for resolution (Year 3)

- Review and implementation of Adjudication Study Committee Findings (Year 3)

- Develop and Begin Implementation of Direct Potable Reuse of Reclaimed Water Public Perception Campaign (Year 4)

- Begin discussions with New Mexico on an interstate cooperative program for watershed management/weather modification in the Upper Gila watershed (Year 4)

- Resolve Remaining Indian Settlements (Year 1 - 10)

- Resolve General stream Adjudication (Year 5 - 10)

CONCLUSION

Just as Arizona's greatest past successes have been directly linked to water, Arizona's future success is tethered to how well we continue to manage our water resources and develop new water supplies and infrastructure. Previous achievements in water management and water supply development such as the Salt River Project, the Central Arizona Project, the Groundwater Management Act, and the Arizona Water Banking Authority have contributed to Arizona's phenomenal growth, its robust economy, an attractive way of life, and protection of much of its natural resources. Arizona has been more proactive in water management than its neighbors; thus, creating of culture of investment in water supplies and giving Arizona residents and businesses a secure foundation.

Yet, our present success cannot sustain Arizona's economic development forever and we must continue to plan and invest in our water resources. The recent work of the State's WRDC and the Basin Study both concluded that between 2030 and 2060, Arizona will begin to have a growing statewide imbalance between its water supplies and demand. While there are local areas that require more immediate action, the State as a whole has the good fortune of not facing an immediate water crisis. Now is the time to begin addressing this challenge by developing a strategic vision for Arizona's water future. **The lack of an immediate problem increases the potential for inaction, running the risk of procrastinating and not motivating ourselves to plan and invest in our future.**

Arizona needs a Strategic Vision for Water Supply Sustainability to guide its economic stability through the next century. The water professionals of this State recognize that if planning and investing in our next water resources does not start now, Arizona's foundation and advantageous position in the West will erode. Unlike the most notable successes in our past, the SRP and CAP, the Strategic Vision for our future will not have a single solution or region to unite around. Rather this Strategic Vision will encompass the entire State and identify potential water resource development and infrastructure needs for various regions and water users in Arizona. This is critical since all areas of the State are becoming more and more linked and our future success will be based more and more on the sum of the whole. This Strategic Vision provides a foundation for how Arizona can continue to plan and invest in its water resources and is just as important to Arizona as the Central Arizona Project was in the 1940s.

[SECTION 3: PLANNING AREA ANALYSIS]

SECTION 3 – PLANNING AREA ANALYSIS

PLANNING AREAS

In Section 2, a generalized overview of the issues and possible solutions was discussed. This section will contain a more specific regional overview and evaluation of the water supply needs for each delineated "Planning Area" within Arizona. Planning Areas have been identified based on possible short-term and long-term solutions available to meet the water supply imbalances. While these Planning Areas may differ from previous studies, the information on water demands and supplies comes directly from the work done for the WRDC and is simply reconfigured to the new geographic region. Figure 8 illustrates the Planning Areas used for this analysis. Detailed discussions for each Planning Area are presented below. Strategies have been identified on a generalized basis and may include the same option described for a different Planning Area. This is important to provide all viable options but does not mean that there is sufficient water available to meet the needs for all Planning Areas.

PLANNING AREAS

1. Apache
2. Arizona Strip
3. Basin & Range AMA
4. Bill Williams
5. Central Plateau
6. Cochise
7. Colorado River Main Stem - North
8. Colorado River Main Stem - South
9. East Plateau
10. Gila Bend
11. Hassayampa/Agua Fria
12. Lower Gila
13. Lower San Pedro
14. Navajo/Hopi
15. Northwest Basins
16. Roosevelt
17. Upper Gila
18. Upper San Pedro
19. Verde
20. West Basins
21. West Borderlands
22. Western Plateau

[APACHE PLANNING AREA]

Apache Planning Area

Background

The Apache Planning Area is located in the east central portion of the State. The Planning Area encompasses two Indian reservations – the White Mountain Apache Tribe of the Fort Apache Reservation and the San Carlos Apache Reservation. Lands within the Planning Area are located within portions of Navajo, Apache, Gila, Greenlee, Graham, and Pinal counties. The Apache Planning Area contains portions of three watersheds: the Salt, Upper Gila, and Middle Gila river watersheds. The Planning Area includes portions of seven groundwater basins: Bonita Creek, Morenci, Safford, Aravaipa, Dripping Springs Wash, Lower San Pedro, and Salt River. The primary communities on tribal lands are Whiteriver, Cibeque, McNary, Hon-dah, San Carlos, and Peridot.

Nearly all of the land within this Planning Area is under tribal ownership (*see Figure P.A.1-1*). White Mountain Apache lands within the Planning Area total approximately 2,866 square miles, while the San Carlos Apache lands encompass about 2,500 square miles. The lands are sparsely populated and primary land uses are domestic, commercial, recreation, timber, livestock grazing, farming, and mining.

Water Supply Conditions

<u>Groundwater</u>

The majority of the Planning Area falls within the Transition Zone Physiographic Province. The mountainous terrain of this region have aquifers that consist of relatively thin alluvial aquifers, and in fractured crystalline, sedimentary, and volcanic rock. A unique geographic feature of the Planning Area is the Mogollon Rim, an escarpment that defines the southern boundary of the Colorado Plateau. A small portion of the southern extent of the Planning Area is within the Basin and Range Physiographic Province, which is characterized by northwest-southeast trending mountain ranges separated by broad alluvial valleys.

No groundwater level data are currently available to ADWR within the Apache Planning Area (*see Figure P.A.1-2*). As a result, no water level trend analysis could be performed within the Planning Area. Groundwater quality information is also generally not available to ADWR.

<u>Surface Water</u>

The Salt River is the primary surface water drainage for the Salt River watershed portion of the Planning Area. It is also the largest tributary to the Gila River, joining the Gila southwest of Phoenix. Its headwaters are the White and Black rivers where winter snow accumulation is critical to downstream supplies. There are many perennial streams in this watershed. Surface water from the watershed flows into Theodore Roosevelt Lake, then is subsequently released to three other downstream reservoirs for use on SRP member lands in the Phoenix area.

Within the Upper Gila River watershed, the primary surface water drainage is the Gila River, predominantly an intermittent stream in the Planning Area (*see Figure P.A.1-3*). The San Carlos River is

the primary tributary to the Gila within the Planning Area. The largest reservoir in the Planning Area, San Carlos Reservoir, was created by the construction of Coolidge Dam in 1929. In addition to the Dam's flood control function, the water impounded and released from San Carlos Reservoir provides hydroelectric generation, irrigation, and recreational uses.

There are currently a total of 29 streamgage stations in the Planning Area, 11 of which are currently active. Of this total, 25 stations are located in the Salt River watershed and only four are located in the Middle Gila River Watershed. Maximum annual flows were 1,732,915 acre-feet and 1,459,907 acre-feet on the Gila River at Calva and Salt River near Chrystile stations, respectively. Both of these flows occurred in 1993 during a major flood.

<u>Reclaimed Water</u>
There are five wastewater treatment plants (WWTP) identified on tribal lands within the Apache Planning Area with three facilities reporting evaporation ponds as the disposal method. Given proximity to the lagoon-based WWTP, reuse through center pivot irrigation appears to be the practiced at the plant servicing San Carlos and Peridot.

<u>Ecological Resources</u>
There are multiple ecological resources within the Planning Area (*see Figure P.A.1-3*). Critical habitat has been designated for the Mexican Spotted Owl, Southwestern Willow Flycatcher, Razorback Sucker, and Loach Minnow. The Apache Trout is one of only two trout native to Arizona. Once nearing extinction, a recovery program has restored Apache Trout to much of their historic range in the White Mountains on the White Mountain Apache Reservation and Apache-Sitgreaves National Forest. In addition, portions of the Black and Salt Rivers and other tributary streams in the White Mountains have mapped riparian areas. Riparian areas have also been mapped along the San Carlos River in the Safford Basin.

Water Demands

Table P.A. 1-1, below, presents the baseline and projected water demands for the Apache Planning Area. Agriculture is the largest water demand sector and is projected to remain constant at 23,860 acre-feet per year throughout the planning period. Municipal use is estimated to increase slightly, but will remain significantly less than agricultural use. Mining demands include water diversions for mines located in the adjacent Planning Area. Surface water from the Black River in the Salt River basin is diverted for use in the Upper Gila Planning Area pursuant to complex exchange agreements with the San Carlos Apache Tribe, SRP, CAP, and Freeport McMoRan (FMC). FMC diverts surface water from the Black River at the Black River Pump Station, transfers that water into the Eagle Creek drainage, and pumps it again for delivery and use at the Morenci Mine.

Characteristics Affecting Projected Water Demands and Supply Availability

<u>Legal Availability</u>
The right to use Gila River water is governed by the Globe Equity Decree. The U.S. District Court entered a consent decree in 1935, Globe Equity No. 59, for all diversions of the mainstem of the Gila River from the confluence with the Salt River to the headwaters in New Mexico. The Decree encompassed both the Gila River and San Carlos Apache reservations, and non-Indian landowners below and above Coolidge Dam. It awarded rights to use water on lands within the Gila River Indian Reservation with a priority date of "time immemorial" and also awarded rights to the San Carlos Apache Tribe with a priority date

of 1846. The Gila Water Commissioner is appointed by the US District Court to administer the Decree. Each year, the Commissioner issues a report on the distribution of waters of the Gila River.

Table P.A. 1-1. Projected Water Demands (in acre feet) – Apache Planning Area

Sector	2010	2035	2060
Agriculture	23,860	23,860	23,860
Dairy	0	0	0
Feedlot	0	0	0
Municipal	4,378	4,900	5,545
Other Industrial	0	0	0
Mining	2,565		
High		7,800	7,800
Low		8,300	2,600
Power Plants	0		
High		577	723
Low		420	502
Rock Production	315		
High		403	455
Low		168	190
Turf			
High	443	443	443
Low	232	232	232
Total (High)	**31,561**	**37,982**	**38,826**
Total (Low)	**31,350**	**37,880**	**32,928**

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 this Planning Area will make it difficult to identify and implement strategies for meeting the projected water demands.

Indian Water Rights Claims

While one outstanding claim still remains – the San Carlos Apache Tribe's on-reservation Gila River tributary claim, successful resolution of Indian water rights claims has significantly improved the water supply availability in this Planning Area.

The Arizona Water Rights Settlement Act of 2004 (P.L. 108-45) includes settlement of the Gila River Indian Community's water rights claims in Title II of the Act. This settlement affects the volume and utilization of groundwater and surface water upstream from the Community in parts of the Planning Area.

In addition to the Arizona Water Settlement Act, the White Mountain Apache Tribe Water Rights Quantification Act (Act) has helped to clarify and will improve water supply availability in the Planning Area. The Act was introduced in 2009 to resolve the White Mountain Apache Tribe's water claims and provide a reliable drinking water supply to its members. In 2009, the Tribe and a number of other parties entered into an agreement quantifying the Tribe's rights in the Gila River and Little Colorado River Adjudication areas (Quantification Agreement). Federal legislation approving and authorizing the agreement was passed by Congress and signed into law on December 8, 2010.

Under the Quantification Agreement, the Tribe will be entitled to a depletion of 27,000 acre-feet of water per year (AFY) from the White River and other tributaries to the Salt River. The Tribe will receive an allocation of 25,000 acre-feet per year of non-Indian Agricultural (NIA) priority Central Arizona Project (CAP) water. All of this water shall be leased for 100 years by Phoenix area municipalities and the Central Arizona Groundwater Replenishment District (CAGRD). Additionally, the US Bureau of Reclamation will construct the White Mountain Apache Tribe Rural Water System to divert, store and distribute water from the White River to the Tribe. The project includes a dam and storage reservoir (Miner Flat Dam and Reservoir). A portion of the impounded water will be treated and distributed for potable use at Whiteriver and other communities on the reservation.

<u>Downstream Water Demands</u>

This Planning Area contains a portion of the watershed that is essential to the Phoenix area - through the Salt River Project. Management of this watershed for forest health and water supply development is important to ensuring a secure water supply for central Arizona, while at the same time balancing the needs of the water users in this area.

<u>Wildfire</u>

There were several major wildfires either within or upstream of this Planning Area that has impacted water supplies in this area. The Rodeo-Chediski Fire in 2002 consumed about 462,600 acres, much of it in the north-central part of the Salt River Basin and most recently, the Wallow Fire burning 538,049 acres in the Apache-Sitgreaves National Forests in 2011, becoming Arizona's largest wildfire in recorded history.

In the Southwest, fire can be among the most significant watershed disturbance agents, particularly to peak stream flows. For example, in areas severely burned by the Rodeo-Chedeski Fire, peak flows were as much as 2,350 times greater than the previously measured highest known post-fire peak flow in the Southwest. Increased peak flows can degrade stream channels and make them unstable, increase sediment production and cause flood damage (Neary and others, 2003). Wildfire and drought can result in vegetative changes in the Planning Area with implications for runoff, infiltration and downstream water supplies.

<u>Protected Species and Habitat</u>

The presence of a listed species may be a critical consideration in water resource management and supply development in a particular area.

Strategies for Meeting Future Water Demands

Implementation of Terms of Settlement Agreements and Resolution of Outstanding Water Rights Claims

The agreement struck with the White Mountain Apache Tribe will serve to provide the framework for water supply development for this community. Construction of the reservoir at Minor Flat, and the associated treatment and distribution works, will improve water service and reduce reliance on local groundwater on the White Mountain Apache Reservation.

Uncertainty regarding the fate of the San Carlos Apache Tribe and competing water uses and claims on the tributary water on the San Carlos Apache Reservation will likely impede the development of water supply projects for that portion of the Apache Planning Area. Resolution and settlement of these claims will be required to provide certainty as to available supplies and potential projects both on the San Carlos Reservation and for upstream and downstream users on the Gila River.

Constructive efforts to resolve the San Carlos Apache Tribe's claims, as well as the Gila River General Stream Adjudication, is essential to not only provide a secure water supply for water users in Arizona. 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.

Reclaimed Water Reuse

Formal wastewater treatment works in the Apache Planning Area is largely conducted in lagoon-based wastewater treatment plants, with evaporation as the principal disposal practice. Increasing the utility of this resource would likely require upgrading wastewater treatment works throughout the Planning Area to produce reclaimed water of a quantity suitable for reuse or aquifer enhancement.

Watershed/Forest Management

Much of the Apache Planning Area drains to either the Salt or Gila River Systems. Like much of the State, past land use and fire suppression practices have resulted in compromised watershed conditions. Watershed management practices aimed at increasing watershed yield have been evaluated in Arizona showing opportunities for success. Due to the significant acreage of forested land in this area, continuation of this process, and implementation of safe and effective strategies, is important to water users within and outside of this Planning Area. Combining efforts with other management initiatives (such as the Four Forest Restoration Initiative) may be a cost-effective way to advance this option and provide multiple benefits to this Planning Area and those dependent on its resources. 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]. Restoration of forest and range lands within the Planning Area may serve to improve grazing conditions, reduce wildfire threats, and provide increased water yields for local and downstream users.

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

Increase Access to Locally Available Groundwater

ADWR believes that enhanced access to the groundwater resources within the Apache Planning Area can serve to meet current and projected water demands. Leveraging existing hydrogeologic information with additional studies, drilling and testing of wells, planning and development of water delivery and storage infrastructure, and monitoring and modeling will provide a basis for prudent use of this resource. Given the dispersed nature of the population throughout the planning area, this option will likely entail the development of many small to moderate scale production, transmission and distribution elements.

Expanded Monitoring and Data Collection & Groundwater System Analysis and Modeling

Monitoring of water use within the Apache Planning Area is conducted by Tribal and Federal authorities. The monitoring and reporting is not consolidated within Arizona's statewide programs, such as the Community Water System Reports or ADWR's Groundwater Site Inventory (GWSI) program. Coordination of these data collection efforts would increase the utility of this data through integration and consistency of reporting across the State.

Metering and reporting across the Planning Area would serve to support and enhance analysis of current hydrologic conditions. Data collection is a crucial element of the development of groundwater models, which have proven to be invaluable tools throughout the State in developing more thorough understandings of hydrologic systems and evaluating future conditions and potential impacts of new uses and/or alternative water management strategies.

Exploration drilling and testing will increase knowledge and understanding of the local groundwater systems, in addition to increasing access to water supplies and mitigating local pumping impacts within the Planning Area.

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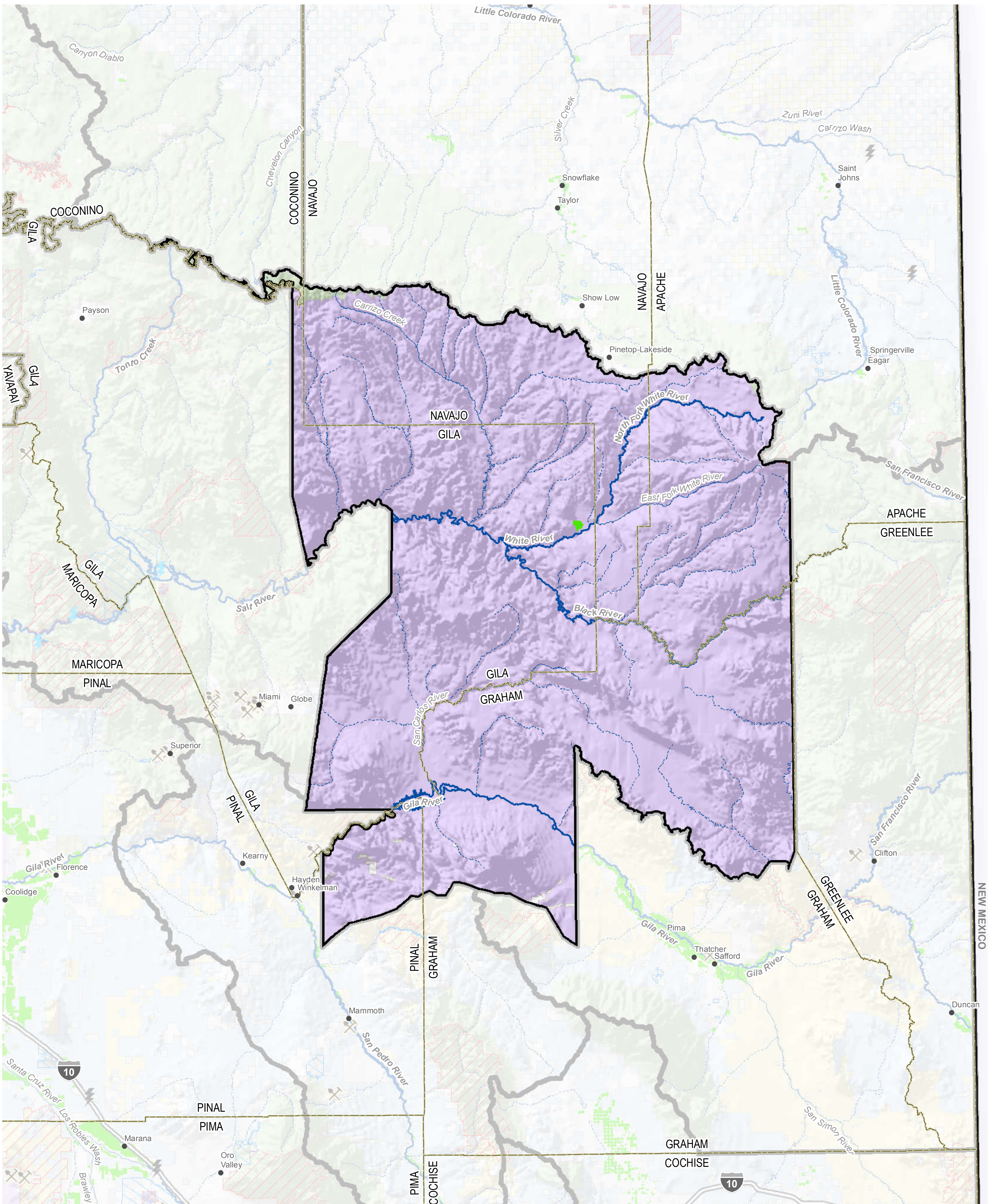

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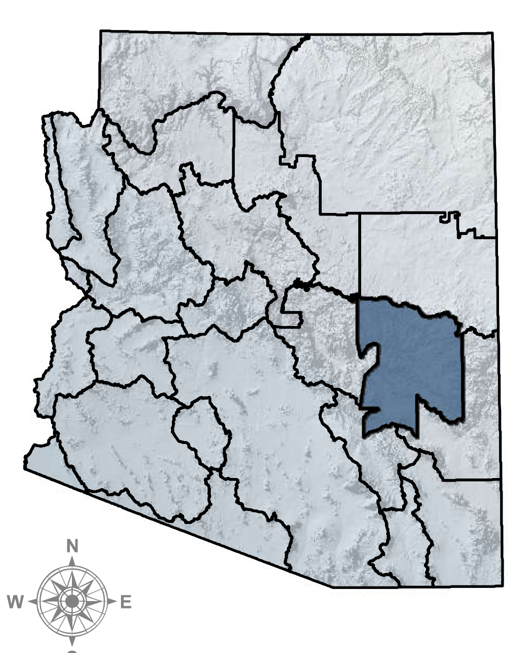

MAP LOCATION
(Planning Area Boundaries)

- 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

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.1-1

Apache
Land Ownership

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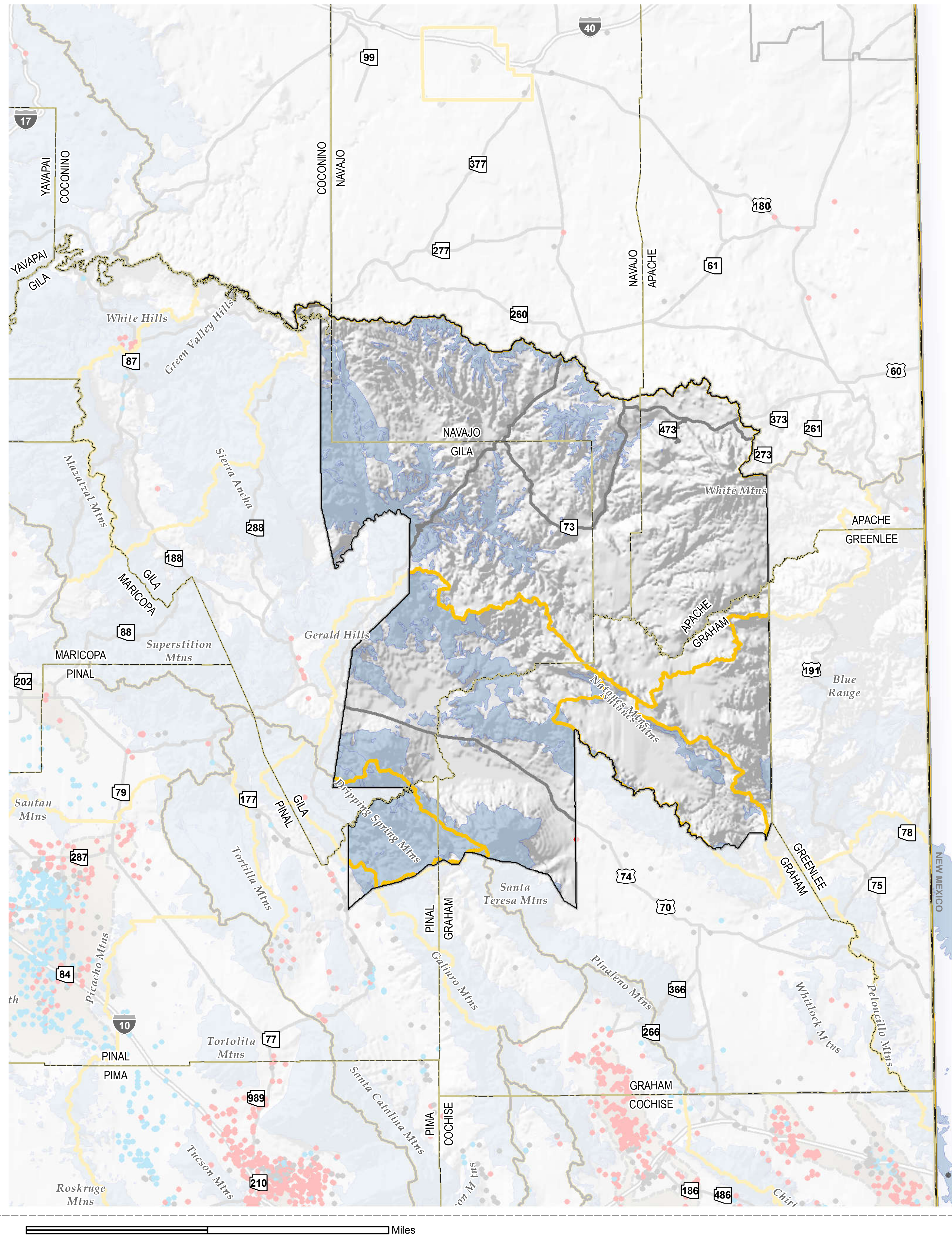

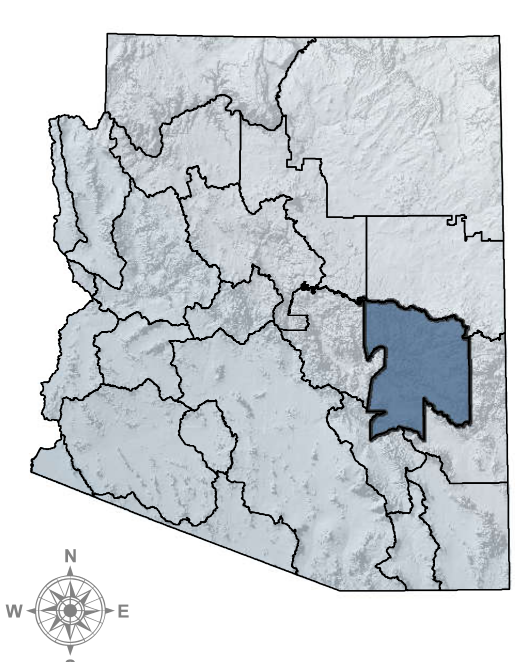

MAP LOCATION
(Planning Area Boundaries)

- 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.1-2

Apache
Groundwater Hydrology

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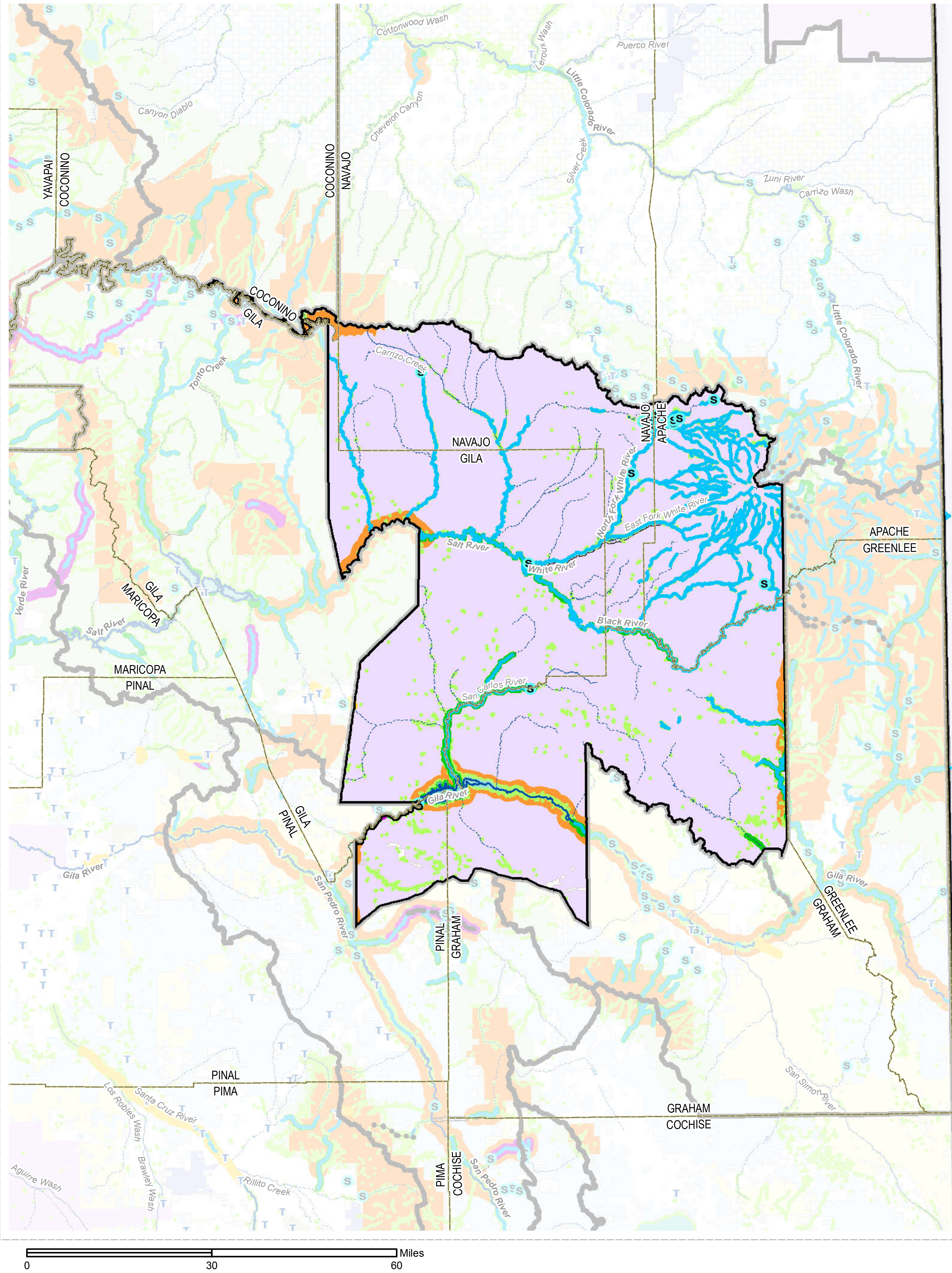

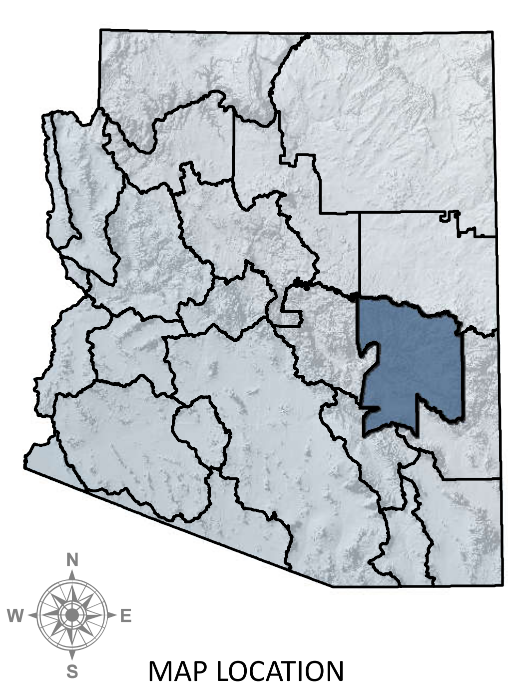

MAP LOCATION
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- County (ALRIS)
- Reservoir or Lake (NHD)
- Waste Water Treatment Plant (ADEQ)
- Major Spring (ADWR, Pima County)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ASLD)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, 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.1-3

Apache
Surface Water and Natural Features

[ARIZONA STRIP PLANNING AREA]

Arizona Strip Planning Area

Background

The Arizona Strip Planning Area is located in the far northwestern corner of the state, north of the Grand Canyon and the Colorado River. The Planning Area is portions of Coconino and Mohave Counties. The area is sparsely populated with the largest population center being Colorado City. Other population centers include: Fredonia, Centennial Park, Beaver Dam and Littlefield. The Planning Area also includes the Kaibab Indian Reservation near Fredonia along the northern border with Utah.

The majority of the land within the Planning Area is owned and managed by federal land management agencies, with over 90 percent controlled by the US Bureau of Land Management (BLM) and the National Park Service (*see Figure P.A. 2-1*). Less than five percent of the land is privately held. The balance of the Planning Area includes State Trust Lands managed by the Arizona State Land Department.

Water Supply Conditions

<u>Groundwater</u>

The Arizona Strip Planning Area is located within both the Colorado Plateau Physiographic Province, and the Basin and Range Physiographic Province. Water resources vary in each of these provinces. The Colorado Plateau Province is characterized by mostly level, horizontally stratified sedimentary rocks that have been eroded into canyons and plateaus, and by some high mountains. The Basin and Range Province is characterized by long broad alluvial valleys separated by mountain ranges, with thick productive regional alluvial aquifers. The province contains regional aquifers within sandstone and limestone layers and relatively thin deposits of alluvium that support unconfined aquifers along streams.

There are five groundwater basins within the Planning Area (*see Figure P.A. 2-2*). From east to west three basins, the Paria, Kanab Plateau, and Shivwits Plateau lie within the Colorado Plateau Province. The Virgin River and Grand Wash basins are adjacent to the western side of the Planning Area along the Nevada state border. This portion of the Planning Area is located within the Basin and Range Province.

Groundwater conditions in the Paria Basin generally declined at an average rate of 1.8 feet per year from 1989 to 2012 (*see Figure P.A. 2-2*). Groundwater levels in the Kanab Plateau Basin are generally stable to rising at approximately 0.3 feet per year from 1992 to 2012. Levels within the Virgin River Basin are generally increasing about 0.3 feet per year. Groundwater levels are also generally rising at approximately 1.2 feet per year in the Grand Wash Basin. Insufficient data is available for the Shivwits Plateau Basin.

<u>Surface Water</u>

Surface water features in the Planning Area include the Colorado River, which flows from northeast to the southwest and defines the southern border of the Planning Area (*see Figure P.A. 2-3*). The Colorado River is impounded in the northeast region of the Planning Area forming Lake Powell, and in the southwest region of the Planning Area forming Lake Mead. Other surface water features are the Paria

River in the northeast region of the Planning Area and the Virgin River and Beaver Dam Wash in the northwest region of the Planning Area.

Reclaimed Water
Reclaimed water generation is mostly limited to the population centers within the Kanab Plateau Basin and Virgin River Basin. Total reclaimed water production is estimated to be less than 500 acre-feet per year.

Ecological Resources
Large portions of the Arizona Strip Planning Area have been designated as critical habitat under the Endangered Species Act (*see Figure P.A. 2-3)*. These areas are largely limited to federal lands. Additionally, the Paiute and Beaver Dam Mountain Wilderness Areas are in the northwestern corner of the Planning Area. The Paria Canyon Wilderness Area is located in the far eastern portion of the Planning Area. The southern border of the Planning Area is defined by the Colorado River and, from east to west, abuts the Glen Canyon National Recreation Area, Grand Canyon National Park, and the Lake Mead National Recreation Area. The northern portion of the Kaibab National Forest lies in the eastern portion of the Planning Area.

Water Demands

Table P.A. 2-1 illustrates the baseline and projected water demands in the Arizona Strip Planning Area. Water demands within the Planning Area are served by a combination of surface water and groundwater. Agricultural demands are present within the Planning Area but are not expected to increase in the future. Municipal and domestic demands are scattered in small isolated population centers across the Planning Area and are expected to increase primarily in the existing population centers. Because of the large tracts of BLM lands, demands for energy production have been projected for this Planning Area.

Characteristics Affecting Future Demands and Water Supply Availability

Information regarding sustainable groundwater development is insufficient for this Planning Area. While demands are currently relatively small, some areas are drought sensitive and water level declines have been observed. However, it is unknown whether these declines will have long-term negative impacts.

Exportation
One item that may have an impact on future water supply availability is the interest for possible exportation of water to neighboring states from this Planning Area. Pursuant to Arizona Revised Statute (A.R.S.) §§ 45-291 et seq. – in compliance with federal commerce laws - it is permissible to transport water out of Arizona in limited circumstances. On March 15, 2005, ADWR received an application from Wind River Resources, LLC (Wind River), proposing to transport water via pipeline from the Mormon Wells area along the Beaver Dam Wash in northwestern Arizona to the Virgin Valley Water District in Mesquite, Nevada. After review of the application and a hearing conducted by the Arizona Office of Administrative Hearings, the application was denied because the applicant failed to demonstrate that the application met the statutory criteria. This application spurred significant controversy not only for the Beaver Dam and Littlefield, Arizona areas but also across Arizona.

Protected Species and Habitat

Large portions of the Arizona Strip Planning Area have been designated as critical habitat under the Endangered Species Act (*see Figure P.A. 2-3)*. These areas are largely limited to Federal lands. The presence of a listed species may be a critical consideration in water resource management and supply development in a particular area.

Table P.A. 2-1 Projected Water Demands (in acre feet) – Arizona Strip Planning Area

Sector	2010	2035	2060
Agriculture	2,100	2,100	2,100
Dairy	27	27	27
Feedlot	0	0	0
Municipal	3,315	4,833	6,061
Other Industrial	0	0	0
Mining	0		
High		0	0
Low		0	0
Power Plants	0		
High		12,832	16,091
Low		9,332	11,171
Rock Production	0		
High		217	274
Low		91	114
Turf	882		
High		882	882
Low		882	882
Total (High)	**6,324**	**20,891**	**25,435**
Total (Low)	**6,324**	**17,265**	**20,355**

Strategies for Meeting Future Water Demands

Because projected water demand increases are still small for the Arizona Strip Planning Area, no strategies are being developed at this time. However, interests in Nevada have requested a joint comprehensive hydrologic model be developed and exploration of interstate water management governance in the region including the Arizona Strip Planning Area. Arizona has not yet agreed to participate in either model preparation or governance discussions due to the lack of available information and concerns regarding exportation of water supplies from the State. ADWR believes that Arizona should develop a comprehensive hydrologic model that would assist the evaluation of long-term sustainability of the water supplies in this Planning Area and the availability of water supplies for possible energy development.

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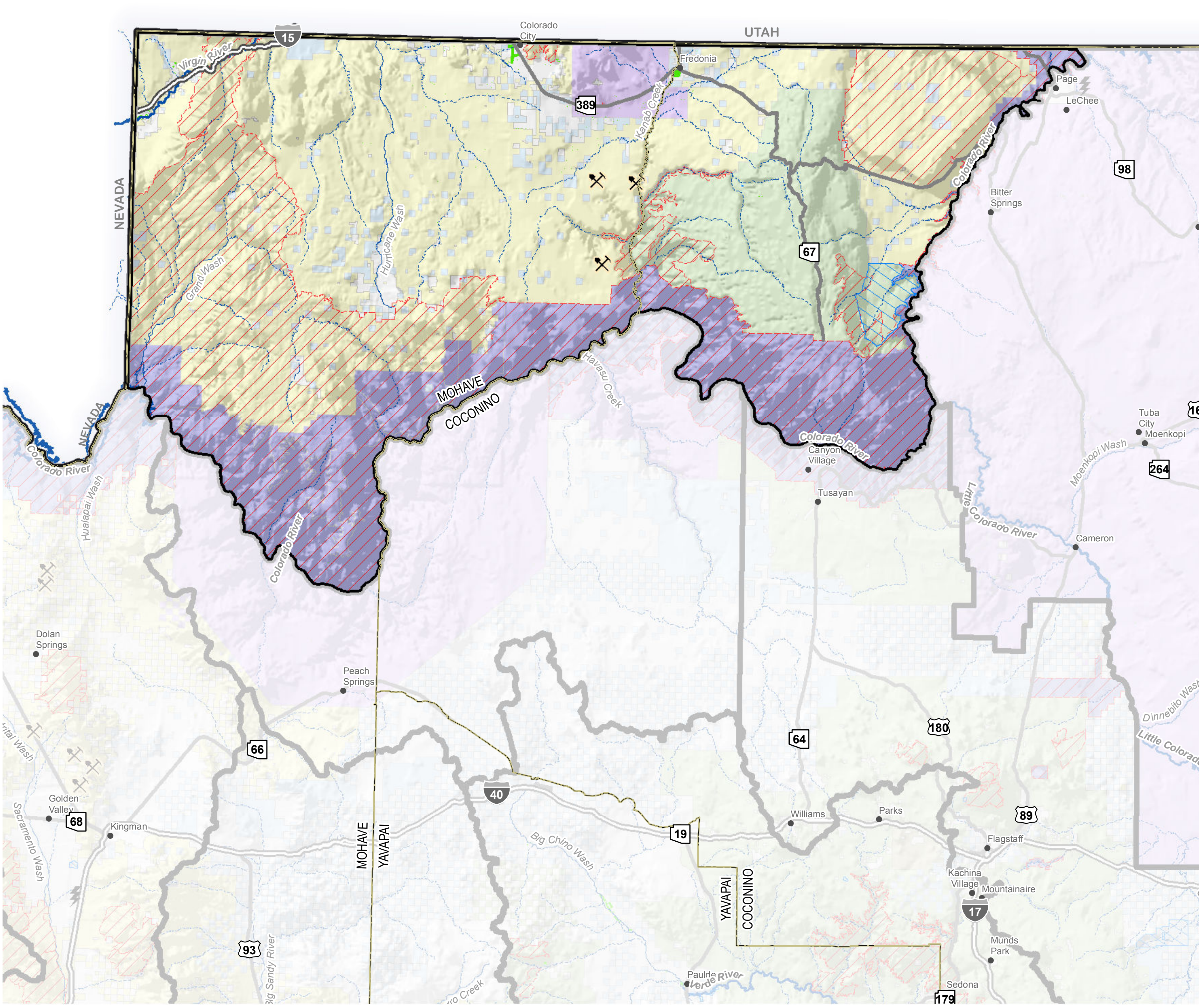

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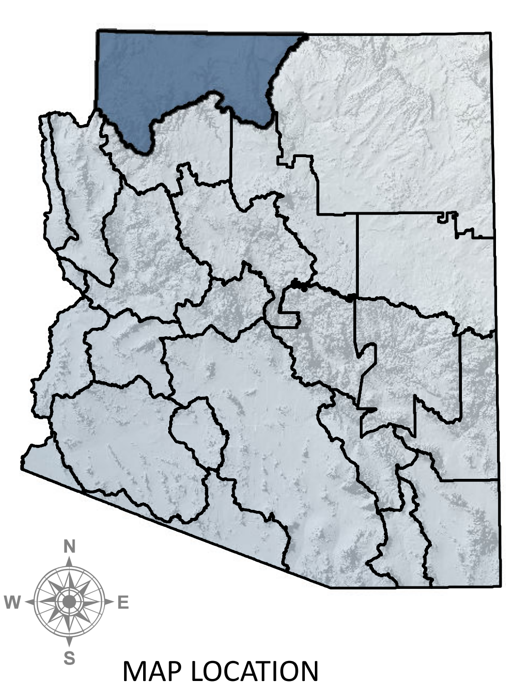

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- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
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Figure P.A.2-1

Arizona Strip Land Ownership

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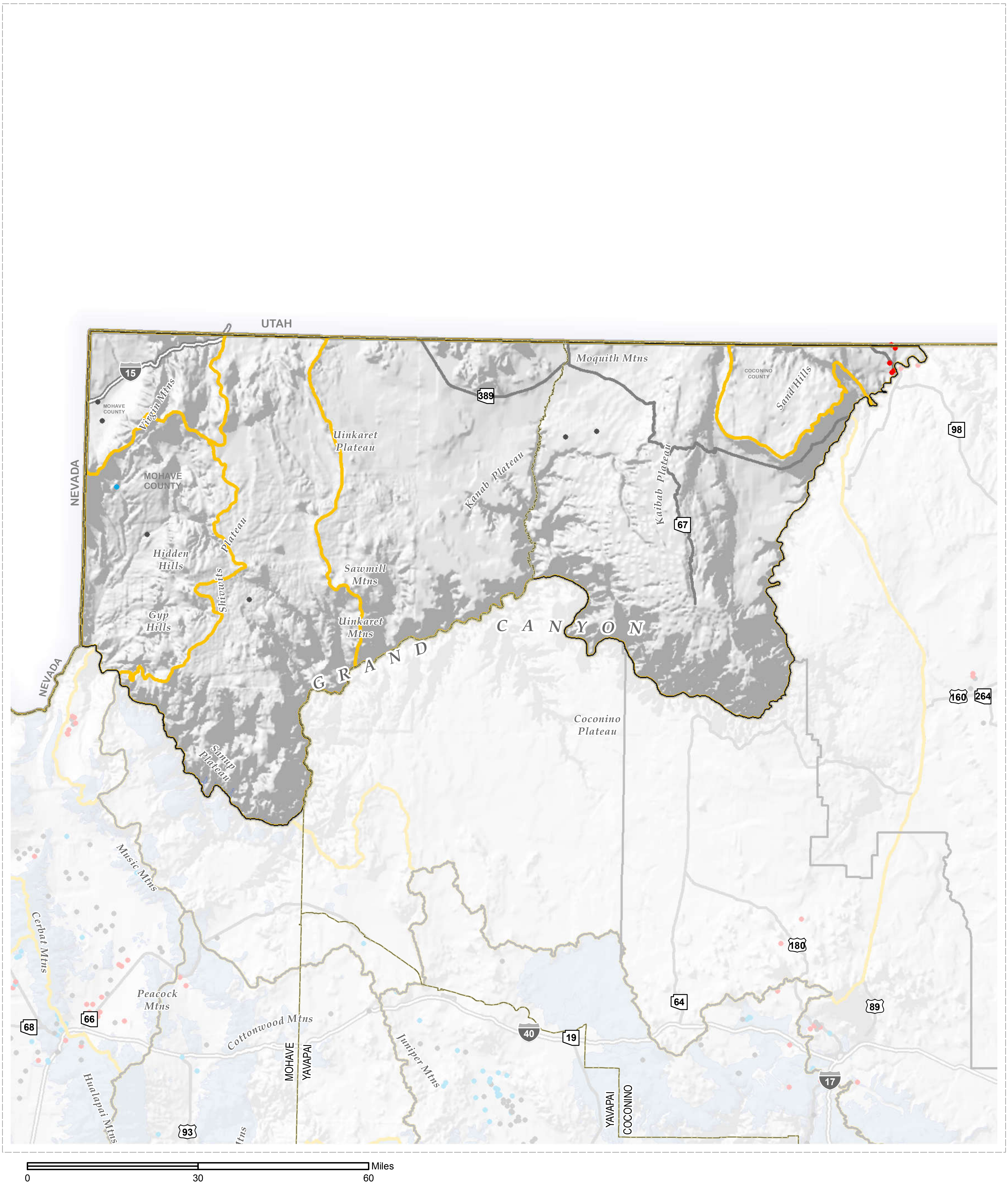

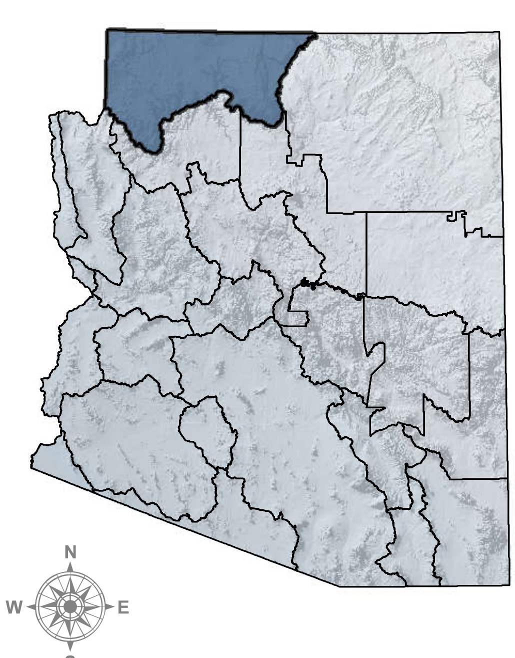

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- County (ALRIS)
- Groundwater Basin (ADWR)
- Area of Active Land Subsidence (ADWR)
- Hard Rock Geology (AZ Bureau of Mines, UofA)
- Interstate (ADOT)

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

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

* Data provided by ADWR

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.2-2

Arizona Strip Groundwater Hydrology

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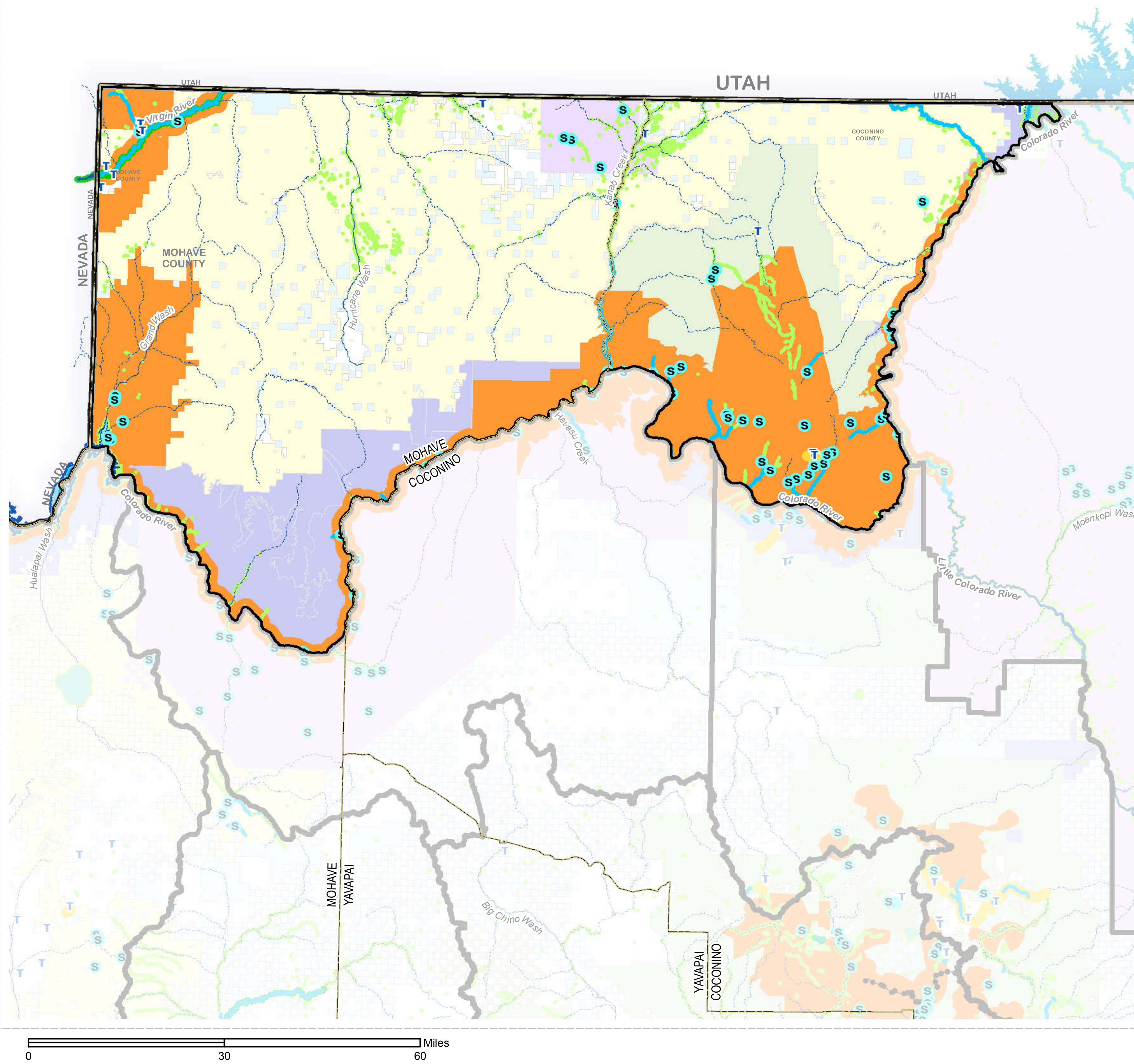

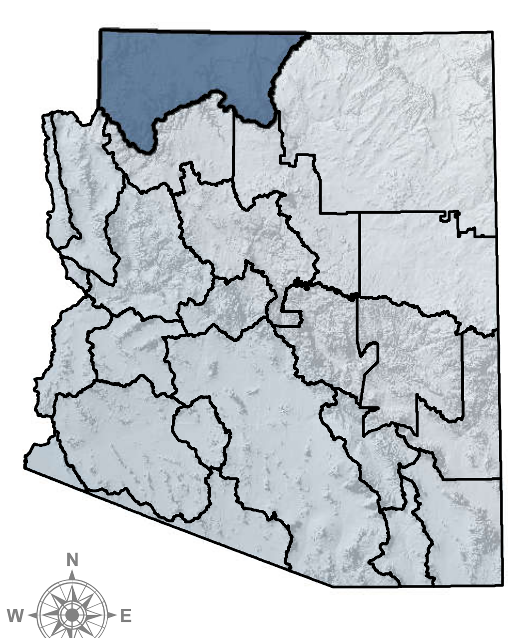

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County (ALRIS)
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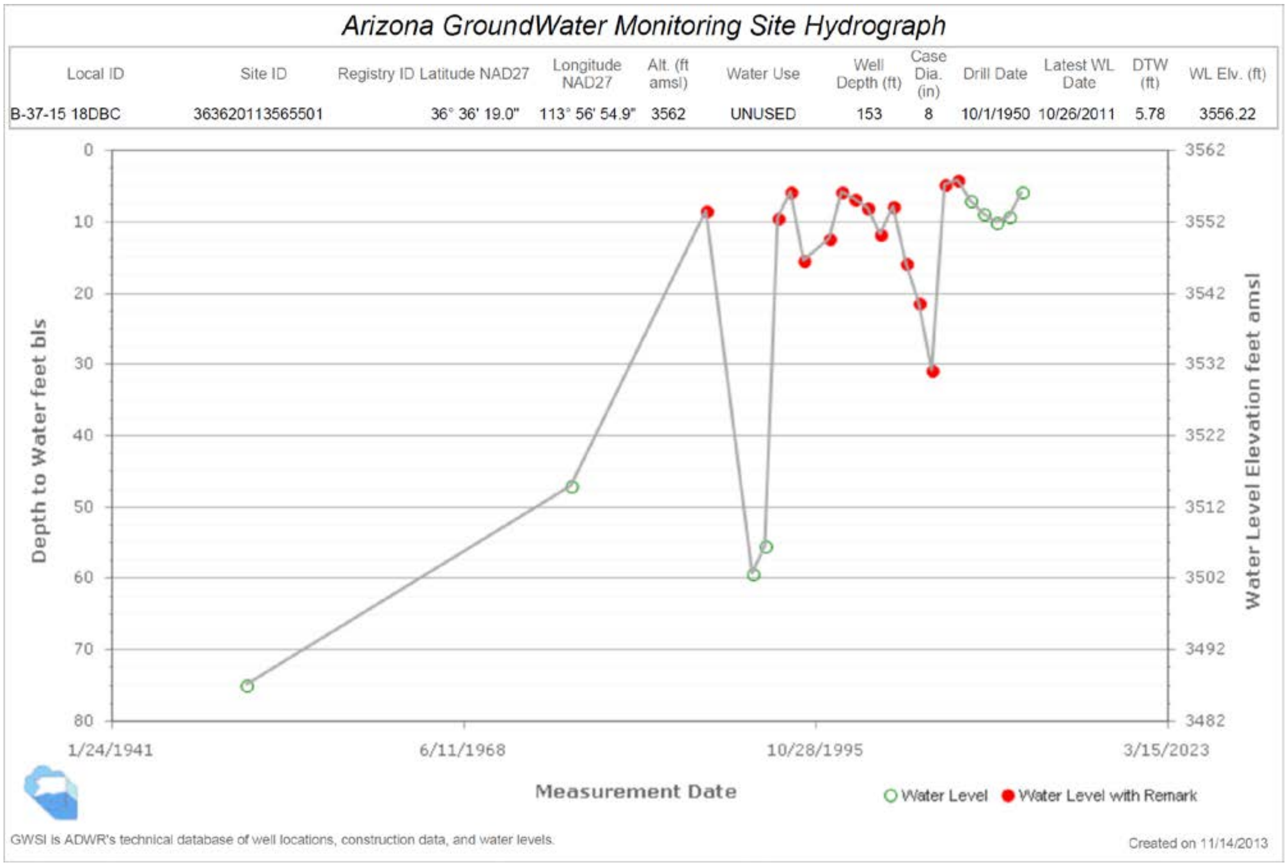
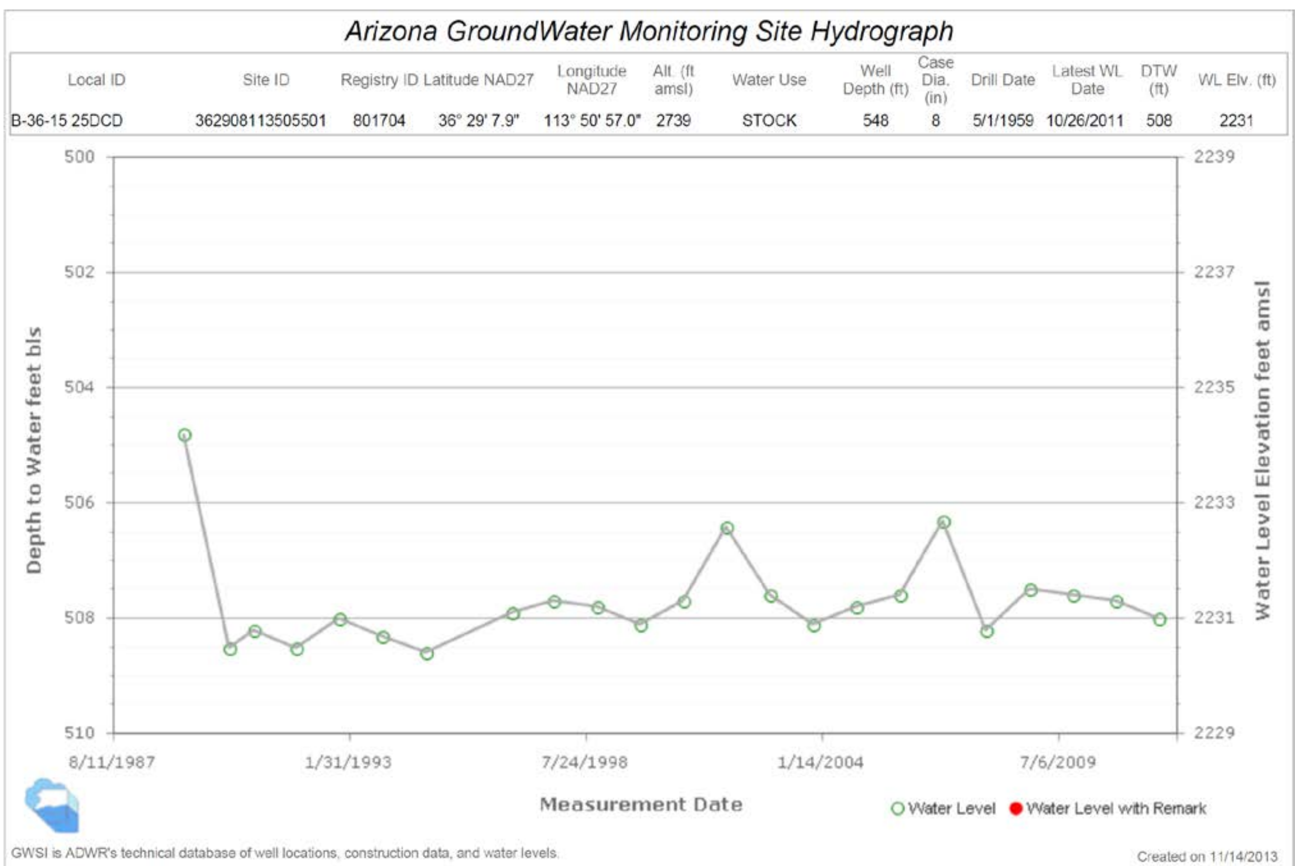
Waste Water Treatment Plant (ADEQ)
Major Spring (ADWR, Pima County)
Perennial Flow (ADEQ, USGS)
River or Stream (ASLD)
Outstanding Arizona Water (ADEQ)
Effluent Dependent Stream (ADWR, NEMO)
Instream Flow Certificate (ADWR)
1993 Riparian Inventory (AZGFD)
Modeled Riparian Habitat (AZGFD)
Designated ESA 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.2-3

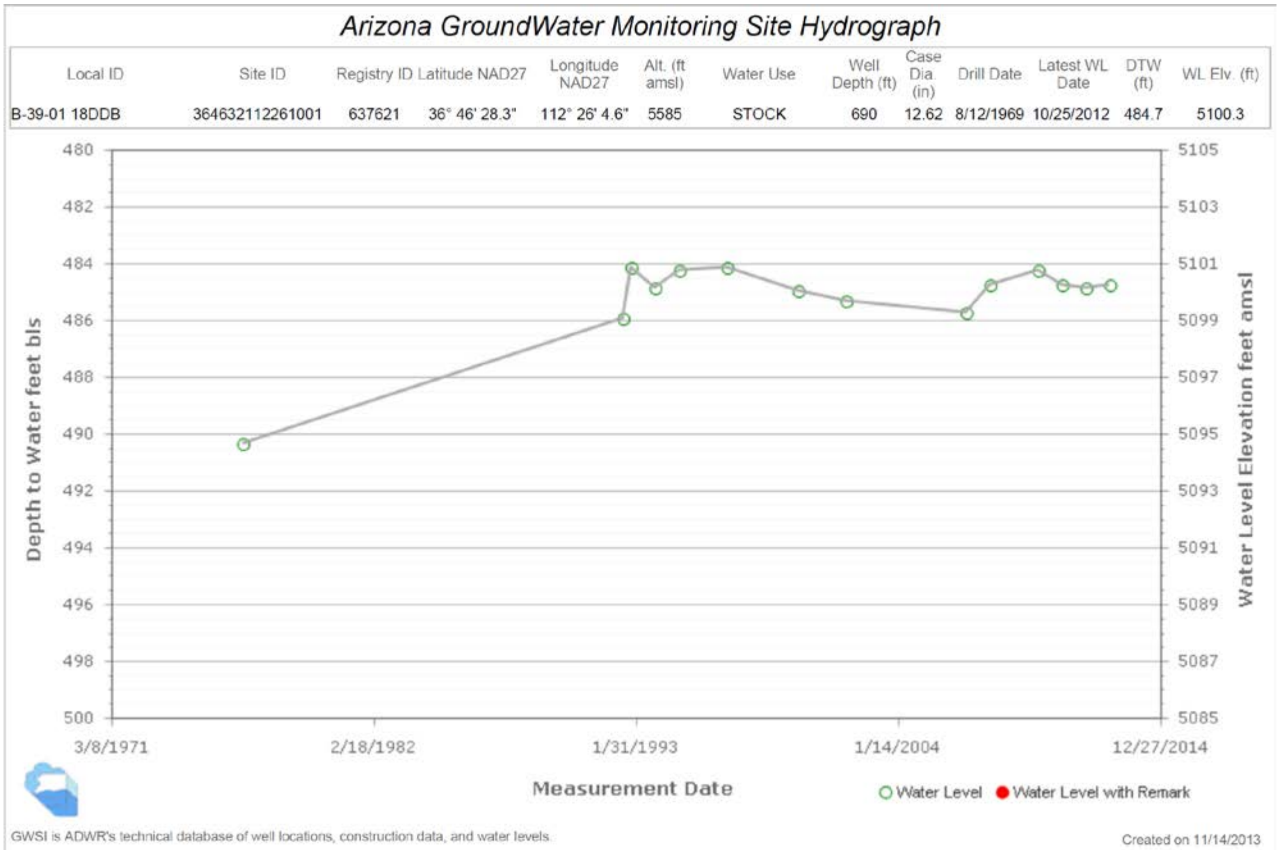
Arizona Strip
Surface Water and Natural Features

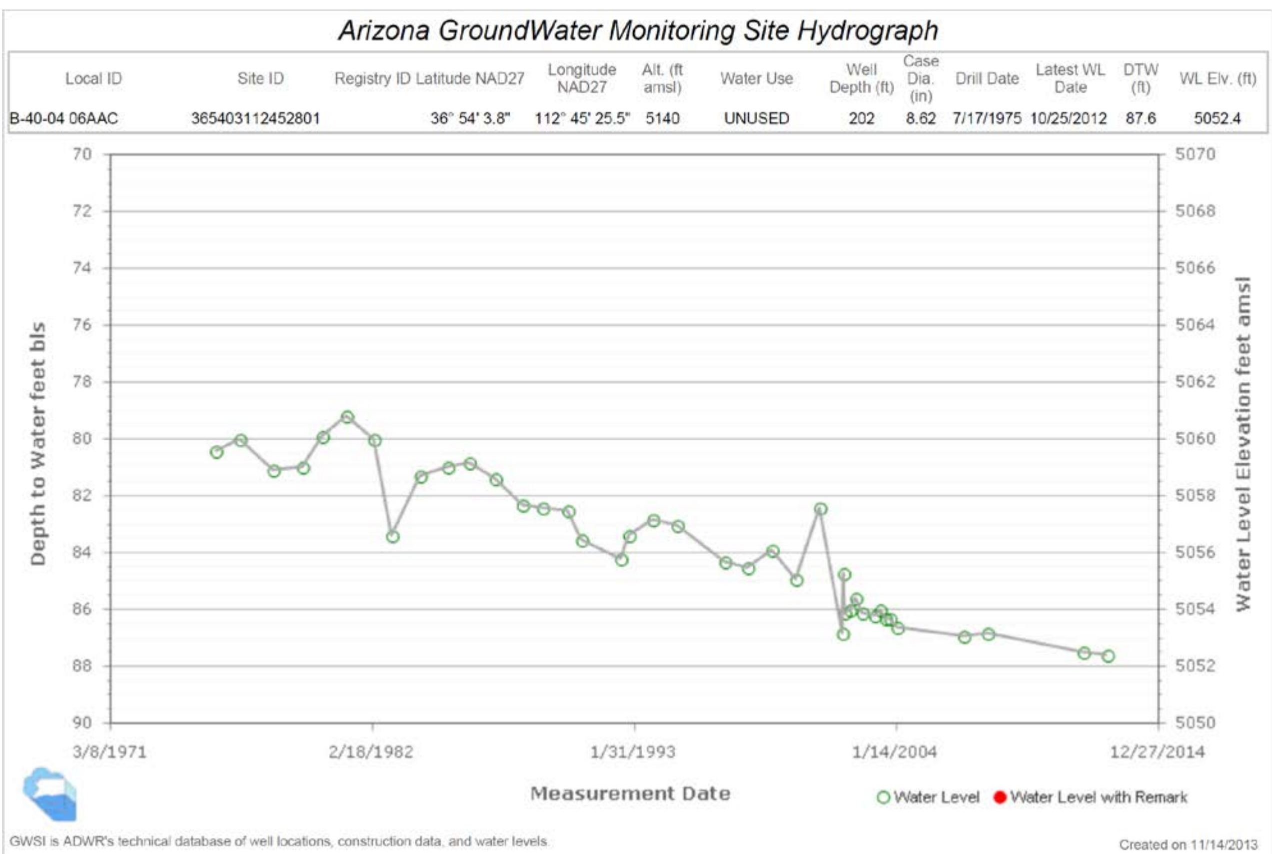
Grand Wash Basin – Arizona Strip Planning Area



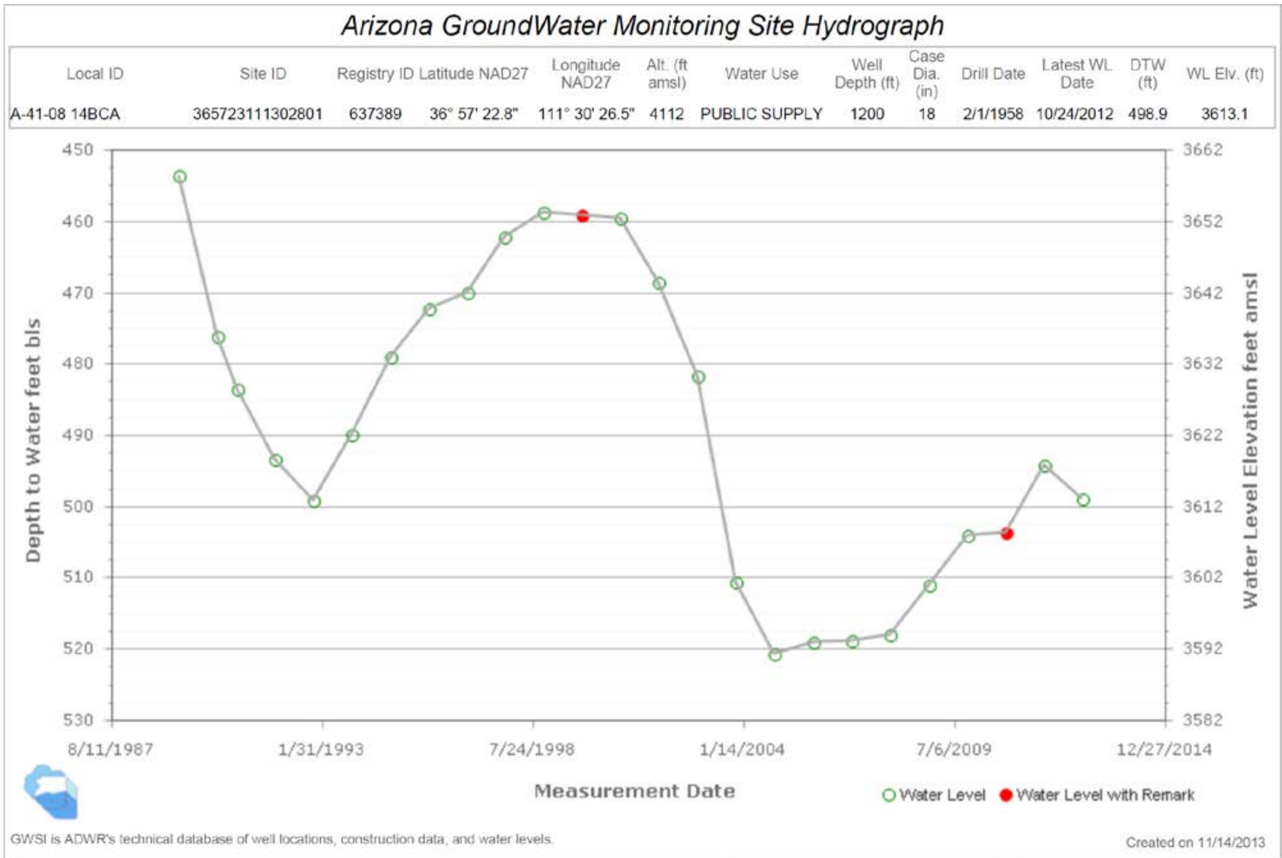


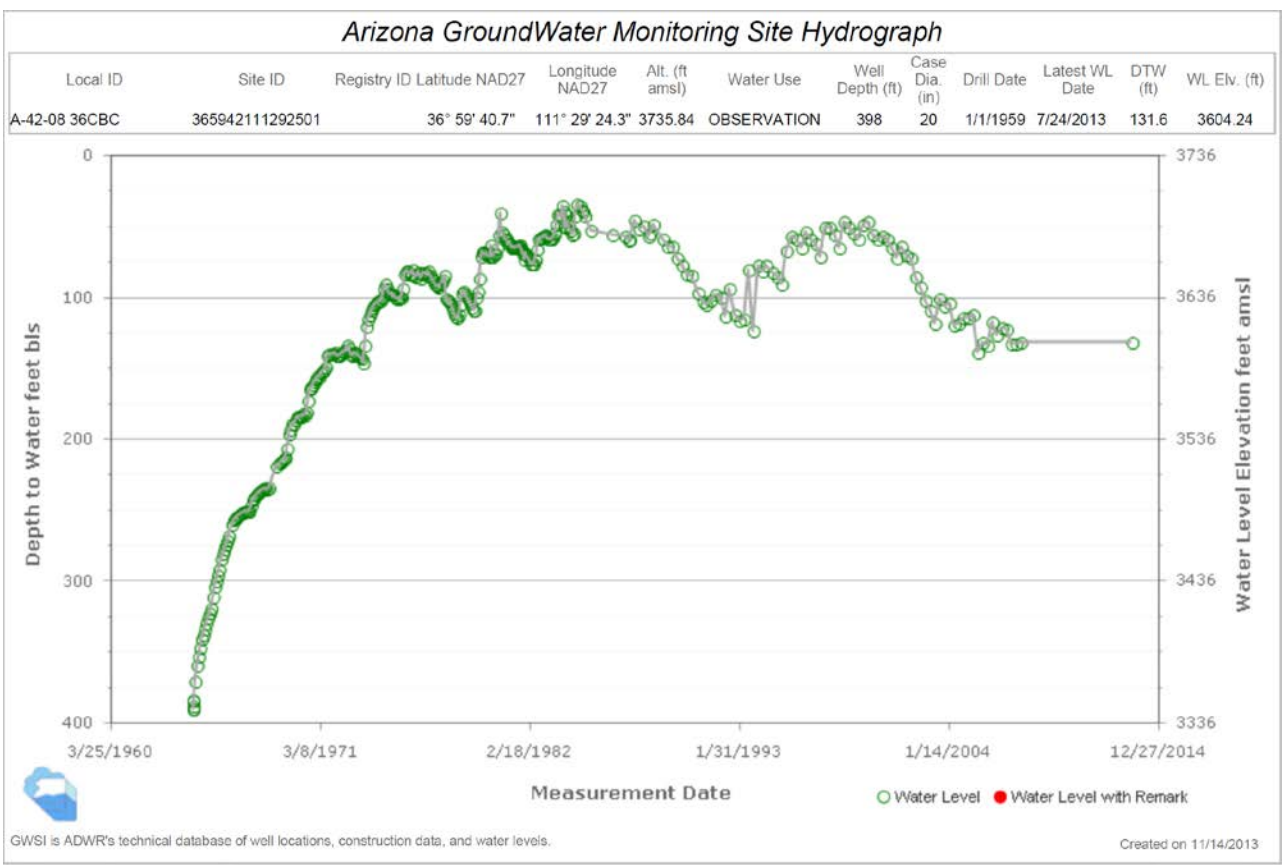
Kanab Basin – Arizona Strip Planning Area





Paria Basin – Arizona Strip Planning Area

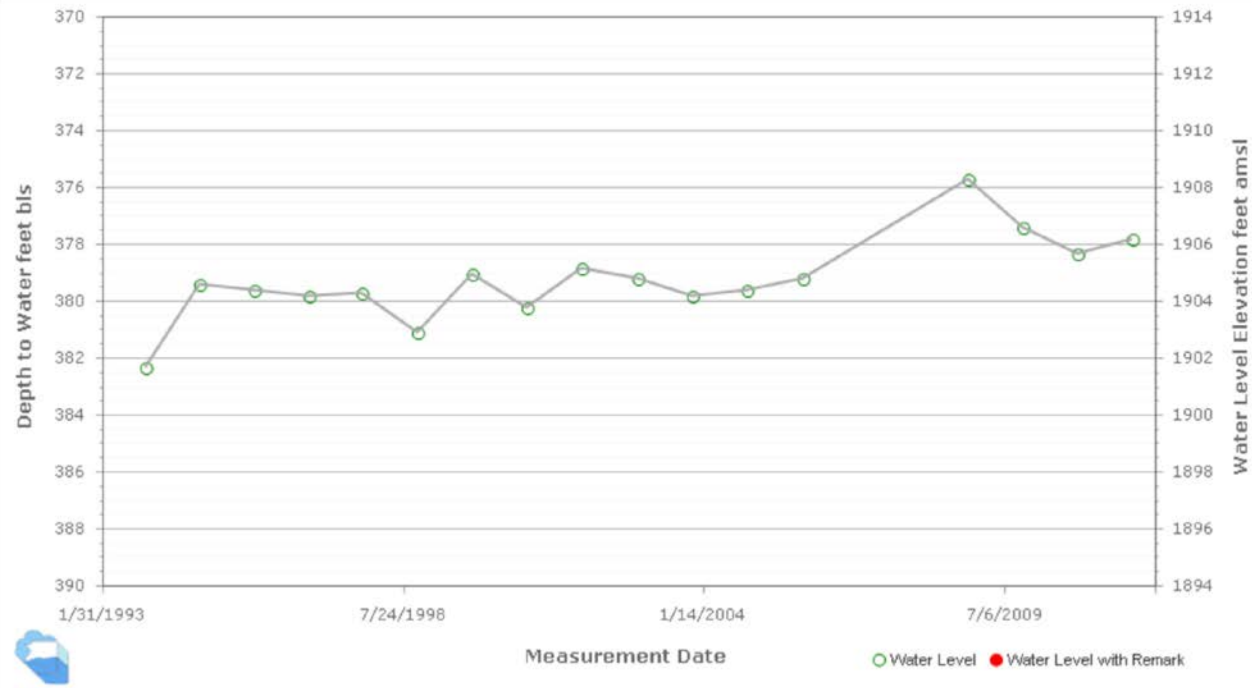




Virgin River Basin – Arizona Strip Planning Area

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)
B-41-15 08ADA	365819113560701	536968	36° 58' 19.3"	113° 56' 7.2"	2284	UNUSED	600	8	11/6/1992	10/26/2011	377.8	1906.2

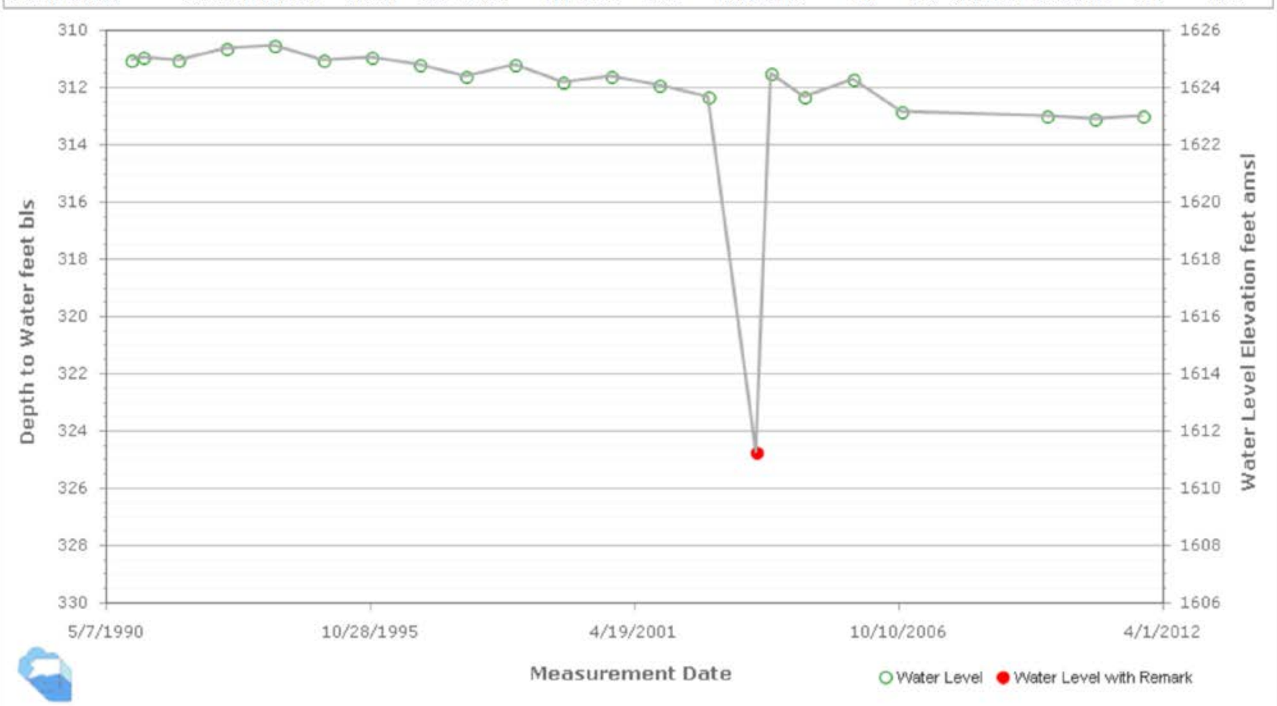


GWSI is ADWR's technical database of well locations, construction data, and water levels.

Created on 11/14/2013

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)
B-39-16 15DDD	364622114000101	516994	36° 46' 22.3"	114° 0' 8.3"	1936	DOMESTIC	410	8.62	3/25/1987	10/26/2011	313	1623



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

Created on 11/14/2013

[BASIN AND RANGE AMAS PLANNING AREA]

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

<u>Groundwater</u>

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.

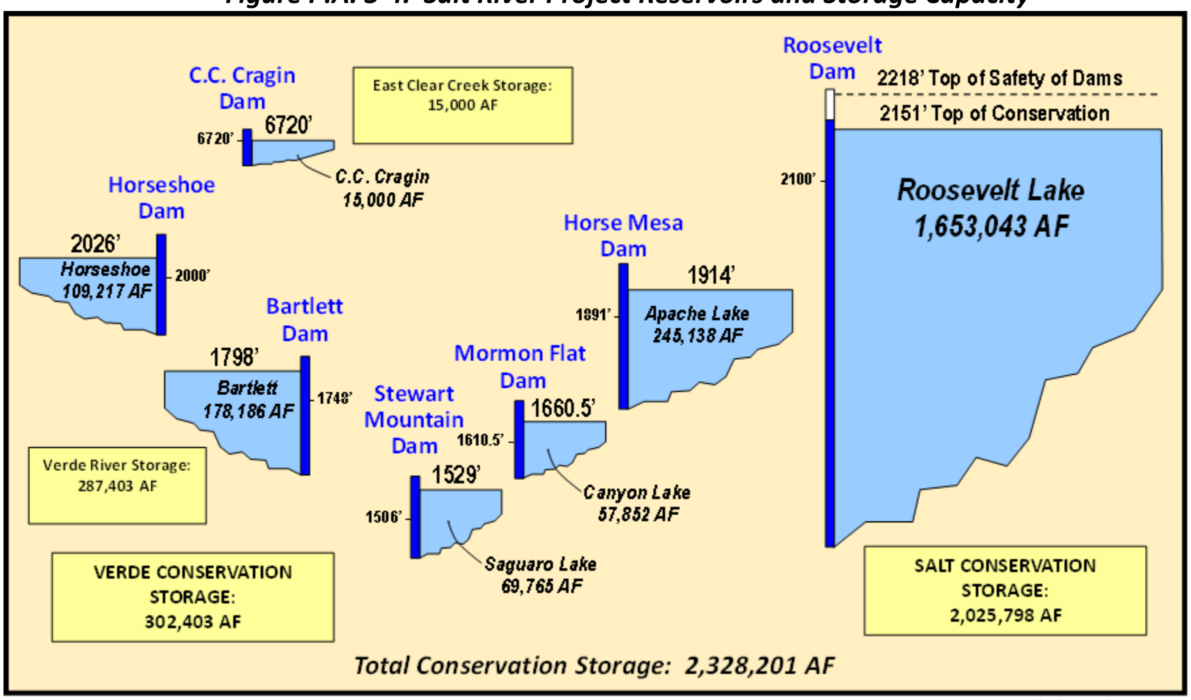
Largely as a consequence of historic agricultural land use practices, the upper aquifer units in many locations within the Planning Area contain high TDS or brackish groundwater, which is also commonly associated with nitrate (NO_3) in concentrations above drinking water standards. These aquifers are 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

<u>General Stream Adjudication</u>

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.

<u>Unresolved Indian Water Rights Claims</u>

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.

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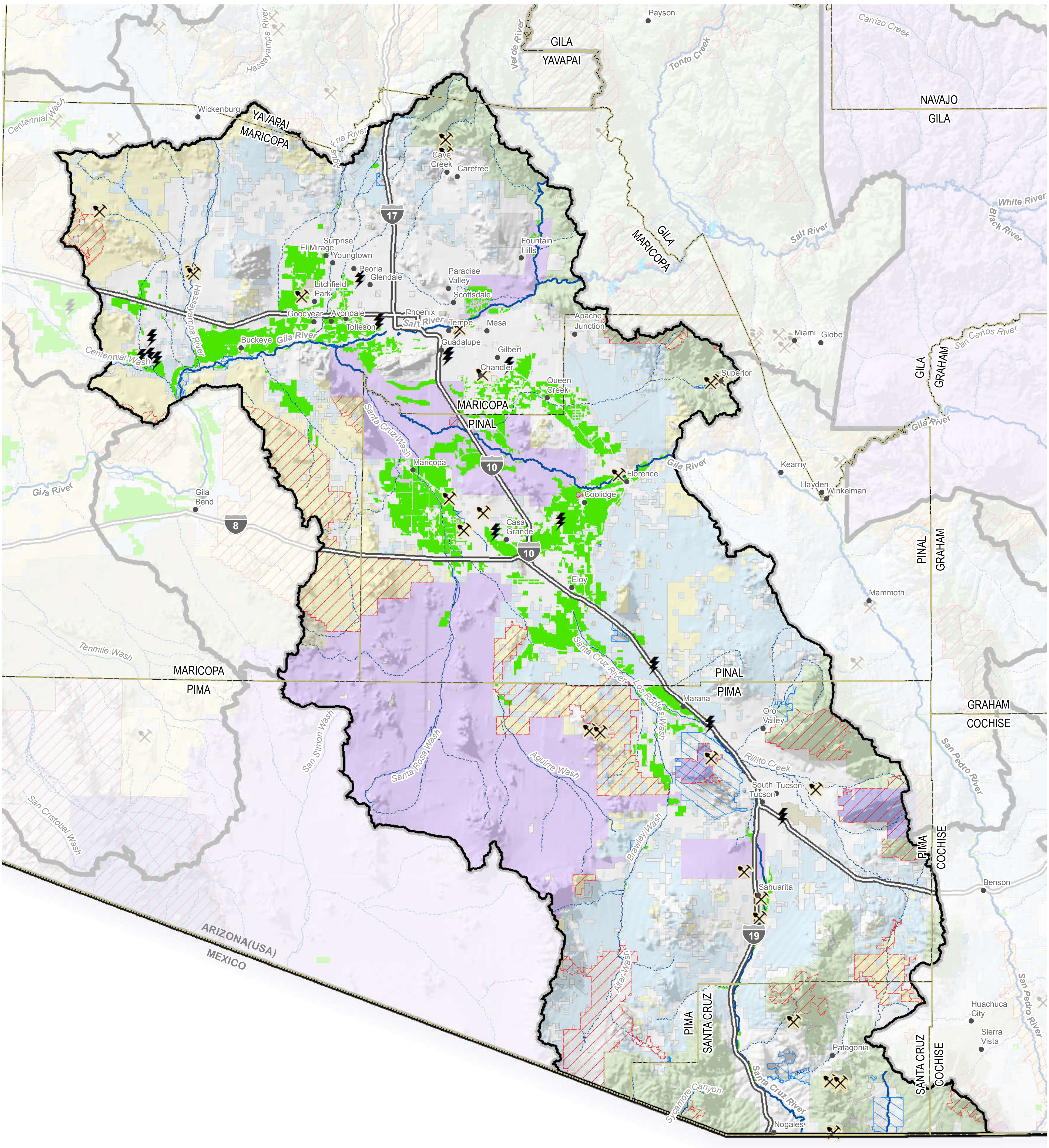

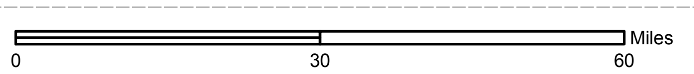

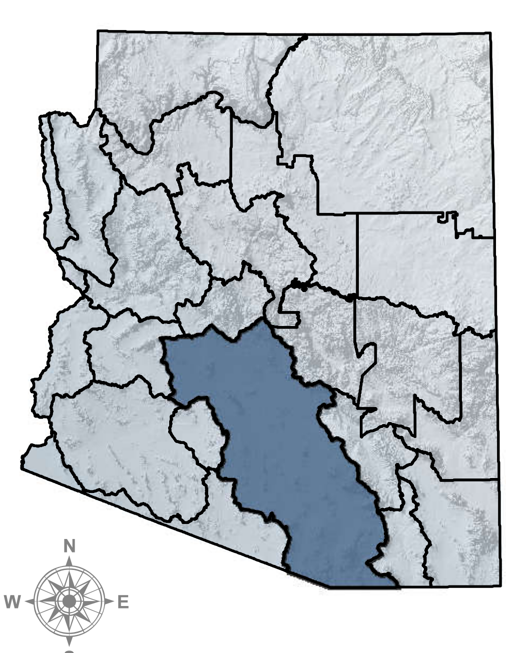

MAP LOCATION
(Planning Area Boundaries)

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

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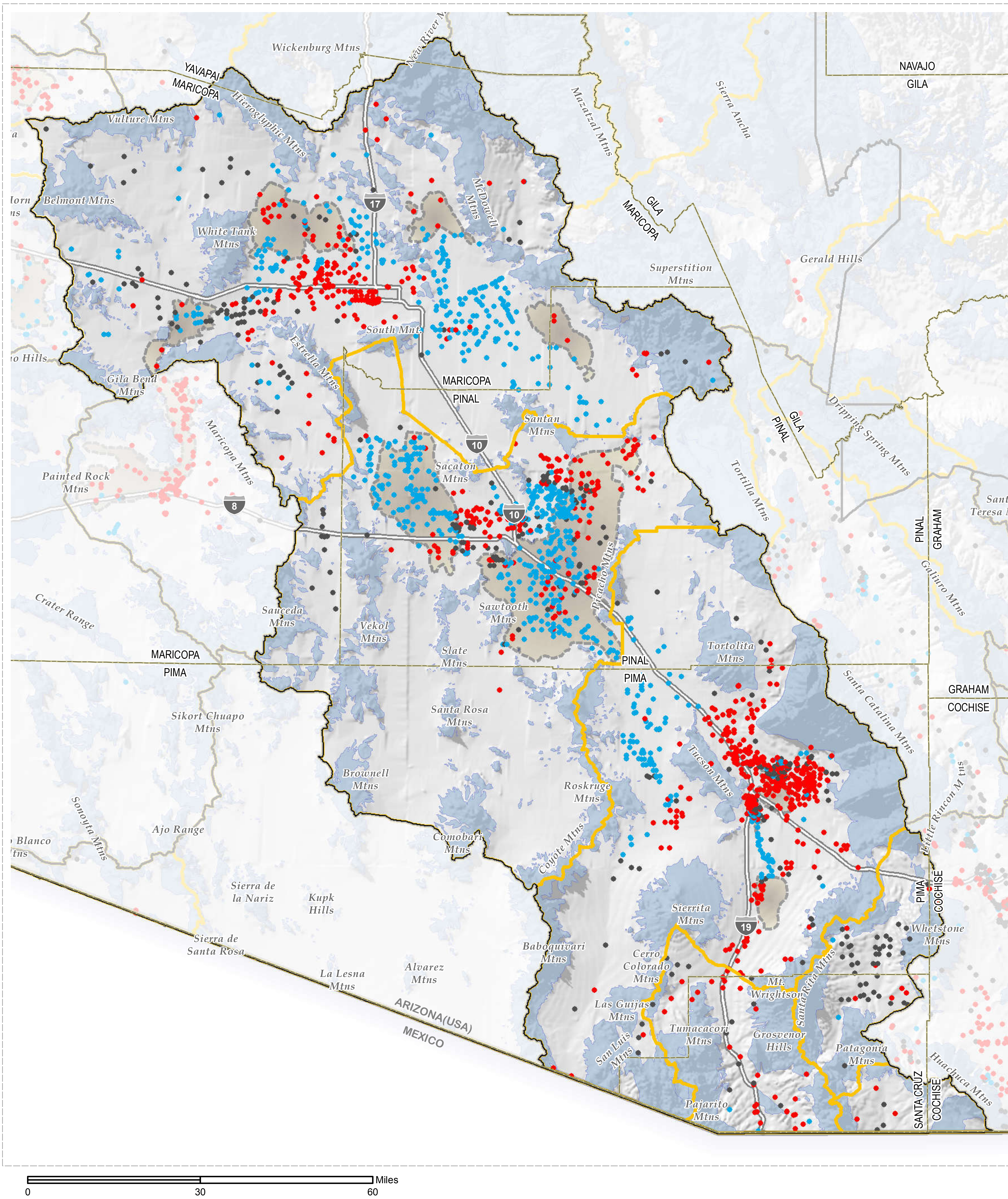

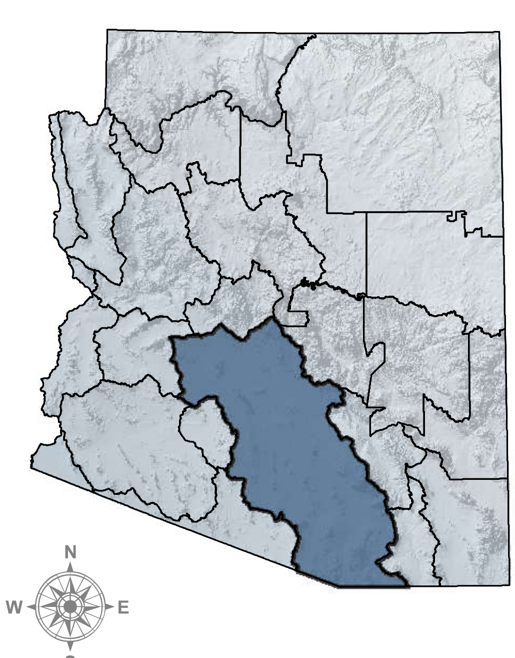

MAP LOCATION
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- County (ALRIS)
- Groundwater Basin (ADWR)
- Area of Active Land Subsidence (ADWR)
- Hard Rock Geology (AZ Bureau of Mines, UofA)
- Interstate (ADOT)

Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

* Data provided by ADWR

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.3-2

Basin and Range AMAs Groundwater Hydrology

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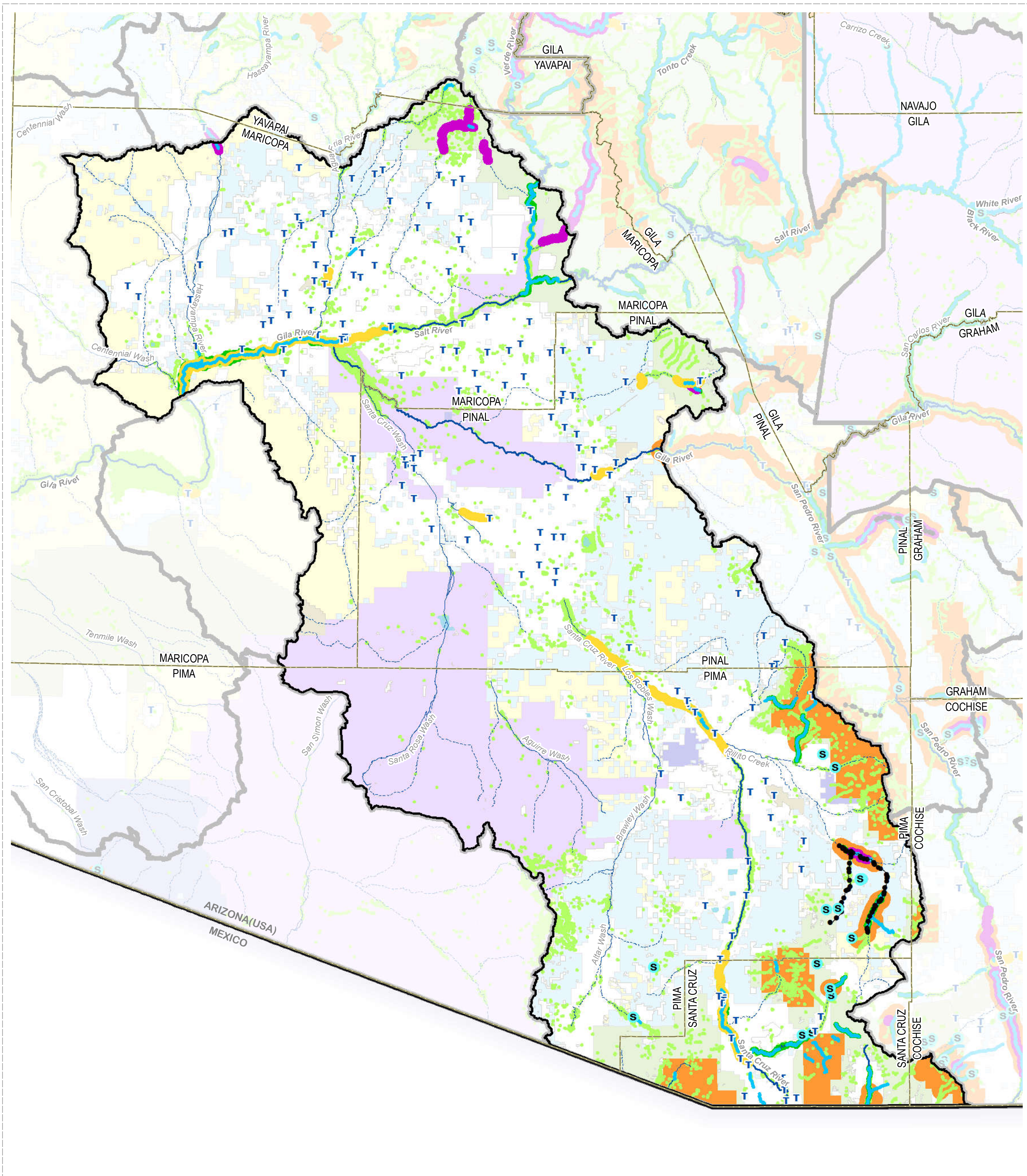

0 30 60 Miles

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
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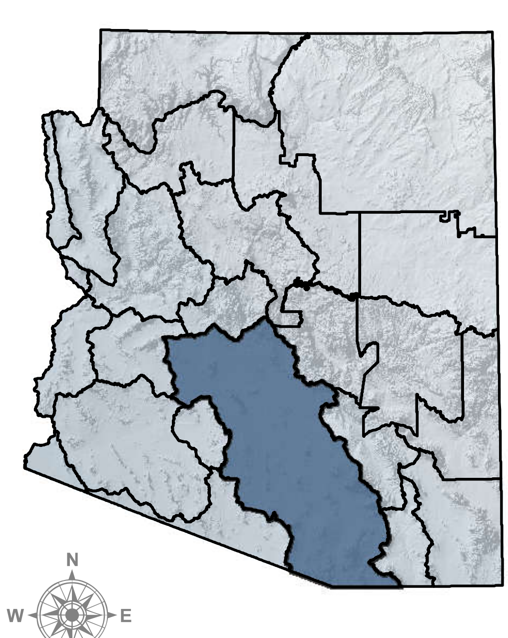
Tribal Land

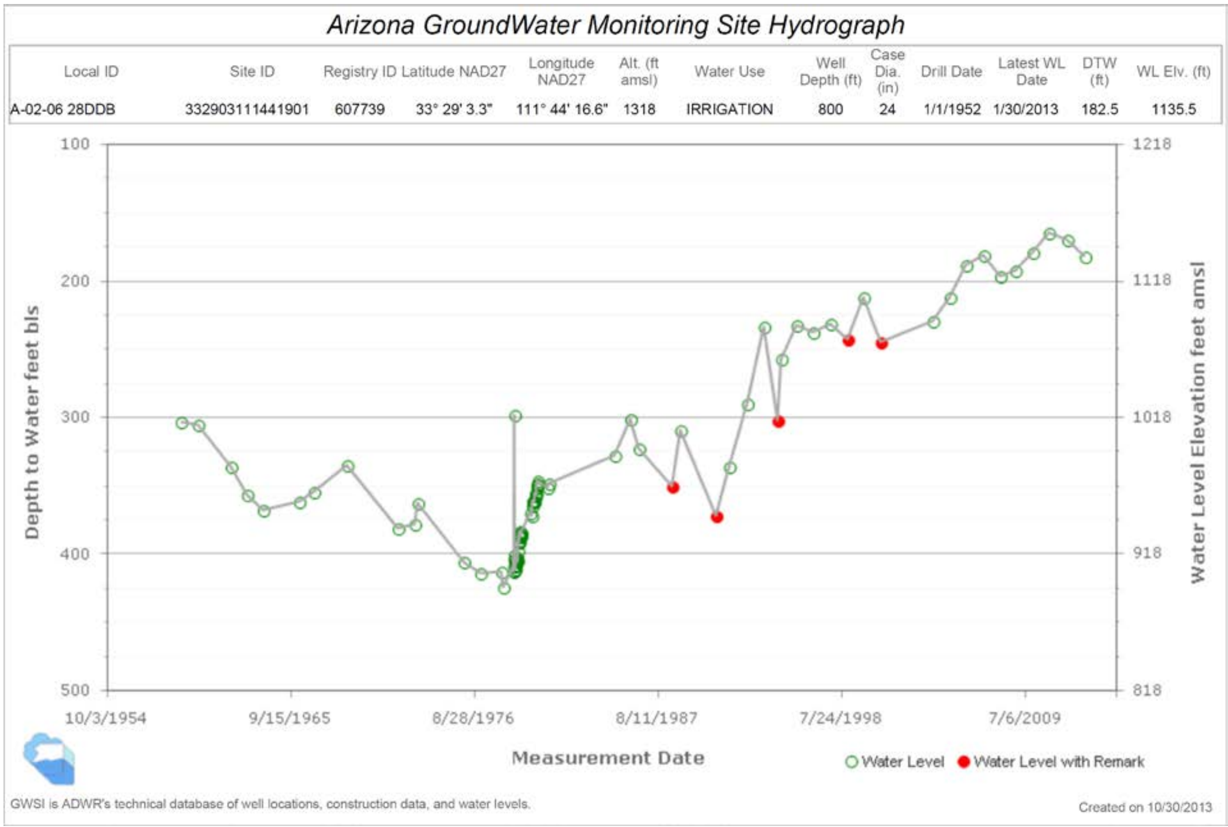


MAP LOCATION
(Planning Area Boundaries)

Figure P.A.3-3

Basin and Range AMAs
Surface Water and Natural Features

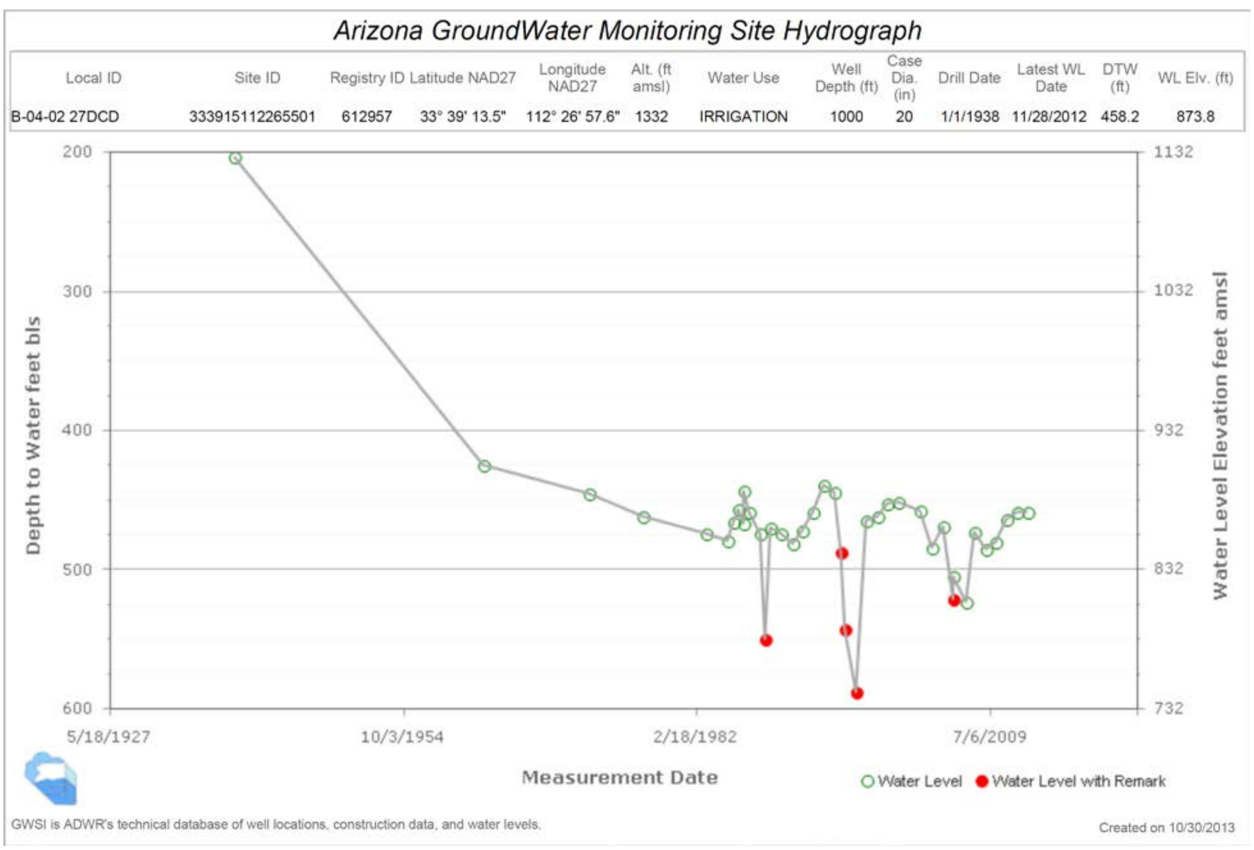
Phoenix AMA- Basin and Range AMA's



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)
A-02-06 28DDB	332903111441901	607739	33° 29' 3.3"	111° 44' 16.6"	1318	IRRIGATION	800	24	1/1/1952	1/30/2013	182.5	1135.5

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

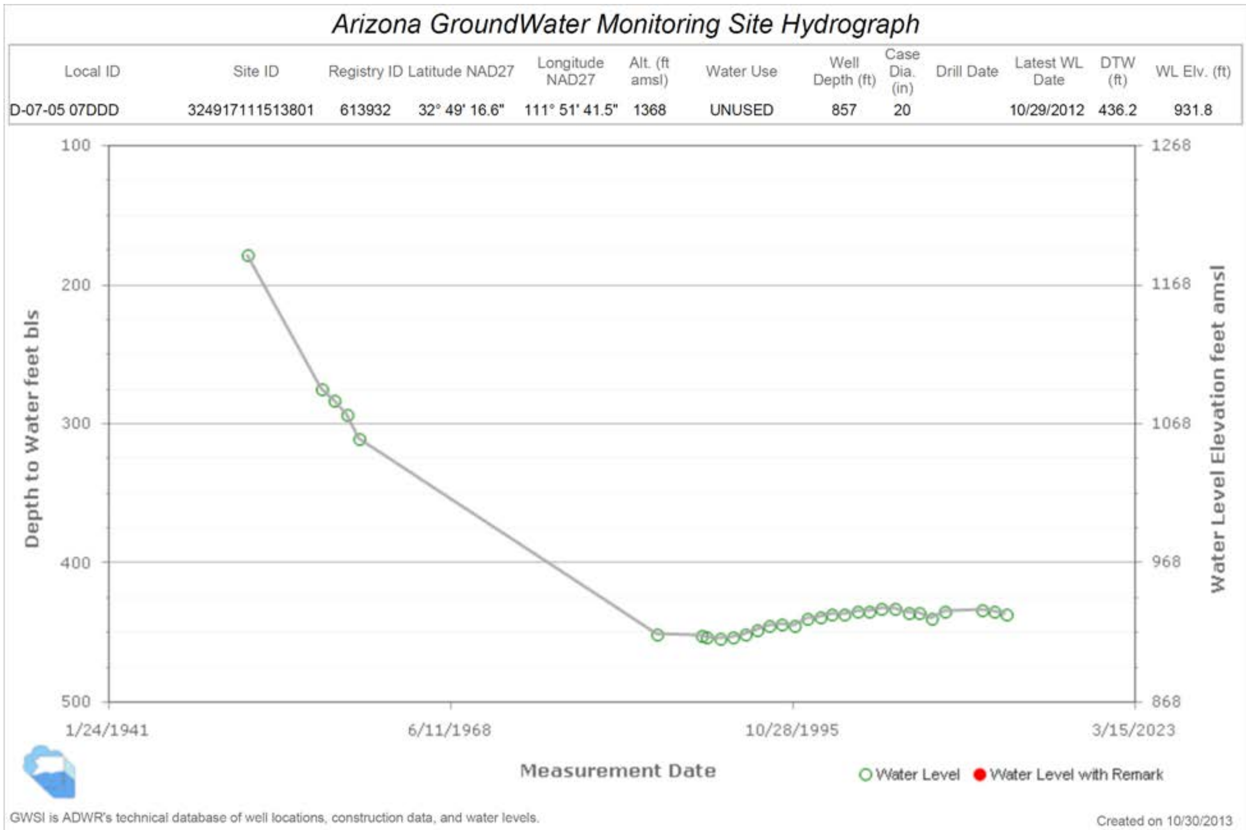


Arizona GroundWater Monitoring Site Hydrograph

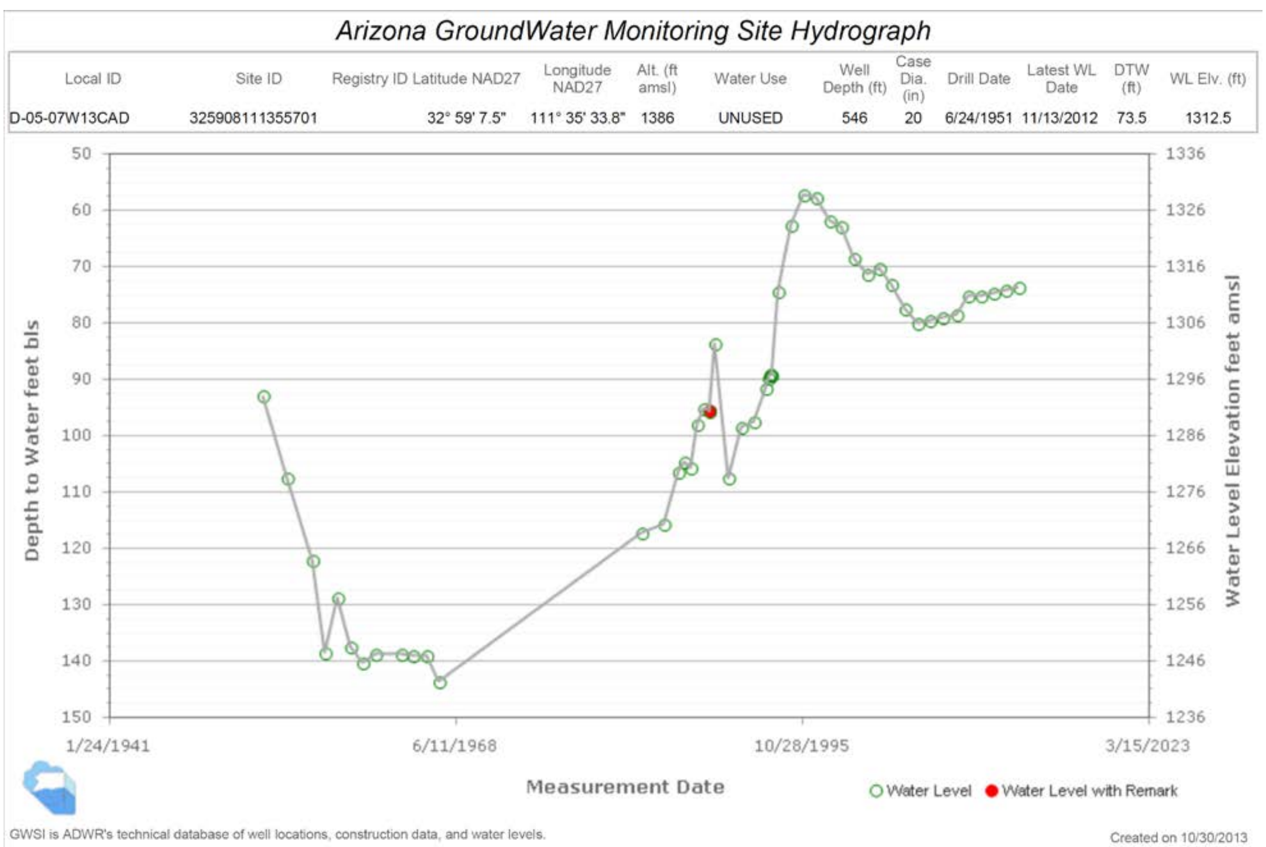
Local ID	Site ID	Registry ID	Latitude NAD27	Longitude NAD27	Alt. (ft amsl)	Water Use	Well Depth (ft)	Case Dia. (in)	Drill Date	Latest WL Date	DTW (ft)	WL Elv. (ft)
B-04-02 27DCD	333915112265501	612957	33° 39' 13.5"	112° 26' 57.6"	1332	IRRIGATION	1000	20	1/1/1938	11/28/2012	458.2	873.8

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

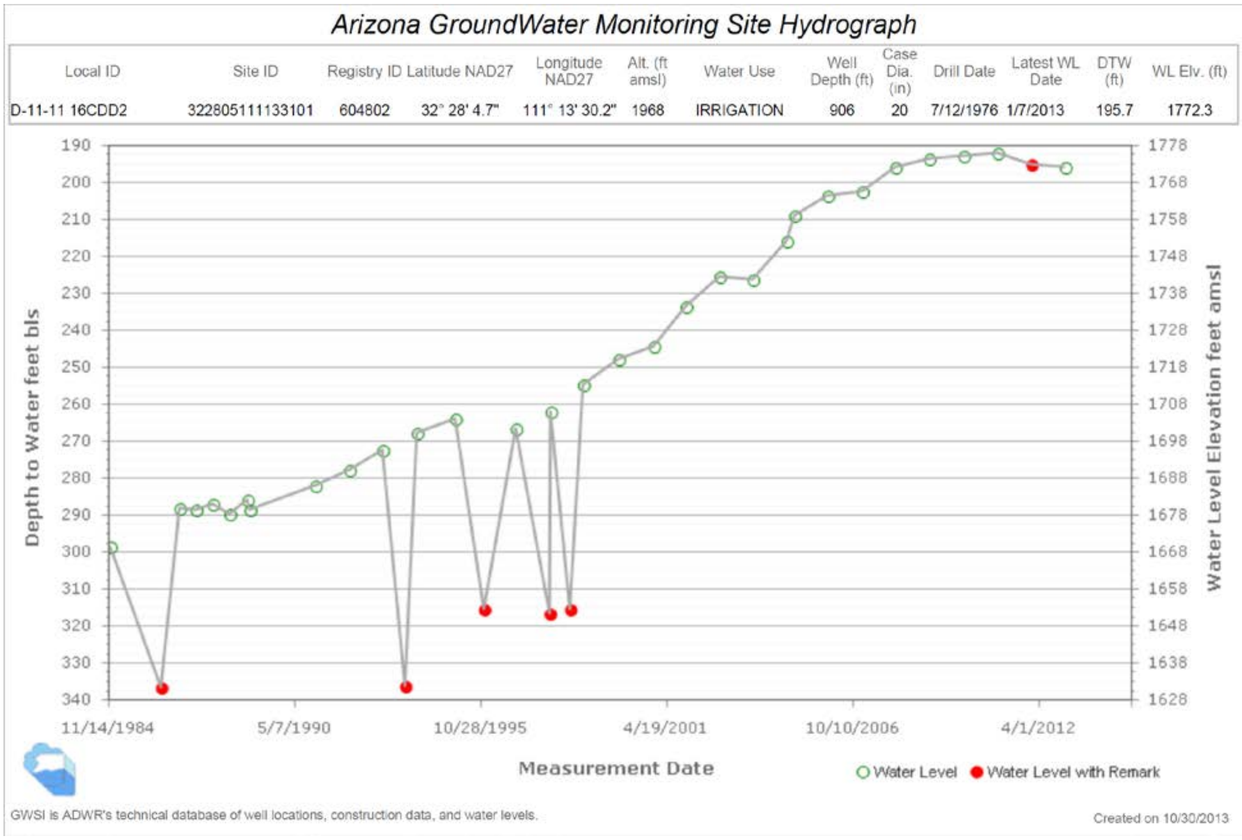


D-07-05 07DDD Pinal AMA – Maricopa-Stanfield sub-basin southern eastern Maricopa Stanfield Irrigation and Drainage District (MSIDD or MARSTAN) area.

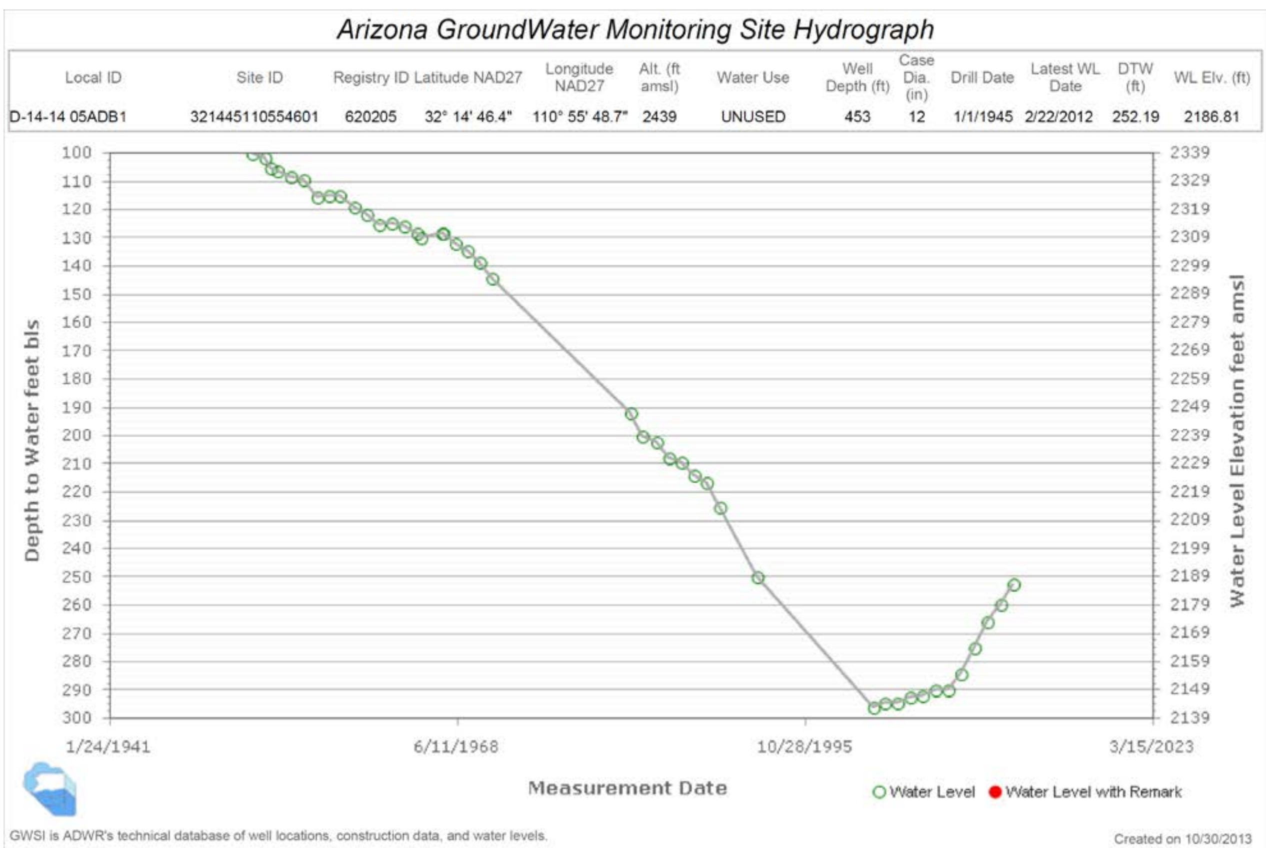


D-05-07W13CAD Pinal AMA – Eloy sub-basin NW Hohokam IDD area near GRIC.

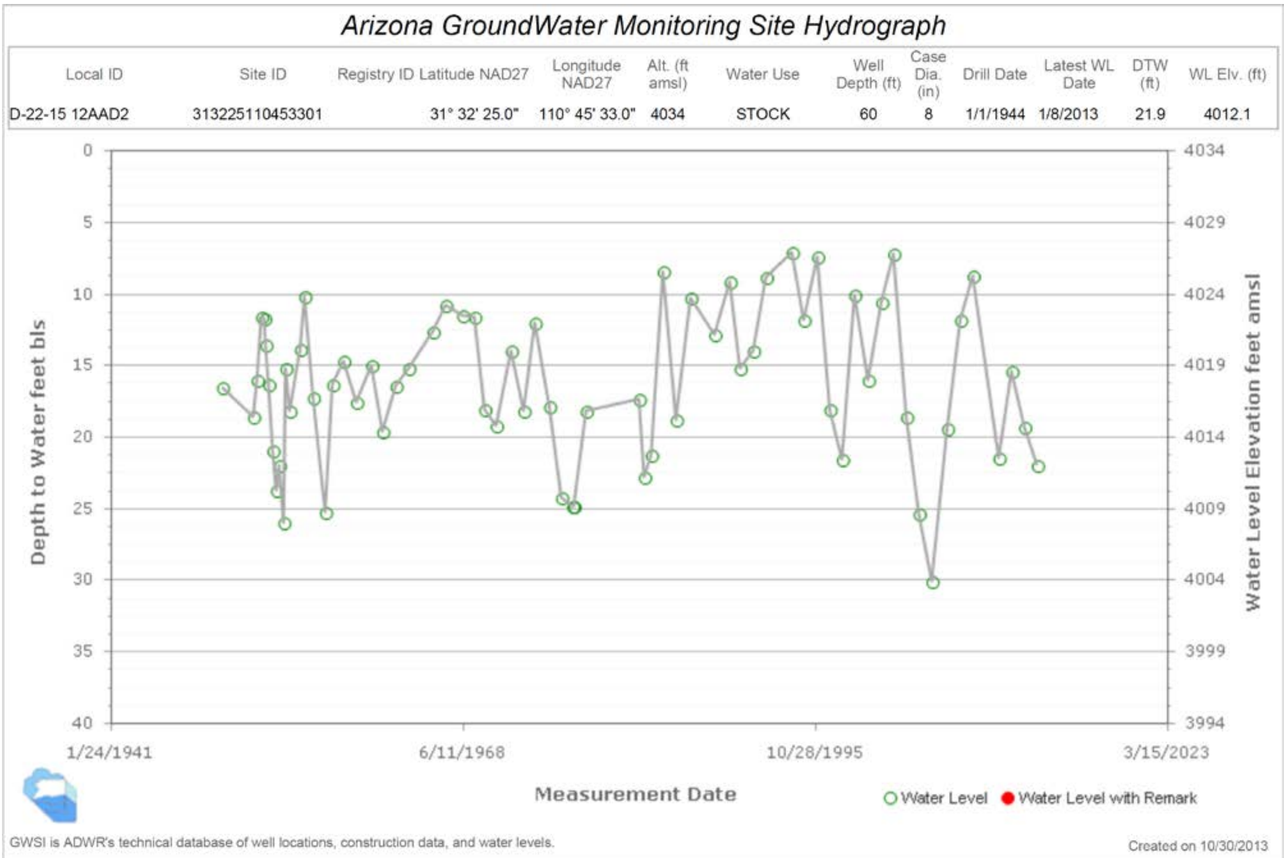
Tucson AMA- Basin and Range AMA's



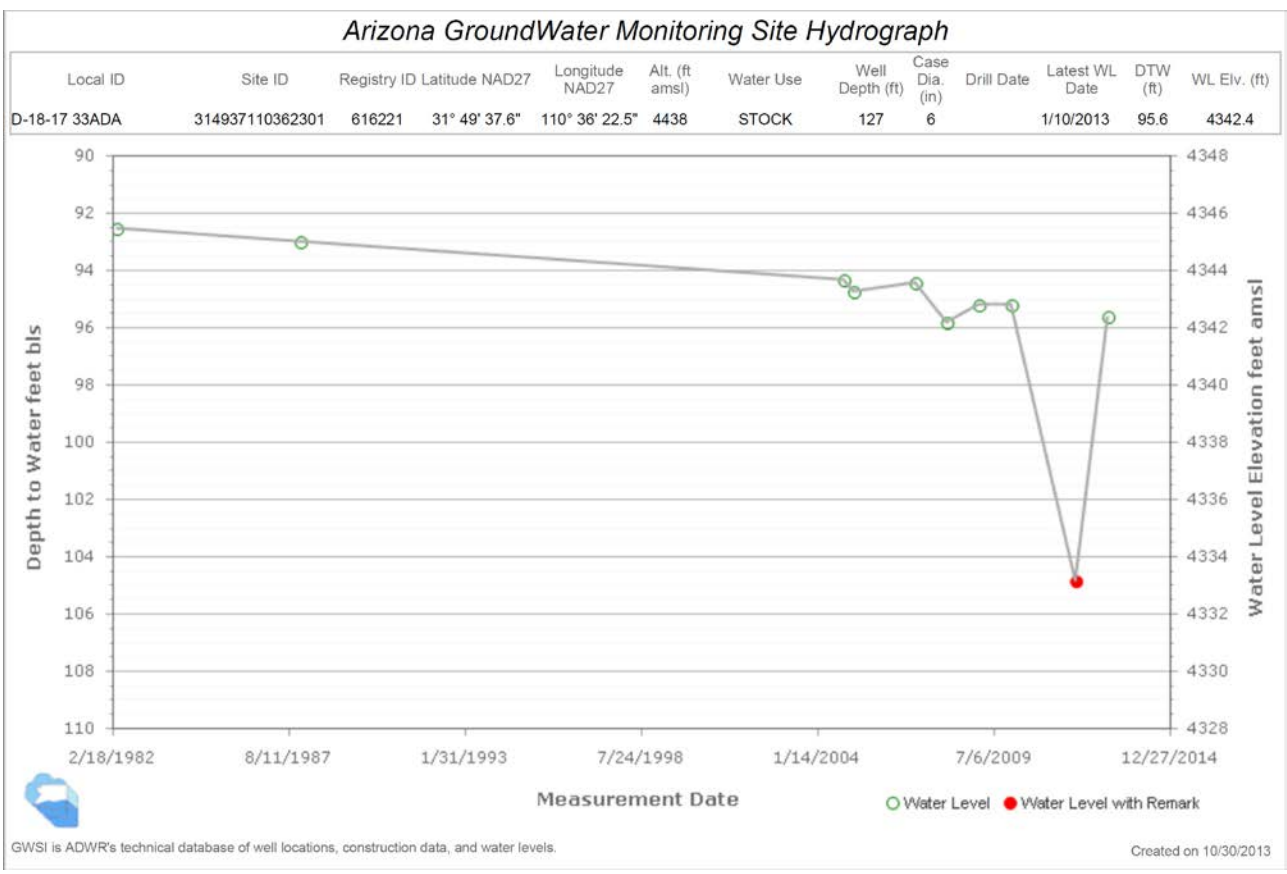
D-11-11 16CDD2 Tucson AMA – Avra Valley sub-basin about 1 mile NW of Marana.



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.

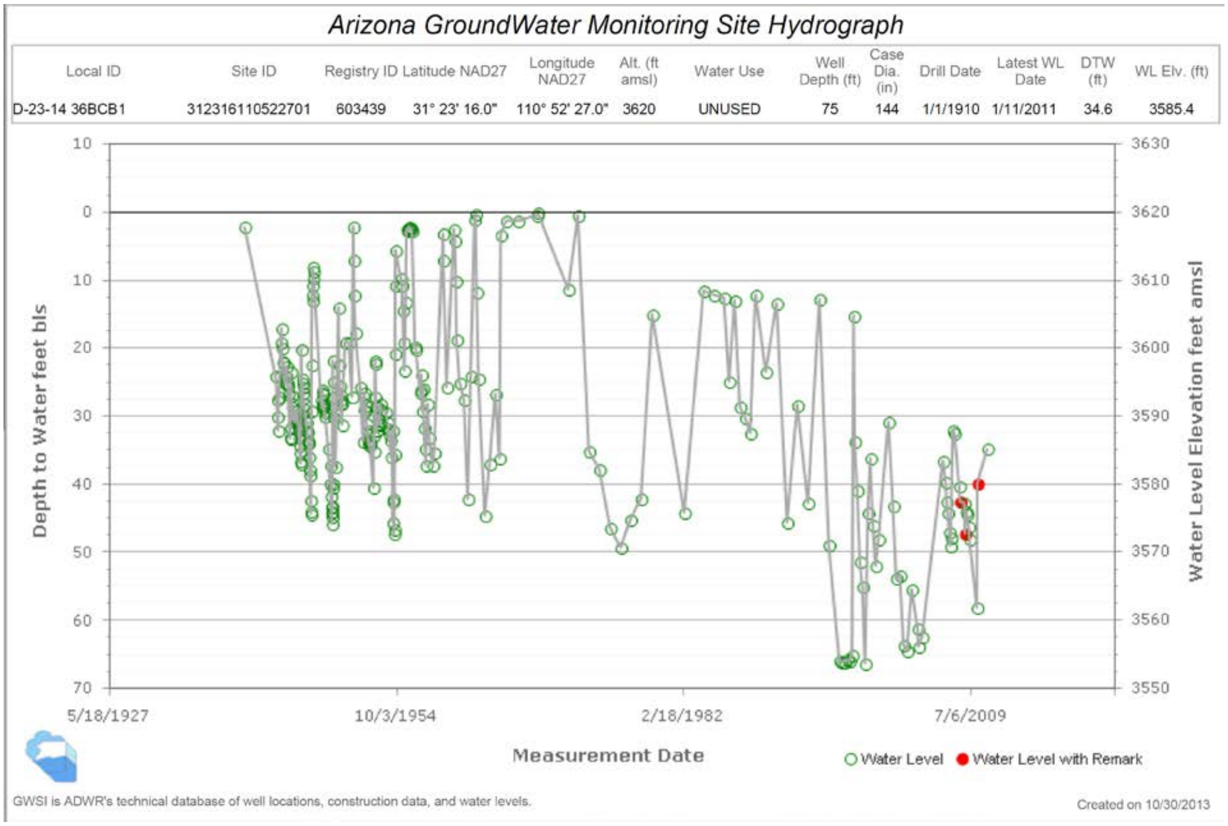


D-22-15 12AAD2 – Cienega Creek basin near Patagonia and Sonoita Creek.

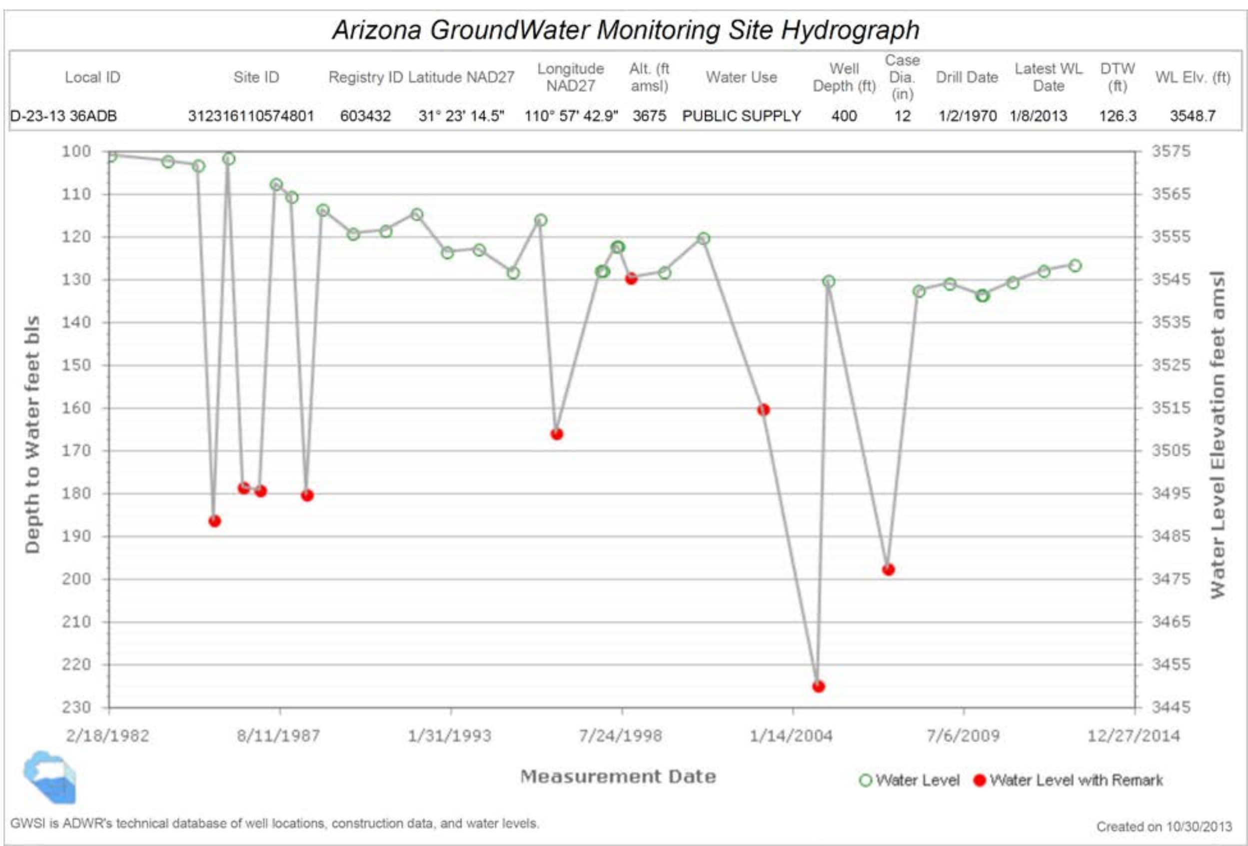


D-18-17 33ADA – Cienega Creek basin about 10 miles north of Sonoita just west of Cienega Creek.

Santa Cruz AMA- Basin and Range AMA's



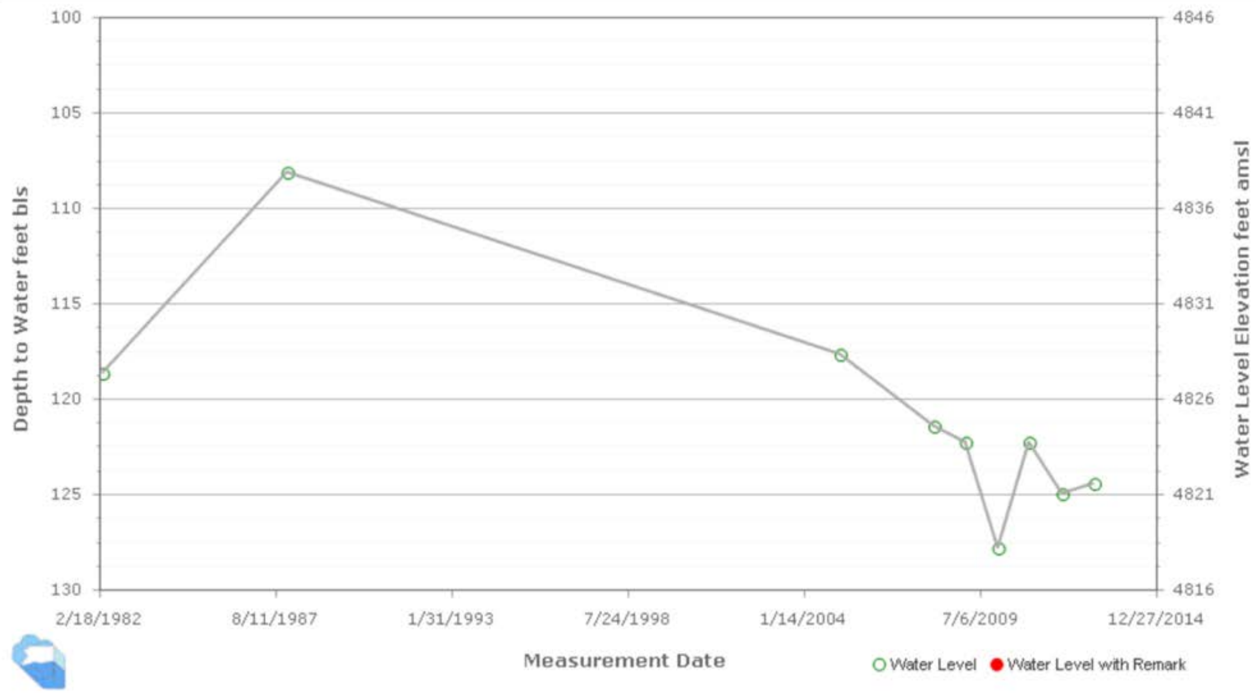
D-23-14 36BCB1 Santa Cruz AMA along Santa Cruz River at Highway 82 well field.



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.

[BILL WILLIAMS PLANNING AREA]

Bill Williams Planning Area

Background

The Bill Williams Planning Area is located in the west central part of the State. It lies within western Yavapai County, northern La Paz County and the southeastern portion of Mohave County. The Planning Area includes the entire Big Sandy Groundwater Basin in the north and the entire Bill Williams Groundwater Basin in the south. Communities within the planning area include: Valentine, Cane Springs, and Wikieup in the Big Sandy Basin; Skull Valley, Kirkland, Peeples Valley, and Yarnell, in the eastern portion of the Bill Williams Basin; and Bagdad and Swansea in the central and western portion of Bill Williams Basin, respectively.

A significant portion of this Planning Area is in federal ownership (*see Figure P.A. 4-1*). Nearly 58 percent of the land in the Bill Williams Basin is managed by federal agencies, the majority of this, 46 percent, by the US Bureau of Land Management (BLM). Much of this land has been set aside in Wilderness Areas – Rawhide Mountains, Swansea, Arrasta Mountain, Tres Alamos, Aubrey Peak and Upper Burro Creek. The remaining lands in the Bill Williams Basin are State Trust Lands (over 30 percent) and private lands (nearly 15 percent).

Forty percent of the land in the Big Sandy Basin is in private ownership (*see Figure P.A. 4-1*). The BLM manages 29 percent of the land, and just over 28 percent of the lands are State Trust Lands. Less than one percent each is controlled by the USDA Forest Service (primarily in the high elevations in the eastern portion of the basin) and the Hualapai Tribe.

Water Supply Conditions

<u>Groundwater</u>

The Bill Williams Planning Area is located within both the Basin and Range and Central Highlands Transition Zone physiographic provinces. The boundary between these provinces divides this planning area nearly in half from southeast to northwest. The Basin and Range province is characterized by long broad alluvial valleys separated by mountain ranges, with thick productive sand and gravel alluvial aquifers located in the valley centers which, subject to available renewable supplies, may facilitate artificial underground water storage and recovery activities. The Central Highlands Transition Zone is characterized by rugged mountains of igneous, metamorphic and sedimentary rocks and has a mixture of both fractured rock and alluvial basins. Groundwater in these fractured rock aquifers is much more limited than in the thin alluvial deposits along stream courses.

Groundwater conditions within the Planning Area are variable due primarily to the nature of the physiographic provinces (*see Figure P.A. 4-2*). Overall, the amount of groundwater in storage in the Big Sandy Basin has been estimated to range from 9.5 to 21 MAF. Groundwater levels in the western basin have generally remained steady or have seen rises of up to 0.2 feet per year from 1992 through 2012, with the exceptions being the Valentine area where declines of 0.8 feet per year have been recorded from 1992 to 2012, and the area around Wikieup where water levels have declined an average of 0.6 feet per year from 1992 to 2012.

Groundwater in storage in the Bill Williams Basin is estimated to range from 10 to 23 MAF. Groundwater in the western part of the Planning Area occurs primarily in recent stream alluvium and basin-fills. Groundwater levels in wells located in the central and eastern part of the basin, including Skull Valley, Kirkland, Peeples Valley and Yarnell have declined up to 1.4 feet per year with the largest declines in Peeples Valley and Kirkland. In the southwest part of the basin groundwater levels were generally rising at 0.02 feet per year from 1992 to 2012.

Groundwater quality varies greatly within the Planning Area. The quality of the groundwater may exceed limits established for drinking water standards but often is a result of naturally occurring conditions in the aquifer. Frequently equaled or exceeded parameters include fluoride and arsenic. Other parameters that have been measured and have equaled or exceeded drinking water standards include cadmium, copper, lead, nitrates, total dissolved solids and radionuclides.

Surface Water

The Bill Williams Planning Area lies mostly within the Bill Williams Watershed which drains into Lake Havasu on the western border. Perennial stream reaches within the Big Sandy Basin include Cottonwood Creek, Willow Creek, Ft. Rock Creek, Trout Creek, and the Big Sandy River. Maximum annual flow in the basin was 8,326 acre-feet in 1976 at the Cottonwood Wash station and minimum annual flow was 22 acre-feet in 2002 at the Truxton Wash station.

Perennial stream reaches within the Bill Williams Basin include the Bill Williams River, Santa Maria River, Big Sandy River, and Burro Creek (*see Figure P.A. 4-3*). It is estimated that approximately 500 acre-feet of surface water from springs near Bagdad in the Bill Williams Basin provides municipal and industrial supplies for the town of Bagdad and the Bagdad mine. The Bills Williams River flows from east to west and forms the boundary between Mohave and La Paz Counties. Alamo Lake and Dam on the Bill Williams River was constructed by the US Army Corps of Engineers primarily as a flood control structure in 1968, significantly impacting streamflow below the dam. The dam is now operated in a manner that provides both flood control and benefits downriver wildlife refuges and vegetation along the River. Median annual streamflow in the Bill Williams River below Alamo Dam is about 34,000 acre-feet, but in 1993 a maximum flow of almost 702,000 acre-feet was recorded.

Several lakes and streams within the Bill Williams Basin have been identified as having impaired waters. Water quality standards were exceeded in two reaches of Boulder Creek, one reach of Burro Creek, Alamo Lake and Coors Lake. The mercury drinking water standard was exceeded in every impaired stream or lake. Other parameters exceeded in Alamo Lake include ammonia and pH levels. Arsenic, copper and zinc were exceeded in Boulder Creek. Boulder Creek and Alamo Lake are part of the ADEQ water quality improvement effort called the Total Maximum Daily Load (TMDL) program.

Reclaimed Water

Population centers are small and widely dispersed throughout the Planning Area and no significant wastewater treatment facilities were identified by ADWR in the Planning Area and may be site specific (e.g., Alamo State Park). As such reclaimed water reuse in the planning area is minimal, although Freeport McMoRan Copper and Gold, Inc. (FMC) reports that reclaimed water is used at the Bagdad Mine.

Ecological Resources

A number of listed threatened and endangered species may be present in the Planning Area. The presence of a listed species may be a critical consideration in water resource management and supply development in certain locations within the Planning Area (*see Figure P.A. 4-3*). The Bill Williams River National Wildlife Refuge (NWR), located along the Bill Williams River at its confluence with Lake Havasu, includes lands originally set aside as Havasu NWR and additional lands purchased by US Fish and Wildlife Service (FWS) since then. The refuge extends 12 miles upstream and protects one of the last stands of natural cottonwood-willow habitat along the lower Colorado River. The refuge provides habitat for at least two endangered species, the Yuma clapper rail and the southwestern willow flycatcher. This area is also supported from regulated releases of water from Alamo Dam. Beaver dams are now common and riparian vegetation has increased substantially in many places. In addition, Alamo Wildlife Area, managed by the Arizona Game and Fish Department, is located at the confluence of the Big Sandy, Santa Maria, and Bill Williams Rivers where riparian vegetation has increased including native cottonwood and black willow.

Water Demands

Water use in the Bill Williams Planning Area is primarily groundwater with a small amount of surface water used in the Town of Bagdad. Groundwater use has increased in the Big Sandy Basin but has decreased in the Bill Williams Basin. Table P.A. 4-1 illustrates the baseline and projected demands for the Bill Williams Planning Area. No increases are projected for agricultural water uses and minimal increases in projected municipal demands are anticipated due to the significant amounts of federal lands in the area. There is significant industrial groundwater demand in the Big Sandy Basin; increases in mining operations are projected, specifically at the FMC Bagdad Mine site. Groundwater is pumped and transported via pipeline from the Big Sandy Basin to the mine site in the Bill Williams Basin.

Characteristics Affecting Future Demands and Water Supply Availability

Limited Groundwater Data

Except for the community water systems, no water users in the Planning Area have an obligation to meter or report their water use. As such, information regarding water demands and sustainable groundwater development is insufficient for this Planning Area, which makes it difficult to estimate the impacts of current or projected water demands.

Land Use

Significant portion of this Planning Area contain federal land designations which limit the potential for increased water supply development. The majority of these are discussed below under Sensitive Environmental Areas.

Sensitive Environmental Areas

In addition to the Bill Williams River NWR, the large number of wilderness areas administered by the BLM is a prominent feature of the Planning Area. These areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition. Wilderness areas represent almost 12 percent of the lands within the Bill Williams Basin. Additionally, several "unique waters", designated as having exceptional recreational or ecological significance and/or providing habitat for threatened or endangered species, (Arizona Department of Environmental Quality - A.A.C.

R18-11-112) have been identified in the Planning Area. Designated unique waters include sections of Peoples Canyon, Francis Creek, and Burro Creek in the Bill Williams Basin.

Table P.A. 4-1 Projected Demands (in acre feet) – Bill Williams Planning Area

Sector	2010	2035	2060
Agriculture	2,700	2,700	2,700
Dairy	0	0	0
Feedlot	0	0	0
Municipal	1,555	2,060	2,409
Other Industrial	0	0	0
Mining	14,917		
High		30,000	30,000
Low		10,000	10,000
Power Plants	0		
High		0	0
Low		0	0
Rock Production	40		
High		113	133
Low		47	55
Turf	0		
High		0	0
Low		0	0
Total (High)	**19,212**	**34,873**	**35,242**
Total (Low)	**19,212**	**14,807**	**15,164**

The potential for increased water production from within this Planning Area may be impacted by these designations and water supply development will have to take this into account, either through mitigation or development and utilization of water supplies that do not impact these areas. Mining is very important to the economic prosperity of this State, and strategies to address the water supply needs for both of these uses will need to be addressed.

Unresolved Indian Water Rights Claims

The Hualapai Tribe Reservation is located in the Western Plateau Planning Area, but also has a smaller portion of its lands in the Bill Williams Planning Area located in a small strip along highway 93 north of Wikieup and around Valentine. The Hualapai Tribe, the State of Arizona, and several non-Indian water users are currently engaged in settlement discussions, but details of those discussions are not available at this time.

Unresolved Non-Indian Water Rights Claims

FMC operates a well field located along the Big Sandy River largely north of Wikieup that provides water to the Bagdad Mine. At the present time, these withdrawals are presumed to have the legal character

of groundwater. The shallow nature of the wells may, upon resolution of the issue in groundwater/surface water issue in the Arizona court system, result in a judicial finding that the wells are pumping surface water at some time in the future. In order to protect its ability to continue to exercise these wells to serve the Bagdad Mine, FMC has acquired Planet Ranch, lands with surface water rights along the Bill Williams River downstream of Alamo Dam, and has applied to ADWR for a sever and transfer a portion of those rights to its Wikieup well field.

Strategies for Meeting Future Water Demands

Settlement of federal water rights claims are likely the most significant issue that needs to be addressed, in addition to the resolution of FMC's sever and transfer applications for the Planet Ranch property. Monitoring water levels and aquifer performance along the Big Sandy River will assist in understanding the long-term sustainability of the water supplies in this area and the availability of water supplies for possible mine expansions and environmental maintenance. Because projected water demand increases are still small for this area, no additional strategies are being developed at this time.

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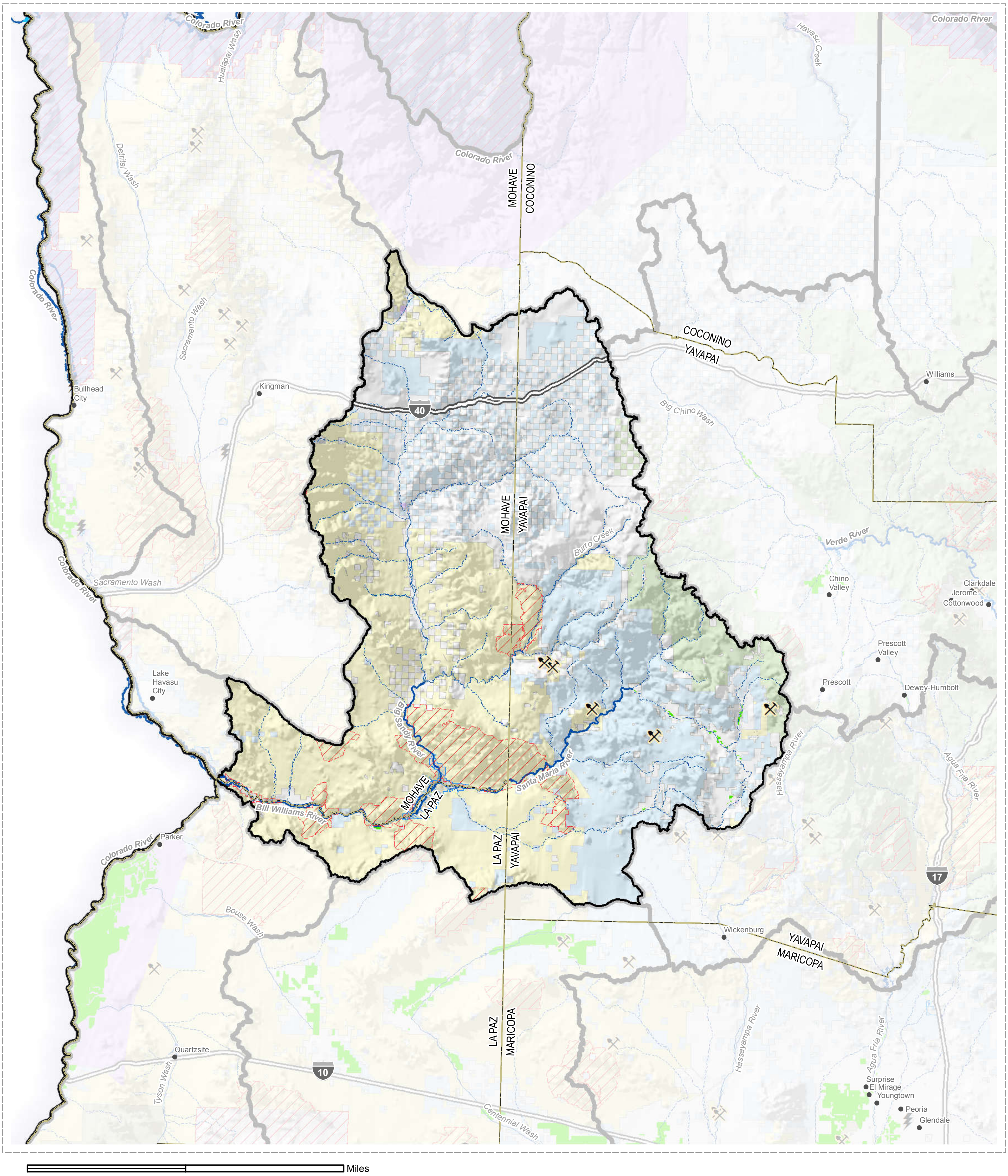

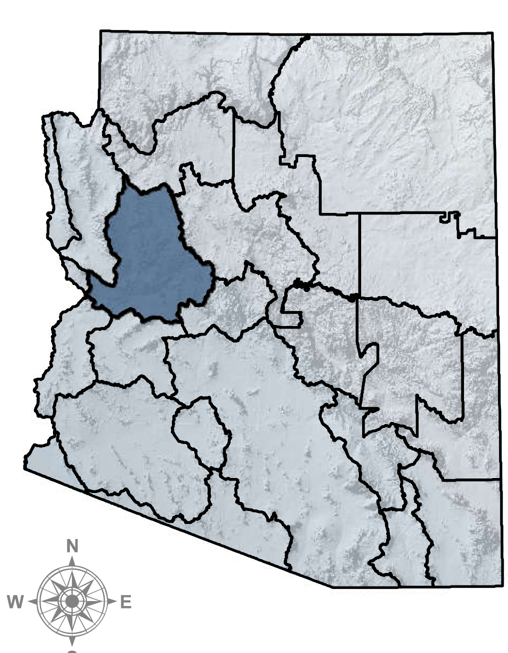

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- National Park
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Figure P.A.4-1

Bill Williams
Land Ownership

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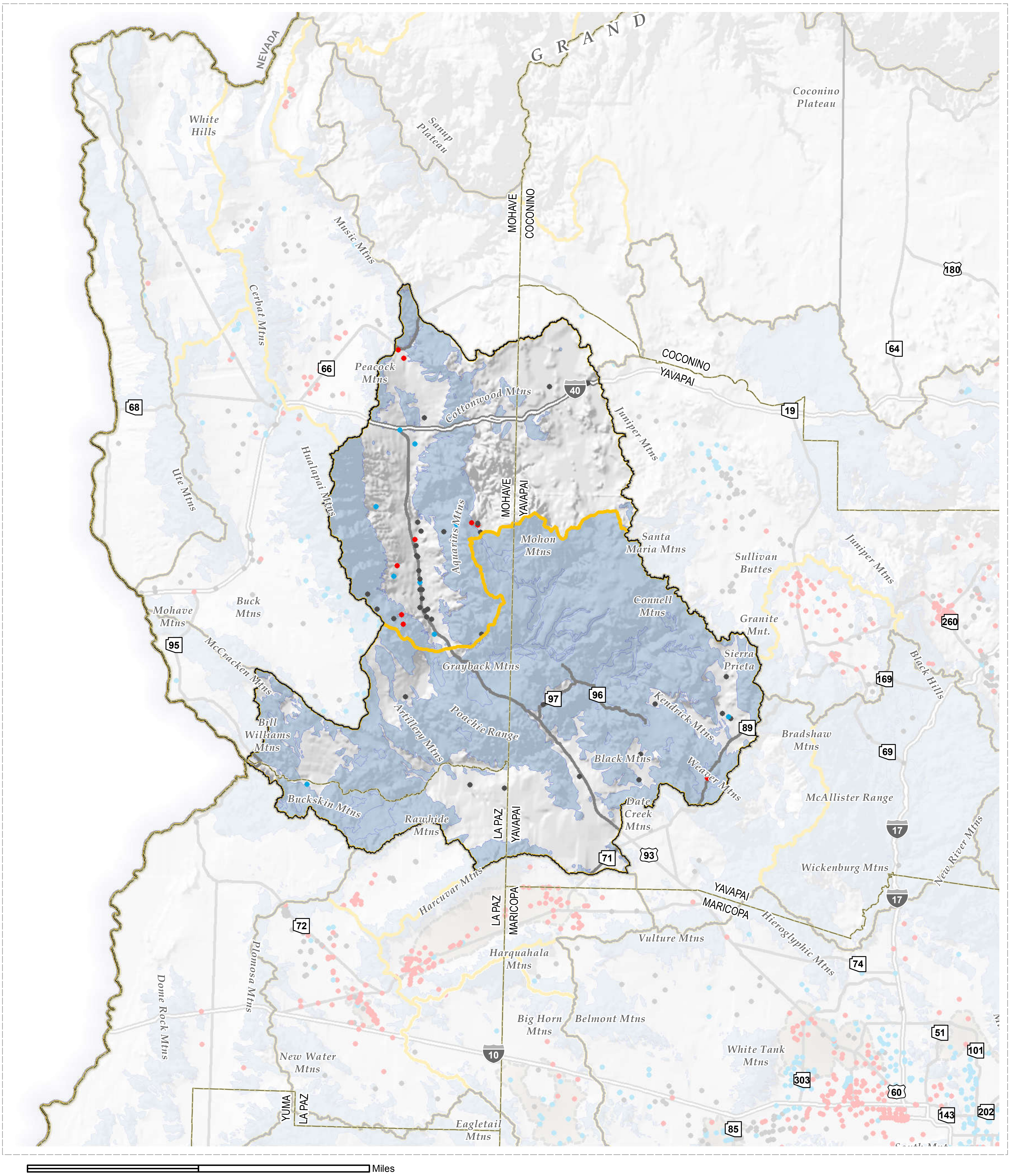

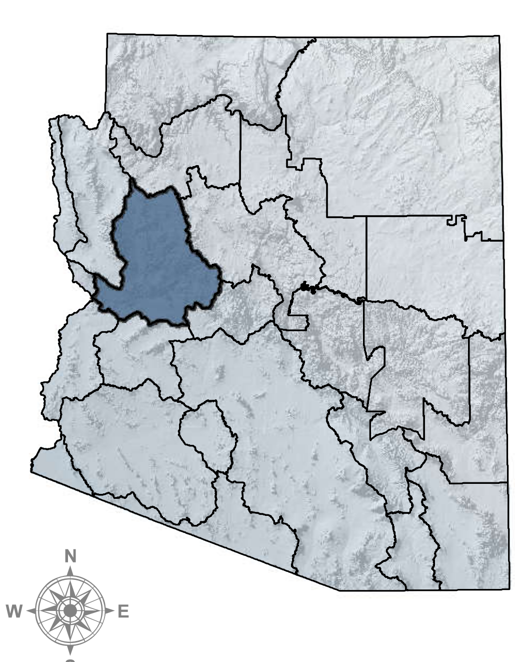

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County (ALRIS)
Groundwater Basin (ADWR)
Area of Active Land Subsidence (ADWR)
Hard Rock Geology (AZ Bureau of Mines, UofA)
Interstate (ADOT)

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

* Data provided by ADWR

Figure P.A.4-2

Bill Williams Groundwater Hydrology

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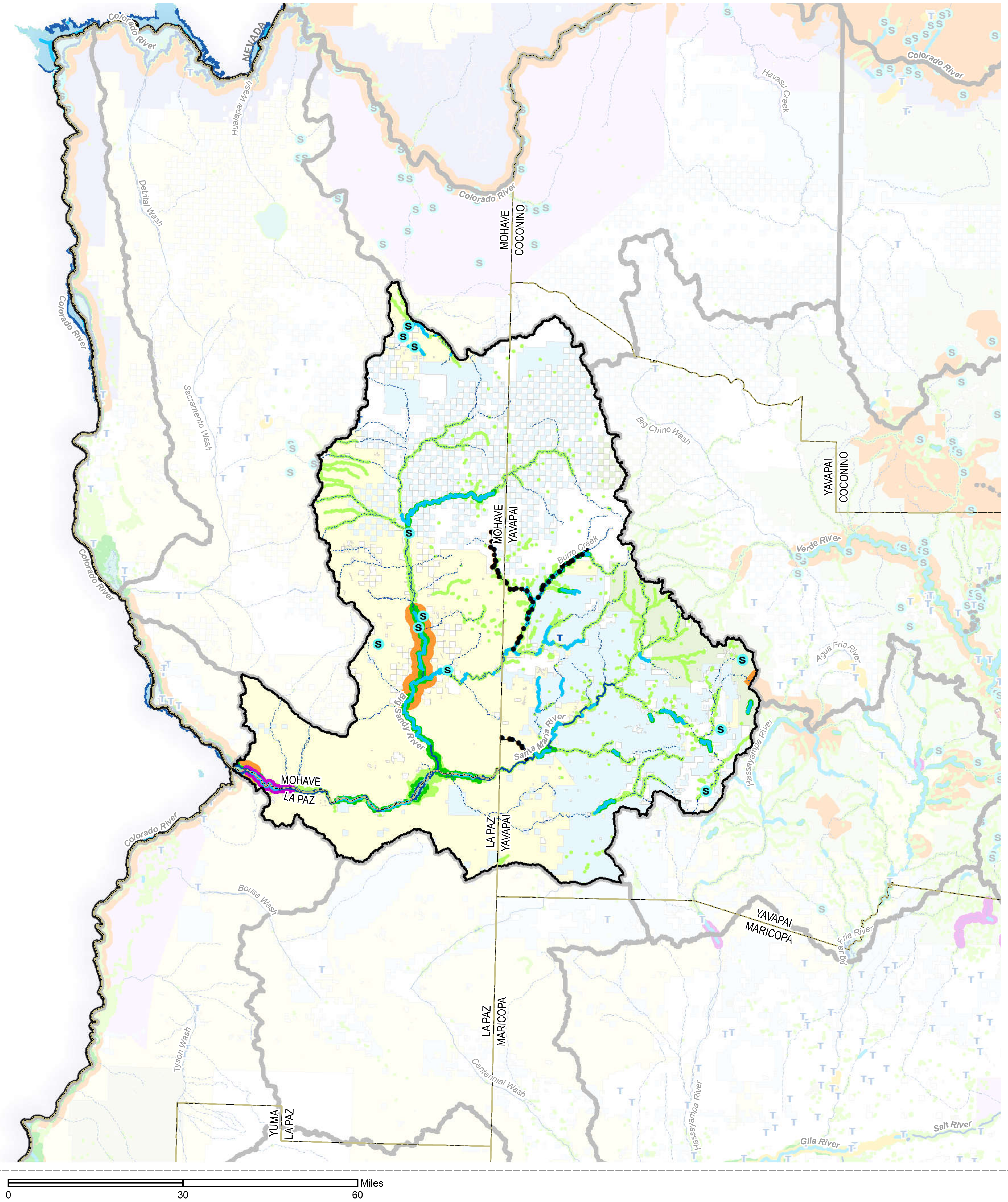

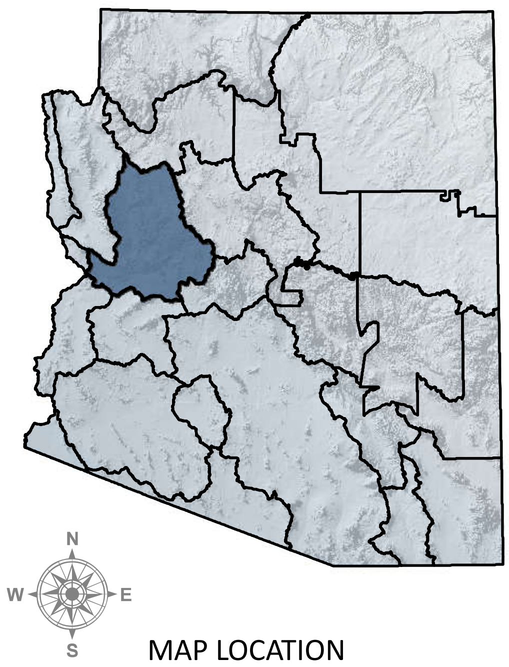

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- Instream Flow Certificate (ADWR)
- 1993 Riparian Inventory (AZGFD)
- Modeled Riparian Habitat (AZGFD)
- Designated ESA Critical Habitat (USFWS)
- Proposed ESA Critical Habitat (USFWS)
- Federally Designated Wild and Scenic River (USFS)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

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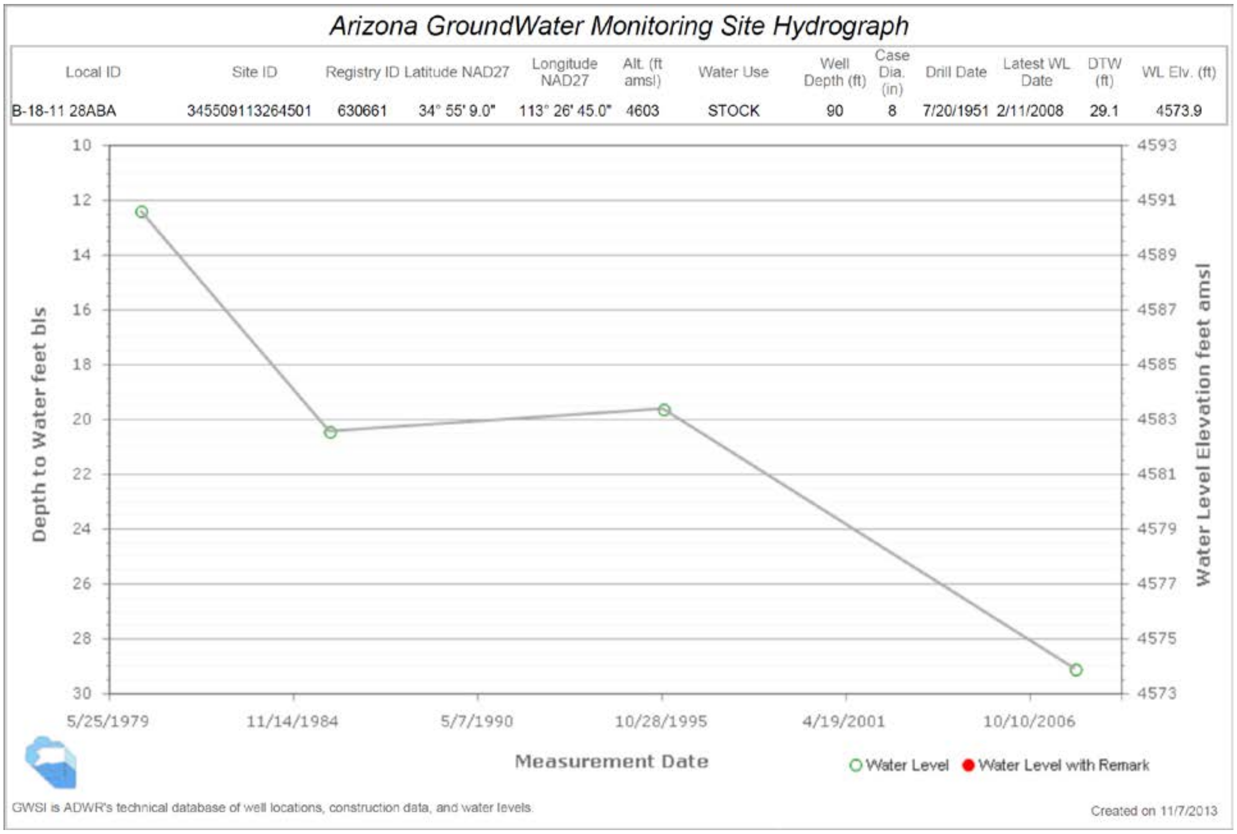
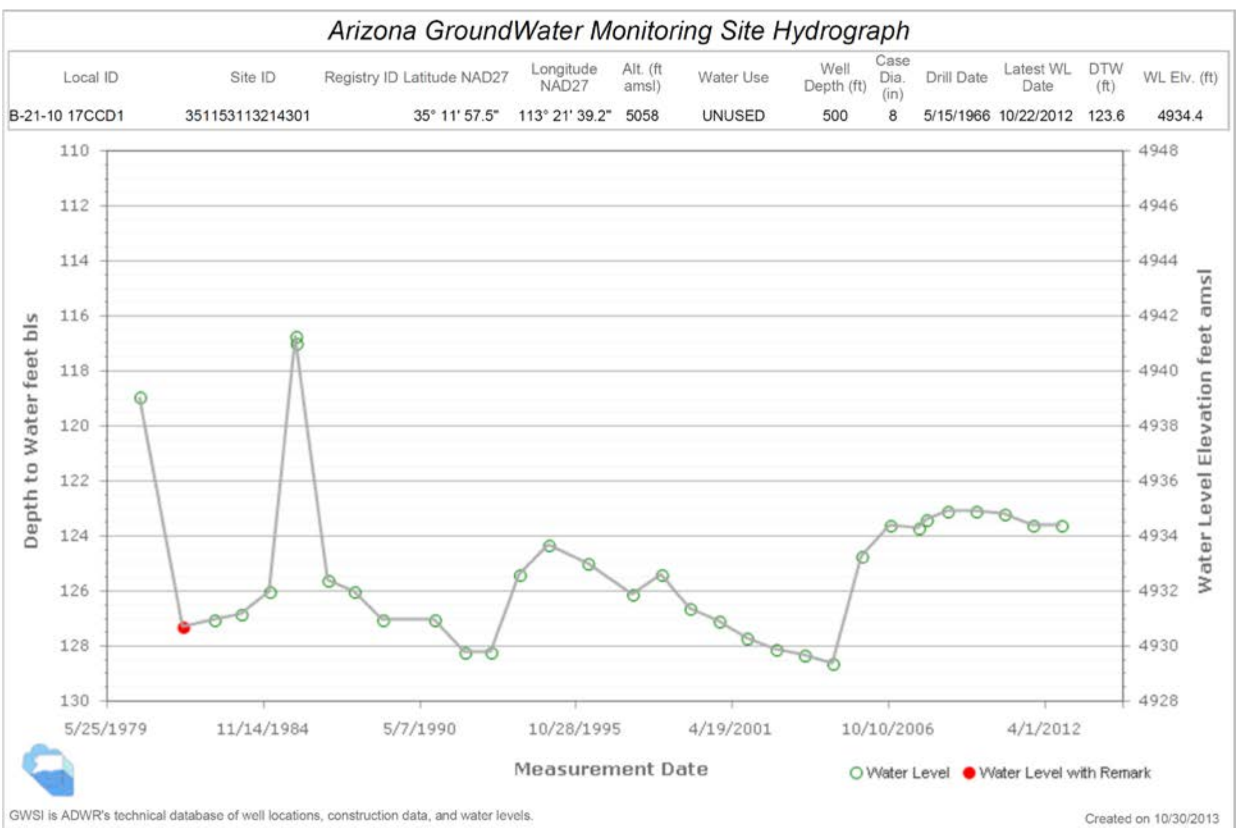
Figure P.A.4-3

Bill Williams
Surface Water and Natural Features

Big Sandy Basin – Bill Williams Planning Area

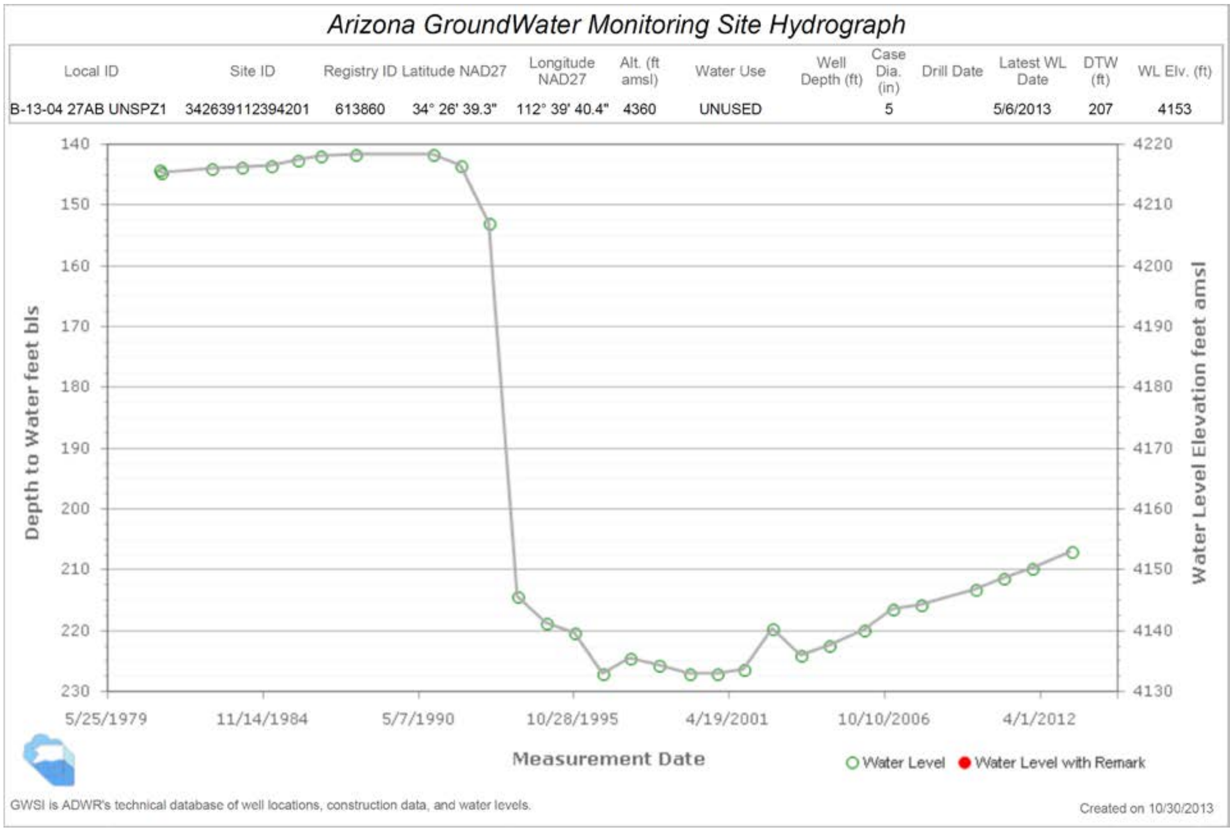


B-18-11 28ABA Big Sandy basin, Fort Rock sub-basin, SW portion of sub-basin in Skunk Canyon/Simmons Gulch area.

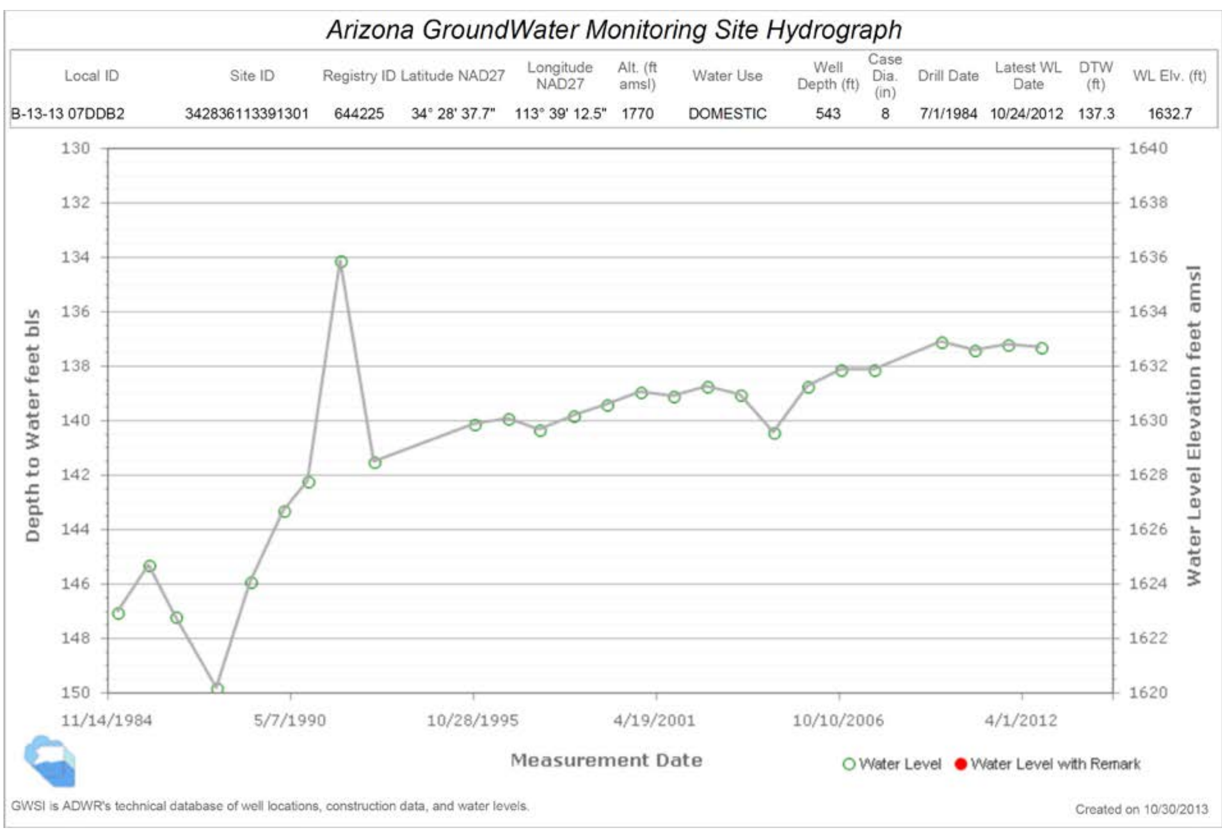


B-21-10 17CCD1 Big Sandy basin, Fort Rock sub-basin.

Bill Williams Basin – Bill Williams Planning Area



B-13-04 27AB UNSPZ1 Bill Williams basin, Skull Valley sub-basin about 3.5 miles NE of Kirkland Junction.



B-13-13 07DDB2 Bill Williams basin, Alamo Reservoir sub-basin about 1.8 miles west of Big Sandy River at Signal.

[CENTRAL PLATEAU PLANNING AREA]

Central Plateau Planning Area

Background

The Central Plateau Planning Area is located in the north-central portion of the State. The Planning Area lies entirely within Coconino County. The largest community in the Planning Area is the City of Flagstaff. Other communities include Williams, Valle, Tusayan, and Grand Canyon Village. Much of the remainder of the Planning Area is sparsely populated. There are portions of two groundwater basins within the Planning Area, the Little Colorado River Plateau in the east and the Coconino Plateau in the west.

Important geologic features in the Planning Area include: the Mogollon Rim, which defines the southern border of the Planning Area; the San Francisco Peaks volcanic zone (including Humphreys Peak, the highest point in Arizona at 12,633 feet in elevation), with a number of volcanic cinder cones and the associated caldera considered to be potentially active; and the South Rim of the Grand Canyon National Park.

The Grand Canyon is of great geologic significance, with a record of three of the four eras of geological time, averaging 4,000 feet deep for its entire 277 miles. The Grand Canyon was given federal protection in 1893 and became a National Park in 1919. Receiving almost five million visitors each year, the Park serves not only as one of Arizona's most important economic sites, but is an ecological refuge, with relatively undisturbed remnants of rare ecosystems, including desert riparian communities, and is home to numerous rare, endemic, and federally protected plant and animal species.

The majority of the land in the Planning Area (60 percent) is owned and managed by the USDA Forest Service (Forest Service) including portions of the Kaibab and Coconino National Forests (*see Figure P.A. 5-1*). The National Park Service manages five percent of the land in the Planning Area, including a portion of the Grand Canyon National Park. Seven percent of the lands are State Trust Lands and 17 percent is privately held.

Water Supply Conditions

<u>Groundwater</u>

The Central Plateau Planning Area is located in the Colorado Plateau Physiographic Province. The main productive aquifers in this province are large regional aquifers consisting of sandstone and limestone. Some formations produce relatively little water, while some fracture zones within these sedimentary rocks may be highly productive locally. Such highly productive areas may provide opportunities for limited artificial recharge and recovery.

Groundwater conditions are highly variable across the Planning Area and include portions of the Coconino Plateau and Little Colorado River Plateau groundwater basins (*see Figure P.A. 5-2*). While some shallow perched aquifers exist in the Planning Area, regional aquifers can be deep and production can be highly variable, depending upon location. The City of Flagstaff produces groundwater from several distinct aquifers. The aquifer system in the vicinity of Flagstaff is complex and groundwater flow is poorly understood because of its depth and complex geologic structure. The City of Flagstaff's Woody

Mountain and Lake Mary well fields produce from this aquifer. Water levels in these well fields exhibit seasonal fluctuations and long-term declines due to pumping. Shallower volcanic aquifers, such as the caldera of the San Francisco Peaks, that have historically supplied much of the municipal water for the City of Flagstaff, can be productive.

Water levels in the Planning Area are typically quite deep. Tusayan's water supply plan reports water level depths of 2,347 and 2,425 feet below land surface in two system wells with well yields of 65 to 80 gallons per minute. While water has been found in perched aquifers near Williams at depths less than 950 feet below land surface, yields from these more shallow wells are generally less than five gallons per minute. At Williams, water level depths in three of the four water system wells are between 2,740 and 2,875 feet below land surface. Groundwater levels in the Planning Area are generally declining between 0.5 feet in the Williams area to 1.4 feet per year near Flagstaff.

Surface Water

The Central Plateau Planning area includes important sources of surface water drainage to the Little Colorado, Colorado and Verde River systems (*see Figure P.A. 5-3*). Several perennial streams also occur at the higher elevations in the Planning Area, and are adjacent and tributary to the Little Colorado River in the northeast and the Colorado River at the Grand Canyon in the north. Several regionally important reservoirs are within the Planning Area including the 1,390-acre Dogtown Reservoir operated by the City of Williams and the Lake Mary reservoir system, an important municipal supply for the City of Flagstaff with average yields of approximately 2,250 acre-feet.

Reclaimed Water

Several communities within the Planning Area operate central wastewater collection and treatment facilities. Reclaimed water generated from these facilities is extensively used directly for turf irrigation and at recreational facilities within the Planning Area. For example, the City of Flagstaff uses reclaimed water for landscape watering at schools, parks, cemeteries, golf courses and an athletic field at Northern Arizona University. In addition, a large industrial user, SCA Tissues, which had been Flagstaff's second largest potable water user, converted to 100 percent reclaimed water use in 2005, resulting in a potable water savings of more than 300 acre-feet per year. Flagstaff also has a reclaimed water hauling program that makes Class A+ and Class B reclaimed water available for non-potable uses from four locations throughout the city. The City also uses reclaimed water for recreational facilities, such as the Arizona Snow Bowl ski area for snow making in the winter months. Excess reclaimed water is discharged to Rio de Flag, which eventually percolates into the local aquifer.

Reclaimed water is also used at the Elephant Rock Golf Course in Williams. Reclaimed water generated at the South Grand Canyon Treatment Plant (SGCTP) is used at Tusayan for toilet flushing in hotels and businesses and for landscape irrigation. At Grand Canyon Village, reclaimed water from the SGCTP is reused for toilet flushing, landscape irrigation and other uses, including fire protection. Reclaimed water generated and treated at Valle is used for landscape irrigation and fire protection.

Ecological Resources

A number of listed threatened and endangered species are found in the Central Plateau Planning Area. In addition, several ecologically and economically important protected areas are present or partially located in the Planning Area (*see Figure P.A. 5-3*). The presence of a listed species or protected areas may be a critical consideration in water resource management and supply development. Protected

areas include the Sunset Crater Volcano (northwest of Flagstaff which erupted as recently as 1065 AD) and Wupatki and Walnut Canyon National Monuments near Flagstaff. Wilderness Areas, designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition, include the Kachina Peak Wilderness Area located on Mt. Humphrey's (contains the only arctic-alpine vegetation in the state), and the Strawberry Crater and Kendrick Mountain Wilderness Areas. Finally, a portion of the South Rim of the Grand Canyon National Park defines the Central Plateau Planning Area on the north.

Water Demands

Table P.A. 5-1, below, presents the baseline and projected water demands for the Central Plateau Planning Area. The majority of the increased demands projected in this Planning Area reflect the potential municipal growth in this region. However, the projections may not adequately reflect the seasonal demands associated with the tourism that is the backbone of this region's economy.

Table P.A. 5-1. Projected Demands (in acre feet) – Central Plateau Planning Area

Sector	2010	2035	2060
Agriculture	1,962	1,962	1,962
Dairy	0	0	0
Feedlot	539	539	539
Municipal	12,248	15,734	18,522
Other Industrial	3,076	2,960	2,939
Mining	360		
High		450	450
Low		450	450
Power Plants	0		
High		0	0
Low		0	0
Rock Production	67		
High		1,059	1,259
Low		442	524
Turf	449		
High		454	466
Low		432	467
Total (High)	**18,702**	**23,159**	**26,137**
Total (Low)	**18,702**	**22,519**	**25,404**

Characteristics Affecting Future Demands and Water Supply Availability

Conservation, Reuse and Water Supply Development

Because of relatively scarce water supplies in the Central Plateau Planning Area, communities have made extraordinary efforts to conserve existing water supplies, develop new water supplies and reuse existing resources such as reclaimed water and gray water. As mentioned previously, communities in this Planning Area such as the City of Flagstaff, Williams, Grand Canyon Village and Tusayan have implemented measures to conserve existing resources and reuse reclaimed water for multiple purposes. Additionally, a rainwater harvesting system at the Tusayan airport is unprecedented in Arizona. The City

of Williams and Tusayan's well drilling programs are excellent examples of local efforts to improve supply reliability and better utilize available resources. The City of Flagstaff purchased Red Gap Ranch, located approximately 40 miles east of the City, to develop a well field to augment its available supplies and improve its water supply reliability.

Ecological Resources

This Planning Area contains some very significant areas that are not only important ecological resources for Arizona, but also important economic engines for tourism for this region and the State. While there is a need for communities in this Planning Area to develop supplies to meet growing needs and reduce their vulnerability to drought, the impacts to these ecological areas have to be managed such that both the intent for which these areas were established and water supply resiliency and economies of the communities reliant on the tourism are protected.

Strategies for Meeting Future Water Demands

Red Gap Ranch

The City of Flagstaff recently purchased Red Gap Ranch located along the Interstate-40 corridor 40 miles east of the City. The Ranch consists of 8,500 acres of City-owned land checker boarded with 7,500 acres of State Trust Land. Recent investigations have revealed groundwater at the Ranch at depths ranging from 235 to 550 feet below land surface. The Red Gap Ranch project is an example of groundwater development projects that may be explored to reduce vulnerability to drought and augment supplies in the Planning Area. The existence of large tracts of federal lands may limit the ability to construct the facilities necessary to transport water from the areas of water supply development and requires careful planning to reduce impacts to surrounding water uses and water dependent resources. Existing transportation corridors (such as Interstate 40 located parallel to the proposed transmission for the Red Gap Ranch pipeline – owned by the Arizona Department of Transportation) potentially offer the least ecological disturbance to important resources and native American cultural sites and ultimately lower costs to rate payers.

Reclaimed Water Reuse

Many municipalities in the Planning Area currently directly use reclaimed water for irrigation in parks, landscaping and other recreational facilities. Additional uses may be applied to industrial facilities as well as recharge and recovery. Currently, about 20 percent of all water deliveries in Flagstaff are derived from reclaimed water. The City also discharges unused reclaimed water from its two wastewater treatment plants into the Rio de Flag, which has become a reclaimed water dominated stream for approximately one mile from the point of discharge until it infiltrates underground. Groundwater mounding has been observed in this area. Delivering a portion of this reclaimed water to other areas for artificial recharge and recovery may provide opportunities to store this water to supplement summertime needs and reduce the mounding associated with this project.

Weather Modification

In conjunction with groundwater development, weather modification, or cloud seeding, is a potential strategy to either augment local water supplies or mitigate the impacts of groundwater management projects. For example, the mountainous topography within portions of the Planning Area situated along the southern edge of the Colorado Plateau expressing as the Mogollon Rim provides favorable

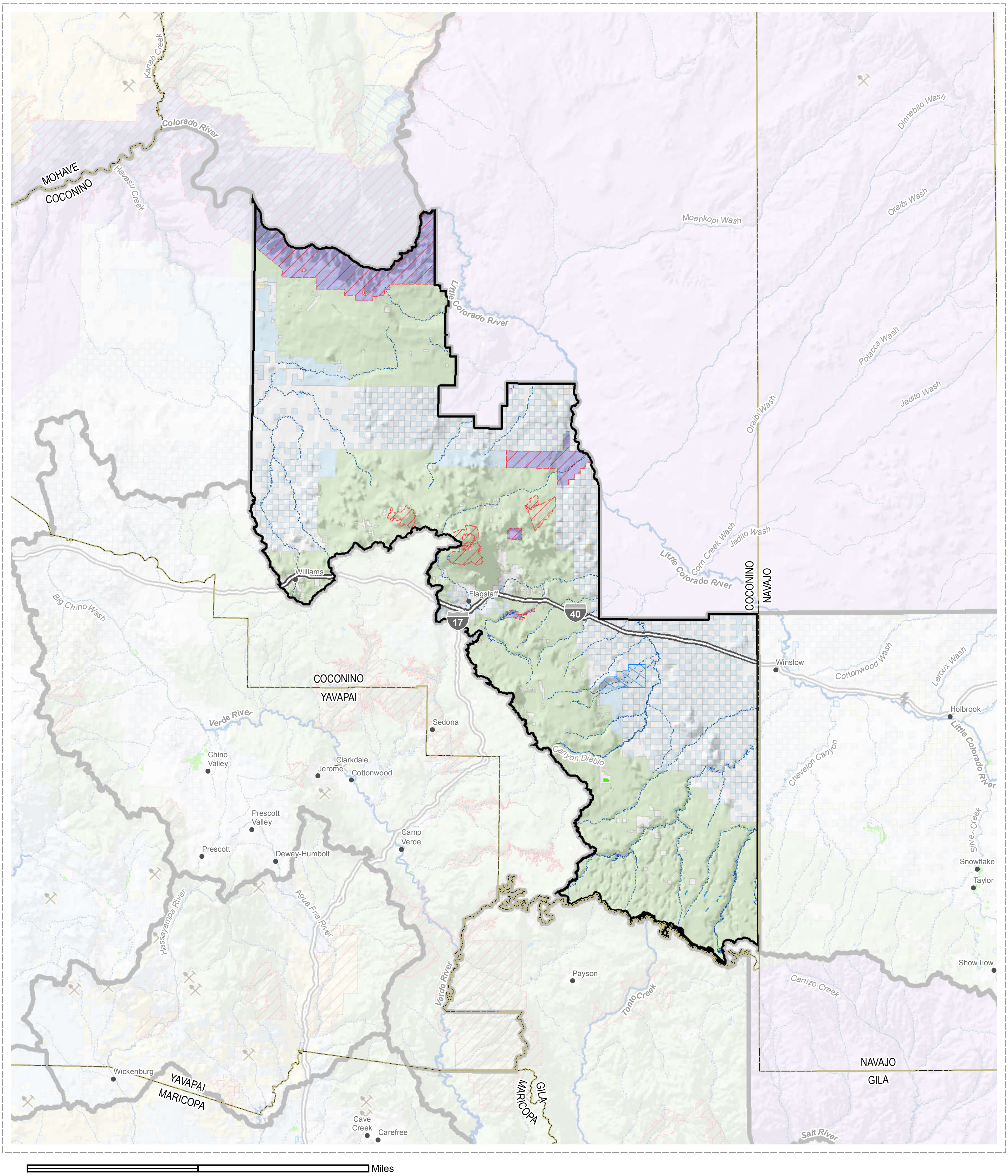
conditions for cloud seeding to increase precipitation and runoff and potentially mitigate impacts from use of supplies that are hydrologically connected to the Verde River.

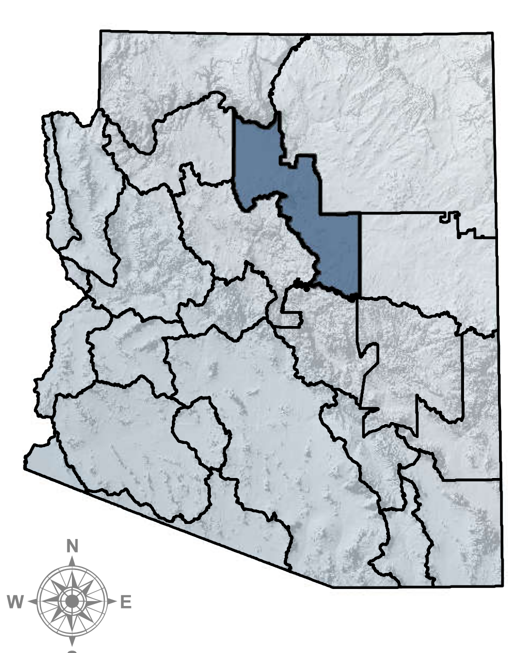
Watershed/Forest Management

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 Central Plateau Planning Area, continuation of this process and implementation of safe and effective strategies are important to water users within and outside of this Planning Area. Combining efforts with other management initiatives (such as the Four Forest Restoration Initiative) may be a cost-effective way to develop this option and provide multiple benefits to this Planning Area and those dependent on its resources. 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].

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

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.





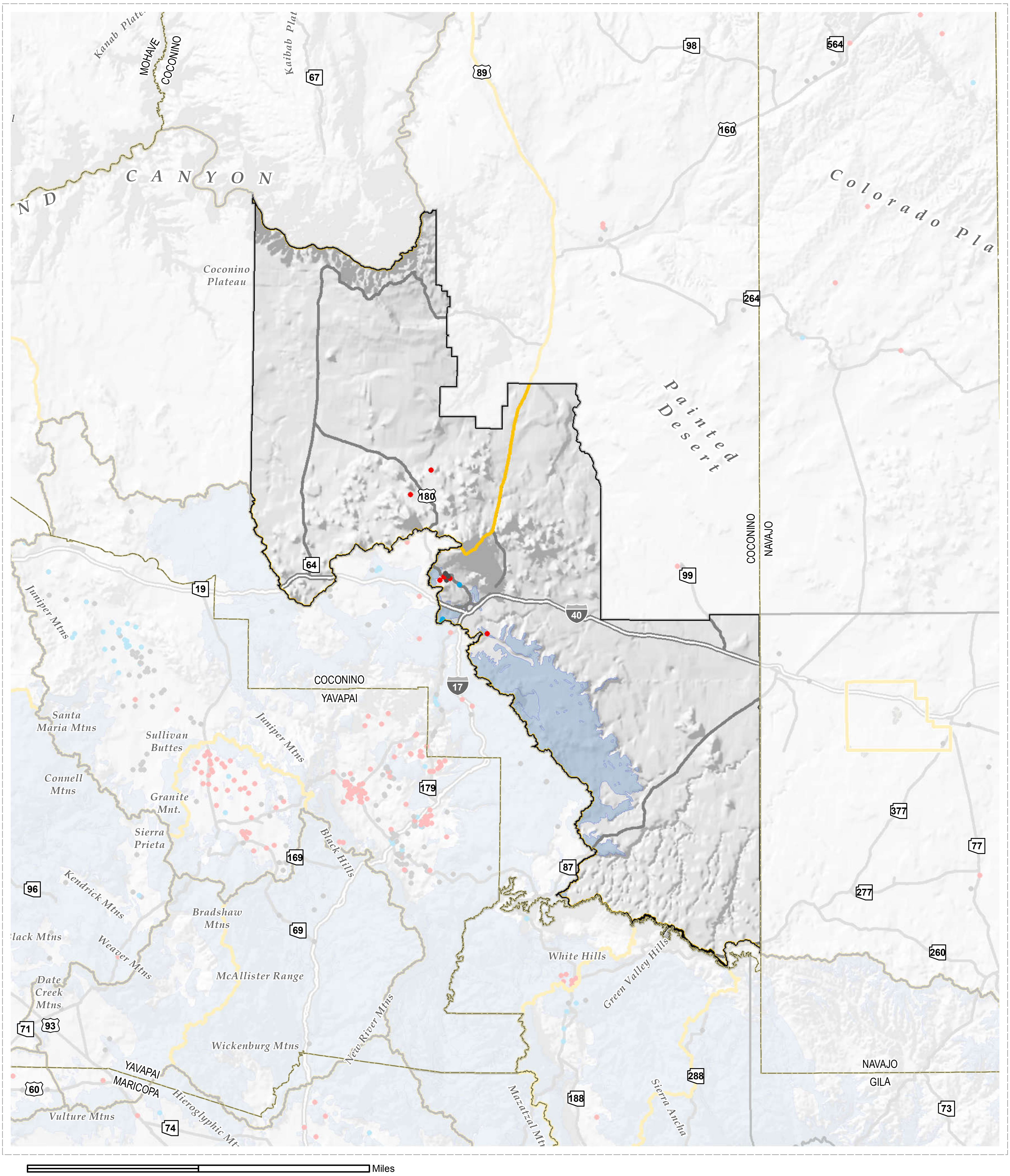
MAP LOCATION
(Planning Area Boundaries)

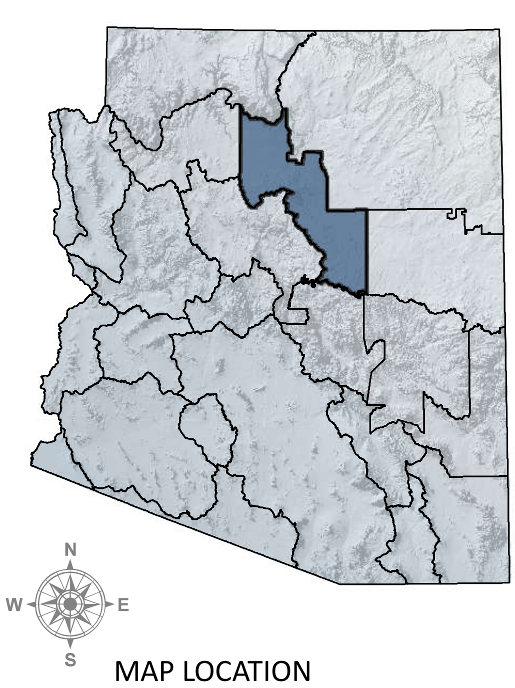
- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- River or Stream (ASLD)
- Interstate (ADOT)
- Population Center (GNIS)
- Mine (ADMMR, ADWR)
- Hydroelectric Power Plant (ADEQ, ADWR)
- Thermoelectric Power Plant (ADEQ, ADWR)
- Agriculture (SWReGAP, 2004)
- Federal Conservation Land (USFS, BLM, 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.5-1

Central Plateau
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)

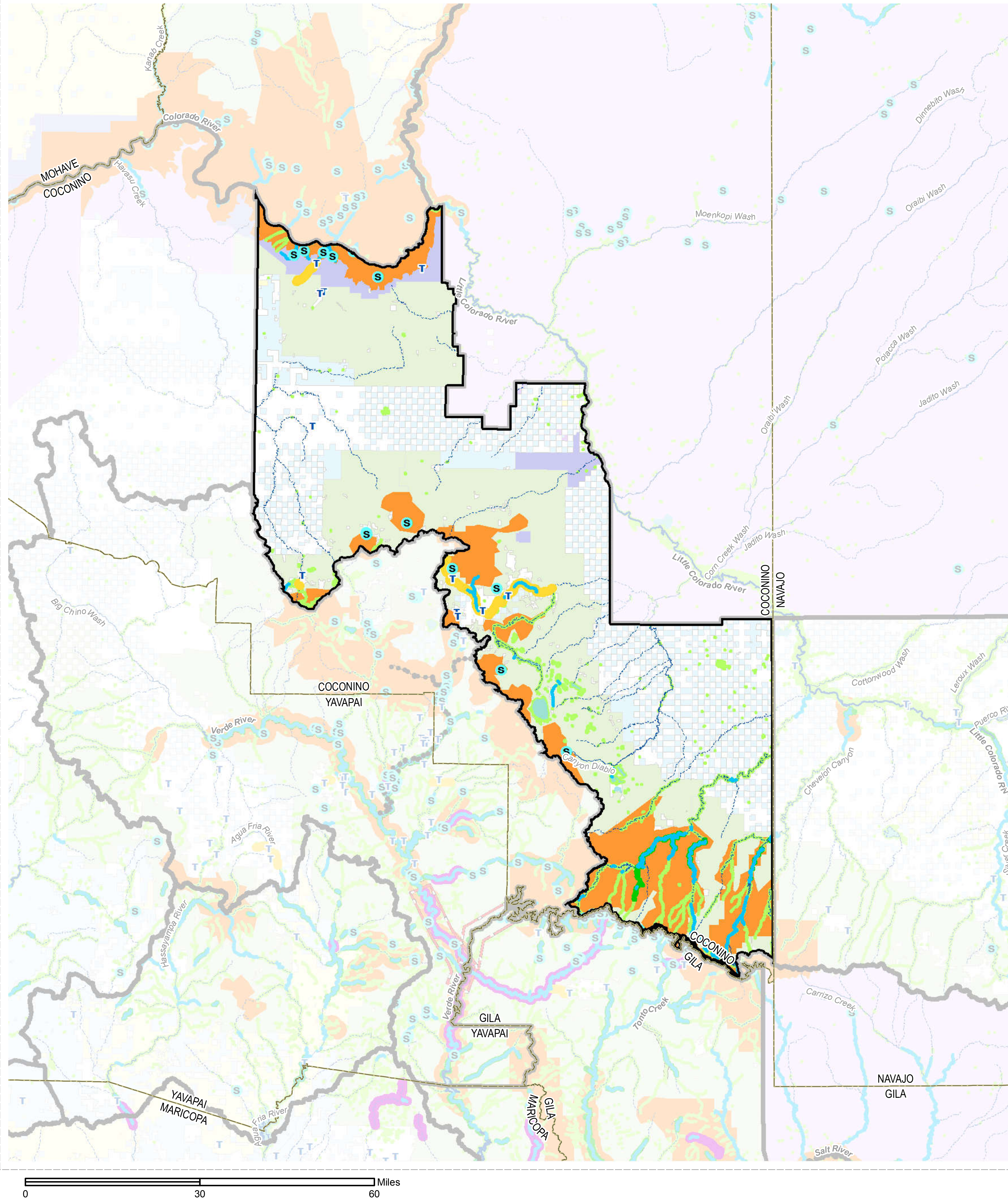
Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

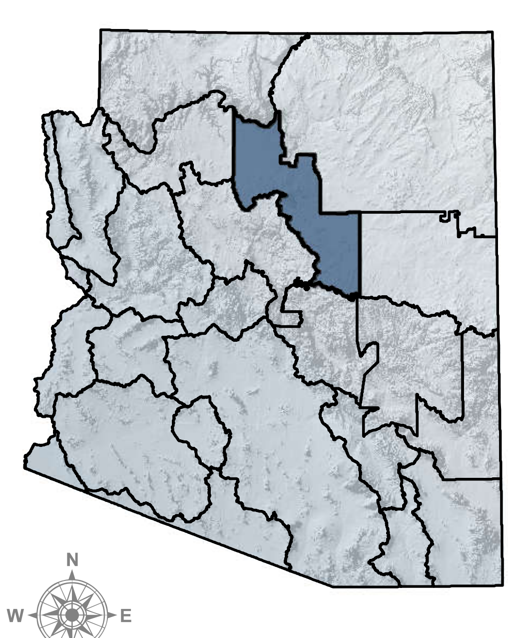
* Data provided by ADWR

Figure P.A.5-2

Central Plateau 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)

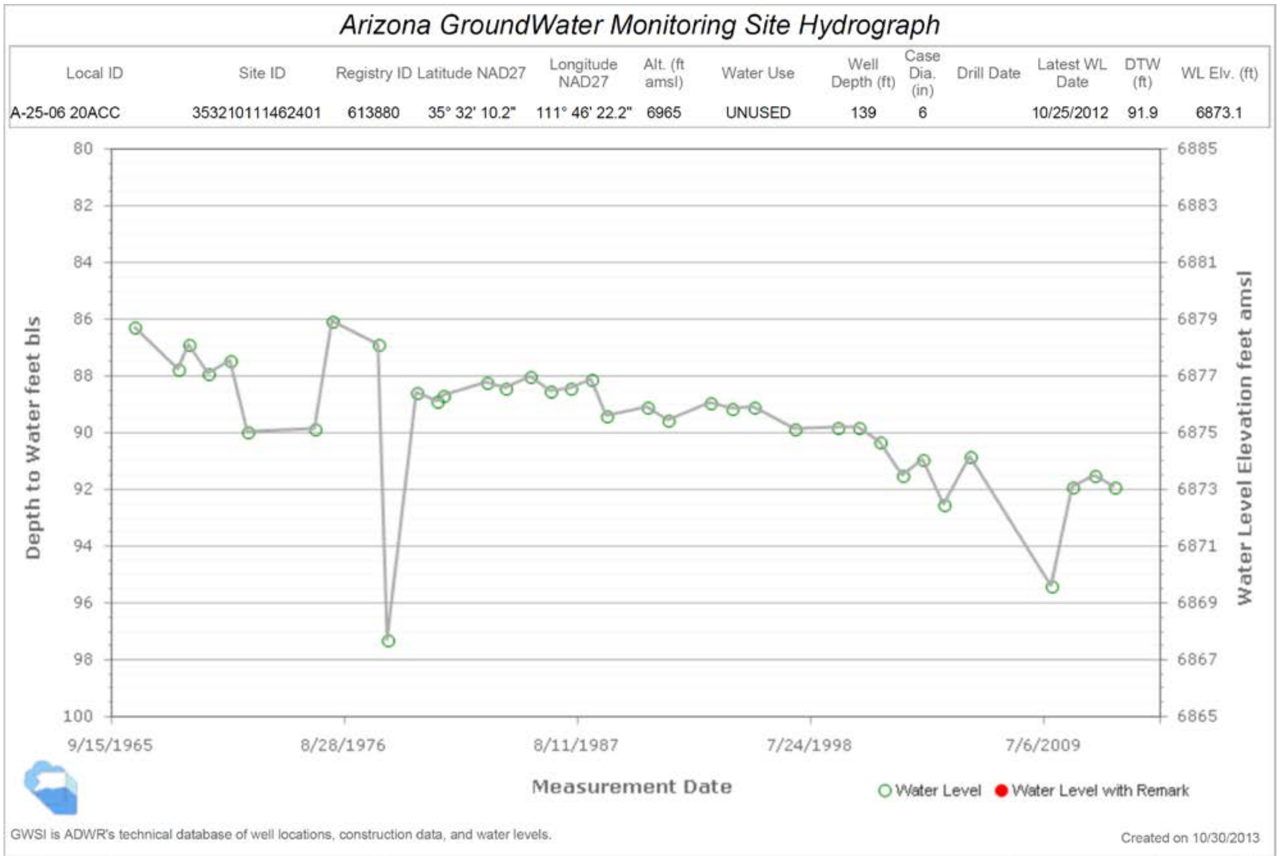
Planning Area (ADWR)
State (ALRIS)
County (ALRIS)
Reservoir or Lake (NHD)
Waste Water Treatment Plant (ADEQ)
Major Spring (ADWR, Pima County)
Perennial Flow (ADEQ, USGS)
River or Stream (ASLD)
Outstanding Arizona Water (ADEQ)
Effluent Dependent Stream (ADWR, NEMO)
Instream Flow Certificate (ADWR)
1993 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

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.5-3

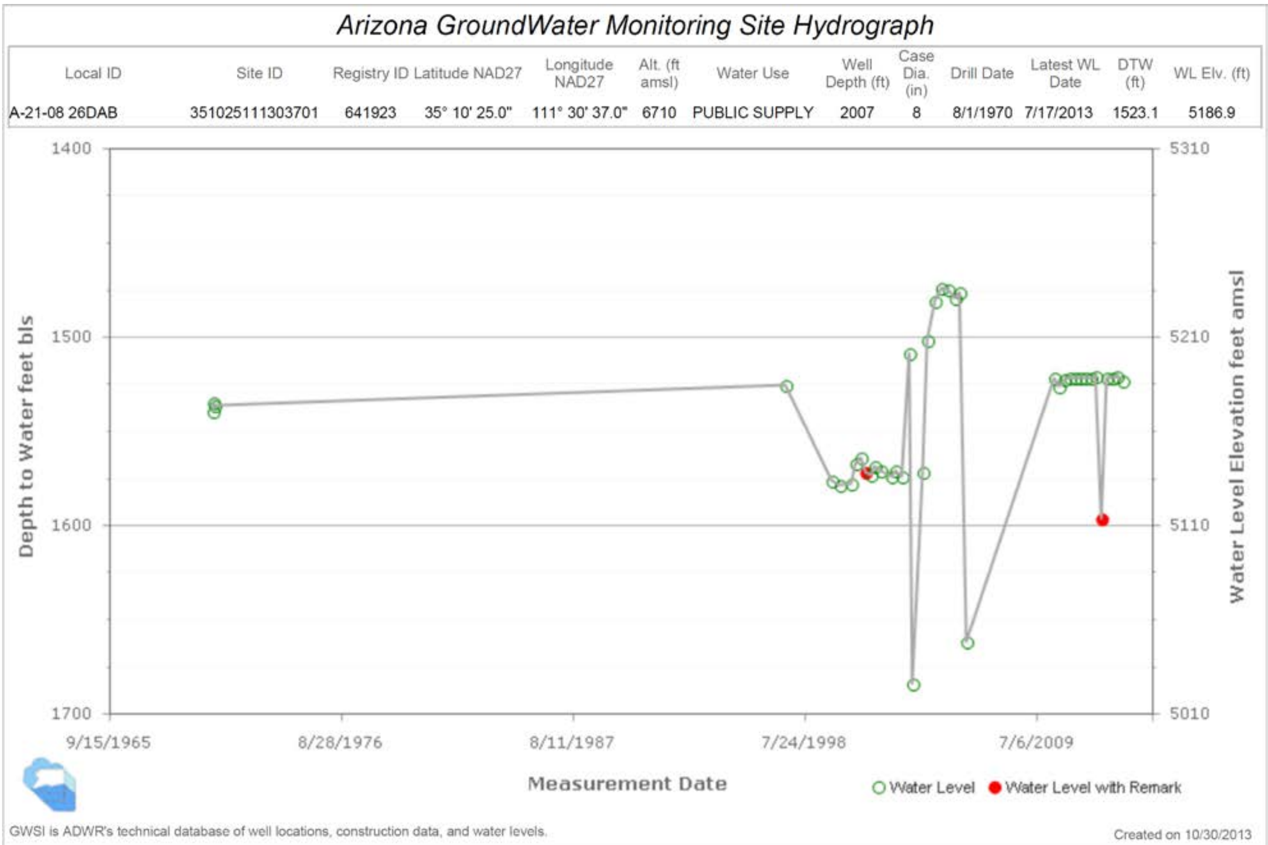
Central Plateau
Surface Water and Natural Features

Coconino Plateau Basin – Central Plateau Planning Area

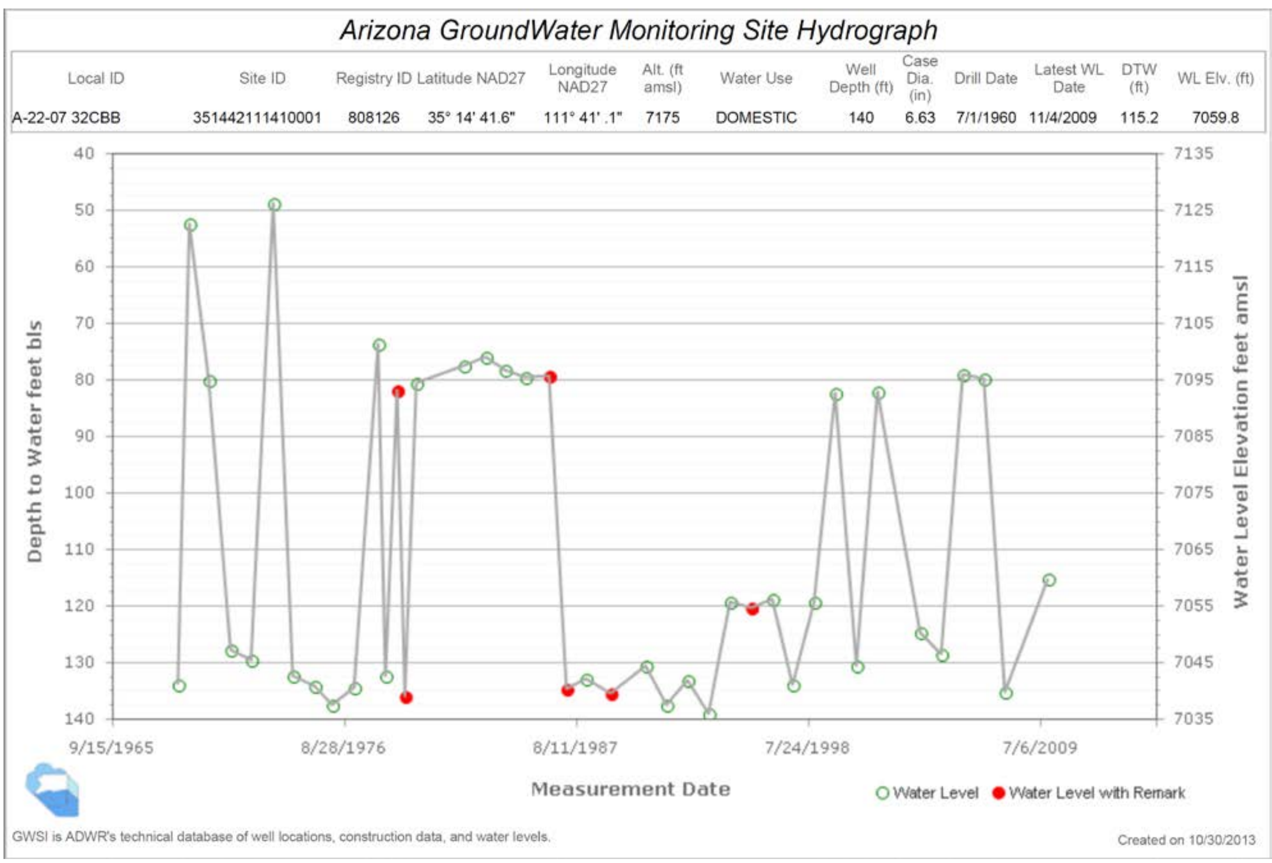


A-25-06 20ACC Coconino Plateau basin about 22 miles SE of Valle.

Little Colorado River Plateau Basin – Central Plateau Planning Area



A-21-08 26DAB Little Colorado River Plateau basin at Walnut Canyon National Monument.



A-22-07 32CBB Little Colorado River Plateau basin along Rio de Flag about 3.7 miles NW of Flagstaff.

[COCHISE PLANNING AREA]

Cochise Planning Area

Background

The Cochise Planning Area is located in the far southeast corner of the State and is comprised of the Sulphur Springs, San Simon, and San Bernardino valleys. The Planning Area is comprised of portions of Cochise and Graham counties. The Cochise Planning Area encompasses all of the Douglas, Douglas INA, San Bernardino Valley, San Simon Valley, and Willcox groundwater basins and shares portions of the Duncan Valley and Safford groundwater basins with the Upper Gila Planning Area. The Planning Area encompasses the entire Rio de Bavispe Watershed and a portion of the San Pedro-Willcox Watershed. Douglas, Willcox, San Simon, and Bowie are the most notable communities in the Planning Area.

The highest elevations in the Planning Area are part of the Coronado National Forest (*see Figure P.A. 6-1*). Primary land uses on forest lands are recreation, livestock grazing and timber production. The US Bureau of Land Management (BLM), State Trust Lands, and private land comprise the majority of the balance of land ownership in the Planning Area. Irrigated agriculture and livestock grazing are the principal land uses on private land. The principal land use on BLM and State Trust Lands is livestock grazing. The National Park Service owns and manages the Chiricahua National Monument. The Arizona Game and Fish Department manages the Willcox Playa Wildlife Area.

Water Supply Conditions

<u>Groundwater</u>

The Cochise Planning Area is within the Basin and Range Physiographic Province, characterized by broad alluvial valleys filled with sediments eroded from the surrounding mountains. The Chiricahua Mountains are a notable interior feature of the Planning Area.

The Douglas Irrigation Non-Expansion Area (INA) was established within the Douglas Groundwater Basin by the 1980 Groundwater Management Act. In general, no additional lands can be put into agricultural production using groundwater within the Douglas INA beyond those legally irrigated at any time between January 1, 1975 and January 1, 1980. All persons withdrawing groundwater from non-exempt wells[1] within an INA must use a measuring device and measuring method to record water use, except for: (1) persons who withdraw 10 acre-feet or less for non-irrigation purposes only, and (2) persons who withdraw groundwater for an irrigation use if the Notice of Irrigation Authority for the land on which the groundwater is used includes 10 or fewer contiguous acres and the land is not part of a farming operation that includes more than 10 acres. Annual water use reports are required to be filed with the Department by March 31st each year. Individual water users in the Planning Area outside of the boundaries of the Douglas INA are not required to meter or report water use.

[1] A non-exempt well has a pump capacity greater than or equal to 35 gallons per minute or used to irrigate more than two acres.

Water levels in the basin-fill aquifers of the groundwater basins within the Planning Area exhibit similar declining trends in recent years in response to agricultural, industrial and municipal demands and reductions in regional recharge as a result of below normal precipitation (*see Figure P.A. 6-2*).

Within the Willcox Basin, 560 of 587 wells measured by ADWR exhibited declining water levels between 1990 and 2004, with the average annual decline rate of 2.0 feet per year. Total declines in wells of up to 90 feet were observed over this period in wells in the south-central portion of the Basin. Wells in the northern reaches of the Basin exhibited declines of 20 to 30 feet over this period. More recent water levels collected in the Willcox Basin confirm that these water level trends continue.

Wells in the San Simon Basin also exhibited water level declines, with 201 of 286 wells measured by ADWR exhibiting water level declines over the period 1987 to 2007. Declines averaged 1.2 feet per year in these wells, concentrated around the communities of Bowie and San Simon. Again, recent water level measurements generally confirm continuance of these water level trends in the San Simon Basin.

Water level declines in the Douglas Basin were generally less severe in the southern portion of the Basin than wells to the north. Wells near the City of Douglas exhibited declines of less than 10 feet over the period from 1990 to 2004, while further north, where agricultural uses are more intense, declines approached 50 feet in some wells. Within the Douglas Basin, 240 of the 272 wells measured by ADWR exhibited declines, which averaged 1.2 feet per year.

More modest declines were experienced in the less developed San Bernardino Basin, with 17 of 24 measured wells experiencing declines averaging 0.4 feet per year.

<u>Surface Water</u>

Precipitation is greater in the higher elevations, supporting perennial mountain streams. These flows are not adequate to support perennial flows in the basin-fill portions of the Planning Area, which quickly transition to ephemeral drainages upon exiting the consolidated bedrock of the mountains. The Rio de Bavispe watershed flows south into Mexico in the San Bernardino and Whitewater Draw drainages (*see Figure P.A. 6-3*). The San Pedro-Willcox Watershed portion of the Planning Area drains to the Willcox Playa, a closed basin, the most notable surface water feature in the Planning Area. The northeast portions of the Planning Area are drained by San Simon Wash, an ephemeral tributary to the Gila River.

There are two active streamgage stations in the Rio de Bavispe Watershed. The streamgage at Whitewater Draw near Douglas recorded maximum annual of flow of approximately 22,300 acre-feet in 1995 with a median flow of 5,960 acre-feet. There are no active streamgage stations in the Cochise Planning Area portion of the San Pedro-Willcox Watershed.

<u>Reclaimed Water</u>

The lack of concentrated development limits the existence of centralized wastewater collection and treatment works and, likewise, limits the production of reclaimed water. Most users rely upon septic systems for wastewater treatment and disposal. The City of Willcox operates a lagoon wastewater treatment plant (WWTP) and reclaimed water from this facility is reused to irrigate the Twin Lakes Golf Course and provide water for recreational and wildlife uses. The City of Douglas WWTP has a reported disposal method of discharge to a watercourse from its mechanical plant. Fort Grant prison also has a lagoon WWTP.

Ecological Resources

The Willcox Playa is sparsely vegetated desert grassland that is best known to the public for its wintering population of Sandhill Cranes that migrate to the Willcox Playa in large numbers (*see Figure P.A. 6-3*). The Willcox Basin, especially the western slopes of the Chiricahuas, contains a broad diversity of wildlife. The Douglas Basin is also notable for the wildlife in the Whitewater Draw Wildlife Area and Leslie Canyon National Wildlife Refuge.

Water Demands

Table P.A. 6-1, below, presents the baseline and projected water demands for the Cochise Planning Area. Agricultural demands are over 250,000 acre-feet, accounting for over 90 percent of all water demands in the Planning Area through 2060. In addition, one of the largest commercial greenhouses in North America, EuroFresh Farms, is located north of Willcox. Agricultural demands are dispersed throughout the alluvial basins in the Planning Area and were projected by the WRDC to remain at current levels through 2060. This projected flat tread belies the recent increases in agricultural activity in the Planning Area, including permitting of wells with "irrigation" as a stated water use, and requires further examination.

Municipal uses comprise the second highest use sector in the Planning Area, projected to increase from just under 8,900 acre-feet per year to 13,900 in 2060. These uses are projected to remain reliant on groundwater supplies through the projection period.

The Arizona Electric Power Cooperative operates the Apache Generating Station, a coal-fired power plant, located immediately west of the Willcox Playa. Current water demand is 6,200 acre-feet per year and is projected to increase to between roughly 8,000 and 11,500 under the low and high projections from the WRDC, respectively. Groundwater is the primary source for cooling at the power plant.

Characteristics Affecting Future Demands and Water Supply Availability

Projected Demands

While providing evidence of a hydrologic system under stress (discussed below), the groundwater system within the Cochise Planning Area has, to date, supported these demands and allowed the growth in the agricultural sector to current levels.

Sustained groundwater declines in wells in each of the groundwater basins located in the Cochise Planning Area provides evidence that the rate of withdrawal to meet the demands of current uses is in excess of natural replenishment of these aquifers. Reversing these declining water tables would require either (1) reductions in the rate of groundwater extraction or (2) increasing the rate of replenishment of the groundwater system by either natural or artificial means.

The groundwater mining occurring in the Cochise Planning Area, largely attributable to a growing agricultural economy and, to a lesser degree, municipal and industrial uses, is consistent with State law. Dropping water tables result in reduced well yields and increased pumping costs, and can have other physical consequences, including, but not limited to: degradation of water quality, disruption of historic groundwater flow paths, land subsidence, and earth fissuring.

TABLE P.A. 6-1. Projected Water Demands (in acre feet) - Cochise Planning Area

Sector	2010	2035	2060
Agriculture	256,400	256,400	256,400
Dairy	584	584	584
Feedlot	130	130	130
Municipal	8,889	11,851	13,862
Other Industrial	0	0	0
Mining	0		
High		300	300
Low		300	300
Power Plant	6,200		
High		9,154	11,479
Low		6,657	7,969
Rock Production	0		
High		699	820
Low		291	343
Turf	21		
High		231	231
Low		20	20
Total (High)	**272,224**	**279,349**	**283,806**
Total (Low)	**272,224**	**276,233**	**279,608**

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 hold 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. Subsidence and fissures can damage infrastructure, including structures, roadways, railroads, and pipelines. Subsidence has altered the function of both natural and constructed drainage systems in portions of the state, redirecting floodwaters and causing property damage.

ADWR conducts a statewide land subsidence monitoring program. Active subsidence features have been observed and are being monitored in areas of concentrated pumping and associated water level decline in the Cochise Planning Area (*see Figure P.A. 6-2*). These include areas both north and south of the Town of Willcox in the Willcox Basin. Additional subsidence features are mapped in the northern reaches of the Douglas INA and a contiguous feature that has developed at and between the pumping centers of San Simon and Bowie. Active earth fissures have also been noted associated with these subsidence features. Continued groundwater mining may accelerate and exacerbate subsidence and fissuring in the Cochise Planning Area.

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 this Planning Area may increase the difficulty in identifying strategies for meeting the projected water demands. Given that the Willcox Basin is a closed drainage and the Douglas Basin drains to Mexico, this uncertainty is largely a factor only in that portion of the Planning Area that drain to the Gila River, the San Simon Basin.

Land Ownership

This Planning Area has significant land holdings under federal ownership, including BLM, Forest Service, and National Park Service, who administers the Chiricahua National Monument. Arizona Game and Fish manages the Willcox Playa Wildlife Area. These designations have the potential to significantly impact water supply development and growth in this Planning Area.

Water Management

The Douglas INA encompasses a portion of the Cochise Planning Area in the northern reaches of the Douglas Basin. Within the INA, administered by ADWR, no new agricultural lands are permitted using groundwater supplies. Additionally, all owners of non-exempt wells (pumping capacity equal to or greater than 35 gallons per minute) must meter and report their groundwater production to the ADWR annually. Other lands within the Planning Area outside of the Douglas INA are not located within in State administered water management region. As such, individual water users are not required to meter or report water use to ADWR. Well impact analyses are not required for issuance of new well permits, the use of which is only governed by legal doctrine of reasonable and beneficial use[2].

Strategies for Meeting Future Water Demands

Modification to the water management program in the Cochise Planning Area may be warranted to: (1) protect existing water users from increasing harm from new pumping; (2) reduce or reverse the declining water levels experienced throughout the Planning Area's groundwater basins at current demand rates; (3) limit damage to structure and infrastructure from land subsidence and earth fissures; and (4) enhance the durability of the regions locally available water resources and the long-term economic viability of local land uses.

Specific actions offered for consideration of adoption to address water management challenges in the Cochise Planning Area include the following:

Expanded Monitoring of Water Use & Data Collection

With the exception of non-exempt water users in the Douglas INA, very few water users are required to meter water use and report that use to a central repository, such as ADWR or the Arizona Corporation Commission (ACC). Public water utilities regulated by the ACC are required to report gross water production and the number of service connections to the ACC each year. Community Water Systems

[2] *A.R.S. §45-453(1)*.

are also required to file annual reports with ADWR and prepare and submit a System Water Plan, which are then updated every five years.

Metering and reporting across the Planning Area would serve to support and enhance analysis of current hydrologic conditions. Data collection is a crucial element of the development of groundwater models that have proven to be invaluable tools throughout the State in developing more thorough understandings of hydrologic systems and evaluating future conditions and potential impacts of new uses and/or alternative water management strategies.

<u>Local Aquifer Management</u>
At the present time, while agricultural irrigation uses in the Cochise Planning Area are served by individual wells, the largest water users are concentrated in a few areas, notably: north and south of the Willcox Playa, the northern portions of the Douglas INA, San Simon, and Bowie. There may be opportunities to lessen local impacts from concentrated pumping, such as continued water level declines and subsidence, by distributing pumping across the groundwater basins in the Planning Area. Doing so would likely require exploration and well drilling in previously undeveloped portions of these basins, securing rights of way, extension of power resources to these well sites, and construction of water conveyance (pipelines or canals) from the new viable well sites to existing irrigated acreage.

The exploration drilling and testing will increase knowledge of the local groundwater system will increase understanding of the local groundwater systems, in addition to mitigating local pumping impacts.

<u>Enhanced Conservation Programs - Agricultural</u>
Given the lack of reporting water monitoring and reporting in the Cochise Planning Area at the present time, it is difficult to assess the potential effectiveness of enhanced water conservation in managing and improving the stability of groundwater supplies. If consistent with other portions of the State, adoption of a comprehensive and effective water conservation program would have the potential to result in significant reductions in on-farm water use and relieve some of the pressure on the local groundwater system.

There are no state-coordinated or local water conservation requirements in the Cochise Planning Area. More detailed evaluation of current agricultural water conservation programs supported by state, county or local organizations (e.g., Natural Resource Conservation Districts) may provide additional insight into conservation potential in the region.

<u>Enhanced Conservation Programs - Municipal</u>
Municipal water use currently accounts for just over 3 percent of the total water use in the Cochise Planning Area. Examination of recent satellite images of the urbanized areas in the Planning Area provides limited evidence of significant exterior landscaping. While conservation can reduce municipal water demand and increase the viability of local water supplies, municipal conservation potential in the Planning Area appears to be limited and unlikely to materially impact water supply conditions across the Planning Area.

Reclaimed Water Reuse

The production of reclaimed water is generally limited to the larger urban centers in the Planning Area. Willcox and Douglas own and operate wastewater collection and treatment works. Willcox' reclaimed water is reused on a local golf course and provides wildlife habitat. Reclaimed water is a by-product of municipal water use, which is insufficient to materially impact the water supply conditions in the Cochise Planning Area.

Individual facilities operate on-site wastewater facilities, including, the Fort Grant Prison and the Apache Generating Station. These facilities may have potential to augment locally available water supplies with reclaimed water reuse or recharge. There may be challenges with finding suitable users for the quality of wastewater from the power plant. It is unlikely that enhanced water reclamation at these facilities would result in consequences of regional significance.

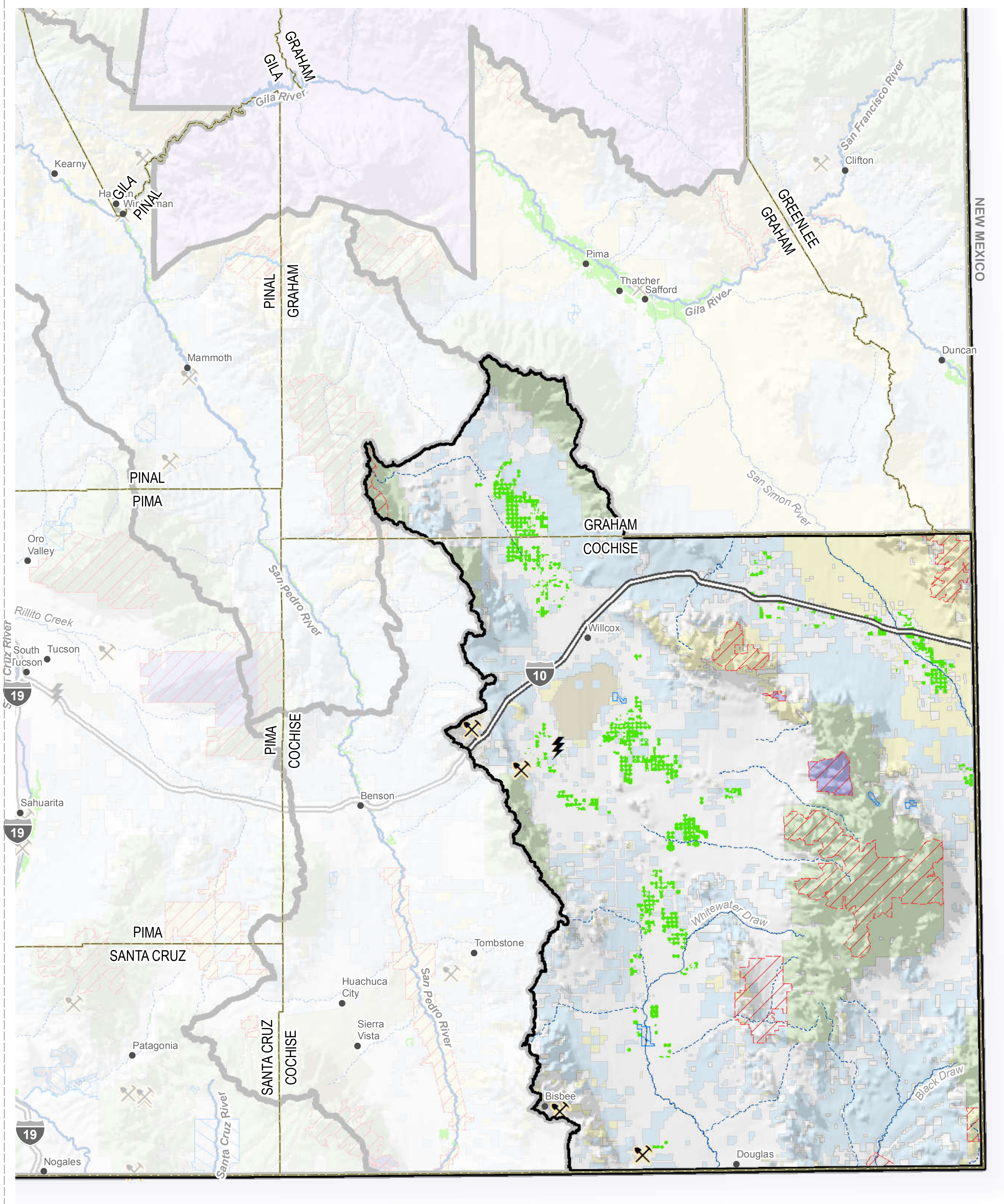
In general, reclaimed water reuse results in water management improvements throughout Arizona. However, the dominance of agricultural water use in the Cochise Planning Area limits its potential effectiveness in materially improving the supply and demand imbalance.

Enhanced Protection of Municipal Supplies

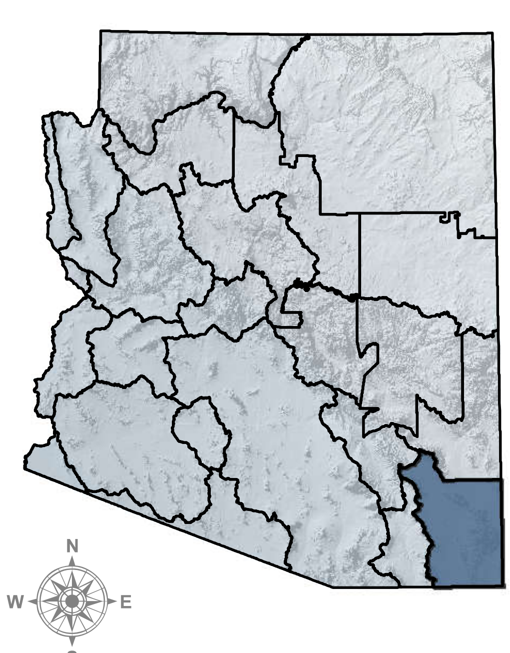
Irrigated agriculture accounts for over 90 percent of the water use in the Cochise Planning Area. Continued groundwater mining has the potential to reduce the viability of supplies for all use sectors. It may be prudent to explore limitations on pumping in close proximity to the production wells for the urbanized centers in the Planning Area in order to reduce the vulnerability of these water supplies. Evaluation of appropriate administrative vehicles to accomplish this protection is required and may include adoption of well spacing rules or groundwater protection zones, similar to those adopted in Indian water right settlements. ADWR believes that, in order to prevent economic disruption in both the agricultural and municipal sector in the Cochise Planning Area, a water management strategy that allows continued groundwater mining for agricultural activities, while protecting municipal water supplies for current uses and limited growth should be adopted.

Importation of supplies from outside the Cochise Planning Area to augment locally available supplies is not envisioned at this time.

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.



0 25 50 Miles



MAP LOCATION
(Planning Area Boundaries)

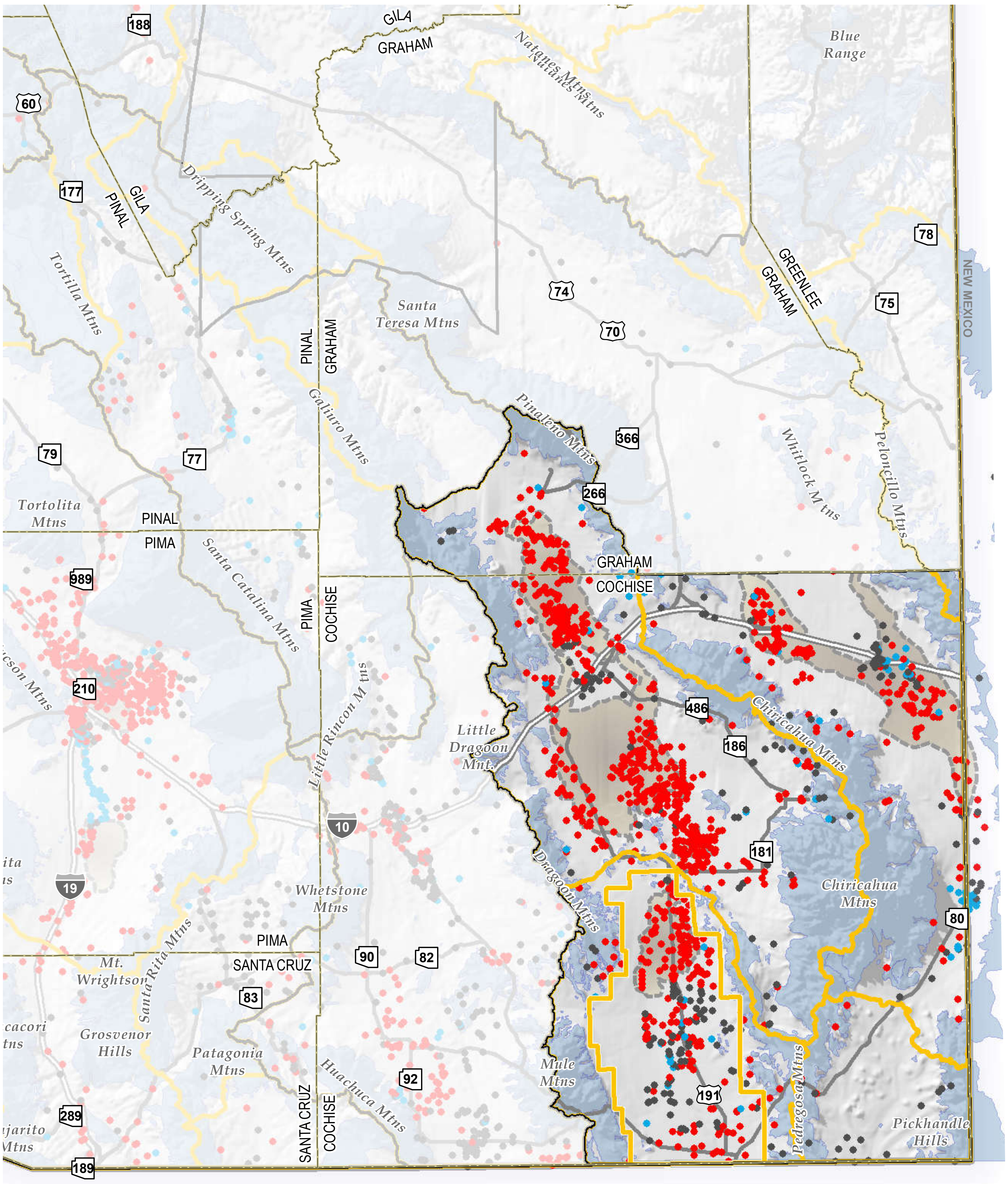
- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- River or Stream (ASLD)
- Interstate (ADOT)
- Population Center (GNIS)
- Mine (ADMMR, ADWR)
- Hydroelectric Power Plant (ADEQ, ADWR)
- Thermoelectric Power Plant (ADEQ, ADWR)
- Agriculture (SWReGAP, 2004)
- Federal Conservation Land (USFS, BLM,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

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

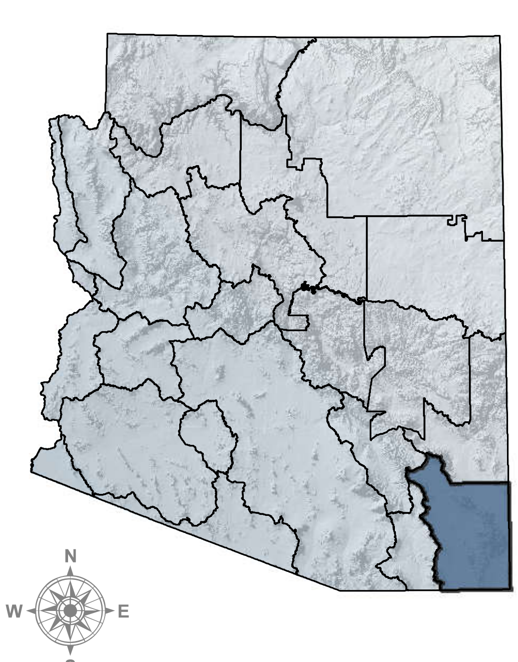
Figure P.A.6-1

Cochise 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.



Miles
0 30 60



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)

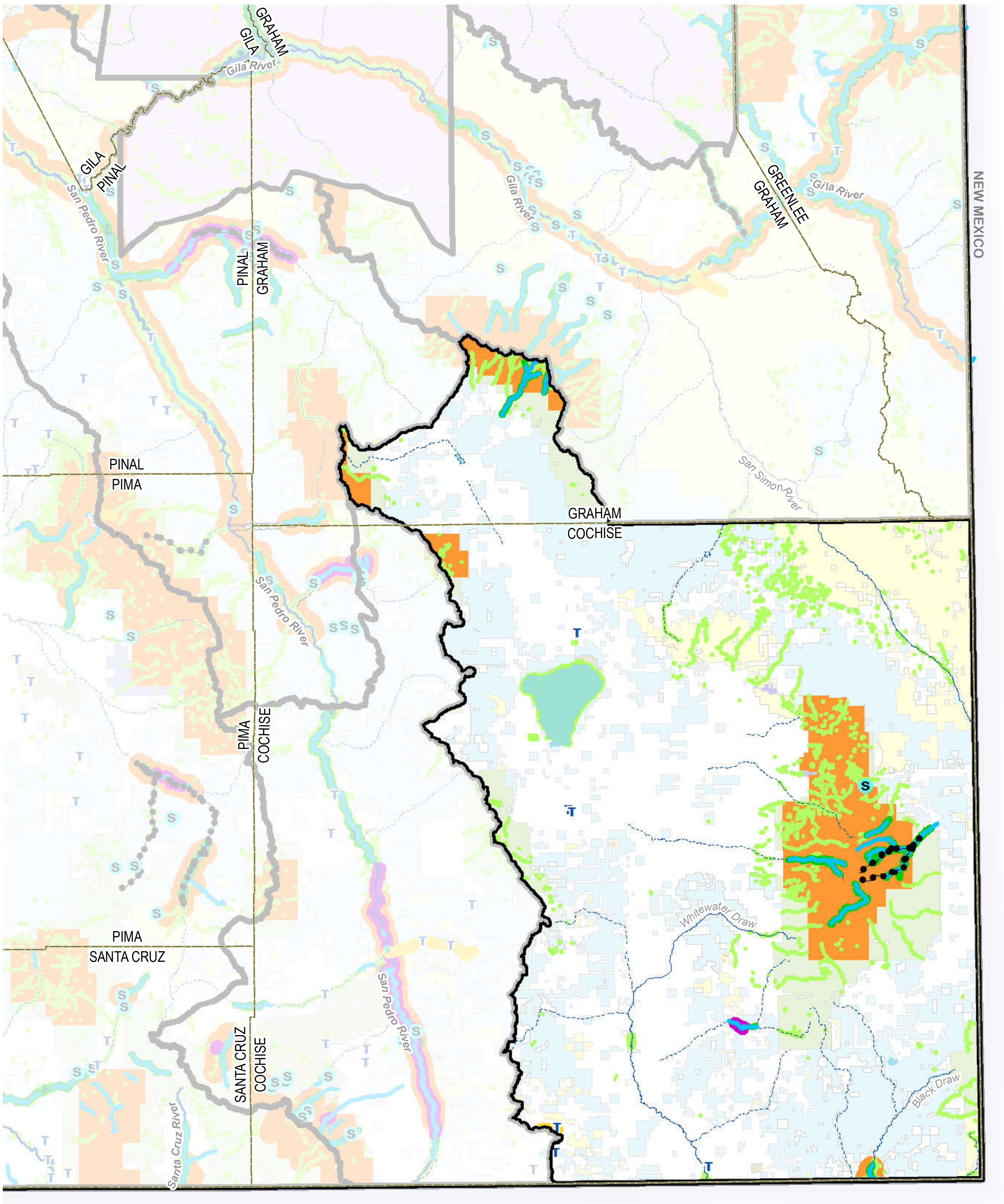
Recent Water Level Change * (1990's through 2000's)
Minor WL Change +5' to -5'
Negative
Positive

* Data provided by ADWR

Figure P.A.6-2

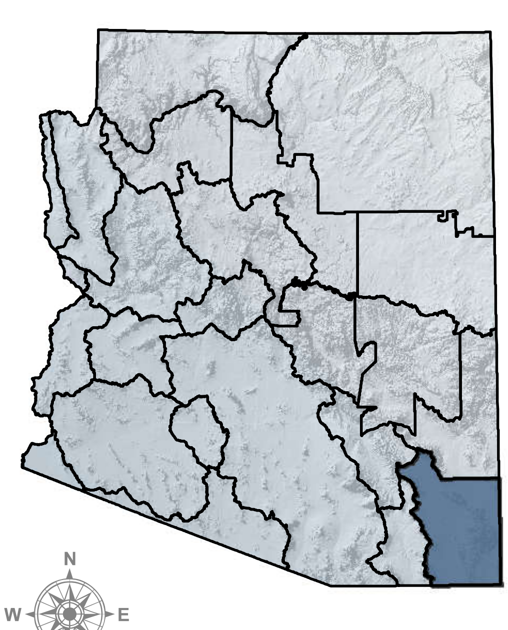
Cochise
Groundwater Hydrology

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.



Miles
0 25 50

- 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



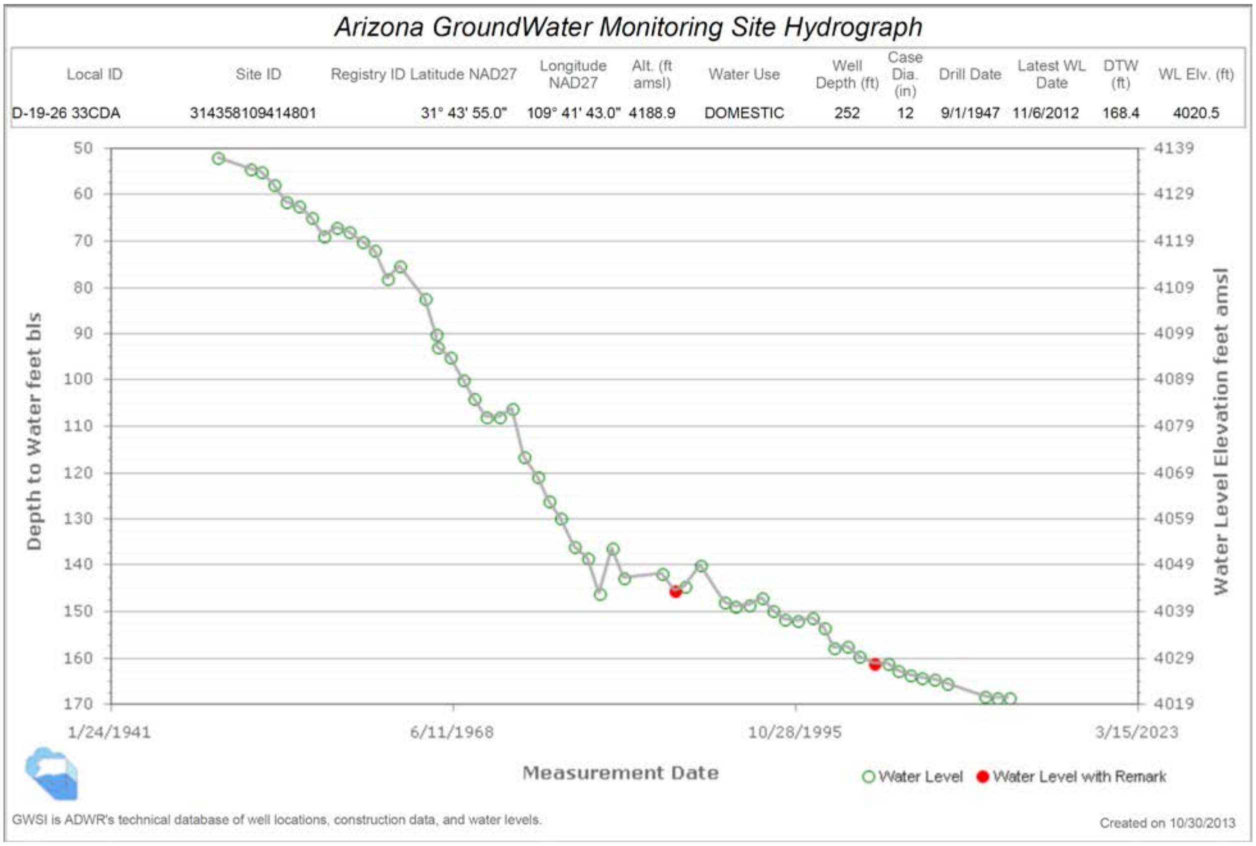
MAP LOCATION
(Planning Area Boundaries)

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

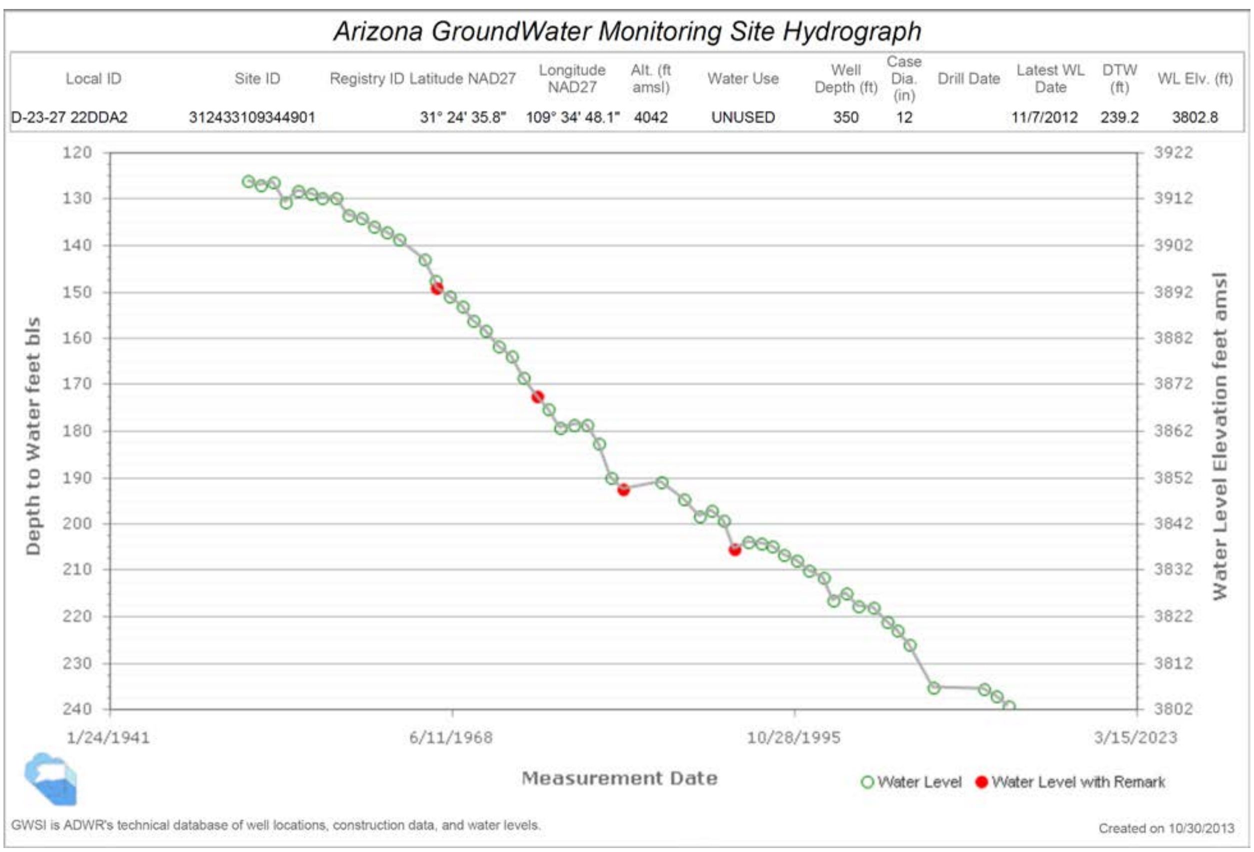
Figure P.A.6-3

Cochise
Surface Water and Natural Features

Douglas Basin – Cochise Planning Area

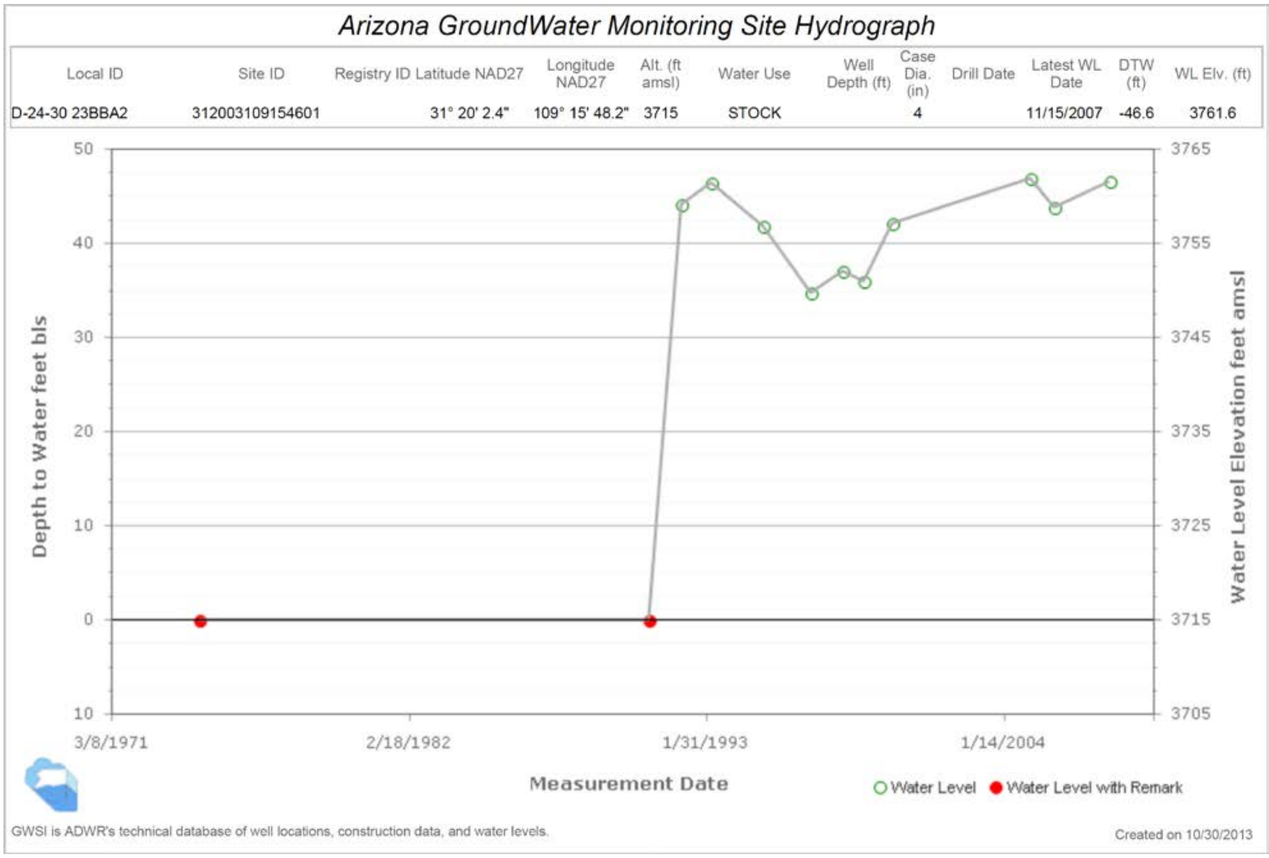


D-19-26 33CDA – Douglas basin - Douglas INA about 3 miles north of Elfrida.



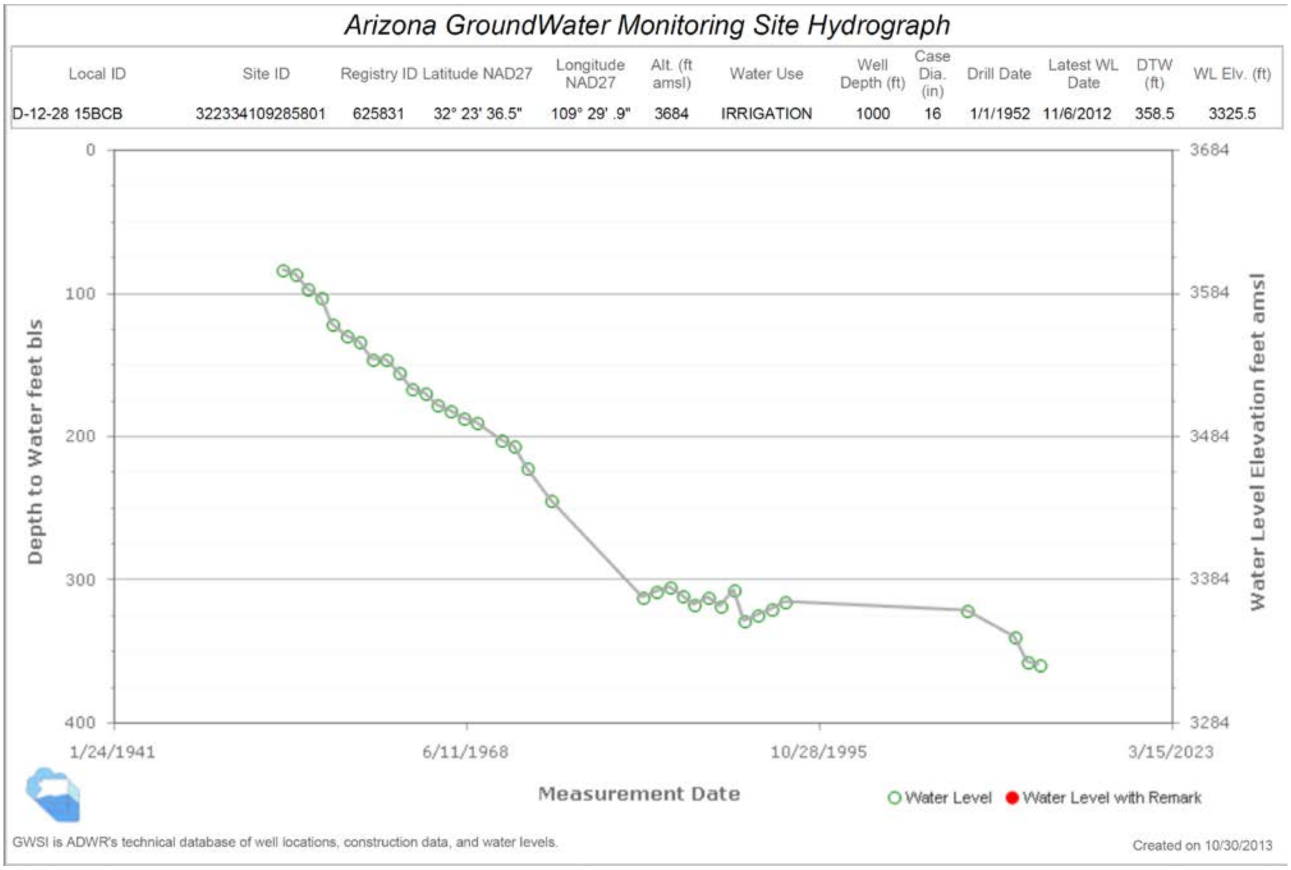
D-23-27 22DDA2 Douglas basin – Douglas INA about 5 miles NW of Douglas.

San Bernardino Valley Basin – Cochise Planning Area



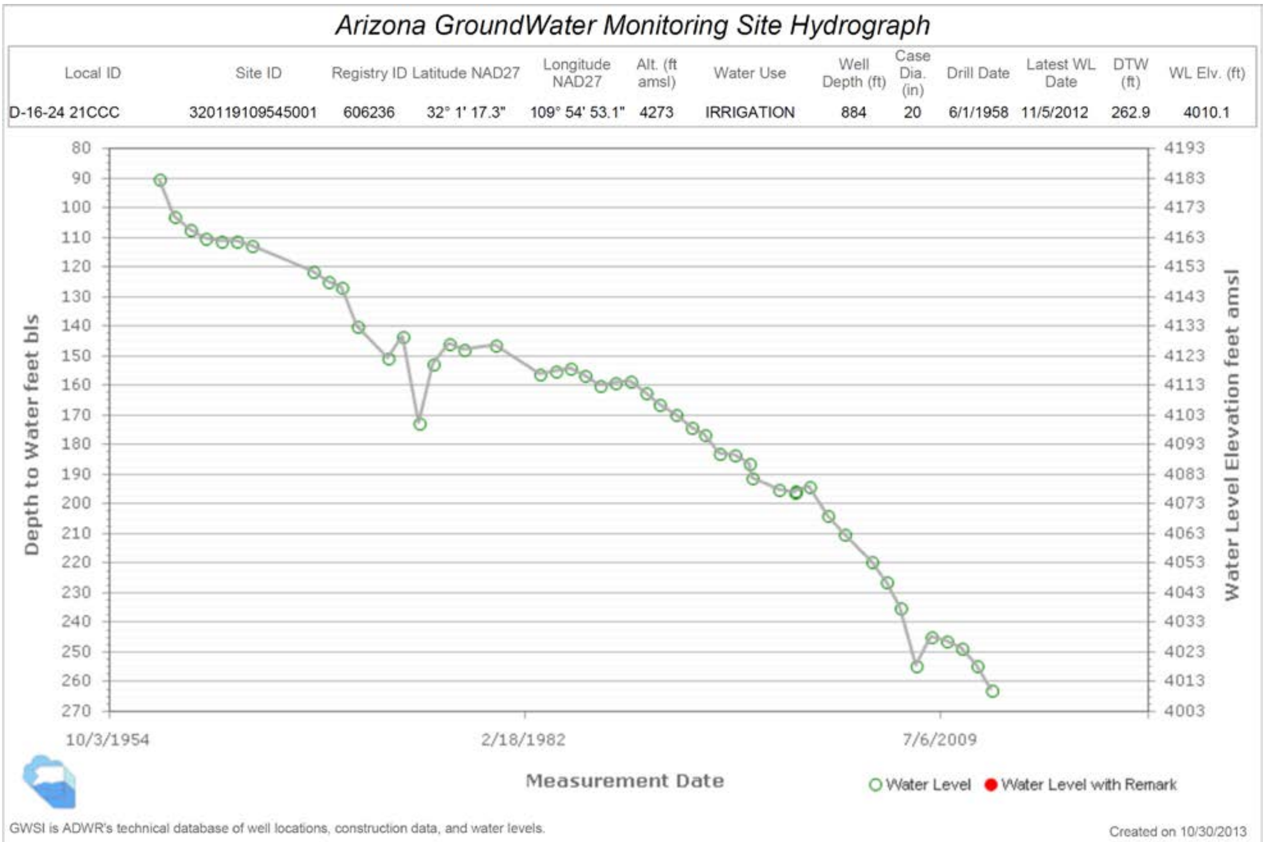
D-24-30 23BBA2 – San Bernardino Valley basin near San Bernardino National Wildlife Refuge. An artesian well that is measured using a pressure gage.

Safford Basin – Cochise Planning Area

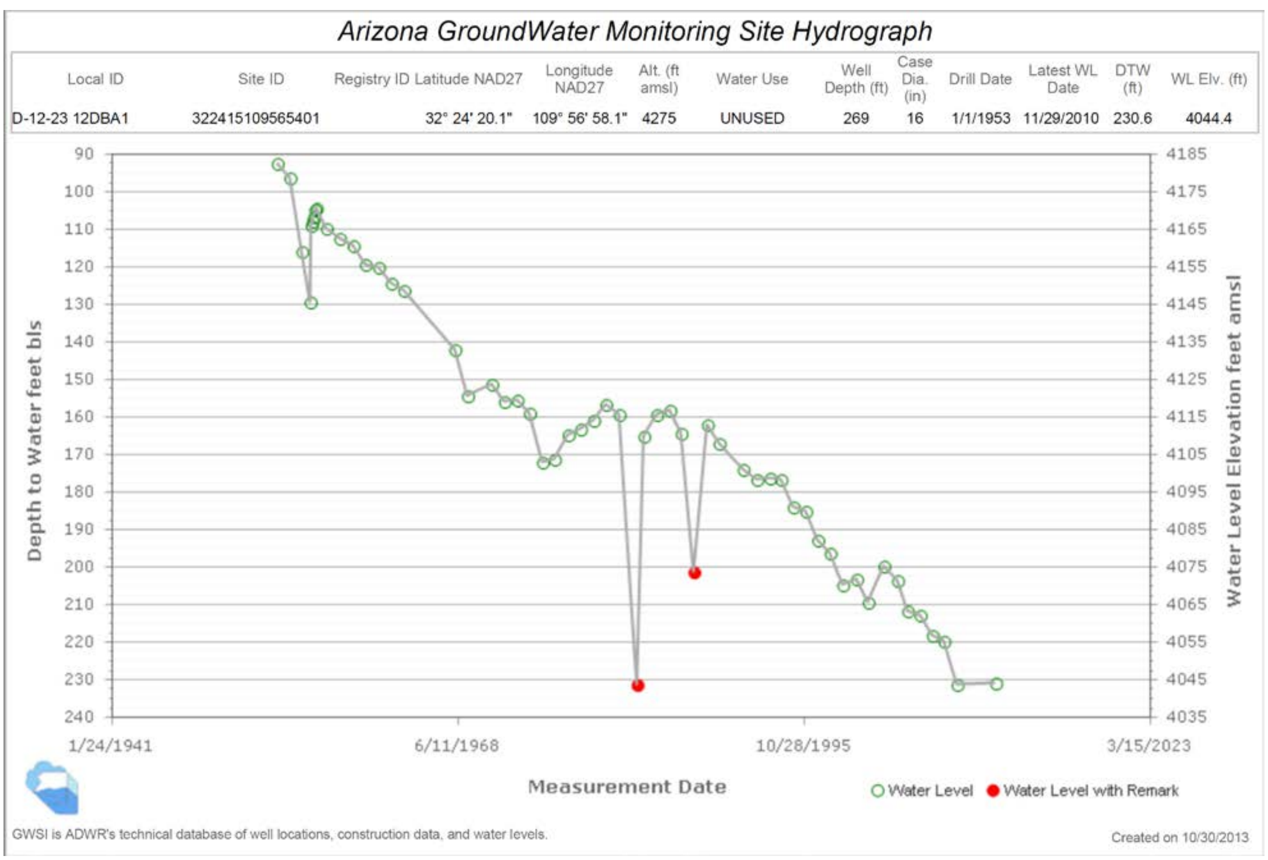


D-12-28 15BCB -- Safford basin – San Simon Valley sub-basin about 4 miles north of Bowie.

Willcox Basin – Cochise Planning Area



D-16-24 21CCC Willcox basin about 6 miles NW of Sunsites.



D-12-23 12 DBA1 – Willcox basin about 12 miles NW of Willcox.

[COLORADO RIVER MAIN STEM NORTH PLANNING AREA]

Colorado Main Stem North Planning Area

Background

The Colorado Main Stem North Planning Area consists of two basins adjacent to the Colorado River along the western border of the state. The Planning Area contains the Lake Mohave Groundwater Basin in the North and the Lake Havasu Groundwater Basin in the South. The Planning Area is entirely within Mohave County. The principal municipal demand centers in the Colorado Main Stem North Planning Area are Lake Havasu City and Bullhead City. The Fort Mojave Indian Reservation also lies within the Planning Area south of Bullhead City.

The largest land owner within the Planning Area is the federal government (*see Figure P.A. 7-1*). The US Bureau of Land Management (BLM) manages approximately 49 percent of the lands in the Lake Mohave Basin and 57 percent of the lands in the Lake Havasu Basin, primarily for recreation and grazing purposes. The National Park Service (NPS) manages approximately 35 percent of the land in the Lake Mohave Basin including portions of the Lake Mead National Recreation Area. The remaining federally-owned lands are held by the U.S. Fish and Wildlife Service (FWS) at the Havasu National Wildlife Refuge and by the Fort Mojave Indian Tribe. Private lands primarily include lands in the vicinity of Bullhead City, the Mohave Valley and Lake Havasu City. Nearly 14 percent of the land in the Lake Havasu Basin and three percent of the land in the Lake Mohave Basin are State Trust Lands, used primarily for recreation and livestock grazing. The Arizona Game and Fish Department (Colorado River Nature Center) and Arizona State Parks also manage a small portion of the lands in the Planning Area.

Water Supply Conditions

<u>Groundwater</u>

The Colorado Main Stem North Planning Area is located in the Basin and Range Physiographic Province. This province is characterized by long broad alluvial valleys separated by mountain ranges, typically with thick productive regional alluvial aquifers. Within this Planning Area, there is some differentiation between the hydrologic definition of groundwater and the contractual definition of groundwater for entities that hold Section 5 contracts for Colorado River water. For the majority of water users in this Planning Area, water withdrawn by pumping within the area covered by their Section 5 contracts (see discussion regarding contracts in Colorado River section below) is contractually defined as Colorado River water and not groundwater.

Groundwater in storage within the Lake Mohave Basin is estimated to range from 1.2 to 8.0 MAF. Groundwater levels in the basin are generally rising at an average rate of 1.2 feet per year, although water level change data from the early 1990s to the mid-2000s show slight declines south of Bullhead City and an increase north of the city (*see Figure P.A. 7-2*). The water level in these wells ranged between 337 and 427 feet below land surface. Groundwater in storage within the Lake Havasu basin is estimated to be up to 2.0 MAF. Groundwater levels in the Basin are generally rising at an average rate of 1.3 feet per year. Lake Mead, created by Hoover Dam, has affected groundwater conditions in the adjacent basins in the watershed. There is outflow from the lake into the surrounding aquifers. There is also outflow from the Colorado River, Lake Mohave, and Lake Havasu into the surrounding aquifers.

Colorado River Water

Colorado River water is the primary water supply in the Planning Area (*see Figure P.A. 7-3*). There are three large dams located in this Planning Area: 1) Hoover Dam - located at the northern end of the Lake Mohave Basin, with a maximum storage capacity in Lake Mead of 29,755,000 acre-feet (most of Lake Mead is located in the northern extent of the Northeast Basin Planning Area and the State of Nevada); 2) Davis Dam – located just north of Bullhead City with a maximum storage capacity in Lake Mohave of 1,818,300 acre-feet; and 3) Parker Dam - located south of Lake Havasu City at the southern boundary of the Planning Area, with a maximum storage capacity in Lake Havasu of 651,000 acre-feet. The dams and the reservoirs also provide recreation, hydroelectric power, environmental habitat, and are the primary water operation features for the Lower Colorado River. The vast majority of Colorado River diversions in the Planning Area are associated with agricultural irrigation on the Fort Mojave Indian Reservation and within the Mohave Valley Irrigation and Drainage District (MVIDD). Other uses of Colorado River water include recreation, environmental, municipal and industrial demands (including electrical power generation).

The right or authorization to beneficially use Colorado River water is defined as an entitlement created by decree of the United States Supreme Court in Arizona v. California[1] (Decree), through a contract with the U.S. Secretary of the Interior under Section 5 of the Boulder Canyon Project Act (1928), or by Secretarial Reservation[2]. Because the direction and occurrence of groundwater is strongly influenced by the amount of streamflow in the Colorado River, the US Bureau of Reclamation (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* (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 entitlements. Reclamation's most current assessment indicates that most existing non-contract use results from water withdrawn from wells located in 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 is pumping Colorado River water and a process for a water user to appeal a subsequent finding. At present, Reclamation has not adopted the proposed rule.

Reclaimed Water

Population centers in the Planning Area, Bullhead City and Lake Havasu City, produced the majority of the reclaimed water in this Planning Area. Approximately 3,100 acre-feet per year of reclaimed water is produced in the Lake Mohave Basin, and 3,300 acre-feet per year is produced in the Lake Havasu Basin. In 2005, Lake Havasu City reused approximately 2,400 acre-feet of treated reclaimed water to irrigate two golf courses and landscaping and in 2006, reclaimed water deliveries began to the Refuge Golf Course. Additionally, Lake Havasu City is engaged in an aggressive wastewater system expansion program to convert the majority of residences within the city limits from septic systems to a conventional sewer system. Similar actions in Bullhead City are also being explored. It should be noted that some Section 5 contracts have limited the use of reclaimed water (defined as Effluent Water in the contracts) to use within the contract service area.

[1] 373 U.S. 546 (1963)

[2] Secretarial Reservation" means water rights created by the Interior Secretary for the use of federal establishments under federal law. Examples of Secretarial Reservations are mainstem water rights reserved for National Wildlife Refuges, Indian Tribes and certain public lands administered by the Bureau of Land Management.

Ecological Resources

Environmental and recreational resources are also important in this Planning Area (*see Figure P.A. 7-3*). The Havasu National Wildlife Refuge (NWR) is located in the Lake Havasu Basin. Managed by the FWS, the Havasu NWR was established in 1941 at the time of construction of Parker Dam as a refuge for migratory birds and other wildlife. The refuge protects 30 river miles of the Colorado River from Needles, CA to Lake Havasu City. Suitable habitat within Havasu NWR adjacent to Topock Marsh is maintained for southwestern willow flycatcher and Yuma clapper rail. In addition, Beal Lake, just west of Topock Marsh, is managed as a refuge for native razorback sucker and bonytail chub. There is experimental planting to create cottonwood-willow habitat suitable for southwest willow flycatcher and other riparian obligate species on lands adjacent to Beal Lake.

The Lake Mead National Recreation Area (LMNRA), created in 1964 and administered by the NPS, is located in the northwestern portion of the Planning Area. The LMNRA stretches from Davis Dam at Bullhead City in the Lake Mohave Basin to the western boundary of Grand Canyon National Park in Meadview Basin and includes Lake Mead, Lake Mohave, the Colorado River and adjacent areas.

Lake Mohave functions as a genetic refuge for razorback sucker. Under the Lower Colorado River Multi-Species Conservation Program (LCR MSCP), funded by a partnership of State, federal and other public and private stakeholders in Arizona, California and Nevada, for the Lake Mohave area, razorback sucker larvae are collected and reared prior to release back into the lake or elsewhere, including Lake Havasu.

Water Demands

Table P.A. 7-1 illustrates the baseline and projected water demands in the Colorado Main Stem North Planning Area. Based on water demand projections prepared during the WRDC process, it is estimated that the largest increases may occur in the municipal sector. Agricultural irrigation occurs in the Lake Mohave Basin in the Mohave Valley on the Fort Mojave Indian Reservation and on private lands located within the MVIDD. These uses are projected to continue through the planning period. In the southern end of the valley, tribal and district lands are interspersed in a checkerboard pattern. Additionally, because of the large tracts of federal lands, it was assumed that there was a high potential for future renewable energy development, although this would need to be balanced with the ecological priorities in the region.

Characteristics Affecting Projected Water Demands and Supply Availability

Land Ownership

Because of the large areas of land in federal ownership, it is not anticipated that significant development will occur outside of the current population centers. There is some potential for growth on the remaining undeveloped private lands and State Trust Lands. Additionally, many of the federally-owned lands provide habitat for both listed and non-listed species as well as recreational opportunities that are important to the economy of this region. As projected growth occurs, it will have to do so in a manner that is compatible with these uses.

Colorado River Entitlement Priority

Rights to Colorado River water in Arizona are based on the following priority levels:

a. 1st Priority: Satisfaction of Present Perfected Rights as defined in the Arizona v. California decree (pre-1928);
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 Arizona entitlement; and
f. 6th Priority: Surplus water

Table P.A. 7-1. Projected Water Demands (in acre feet) – Colorado Mainstem-North Planning Area

Sector	2010	2035	2060
Agriculture	81,500	81,500	81,500
Dairy	0	0	0
Feedlot	0	0	0
Municipal	37,990	67,420	84,140
Other Industrial	0	0	0
Mining	0		
High		0	0
Low		0	0
Power Plants	4,000		
High		19,383	24,307
Low		14,097	16,874
Rock Production	137		
High		2,459	3,076
Low		1,024	1,281
Turf	882		
High		1,261	1,337
Low		882	1,128
Total (High)	**124,509**	**172,023**	**194,360**
Total (Low)	**124,509**	**164,923**	**184,923**

Within the Planning Area, entitlement holders with a first priority or present perfected rights include the Fort Mojave Indian Reservation and several private entities within the MVIDD. Second and third priority

entitlement holders (which are coequal during a shortage), include Havasu National Wildlife Refuge, Bureau of Reclamation (Davis Dam), and the NPS. Fourth priority entitlement holders include Arizona-American Water Company (Lake Havasu), Bullhead City, Golden Shores Water Conservation District, Lake Havasu City, Mohave Water Conservation District, MVIDD, and the Mohave County Water Authority and are, like the CAP, junior in priority to California and subject to possible reductions in the event of a shortage on the River. Lake Havasu City and the Mohave County Water Authority also have fifth and sixth priority entitlements –which are only available when excess water is available.

Lower priority holders (4^{th}, 5^{th} and 6^{th} Priority) in the Colorado River Mainstem North Planning Area primarily serve municipal purposes making those uses more vulnerable to supply shortage than any other users in the Planning Area and highlighting the need for reserves. In general, the lower priority entitlements will be the first to be impacted when the US Secretary of the Interior declares a shortage on the Colorado River system.

<u>Proactive Environmental Compliance</u>

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 Endangered Species Act (ESA) directs federal agencies to support the conservation of listed threatened and endangered species and to make sure that their actions do not jeopardize the continued existence of listed species or result in adverse modification of critical habitat. To comply with the requirements of the ESA, state and federal water, power and wildlife interests voluntarily created the LCR MSCP. The LCR MSCP is a cooperative, habitat conservation program (HCP) 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. 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.

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. 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.

Strategies for Meeting Future Water Demands

<u>Development of Water Supplies to Meet Projected Municipal Growth</u>

The municipalities are seeking additional sources of water since their Colorado River entitlements may be insufficient to meet future increases in demands. Because of the Section 5 contract provisions and the hydrologic connection between the Colorado River and the groundwater supplies along the river, water withdrawn from wells in this area may not be considered groundwater, but rather Colorado River water for which an entitlement is required. Therefore, expansion of groundwater development may be

limited and because the Colorado River entitlement in Arizona is largely fully allocated, other sources may need to be acquired to meet these projected increases.

The Mohave County Water Authority (MCWA) was organized in 1995 pursuant to A.R.S.§ 45-2201 primarily for the purpose of acquiring the city of Kingman's unused 18,500 acre-feet Colorado River entitlement and making it available to other authority members for municipal and industrial water uses. MCWA members include Bullhead City, Golden Shores Water Conservation District, Kingman, Lake Havasu City, Mohave County, MVIDD and Mohave Water Conservation District. As well as providing other services and functions, MCWA can acquire additional water supplies, including reclaimed water, and it may store, recharge and recover these supplies for the benefit of Mohave County water users. The MCWA can also assist members with the development and operation of water diversion, conveyance, treatment, storage and recharge facilities and the development of augmentation and conservation programs.

MCWA is actively evaluating the future potential of existing supplies to meet the needs of the water users in this Planning Area. Through membership in the MCWA, expansion of existing water conservation programs and expanding the use of reclaimed water either through direct delivery or artificial recharge and recovery for future supplies, this Planning Area is making strides towards meeting its future water supply needs.

<u>Firming of Low Priority Water Supplies</u>

Water supply availability during shortages on the Colorado River is a major concern for communities in this Planning Area as many do not have access to alternative supplies. One of the duties of the Arizona Water Banking Authority (AWBA) was to store Colorado River water within the CAP service area for the benefit of on-river communities during declared shortages on the Colorado River. By resolution, the AWBA established on-river firming as the highest priority for use of credits accrued from expenditure of general fund appropriations. On behalf of its members and subcontractors, the MCWA entered into agreements with the AWBA that transferred a total of 256,174 acre-feet of long-term storage credits to them for use by their subcontractors during these shortages. 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. Additionally, funding should be appropriated as needed to meet the firming needs for the communities.

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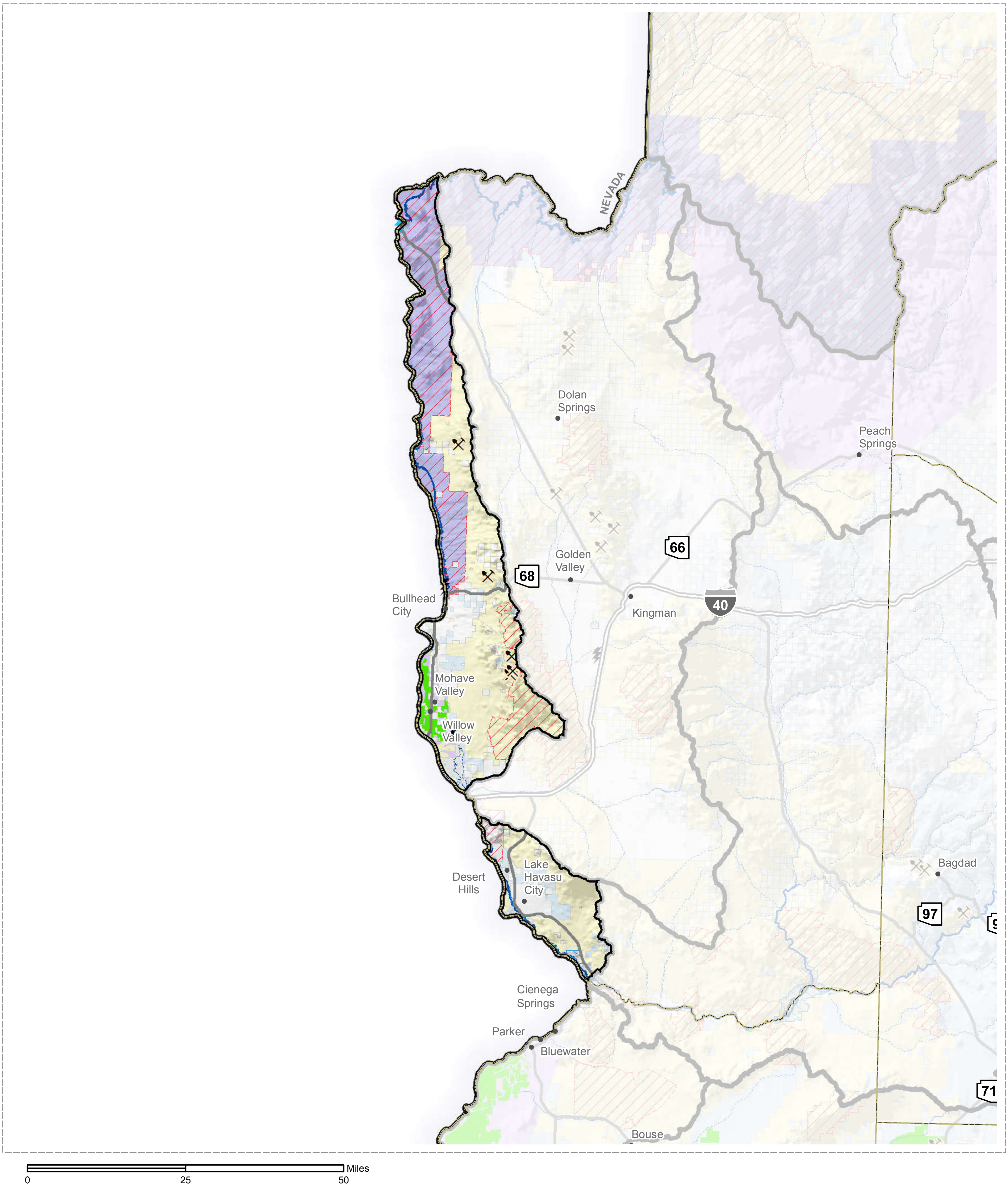

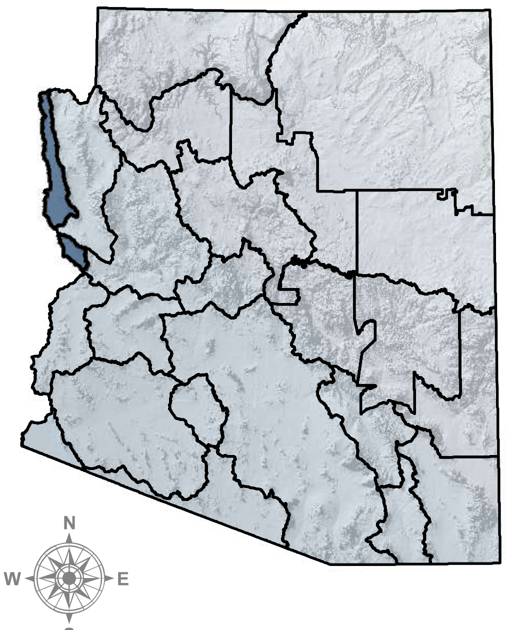

MAP LOCATION
(Planning Area Boundaries)

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- River or Stream (ASLD)
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Figure P.A.7-1

Colorado Main Stem North Land Ownership

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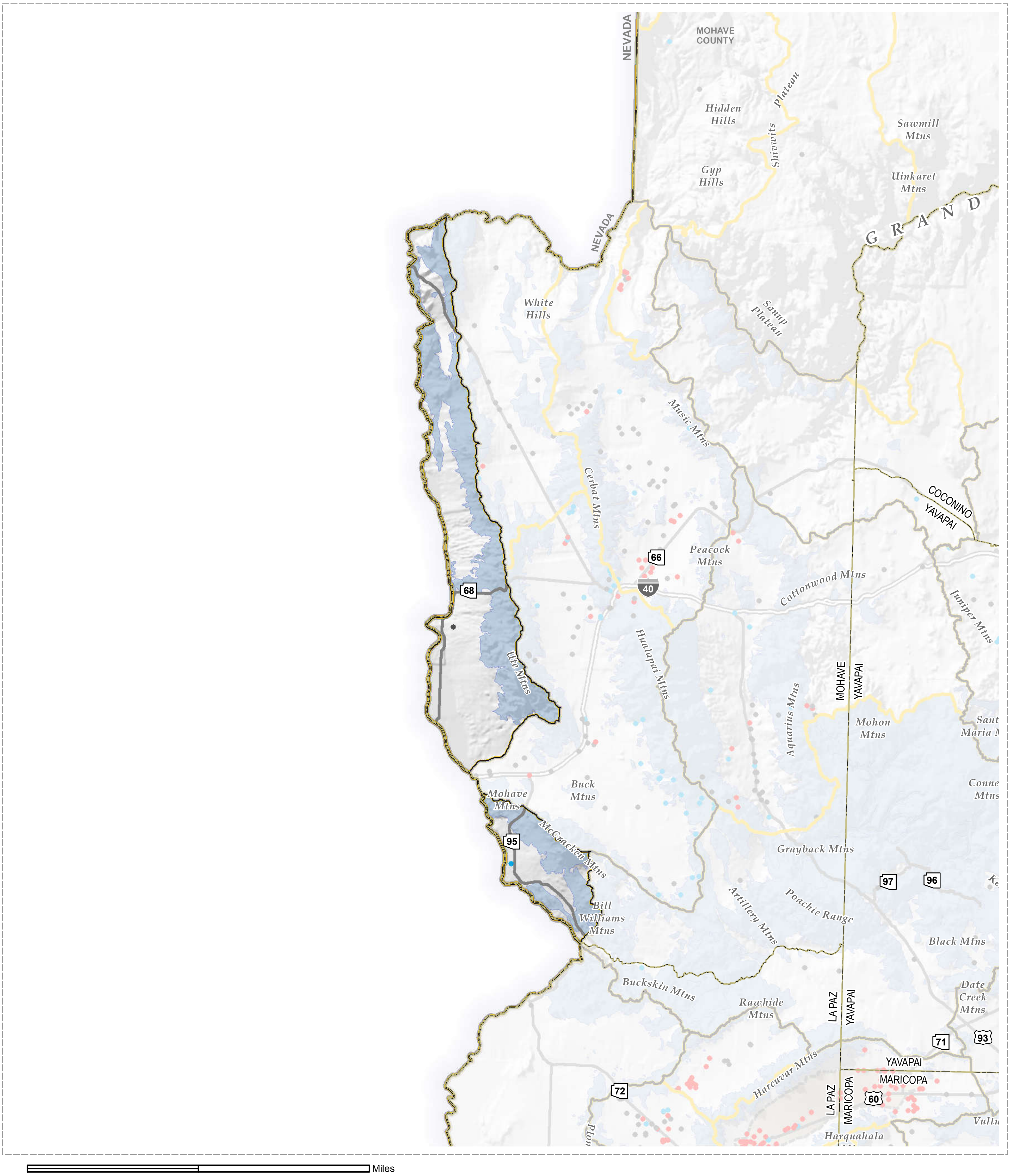

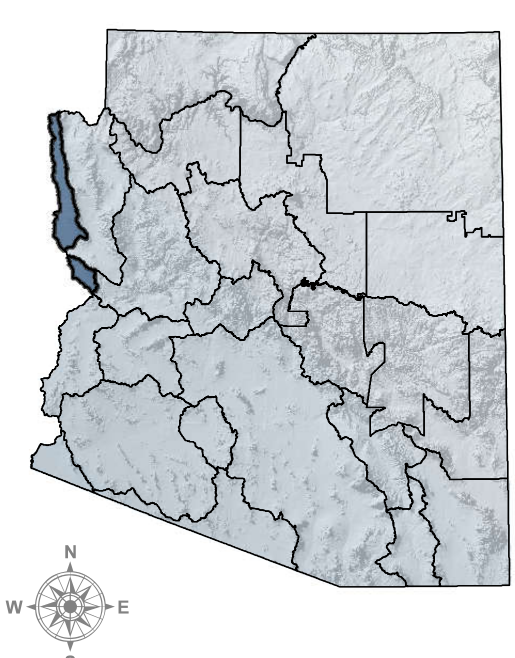

MAP LOCATION
(Planning Area Boundaries)

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.7-2

Colorado Main Stem North Groundwater Hydrology

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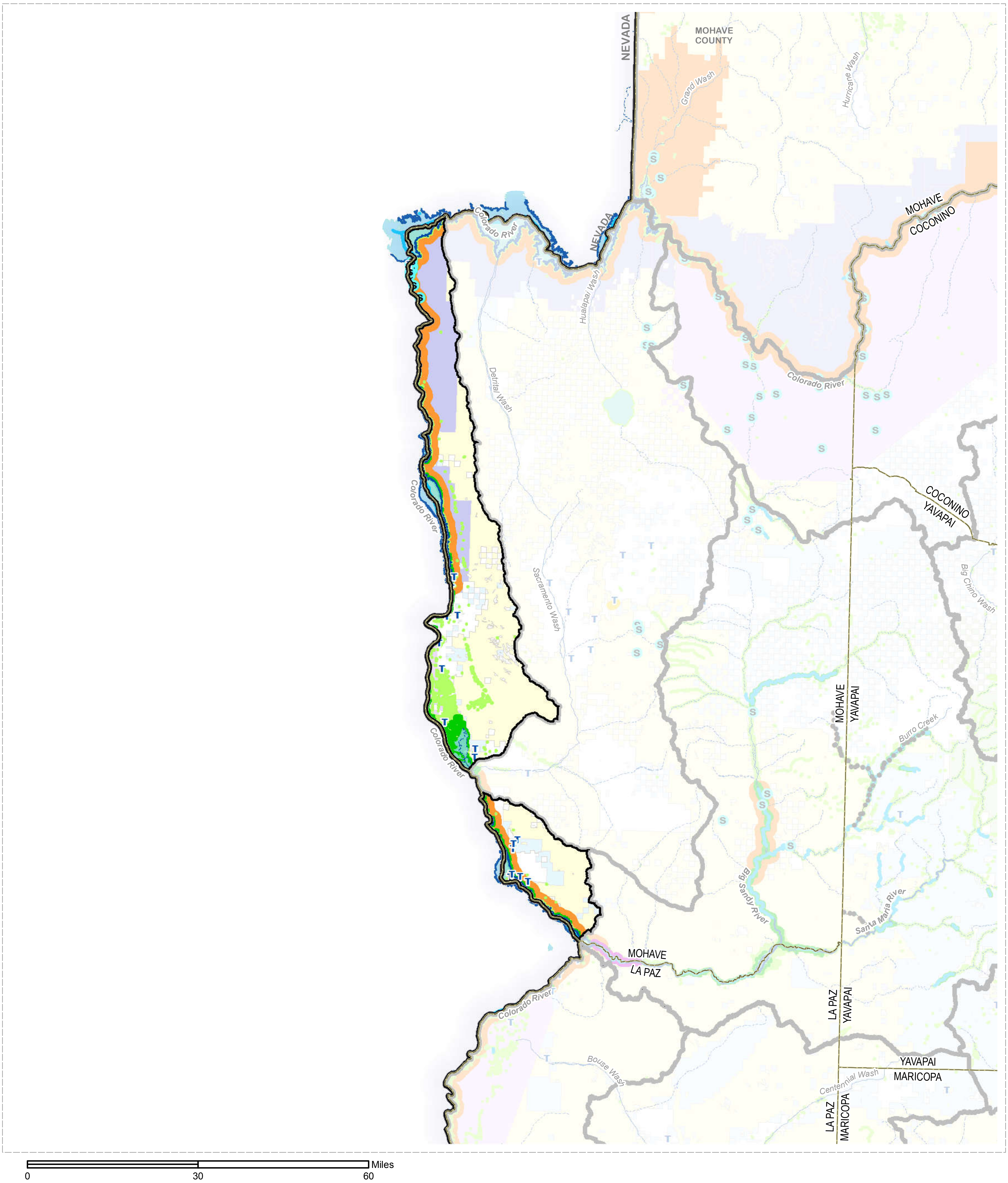

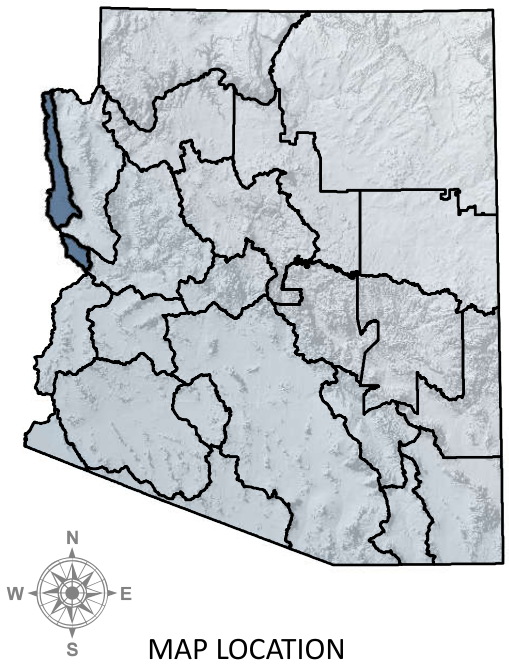

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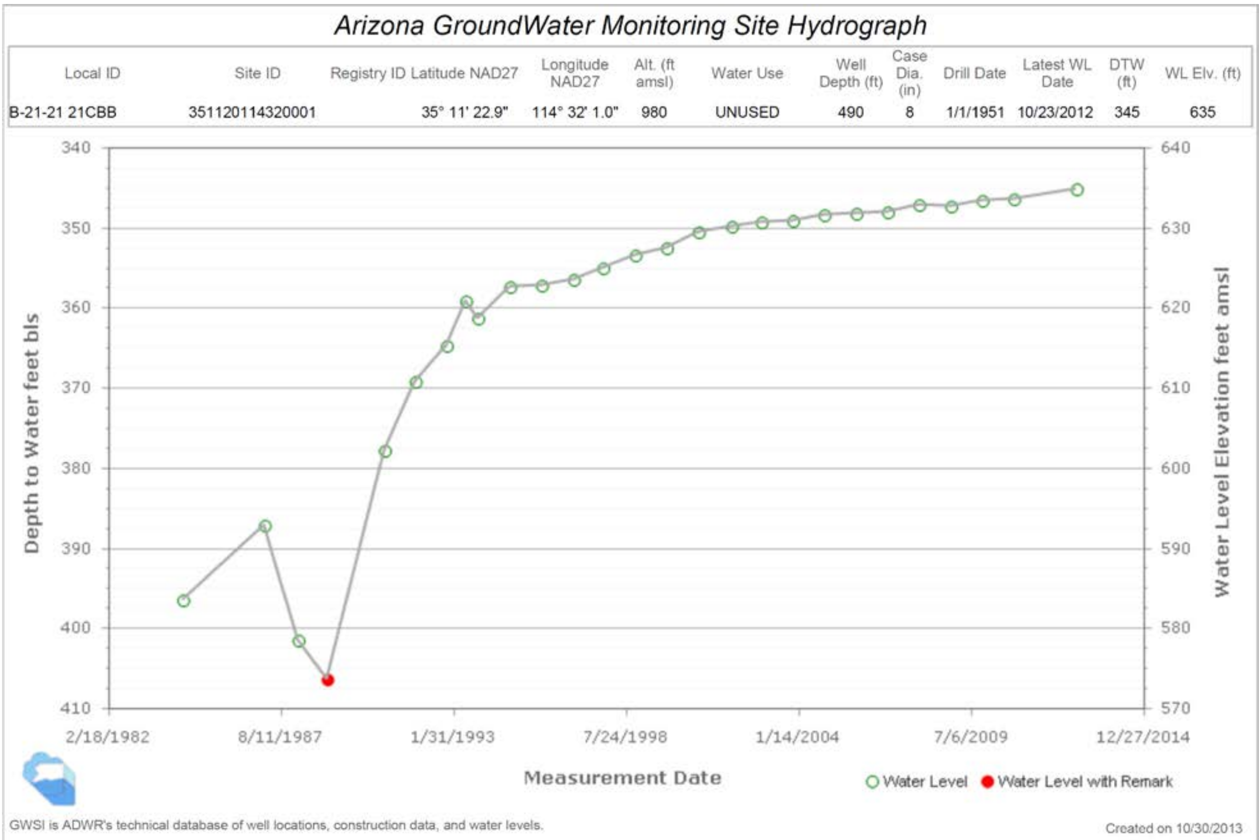
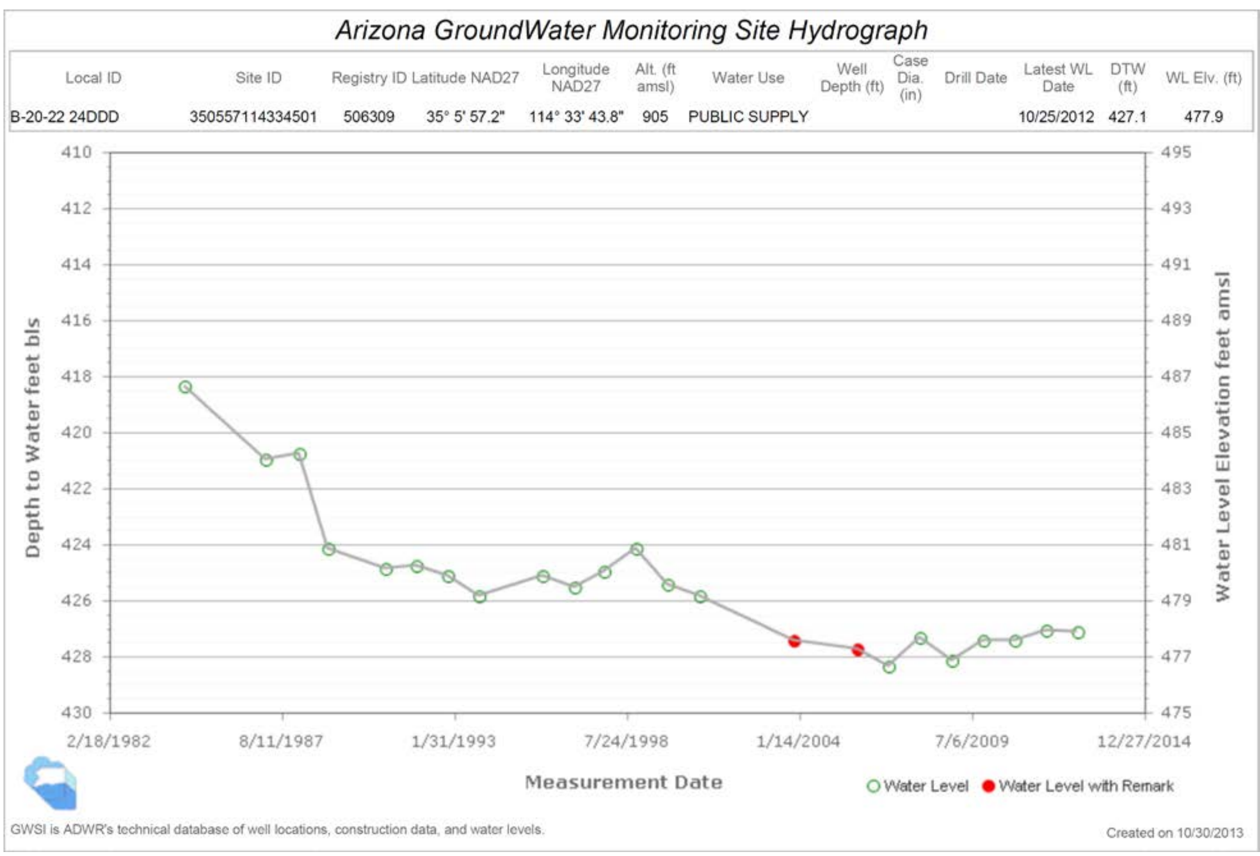
Figure P.A.7-3

Colorado Main Stem North
Surface Water and Natural Features

Lake Mohave Basin – Colorado River Main Stem North

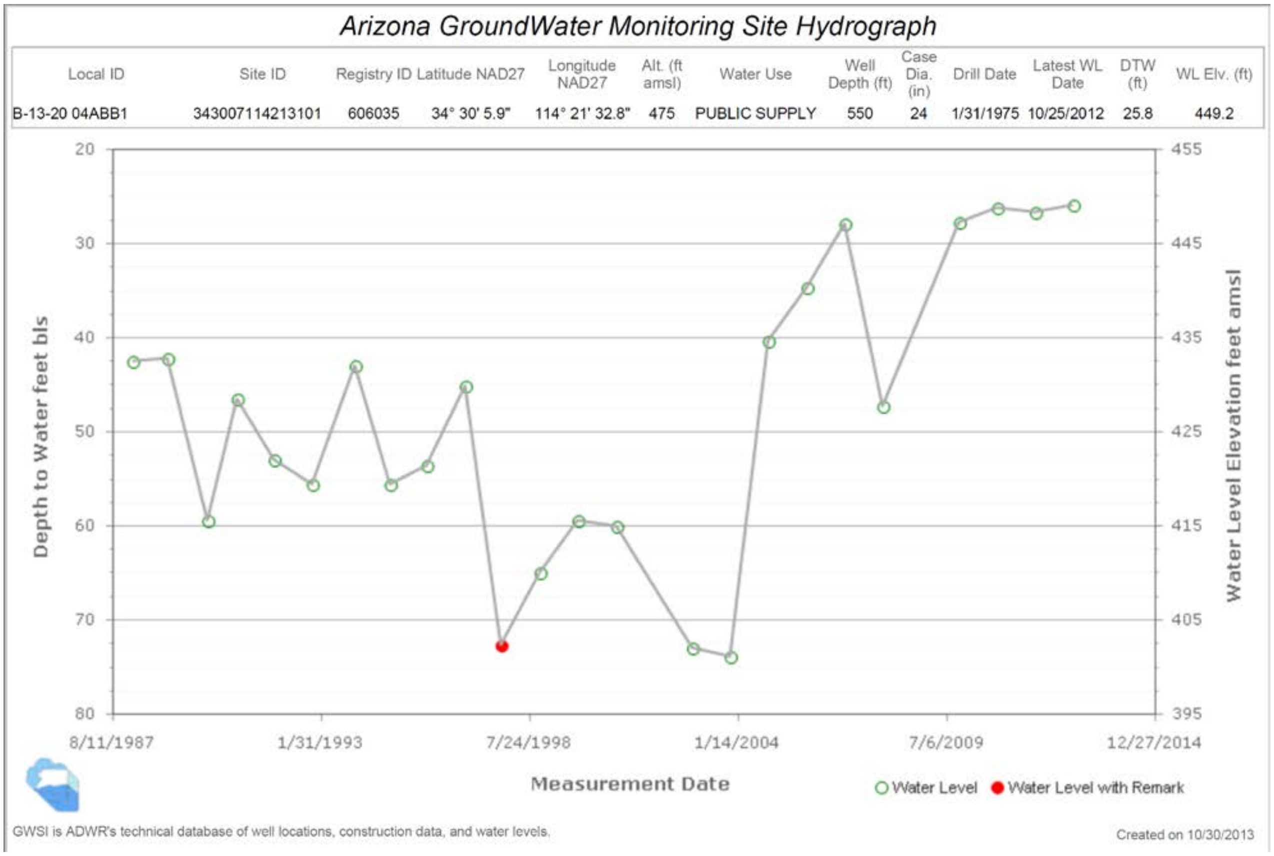


B-21-21 21CBB Lake Mohave basin 2 miles east of Colorado River, 3.5 miles NE of Bullhead City.



B-20-22 24DDD Lake Mohave basin about 4.5 miles due east of Big Bend on Colorado River near Riviera.

Lake Havasu Basin – Colorado River Main Stem North



B-13-20 04ABB1 Lake Havasu basin at Lake Havasu, about 2.2 miles north of London Bridge.

[COLORADO RIVER MAIN STEM SOUTH PLANNING AREA]

Colorado Main Stem South Planning Area

Background

The Colorado Main Stem South Planning Area is located in the far southwest corner of the state along the Colorado River sharing political boundaries with the State of California to the west and the international border with the Mexican states of Baja California Norte and Sonora at the southwest corner and along the southern boundary, respectively. The Planning Area lies within Yuma and La Paz counties. The Planning Area consists of two groundwater basins, the Yuma Basin to the south and the Parker Basin to the north. Communities in the Colorado Main Stem South Planning Area include the cities of Yuma, San Luis, Parker, Quartzsite, and Ehrenberg. There are three Indian Reservations within the Planning Area, the Cocopah, Fort Yuma Quechan, and the Colorado River Indian Tribes[1].

The majority of the land within Colorado Main Stem South Planning Area is owned and managed by federal agencies (over 80 percent), dominated by the Department of Defense (over 35 percent) operating the Barry M. Goldwater Air Force Range, the Yuma Marine Corps Air Station and the Yuma Proving Ground (*see Figure P.A. 8-1*). The US Bureau of Land Management (BLM) has nearly 29 percent of the lands in the Planning Area, including portions of three Wilderness areas; the land use is primarily resource conservation, recreation, irrigated agriculture and livestock grazing. The remaining federal lands are controlled by the US Fish and Wildlife Service (FWS) - 4.65 percent; the US Bureau of Reclamation (Reclamation) - 2.5 percent; and three Indian communities - 8.95 percent. Approximately 14.55 percent of the land is in private ownership and State Trust Lands comprise approximately 4.8 percent, primarily in agricultural production. These private and State controlled lands are concentrated together in the central and western portions of the Yuma Basin, near the existing population centers, and in the northern portion of the Parker Basin east of the Colorado River Indian Tribe lands.

Water Supply Conditions

Water supplies in the Colorado Main Stem South Planning Area are dominated by the Colorado River. As such, this section will first focus on the Colorado River, as it impacts the availability and operation of all other available water supplies.

Colorado River

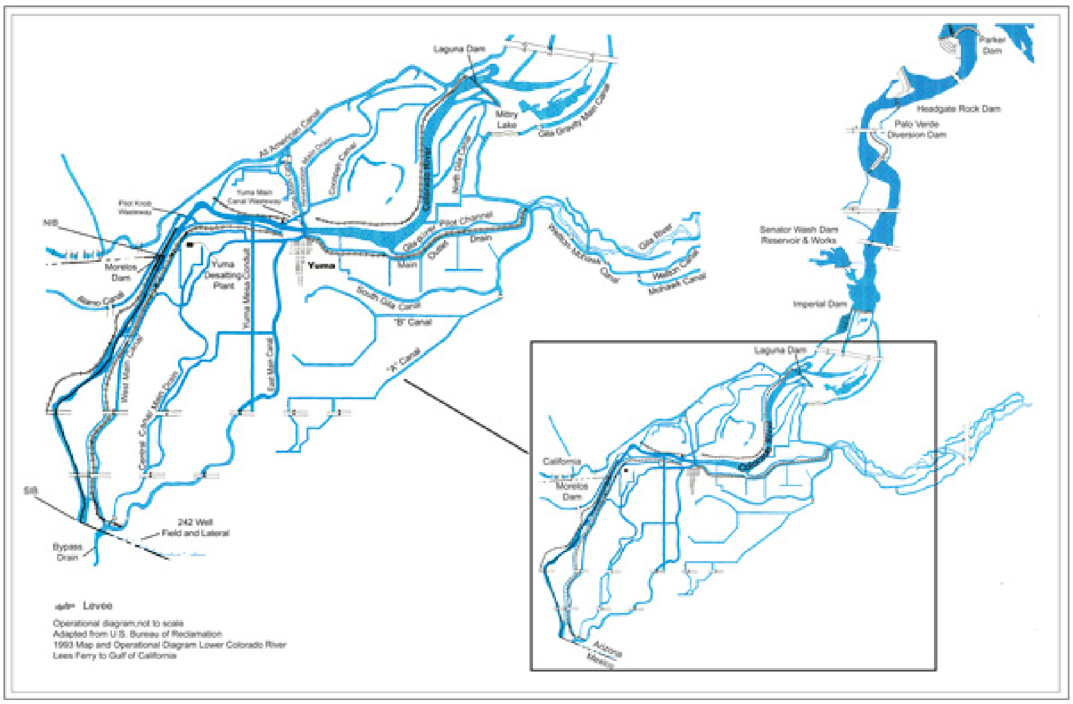
The Colorado River flows through the Planning Area for about 200 miles south from Parker Dam to Mexico at the Southerly International Boundary (SIB) within the Planning Area. Four large dams on the River significantly impact the river's flow within the Planning Area (*see Figure P.A. 8-2- Operational Diagram of the Colorado River – Colorado Main Stem South Planning Area*). These dams are, from north to south, Parker, Imperial, Laguna and Morelos. Additionally, there are major diversions at Imperial Dam to the All-American Canal, which delivers agricultural water to California and Arizona water users and to the Gila Gravity Main Canal for use in Arizona (in both the Colorado Main Stem South and the Lower Gila Planning Areas). Additional smaller dams and check structures are present in this reach.

[1] The Colorado River Indian Tribes include the Mohave, Chemehuevi, Hopi and Navajo.

Median and mean flow at the gage below Parker Dam is 7.2 and 8.9 MAF, respectively. The highest maximum annual flow (20.4 MAF) in the watershed was reported at this gage in 1984.

The majority of the flow in the Colorado River is diverted at Imperial Dam. The three operating gages below the Imperial Dam diversions report mean flows substantially greater than median flows. For example, the median and mean flow on the Colorado River below Laguna Dam is 0.39 MAF and 1.8 MAF, respectively. Tributary drainages to the Colorado River in the Planning Area are ephemeral and contribute little to River flow, with the occasional exception of the Gila River, which flows only in response to significant precipitation events, irrigation return flow or releases from upstream dams.

Figure P.A. 8- 2. Operational Diagram of the Colorado River – Colorado Main Stem South Planning Area



The right or authorization to beneficially use Colorado River water is defined as an entitlement created by decree of the United States Supreme Court in Arizona v. California[2] (Decree), through a contract with the U.S. Secretary of the Interior (Secretary) under Section 5 of the Boulder Canyon Project Act (1928), or by Secretarial Reservation[3]. Because the direction and occurrence of groundwater is strongly influence by the amount of streamflow in the Colorado River, the US Bureau of Reclamation (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* (Federal Register 40916, et. seq.) to prevent non-contract Colorado River water use from depleting the River and reducing water supplies available to holders of Colorado River

[2] 373 U.S. 546 (1963)

[3] Secretarial Reservation" means water rights created by the Interior Secretary for the use of federal establishments under federal law. Examples of Secretarial Reservations are mainstem water rights reserved for National Wildlife Refuges, Indian Tribes and certain public lands administered by the Bureau of Land Management.

entitlements. Reclamation's most current assessment indicates that most existing non-contract use is through water withdrawn from wells located in the hydraulically connected aquifer of the Colorado River or direct diversion via river pumps. The proposed rule would establish a methodology for Reclamation to determine if a well is pumping Colorado River water and a process for a water user to appeal such a finding. At present, Reclamation has not adopted the proposed rule.

<u>Groundwater</u>

The Colorado Main Stem South 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. Groundwater within the Parker Basin is largely found within recent stream alluvium and sedimentary rock formations. Groundwater in storage is estimated to be 14 MAF. Groundwater within the Yuma Basin is usually found within productive basin-fill with relatively shallow groundwater levels. Groundwater in storage is estimated to be 49 MAF.

Significant drainage infrastructure is operated in the Yuma Basin to control groundwater levels and salinity which facilitates utilization of Colorado River water for production agriculture (*see Figure P.A. 8-3 - Yuma area drainage fields and conduit systems*). In order to keep salts from accumulating in the root zone of crops, drainage wells to pump excess irrigation water have been installed throughout the Yuma Basin. Roughly 140,000 acre-feet of groundwater is pumped annually and flows in drainage canals into and through the Colorado Main Stem South Planning Area to Mexico. Groundwater pumped from the less saline Minute 242 Well Field is used, as needed, to reduce the salinity of the drainage water delivered to Mexico at the Boundary Pumping Plant (*described in more detail below in Characteristics Affecting Projected Water Demands and Supply Availability – Salinity*).

<u>Reclaimed Water</u>

There are numerous waste water treatment plants (WWTP) within the Planning Area. In total, 15,200 acre-feet per year of reclaimed water is generated. Reuse in the Planning Area is limited, 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. The remaining reclaimed water is either discharged into the Colorado River or disposed of through pond evaporation/infiltration basins. The City of Yuma is the largest potable water provider, with Priority 1 and Priority 3 Colorado River water annual consumptive use entitlements totaling 50,000 acre-feet. The City increases its Colorado River diversions by generating return flow credits through the discharge of reclaimed water to the River following treatment.

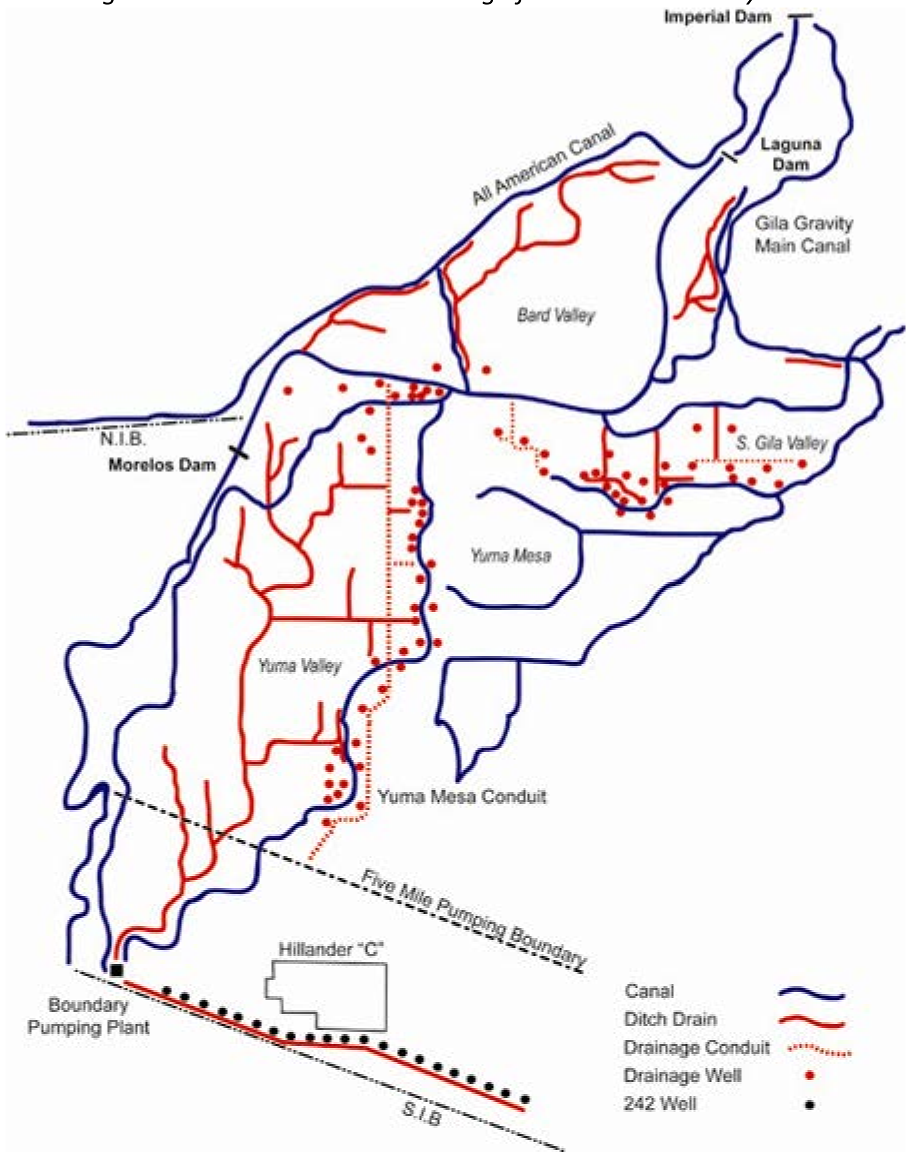
<u>Ecological Resources</u>

There are several protected and wilderness areas, as well as, significant stretches of designated critical habitat within the Planning Area (*see Figure P.A. 8-4*). Protected areas in this Planning Area include:

- Portions of the Cibola National Wildlife Refuge, which straddles the Colorado River, with almost 13,000 acres located in the Parker Basin and the remainder in California;
- Portions of the National Wildlife Refuge, at 665,400 acres, primarily designated as wilderness (including lands within the West Basins and Lower Gila Planning Areas); and
- A significant portion of the Imperial National Wildlife Refuge, at almost 25,800 acres, of which 15,000 acres is designated wilderness (including lands within the Lower Gila Planning Area).

Additional BLM wilderness areas include the Trigo Mountain, Gibraltar Mountain and Cactus Plain Wilderness.

Figure P.A. 8-3. Yuma area drainage fields and conduit systems



Water Demands

Table P.A. 8-1 below illustrates the baseline and projected demands for the Colorado River Main Stem South Planning Area. The Planning Area contains one of the largest agricultural areas in Arizona and the Nation. Over 150,000 acres in the Planning Area are in agricultural production, primarily irrigated by water diverted from the Colorado River to: the Colorado River Indian Tribes, Cibola Valley Irrigation and Drainage District (IDD), the Cocopah Tribe, Fort Yuma Quechan Tribe, Yuma-Mesa IDD, North Gila Irrigation District (ID), Yuma ID, Yuma County Water Users Association, Unit B, Gila Monster Farms, and Highlander C (groundwater). Yuma County, which contains most of the privately owned agricultural lands in the Planning Area, is considered the nation's winter vegetable capital. Crops include head and leaf lettuce, romaine, broccoli, cauliflower, honeydew, cantaloupe, watermelon, cabbage, spring mix,

celery, endive/escarole, as well as citrus including lemons, oranges, grapefruit, and tangerines. Many seed crops are also grown including broccoli, cauliflower, grasses, and onions. In Yuma County, annual agricultural sales in 2011 were reported to total just under $1.3 billion (including WMIDD in the Lower Gila Planning Area) and account for 29 percent of the State's total cash receipts from the agricultural sector[4]. In La Paz County, upland cotton is the largest crop, followed by Durum wheat, barley, corn for grain, and alfalfa. Other crops include onions, honeydews, cantaloupe and watermelon. Annual agricultural sales in LaPaz County are reported to total over $178 million, four percent of Arizona's agricultural cash receipts (2011)[5]. Much of this irrigation occurs on the lands of the Colorado River Indian Tribe. Agricultural demands are expected to remain stable through the planning period[6].

Municipal and Industrial demands rely on a combination of Colorado River water and groundwater. The City of Yuma is the largest water provider, with 50,000 acre-feet of Priority 1 and Priority 3 Colorado River water annual consumptive use entitlements. Parker's 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. 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. Municipal demands are expected to grow through the planning period, including demands associated with significant seasonal population (wintertime "residents") and recreational tourism at the Colorado River.

Industrial demands are anticipated to increase given water supply availability and the anticipated demand for new electrical power production and rock product mining to meet construction needs for new growth.

Characteristics Affecting Projected Water Demands and Supply Availability

<u>Land Ownership</u>

Because of the large areas of land in federal ownership, it is not anticipated that significant development will occur outside of the current population and agricultural centers. There is some potential for growth on the remaining undeveloped private lands and State Trust lands. Additionally, many of the federally-owned lands provide habitat for both listed and non-listed species as well as recreational opportunities that are increasingly important to the economy of this region. As projected growth occurs, it will have to do so in a manner that is compatible with these resources and uses.

<u>Colorado River Entitlement Priority</u>

Rights to Colorado River water in Arizona are based on the following priority levels:

a. 1st Priority: Satisfaction of Present Perfected Rights as defined in the Arizona v. California decree (pre-1928);
b. 2nd Priority: Satisfaction of Secretarial Reservations and Perfected Rights established prior to September 30, 1968;

[4] AZ Department of Agriculture
[5] AZ Department of Agriculture
[6] Demands are expressed in consumptive use of Colorado River supplies and groundwater which differs from the WRDC projections which were expressed as diversions.

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 Arizona entitlement; and
f. 6th Priority: Surplus water

Table P.A. 8-1. Projected Demands (in acre feet) – Colorado River Main Stem South

Sector	2010	2035	2060
Agriculture	900,500	900,500	900,500
Dairy	0	0	0
Feedlot	0	0	0
Municipal	49,480	81,635	99,444
Other Industrial	1,178	1,178	1,178
Mining	0		
High		300	300
Low		300	300
Power Plants	658		
High		9,763	16,173
Low		7,624	12,599
Rock Production	238		
High		3,931	4,790
Low		1,638	1,995
Turf	441		
High		756	794
Low		476	584
Total (High)	**952,495**	**998,063**	**1,023,179**
Total (Low)	**952,495**	**993,351**	**1,016,600**

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. Second and 3rd priority entitlement holders (which are coequal), include the Imperial and Cibola National Wildlife Refuges,

Yuma Proving Grounds, the Marine Corps Air Station–Yuma, and others. Fourth priority entitlement holders include the Town of Parker and Brooke LLC, and are, like the CAP, junior in priority to California and subject to possible reductions in the event of a shortage on the River.

Salinity

As a result of operation of the Colorado River, including construction of dams along the mainstem and the need to dewater the highly productive agricultural regions, salinity levels have increased in the river. To address the on-going salinity issue, in 1974 Congress enacted the Colorado River Salinity Control Act, which authorized the construction, operation, and maintenance of works in the Colorado River Basin to control the salinity of water delivered to Mexico – including the Yuma Desalination Plant (YDP) and the Minute 242 Well Field in Arizona[7].

The Yuma Desalination Plant (YDP) was constructed to desalinate the drainage water from the Yuma area so that it could be returned to the mainstem and accounted for as deliveries towards Mexico's apportionment. The YDP was completed in 1992 and designed to treat up to 96,000 acre-feet per year. It operated briefly in 1993 and was then placed on standby status because high flows in the Colorado River made it unnecessary to operate the plant. A 90-day demonstration run was conducted in 2007 and an additional year-long pilot run of the YDP at one-third capacity was conducted in May 2010 to assess the suitability of the treatment process and define its long-term design. The pilot run included a monitoring program that evaluated impacts to the wildlife and habitat associated with the Cienega de Santa Clara. Today, the YDP remains on standby status and 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).

The Protective and Regulatory Pumping Unit, consisting of the "242 Well Field and Lateral" is located east of San Luis in a five-mile wide protected and regulated zone and consists of 35 wells, the 242 Lateral and other connecting laterals. The well field intercepts part of the groundwater flow, including irrigation drainage water flowing south towards Mexico from the Yuma Mesa. Water pumped from the well field is delivered at the Boundary Pumping Plant (Southerly International Boundary or "SIB") to Mexico through the 242 Lateral and other laterals in partial fulfillment of international treaty obligations for Colorado River water deliveries.

Water Management

The Colorado River Main Stem South Planning Area is not within any State administered water management area, such as an Active Management Area or Irrigation Non-expansion Area that requires additional water management or reporting. Water use along the main stem of the Colorado River is administered by the US BOR under contract with Arizona water users.

Because of the relatively high priority Colorado River entitlements held by the agricultural districts in the Planning Area, entities may be exploring the potential for water transfers for use within other parts of the State. While it is legal to transfer Colorado River water within Arizona, it does require consultation with ADWR, a recommendation from ADWR to the Secretary of the Interior, and approval of the transfer by the Secretary. Consultation and recommendations by ADWR are required by A.R.S. §45-107(D) and

[7] *Public Law 93-320*

are executed through its *Policy and Procedures for Transferring an Entitlement of Colorado River Water*[8]. Generally the policy requires that if the proposed transfer involves water associated with lands located within an irrigation district, the district must approve the transfer; city and/or county economic impacts should be considered; and environmental compliance may be required.

Within the Planning Area, the Cibola Valley Irrigation and Drainage District has assigned a portion of its entitlement to the Mohave County Water Authority for the Hopi Tribe (Colorado River Main Stem North Planning Area), and to Cibola Resources, LLC for municipal use at Ehrenberg (within the Planning Area). Additionally, the Yuma Mesa Irrigation District entered into a short-term, pilot program with the Central Arizona Groundwater Replenishment District in 2013 to analyze land fallowing and development of water supplies for possible future transfers. Colorado River water developed through this pilot-program will remain in Lake Mead and is not considered a transfer.

Proactive Environmental Compliance

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 Endangered Species Act (ESA) directs federal agencies to support the conservation of listed threatened and endangered species and to make sure that their actions do not jeopardize the continued existence of listed species or result in adverse modification of critical habitat. To comply with the requirements of the ESA, state and federal water, power and wildlife interests voluntarily created the Lower Colorado River Multi-Species Conservation Program (LCR MSCP). The LCR MSCP is a cooperative, habitat conservation program (HCP) 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. Its purposes include: 1) protection of habitat while ensuring current Colorado 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 Colorado River.

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. 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.

Strategies for Meeting Future Water Demands

Sufficient groundwater (that may need to be treated to meet water quality standards due to very high TDS in some parts of the Planning Area) and Colorado River supplies are expected to be available to meet the projected demands in the Colorado River Main Stem South Planning Area through the planning period.

[8] **http://www.azwater.gov/AzDWR/StateWidePlanning/CRM/documents/CR7new.pdf**

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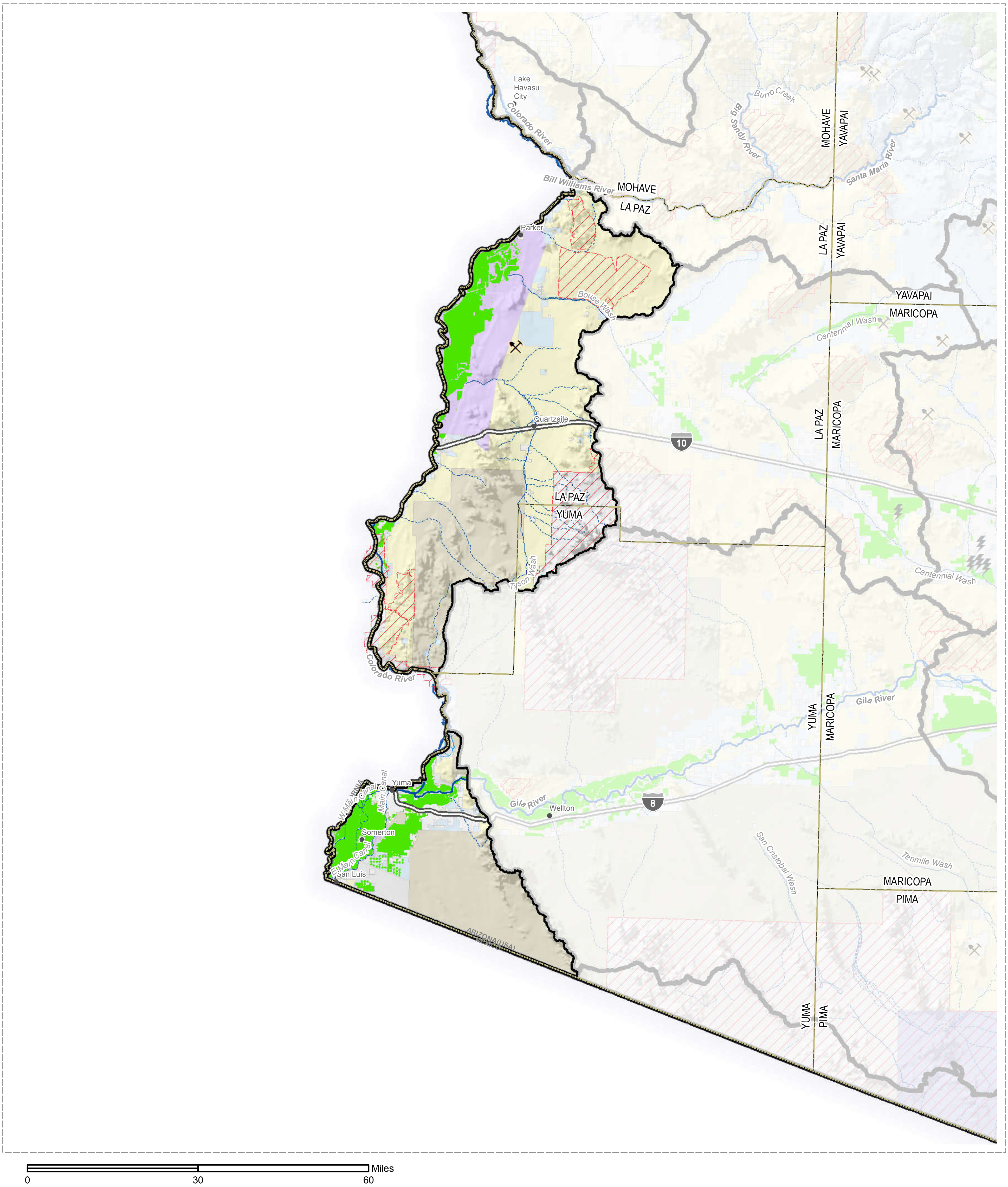

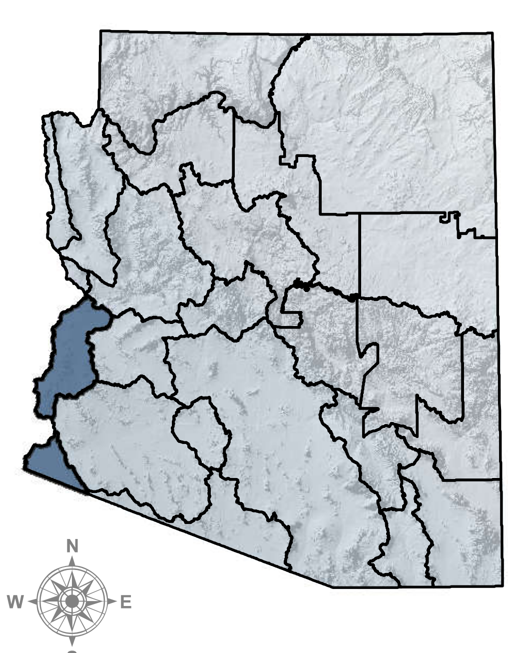

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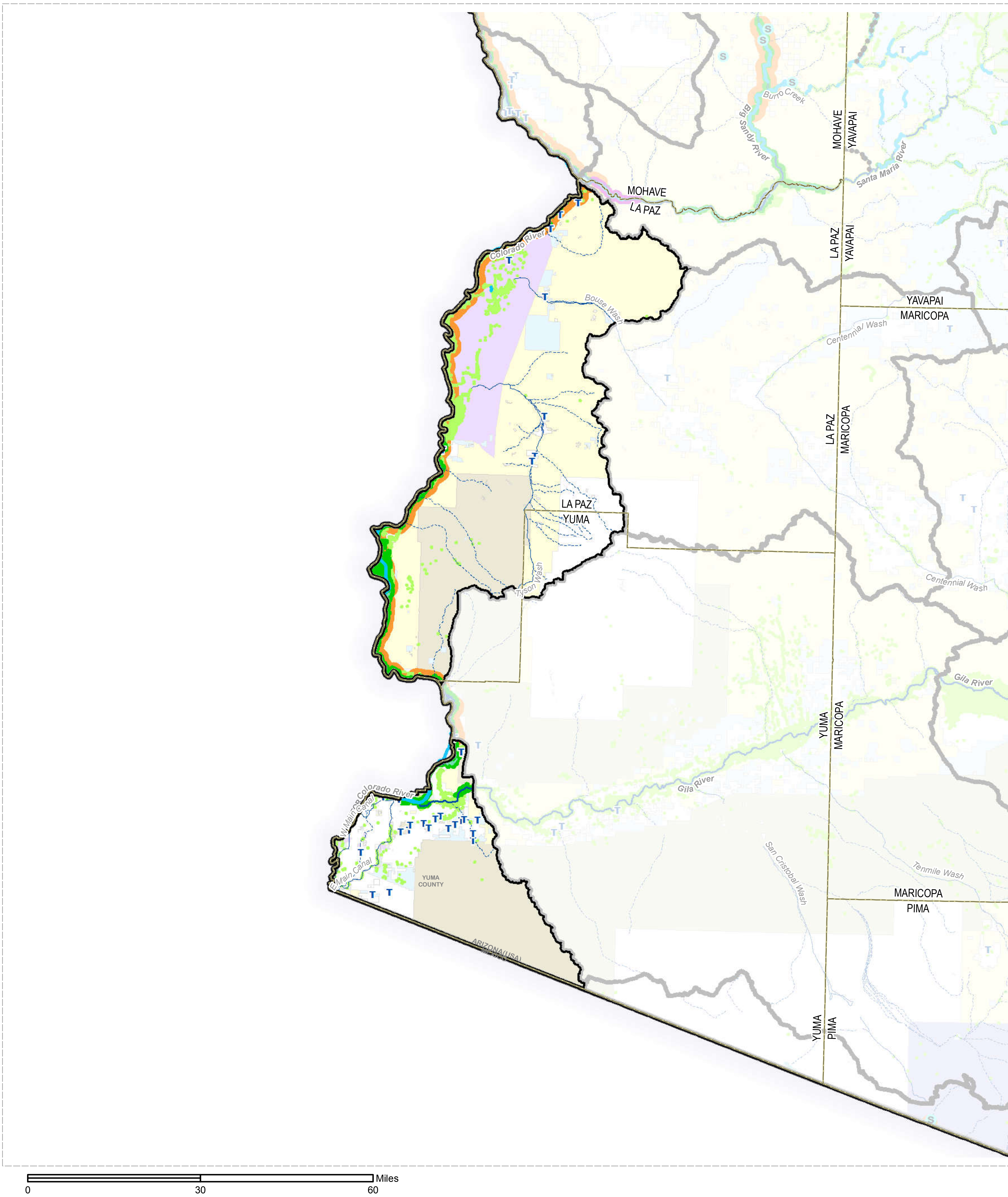

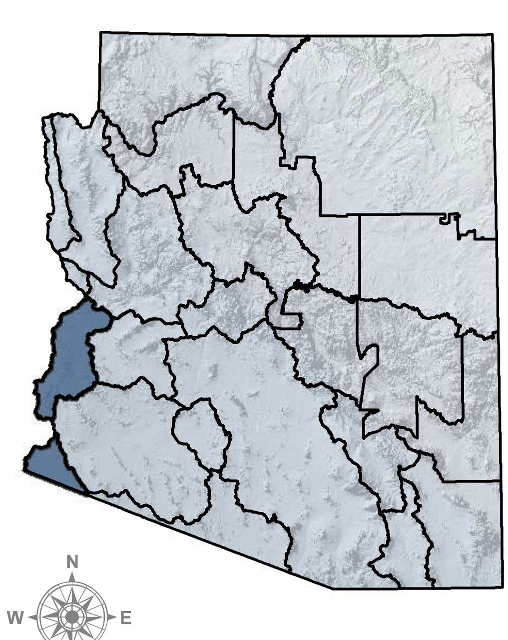

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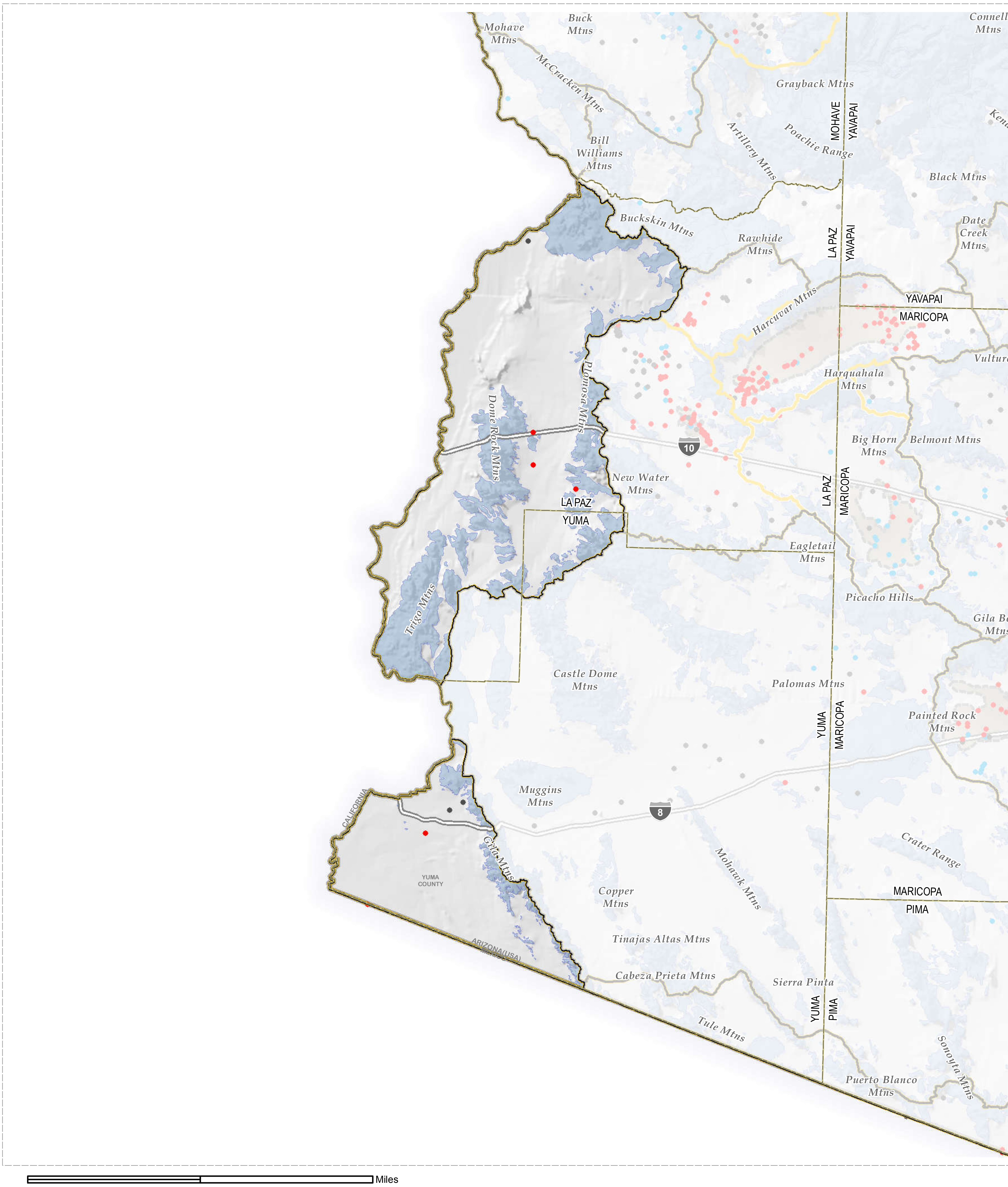
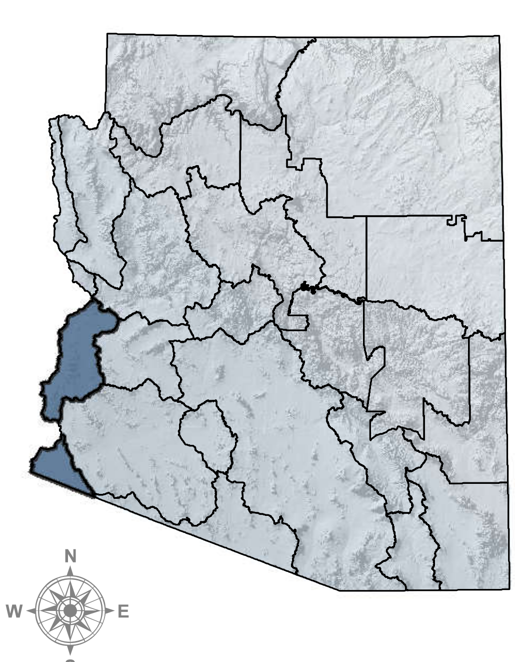
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.8-4 **Colorado Main Stem South Surface Water and Natural Features**

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)

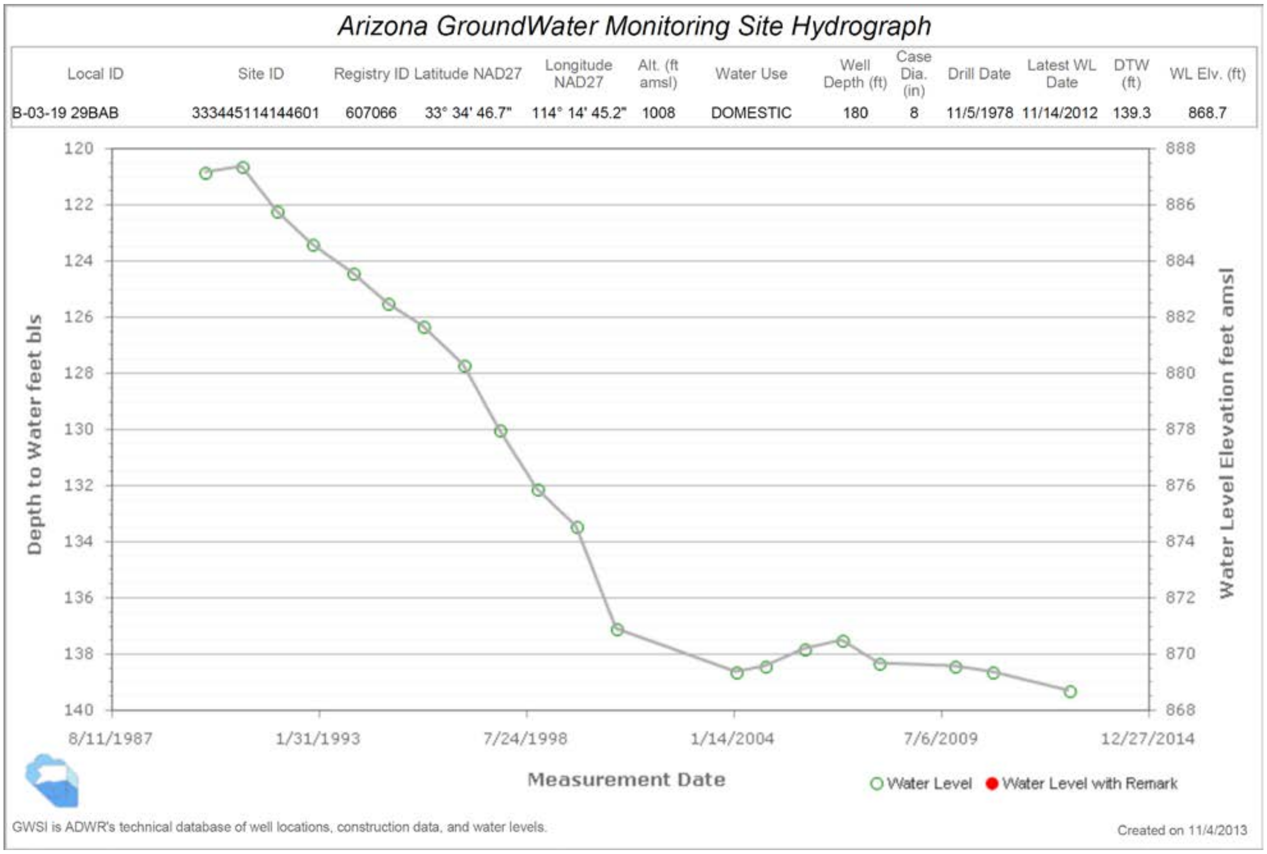
Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

* Data provided by ADWR

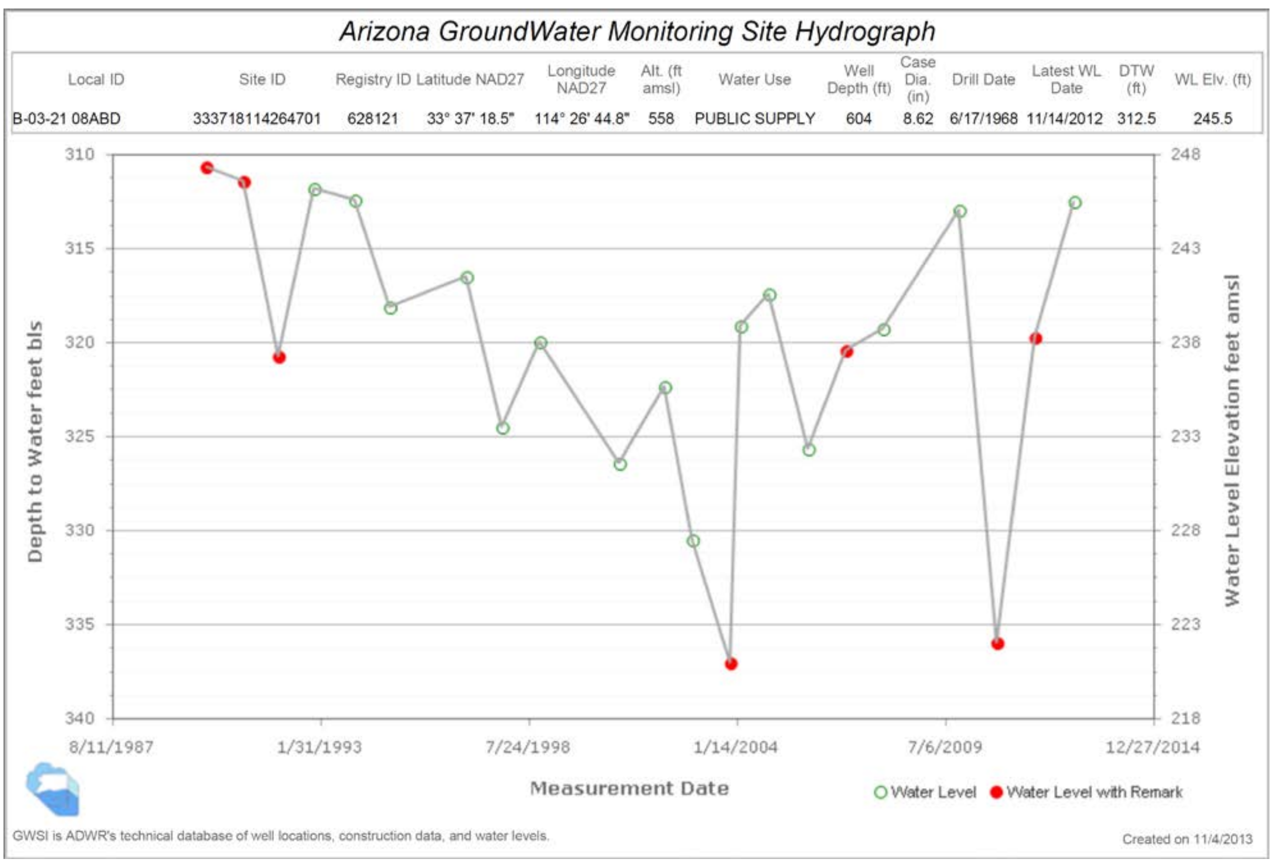
Figure P.A.8-5

Colorado Main Stem South Groundwater Hydrology

Parker Basin – Colorado River Main Stem South

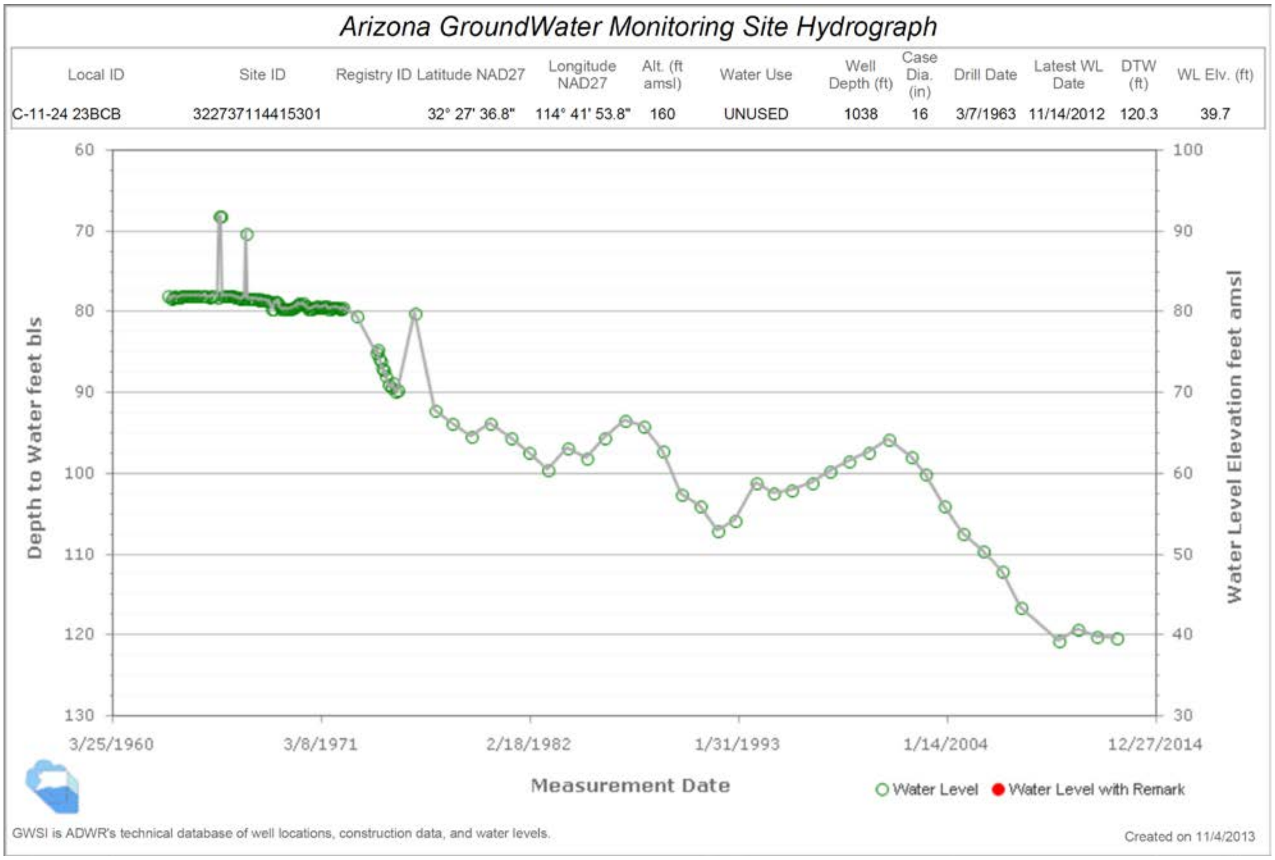


B-03-19 29BAB – Parker basin - La Posa Plain sub-basin about 1 mile west of Quartzite.

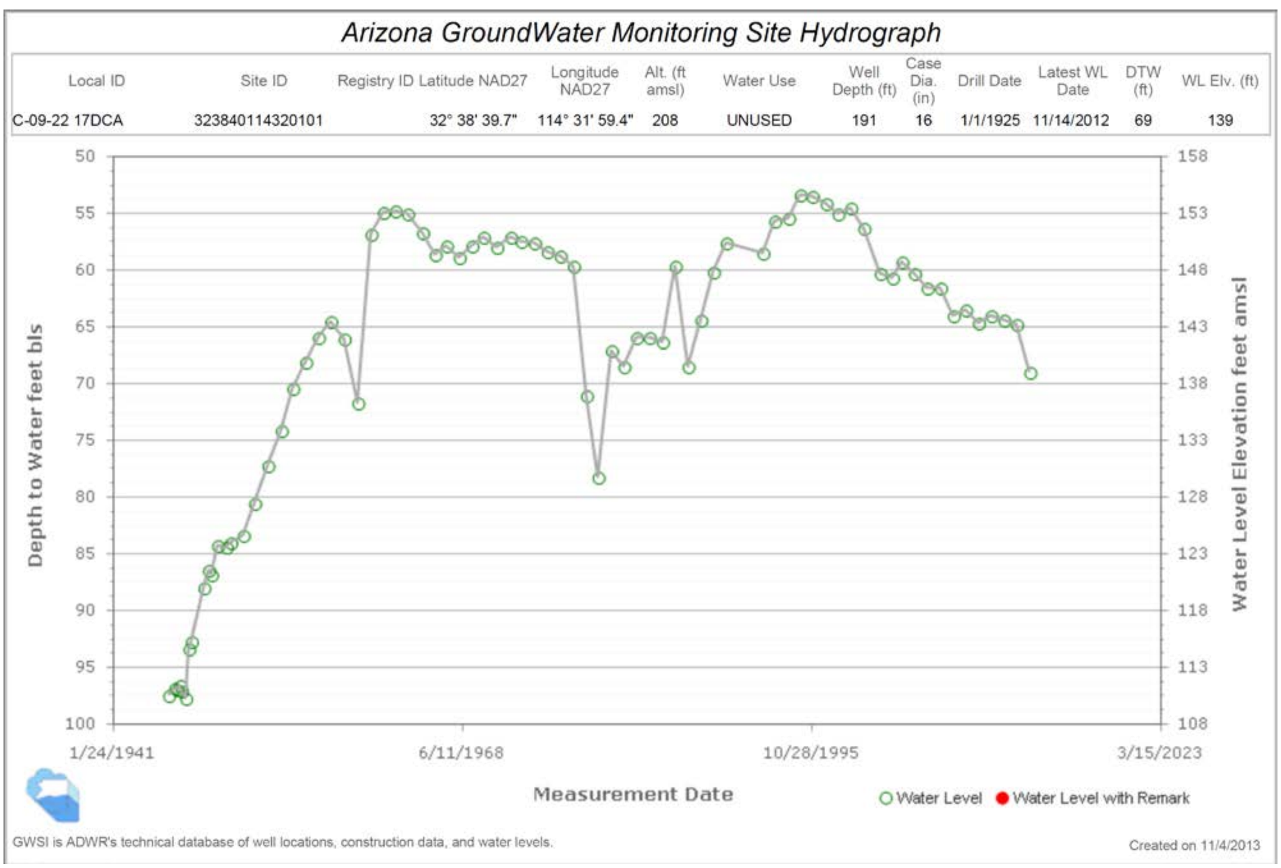


B-03-21 08ABD – Parker basin – Cibola Valley sub-basin about 5 miles east of Ehrenberg.

Yuma Basin – Colorado River Main Stem South



C-11-24 23 BCB -- Yuma basin – about 5 miles SE of San Luis along US/Mexican Border



C-09-22 17DCA Yuma basin – Yuma Mesa area.

[EAST PLATEAU PLANNING AREA]

East Plateau Planning Area

Background

The East Plateau Planning Area is located in the east central portion of the State, immediately south of the Navajo/Hopi Planning Area. The Planning Area is comprised of portions of Navajo and Apache counties and is sparsely populated. The East Plateau Planning Area also contains a portion of the Little Colorado River Plateau Groundwater Basin and encompasses a portion of the Little Colorado River Watershed. Primary population centers include Show Low, Pinetop-Lakeside, Springerville, Winslow, and Holbrook. The Planning Area also includes the Joseph City Irrigation Non-expansion Area (INA), west of Holbrook in Apache County, designated under the 1980 Groundwater Management Act to provide a reasonably secure water supply for irrigation (A.R.S. § 45-431).

Principal features of land ownership are the continuous band of USDA Forest Service (Forest Service) lands along the southern boundary of the Planning Area and the "checkerboard" pattern of land ownership throughout the Planning Area (*see Figure P.A. 9-1*). The checkerboard pattern includes State Trust Lands, US Bureau of Land Management (BLM) lands and private lands. Primary land uses on the private lands are domestic, electrical generation, livestock grazing and agricultural. Forest Service lands include part of the Apache-Sitgreaves National Forests, managed as a single unit from the Supervisors Office in Springerville. Primary land uses are livestock grazing, recreation, and timber. Other lands under federal ownership within the Planning Area include tribal lands, BLM lands and the Petrified Forest National Park located east and northeast of Holbrook which is used for recreational purposes. BLM lands are primarily used for livestock grazing. Tribal lands include those of the Zuni (about 16 square miles) north of Concho and White Mountain Apache lands (about 4.5 square miles) southwest of Greer. There are a large tract of contiguous State Trust Lands between Springerville and St. Johns in the southeast portion of the Planning Area. Primary land use is livestock grazing. Small tracts of land in the vicinity of Springerville are owned by the Arizona Game and Fish Department including a few sections scattered among the checkerboard lands. Primary land uses on these lands is for wildlife conservation.

Water Supply Conditions

<u>Groundwater</u>

The East Plateau Planning Area is located within the eastern portion of the Colorado Plateau Physiographic Province, characterized by mostly level, horizontally stratified sedimentary rocks that have been eroded into canyons and plateaus, and by some high mountains. The Mogollon Rim is an escarpment almost 2,000 feet high in some places, extending from central Arizona to the Mogollon Mountains in New Mexico. It forms a hydrologic divide between the East Plateau Planning Area and the basins of the Central Highlands.

The Joseph City INA was established in 1980 by the Arizona Groundwater Management Act. The area had previously been designated as a Critical Groundwater Area in 1974. Designation of an area as an INA recognizes that there is "insufficient groundwater to provide a reasonably safe supply for the irrigation of the cultivated lands at the current rate of withdrawal" (A.R.S. § 45-402(22)). Within an INA,

irrigation with groundwater is restricted to lands that were irrigated prior to designation of the INA. Groundwater withdrawals by irrigation and large non-irrigation users, such as cities, golf-courses, or power plants must be reported annually to ADWR. Irrigation use in the INA has generally been between 2,000 and 4,000 acre-feet a year, served by the Joseph City Irrigation Company.

Groundwater is withdrawn from both large regional aquifers and from local and perched aquifers within the Planning Area. Groundwater levels were generally stable in many areas along and north of the Mogollon Rim portion of the Little Colorado River basin, but declined in some wells that were used for municipal, agricultural, or industrial purposes (mainly for thermo-electric power generation and paper manufacturing) (*see Figure P.A. 9-2*). Areas that experienced varying levels of water level decline include Heber, Showlow, Pinetop-Lakeside, Snowflake, Springerville and St. Johns. A significant decline was observed in a well located about 2.5 miles east of Lyman Lake, between St. Johns and Springerville. Several wells in the Pinetop-Lakeside area have experienced significant declines in recent years. While ADWR has not conducted a formal investigation of water level conditions in these wells, they appear to reflect conditions in the spatially limited shallow volcanic aquifer system in the area, which has been impacted by limited natural recharge due to lower than normal precipitation and local pumping. Wells completed in the deeper aquifer system in the region do not reflect similar water level trends.

<u>Surface Water</u>
The entire East Plateau Planning Area is located within the larger Little Colorado River Watershed. The Little Colorado River is the major surface drainage in the watershed, originating in the White Mountains and flowing northwest to the Colorado River (*see Figure P.A. 9-3*). The river was formerly perennial throughout its length but now flows perennially only from its headwaters to Lyman Lake, north of Springerville, below its confluence with Silver Creek, and below Blue Springs near its confluence with the Colorado River[1].

There are 32 total streamgage stations in the East Plateau Planning Area, of which, 15 are currently active. The maximum recorded annual flow in these stations was 197,646 acre-feet (1968) at the active gage on the Little Colorado River at Holbrook. The median flow at this station was 82,533 acre-feet. Within the watershed, reaches of the Little Colorado River and Nutrioso Creek have impaired water quality due to levels of turbidity, lead, copper and silver in excess of use standards.

<u>Reclaimed Water</u>
The majority of reclaimed water produced within the Planning Area is generated at several municipal, county and private wastewater treatment facilities. The primary disposal methods include evaporation ponds and irrigation. Other disposal methods include recharge through infiltration basins and discharge to a watercourse. A few communities, Pinetop Lakeside, Show Low and Springerville, report discharges to constructed wetlands that provide wildlife habitat.

<u>Ecological Resources</u>
The Planning Area contains several riparian areas that are usually narrow, often following relatively steep stream channels in restricted valleys (*see Figure P.A. 9-3*). This area also counts a number of high elevation wetlands and cienegas that host cattail, Bulrush, sedges, waterweed, Spike rushes, Quaking Aspen, and Colorado Blue Spruce. Critical habitat has been designated for Mexican Spotted Owl, Little

[1] Tellman and others, 1997

Colorado Spinedace, Navajo Sedge, and the Southwestern Willow Flycatcher. The Little Colorado River Basin also contains all populations and habitat for the federally threatened Little Colorado Spinedace, which is endemic to the Little Colorado River Plateau Basin. The Planning Area also contains several important conservation lands including the Petrified Forest National Park and the Petrified National Forest Wilderness Area (*see Figure P.A. 9-3*).

Water Demands

Table P.A. 9-1, below, presents the baseline and projected water demands for the East Plateau Planning Area. Energy production and agriculture are the two largest water using sectors in the Planning Area. Agricultural use, estimated at roughly 35,000 acre-feet annually, is projected to remain stable through 2060. Water use for power plant cooling was estimated to total 36,000 in 2010 and is projected to increase substantially to approach 77,000 and 128,000 in the low and high 2060 projections, respectively. The power plants are served by groundwater produced from local wells. Agricultural uses are supplied by groundwater and surface water supplies, largely derived from the Little Colorado River and its tributaries, including Silver Creek.

The Catalyst Paper Co. purchased and operated a paper mill located about 23 miles southwest of Holbrook. However, with newsprint demand down more than 10 percent annually since the end of 2008, Catalyst Paper permanently closed in 2012[2] and the Snowflake Power Plant shut its doors in March of 2013, largely as a result of the closure of Catalyst. Novo Power, LLC has acquired the idle Snowflake Power Plant and the Catalyst Paper Power plant in northern Arizona. Novo Power, LLC will assist with targeted forest thinning and the biomass plant will produce enough electricity from processing wood chips from pre-commercial thinning to power most of the residents in the White Mountains, approximately 20,000 homes[3].

Municipal uses accounted for roughly 15 percent of the estimated water use in 2010. These uses are projected to almost double to nearly 26,000 acre-feet by 2060. These uses are anticipated to remain reliant on groundwater supplies through the projection period.

Characteristics Affecting Future Demands and Water Supply Availability

<u>General Stream Adjudication</u>

The general stream adjudication is a judicial proceeding to determine or establish the extent and priority of water rights in the Gila and Little Colorado River systems. Over 14,000 claimants and water users are joined in the Little Colorado 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 this Planning Area will make it difficult to identify strategies for meeting the projected water demands.

<u>Resolution of Zuni Tribe Water Rights Claims</u>

President George W. Bush signed P.L. 108-34, the Zuni Indian Tribe Water Rights Settlement Act, into law in June, 2003. The Act awards the tribe a right to annually use 5,500 acre-feet of surface water from the Little Colorado River and up to 1,500 acre-feet of underground water, both for wetland restoration

[2] http://foresttalk.com/index.php/2012/07/31/catalyst-paper-is-permanently-closing-its-snowflake-mill-in-arizona/
[3] http://www.kcsg.com/view/full_story/23247802/article-State-Senator-Bob-Worsley-Leads-Investment-Effort-to-Repurchase-Idle-Snowflake-Power-Plants-that-Employed-Over-300-Arizonans

at the Zuni Heaven Reservation. It also grandfathers existing surface and ground water uses in the area, restricts future wells near the reservation and facilitates local environmental programs.

Table P.A. 9-1. Projected Water Demand (in acre feet) - East Plateau Planning Area

Sector	2010	2035	2060
Agriculture	35,325	35,325	35,325
Dairy	20	20	20
Feedlot	0	0	0
Municipal	13,478	20,962	25,913
Other Industrial	8,690	8,806	8,827
Mining	240		
High		300	300
Low		300	300
Power Plants	36,006		
High		91,672	127,657
Low		62,829	76,907
Rock Production	132		
High		1,796	2,127
Low		748	886
Turf	529		
High		647	698
Low		615	699
Total (High)	**94,420**	**159,528**	**200,867**
Total (Low)	**94,420**	**129,605**	**148,877**

Uncertainty Outstanding Water Rights Claims

The unresolved claim of the Hopi Tribe and the Navajo Nation to waters of the Little Colorado River creates uncertainty not only for the tribes but for other water users in other parts of the State. Water rights settlement discussions with both of the tribes, the federal government and State parties had been the primary focus through 2012 in resolving these issues. Legislation was introduced in the fall of 2012 that would have provided groundwater projects for the Navajo and Hopi Tribes in exchange for dismissal of the tribes' claim to water from the Little Colorado River and providing for a future settlement to the tribes' claims to the Lower Colorado River. The legislation was removed at the request of the Navajo Nation and the Hopi Tribe as a result of further discussions with their respective Tribal Councils.

In June of 2013, the Navajo Nation re-initiated litigation originally filed on March 14, 2003. In this action, the Navajo Nation alleges that various federal agencies and entities have failed to consider the water rights of the Navajo Nation or protect their interests in the Lower Colorado River when operational decisions were made resulting in detriment to the Navajo Nation's water rights. Arizona is an intervener in this action. This re-initiation of litigation was a result of unsuccessful water settlement negotiations between the tribe, the federal government and State parties. As is typical in litigation, uncertainty

regarding the outcome of this case creates significant uncertainty for both the tribes and the State parties with respect to development of water supplies to meet both current and projected demands.

<u>Wildfire</u>

There were several major wildfires within this Planning Area that has altered the forest health and the possibly water yields in this area. The Rodeo-Chediski Fire in 2002 consumed about 462,600 acres, much of it in the north-central part of the Salt River Basin and most recently, in 2011 the Wallow Fire burned 538,049 acres in the Apache-Sitgreaves National Forests, becoming Arizona's largest wildfire in recorded history.

In the Southwest, fire can be among the most significant watershed disturbance agents, particularly to peak stream flows. For example, in areas severely burned by the Rodeo-Chedeski Fire, peak flows were as much as 2,350 times greater than previously measured the highest known post-fire peak flow in the Southwest. Increased peak flows can degrade stream channels and make them unstable, increase sediment production and cause flood damage. Wildfire and drought can result in vegetative changes in the Planning Area with implications for runoff, infiltration and downstream water supplies.

<u>Potash Mining</u>

Recent analysis of subsurface data largely collected in the 1960s and 1970s indicates the presence of a potash resource south of Holbrook near and under the Petrified Forest National Park. The potash deposit is located many hundreds of feet underground. Worldwide potash prices have climbed in recent years as production has not been able to keep up with demand, increasing the potential economic viability of mining this deposit. Both solution and underground mining are being evaluated to extract this ore[4]. Either option will have local groundwater impacts as source water for the solution mining would likely be groundwater derived and the deposit would need to be dewatered to mine conventionally.

<u>Protected Species and Habitat</u>

The presence of a listed species may be a critical consideration in water resource management and supply development in a particular area.

<u>Groundwater Availability</u>

Localized groundwater declines are evident in wells in isolated locations throughout the East Plateau Planning Area. These include the areas around the large coal fired powers plants, the Coronado, Springerville, and Coronado Generating Stations. Additionally, groundwater levels in the vicinity of Pinetop-Lakeside have declined significantly in recent years in response to increased pumping and climate-forced reductions in recharge as a consequence of lower than normal precipitation.

The groundwater mining occurring in the East Plateau Planning Area, attributable to localized municipal and industrial uses, is consistent with State law. Use of groundwater outside of the AMAs is governed by the doctrine of reasonable and beneficial use[5]. While ADWR has no evidence that the existing water uses in the Planning Area would not meet this standard, dropping water tables result in reduced well yields and increased pumping costs, and can have other physical consequences, including, but not

[4] Rauzi, 2008

[5] *A.R.S. §45-453(1)*

limited to: degradation of water quality, disruption of historic groundwater flow paths, land subsidence, and earth fissuring.

Reversing these declining water tables would require either (1) reductions in the rate of groundwater extraction or (2) increasing the rate of replenishment of the groundwater system by either natural or artificial means.

Strategies for Meeting Future Water Demands

Resolution of Water Rights Claims

Reaching resolution regarding the water rights claims for the Navajo Nation and the Hopi Tribe is the single most important step in ensuring long-term water supply sustainability for this Planning Area. Currently, water rights settlement negotiations have stalled and the Navajo Nation has decided to proceed with its litigation against the United States on issues related to operations in the Lower Colorado River Basin. Settlement negotiations are typically more productive than litigation and result in outcomes that can provide federally financed infrastructure to deliver water to Indian communities or alternatives that guarantee water supplies are used within the state to benefit Arizona citizens. All efforts should be made to get back to water rights settlement discussions and resolution of claims that are beneficial to both tribal and non-tribal communities within Arizona.

Correspondingly, resolution of the Little Colorado River Adjudication is essential to provide long-term certainty for water users in Arizona dependent on water supplies from the Little Colorado River. 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.

Watershed/Forest Management

Much of the East Plateau Planning Area drains to the either the Salt or Little Colorado River systems. Like much of the State, past land use and fire suppression practices have resulted in compromised watershed conditions. Watershed management practices aimed at increasing watershed yield have been evaluated in Arizona showing opportunities for success. Due to the significant acreage of forested lands in this area, continuation of this process and implementation of safe and effective strategies are important to water users within and outside of this Planning Area. Combing efforts with other management initiatives (such as the Four Forest Restoration Initiative) is a cost-effective way to progress this option and can provide multiple healthy benefits to this Planning Area and those dependent on its resources. 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[6]. Restoration of forest and range lands within the Planning Area may serve to improve wildlife forage and livestock grazing conditions, reduce wildfire threats, and provide increased water yields for local and downstream users.

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

Weather Modification

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

Reclaimed Water Reuse

Formal wastewater treatment in the East Plateau Planning Area is largely conducted in lagoon-based wastewater treatment plants, with evaporation as the principal disposal practice. Increasing the utilization of this resource would likely require upgrading wastewater treatment works throughout the Planning Area to produce reclaimed water of a quantity suitable for reuse or aquifer enhancement.

Expanded Monitoring & Data Collection

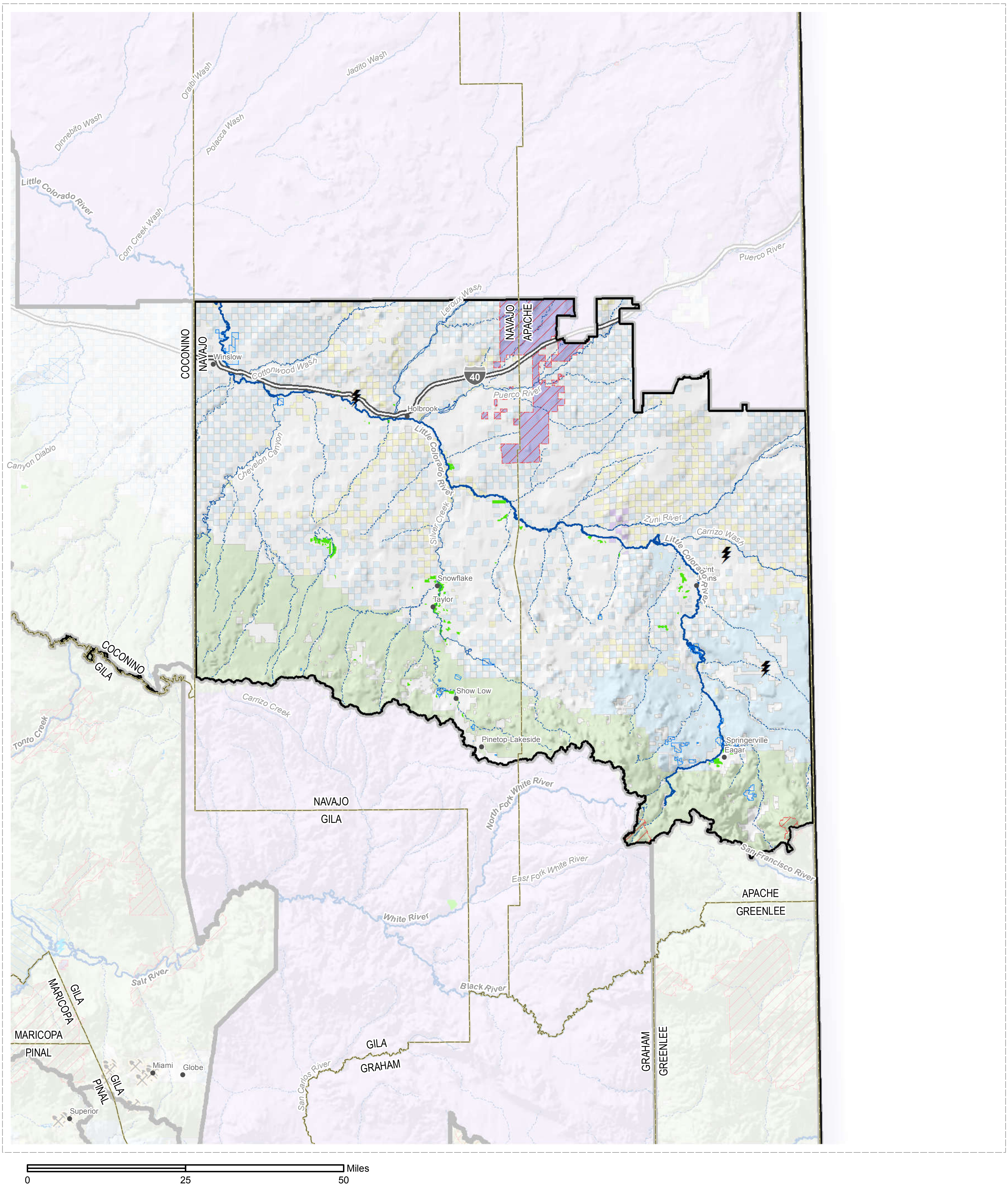
Monitoring of water use within the Eastern Plateau Planning Area is limited to the Community Water System Reports submitted by municipal water providers. Metering and reporting across the Planning Area would serve to support and enhance analysis of current hydrologic conditions. Data collection is a crucial element of the development of groundwater models, which have proven to be invaluable tools throughout the State in developing more thorough understandings of hydrologic systems and evaluating future conditions and potential impacts of new uses and/or alternative water management strategies.

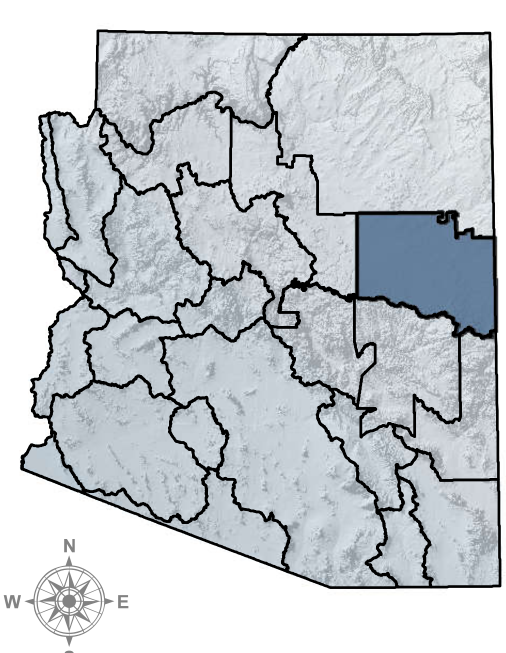
The exploration drilling and testing will increase knowledge of the local groundwater system will increase understanding of the local groundwater systems, in addition to mitigating local pumping impacts.

Increase Access to Locally Available Groundwater

Enhanced access to the groundwater resources within the East Plateau Planning Area can serve to meet current and projected water demands. Leveraging existing hydrogeologic information with additional studies, drilling and testing of wells, planning and development of water delivery and storage infrastructure, and monitoring and modeling will provide a basis for prudent use of this resource. Given the dispersed nature of the population throughout the Planning Area, this option will likely entail the development of many small to moderate scale groundwater production, transmission and distribution elements.

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)
River or Stream (ASLD)
Interstate (ADOT)
Population Center (GNIS)
Mine (ADMMR, ADWR)
Hydroelectric Power Plant (ADEQ, ADWR)
Thermoelectric Power Plant (ADEQ, ADWR)

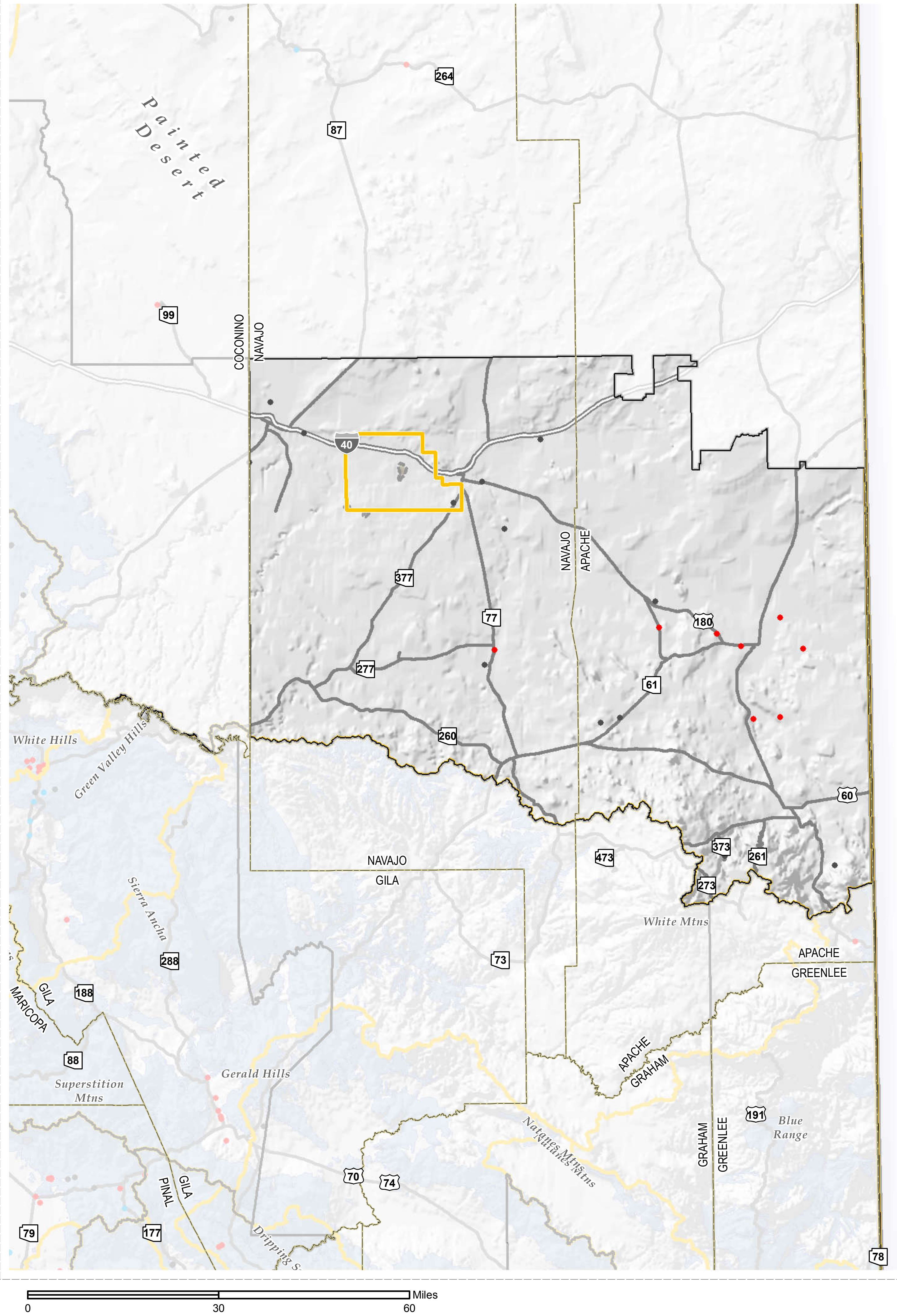
Agriculture (SWReGAP, 2004)
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation Land (AZGFD, AZSP)
BLM Land
National Forest
National Park
Military Reserve
Private and Other Land
State Trust Land
Tribal Land

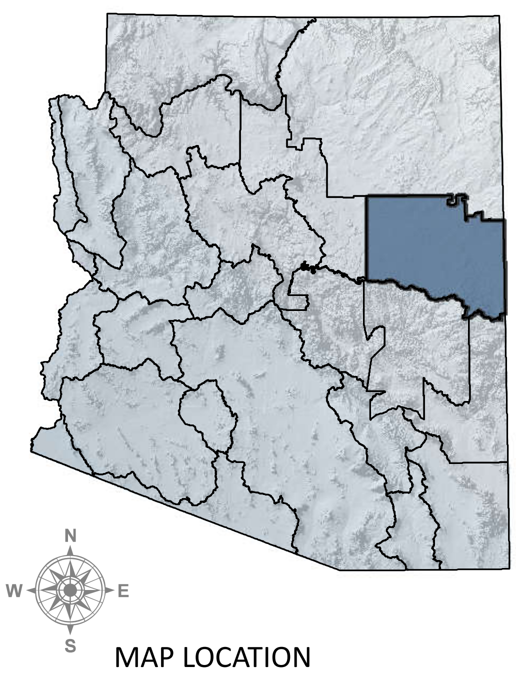
Figure P.A.9-1

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

East Plateau 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.





- 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)

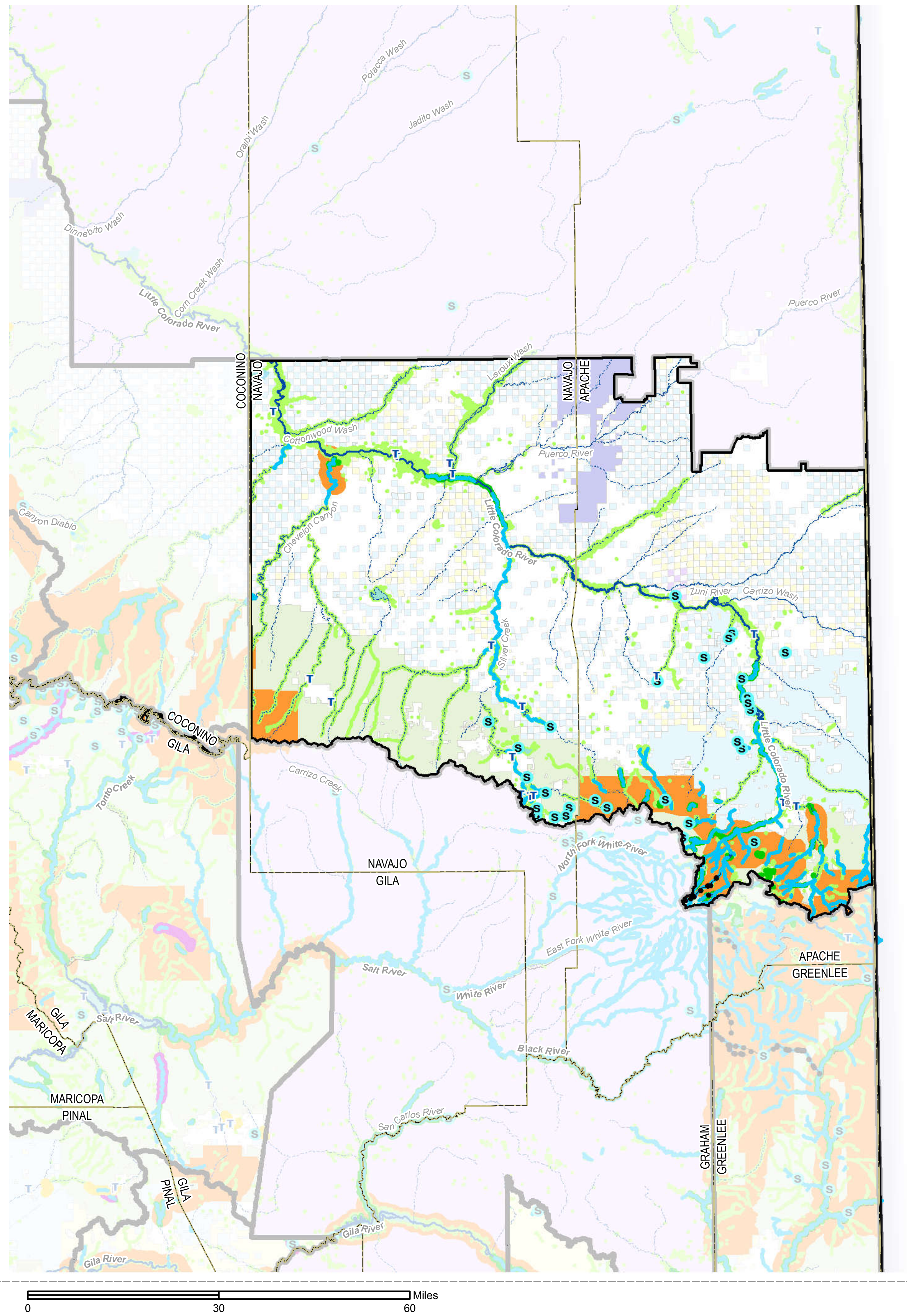
Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

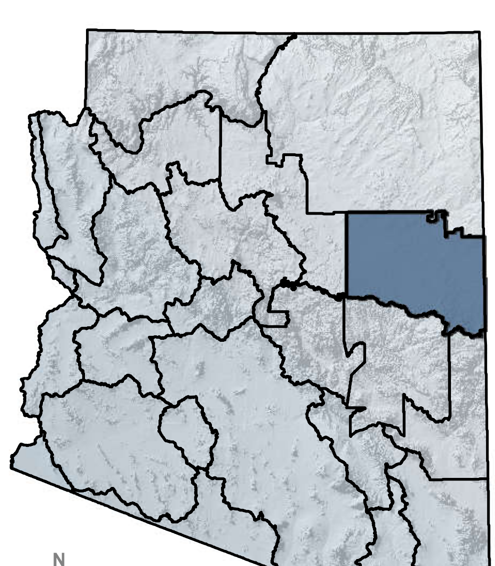
* Data provided by ADWR

Figure P.A.9-2

East Plateau 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)

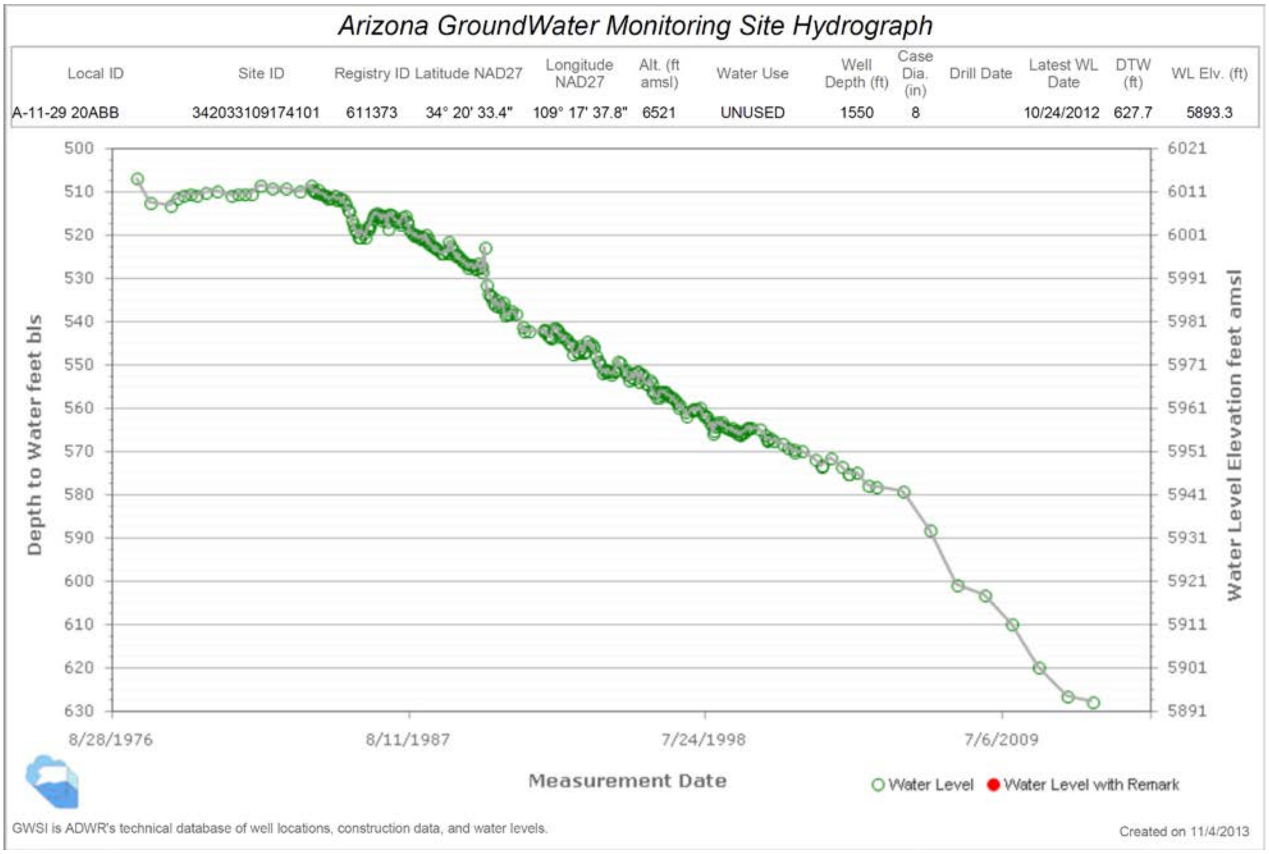
Planning Area (ADWR)
State (ALRIS)
County (ALRIS)
Reservoir or Lake (NHD)
Waste Water Treatment Plant (ADEQ)
Major Spring (ADWR, Pima County)
Perennial Flow (ADEQ, USGS)
River or Stream (ASLD)
Outstanding Arizona Water (ADEQ)
Effluent Dependent Stream (ADWR, NEMO)
Instream Flow Certificate (ADWR)

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

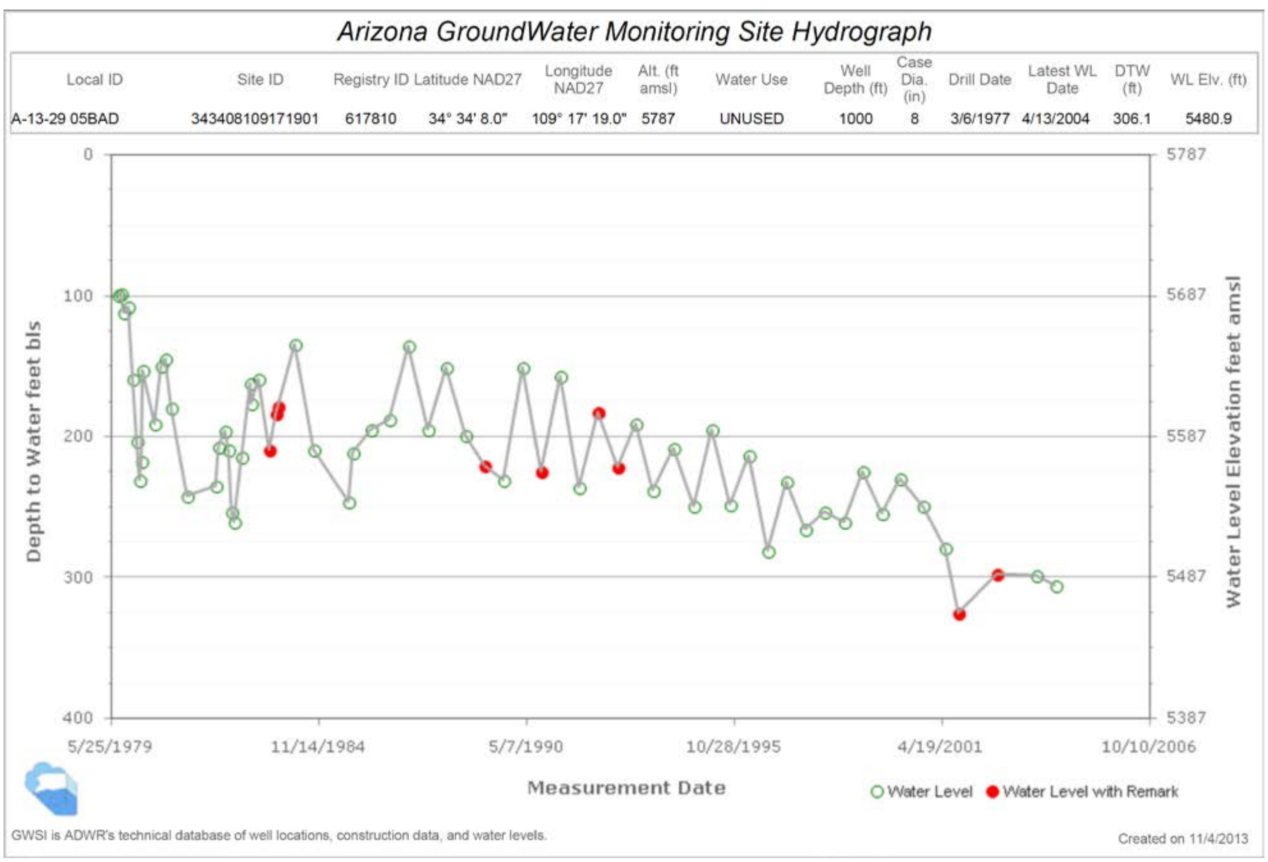
Figure P.A.9-3

East Plateau
Surface Water and Natural Features

Little Colorado River Plateau – East Plateau Planning Area



A-11-29 20ABB Little Colorado River Plateau basin about 2.5 miles east of Lyman Lake.



A-13-29 05BAD Little Colorado River Plateau basin about 7 miles NE of St. Johns.

[GILA BEND PLANNING AREA]

Gila Bend Planning Area

Background

The Gila Bend Planning Area is located entirely within Maricopa County in the southwest portion of the state, contiguous to the southwest boundary of the Phoenix Active Management Area (AMA) and the western boundary of the Pinal AMA. The Planning Area contains the entire Gila Bend Groundwater Basin; an area of approximately 1,284 sq. miles, and encompasses a small portion of the Agua Fria River-Lower Gila River watershed (the southern part of the Lower Gila-Painted Rock Reservoir Watershed). There is limited population in the Planning Area and the Town of Gila Bend is the largest population center in the Planning Area.

Approximately 78 percent of the land in the Gila Bend Planning Area is under federal ownership (*see Figure P.A. 10-1*). The US Bureau of Land Management (BLM) owns and manages just over 41 percent, including portions of the Sonoran Desert National Monument and Woolsey Peak Wilderness Area. The primary land uses on BLM lands are resource conservation, recreation and livestock grazing. The US military owns and operates approximately 34 percent of the land in the Planning Area as the Barry M. Goldwater Air Force Range. Roughly 16 percent of the land is under private ownership, with land uses that include domestic, commercial, irrigated agriculture and livestock grazing. Small portions of land within the Planning Area are held as State Trust Lands or under tribal ownership. The primary land use on the State Trust Lands is livestock grazing.

Water Supply Conditions

Groundwater

The Gila Bend 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 most productive wells are generally located along the alluvium in the floodplain of the Gila River. Groundwater formations are well-suited for artificial underground water storage and recovery.

The Gila Bend Planning Area has generally experienced water level declines throughout the Basin (*see Figure P.A. 10-2*). In some areas, significant declines have been observed and cones of depression have formed due to historic groundwater pumping. Groundwater levels declined significantly ranging from 0.06 to greater than 7 feet per year between 1993 and 2013. During that period, the mean annual water level decline rate was the greatest, on average, of any Basin in the state. In one location along the Gila River approximately eight miles north of the Town of Gila Bend, the water level has declined approximately 146 feet between 1992 and 2012.

Annual natural recharge estimates range from 10,000 to 37,000 acre-feet per year. The largest source of natural recharge in the Planning Area occurs from Gila River flood events and infiltration of water impounded behind Painted Rock Dam. Incidental recharge from agricultural irrigation also contributes to available groundwater in the Planning Area. Groundwater storage estimates range widely from 17 to 61 MAF.

Within the Gila Bend Basin notable land subsidence has occurred and is likely to be an ongoing process. Land subsidence develops where fine-grained sediments have compacted as water tables are drawn down by groundwater pumping. Current land subsidence of 0.5 to 1.5 cm over a two year period (2006 to 2008) has occurred within some areas of the Basin, however a maximum of 3 to 4 cm has been observed in some areas with significant water level declines.

Groundwater quality is generally poor across the Basin, with naturally occurring arsenic and fluoride levels exceeding drinking water standards. High concentrations of total dissolved solids (TDS) and nitrate exceeding drinking water standards have been detected in many wells. There are no identified water quality mitigation sites within the Planning Area.

<u>Surface Water</u>
The Gila River is the only major surface water supply in the Planning Area (*see Figure P.A. 10-3*). Gila River water, combined with reclaimed water discharged from the Phoenix AMA, is used for agricultural water supplies in the northern part of the Planning Area where they are diverted at Gillespie Dam into the Gila Bend and Enterprise canals. The Gila River is intermittent 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, water pumped from dewatering wells located in the Phoenix AMA Basin (wells used to manage groundwater levels beneath irrigated areas), and reclaimed water discharges from the 23rd Avenue and 91st Avenue Wastewater Treatment Plants (WWTPs) located in the Phoenix AMA. The Planning Area contains one large reservoir, Painted Rock Reservoir, with a maximum storage of 4,831,500 acre-feet. This reservoir is used for flood control and has only filled during large flood events. Flow records collected from stream gauges in the Planning Area indicate high variable annual flows ranging from 0 acre-feet per year to a maximum of 5,675,984 acre-feet per year in flood years.

<u>Reclaimed Water</u>
Reclaimed water discharged to the Gila River from the Phoenix AMA Basin is an agricultural water supply in the Gila Bend Planning Area, but the volume used is not quantified. The reuse of reclaimed water generated from within the Planning Area is minimal. There are only a few WWTPs in the Planning Area and reported disposal methods include evaporation ponds and discharge to a watercourse, about 400 acre-feet of reclaimed water is generated at the Gila Bend WWTP in the Town of Gila Bend and all is discharged to a watercourse north of the town.

<u>Ecological Resources</u>
There are no critical habitats designated in the Gila Bend Basin (*see Figure P.A. 10-3*). However, many bird species may be present in Painted Rock Reservoir after floods serving as temporary habitat. There are several conservation lands within the Planning Area: Sonoran Desert National Monument, (BLM); North Maricopa Mountains Wilderness, (BLM); South Maricopa Mountains Wilderness; (BLM); Woolsey Peak Wilderness, (BLM); Buckeye Hills Regional Park; Maricopa County Park; and Painted Rock Wildlife Area (Arizona Game and Fish Department).

Water Demands

Table P.A. 10-1 below presents the baseline and projected water demands for the Gila Bend Planning Area. Currently, over 98 percent of the water demands in the Planning Area are associated with

irrigated agriculture. These demands are projected to remain consistent throughout the projection period. Dairy demands are expected to increase significantly compared to 2010 use for this category due to development pressures and land costs in the adjacent urban centers of the state and migration of dairies from the Phoenix AMA Basin.

Large increases are also projected for water uses associated with power production. Significant power transmission resources are present in the Gila Bend Planning Area, which is attracting electrical generation activity including natural gas and solar production. Concentrating solar production (CSP) typically requires water use during construction for dust control and boiler cooling. The Solana Generating Station, a 280-megawatt solar thermal power plant using concentrated solar power (CSP) technology, was constructed west of the Town of Gila Bend and recently began operation. Solar Reserve is permitting the Crossroads Generating Station, a solar tower CSP, displacing farmland north of Gila Bend. Western Arizona has high potential for solar energy production which, depending on the selected technology, may lead to increased water use in the Planning Area. Concentrated solar technologies require an average of 900 gallons of water per Megawatt hour (MWh) generated or about 2,000 acre-feet per year. The increased industrial uses are also projected to result in increases in local populations and municipal demands.

Table P.A. 10-1. Projected Water Demands (in acre feet) - Gila Bend Planning Area

Sector	2010	2035	2060
Agriculture	351,500	351,500	351,500
Dairy	173	5,281	13,814
Feedlot	0	0	0
Municipal	867	1,332	1,672
Other Industrial	0	0	0
Mining	0		
High		0	0
Low		0	0
Power Plants	5,400		
High		26,147	33,434
Low		19,102	23,435
Rock Production	0		
High		136	171
Low		57	71
Turf	0		
High		0	0
Low		0	0
Total (High)	**357,940**	**384,396**	**400,591**
Total (Low)	**357,940**	**377,272**	**390,492**

Characteristics Affecting Future Demands and Water 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, particularly in the eastern portion of this Planning Area, will make it difficult to identify strategies for meeting the projected water demands.

Land Use

Because less than 22 percent of the area is in private or State Trust ownership, development of this area is limited, although municipal demands are projected to almost double to 1,867 acre feet in 50 years. The remaining land is federally controlled and a large portion of that is either military or national monument, which will not likely be developed beyond its existing uses. The potential for expansion of power facilities by nearly 30,000 acre feet and a projected increase in dairy operations is a factor that needs to be considered and a projected demand for which water supplies are important.

Limited Renewable Water Supplies

Below Painted Rock Dam, the Gila River is mostly dry and, therefore, does not provide a secure water supply for future growth. Prior to 1993, when Gillespie Dam was breached during a flood, more surface water was diverted for agricultural purposes. 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. However, water users have enjoyed the benefit of discharges of reclaimed water and dewatering pumping from the southwest portions of the Phoenix AMA Basin.

Outside of the agricultural area in the north central portion of the Planning Area (Gila Bend Canal and Enterprise Canal Companies), water use is primarily dependent on groundwater supplies. Groundwater quality is generally poor across the Planning Area with several measurements of arsenic and fluoride concentrations meeting or exceeding drinking water standards as well as high concentrations of TDS and nitrate. Water quality is generally acceptable for non-potable uses but treatment for potable uses will need to be addressed for future municipal expansion.

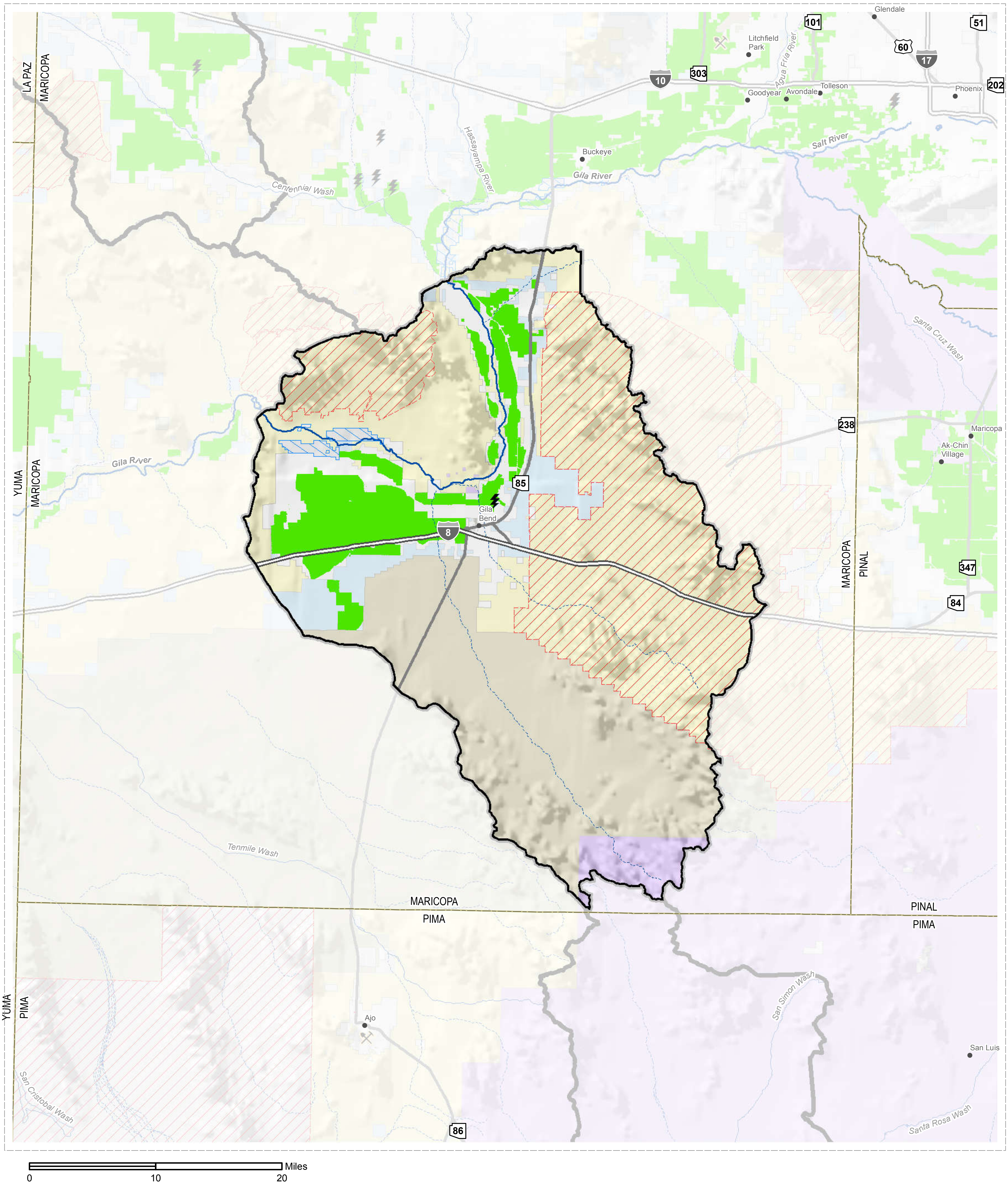
The limited availability of renewable water supplies for uses other agriculture (and the unknown quantity of reclaimed water availability and use) puts additional demands on groundwater supplies to meet projected demands.

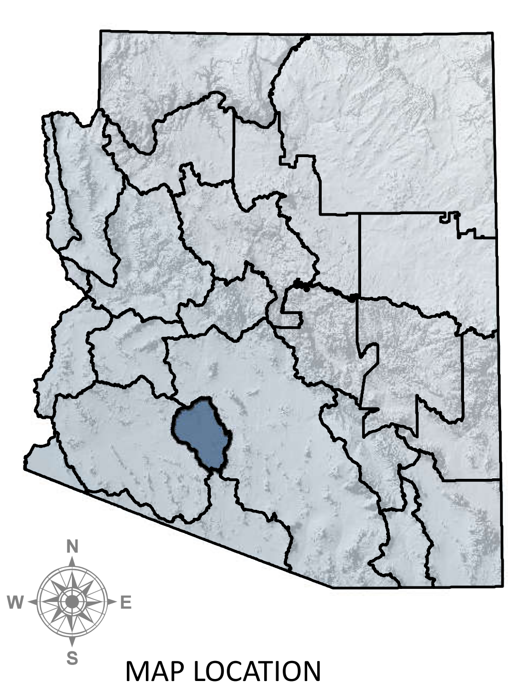
Strategies for Meeting Future Water Demands

In general, groundwater supplies may be sufficient to meet the projected increases in municipal water demands, although water quality will likely require increased treatment as water use increases. Additionally, the availability of reclaimed water in the region will grow as population grows. Currently, reclaimed water generated in the municipal system is discharged but could be treated in mechanical plants to standards that allow for either direct deliveries to non-potable uses or utilized through artificial recharge and recovery to mitigate increases in future demands.

Meeting the needs of expanded electrical generation in the Planning Area will need to be evaluated. Currently groundwater level declines raise concerns in select areas. If expanded electrical generation is the primary expansion of projected water use, the need for more information on actual water demands in the area needs to be addressed. Additionally, groundwater modeling could be a good tool to identify the most appropriate colocation of sustainable groundwater development and sustainable energy development in the region. Increased water use metering and reporting would serve to improve the accuracy of future groundwater models. Finally, resolution of the Gila River General Stream Adjudication will support long-term certainty of water supply availability in this 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.





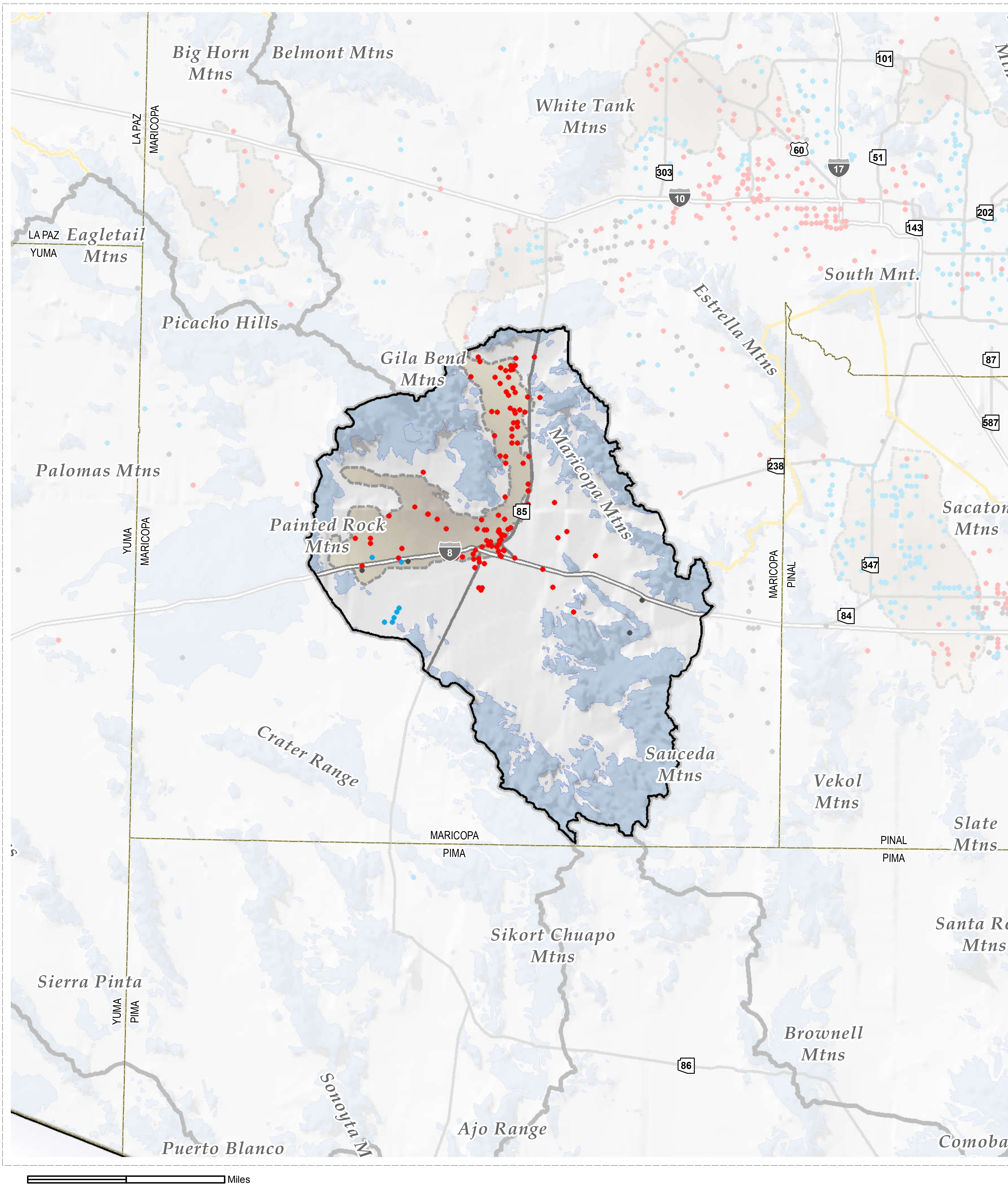
MAP LOCATION
(Planning Area Boundaries)

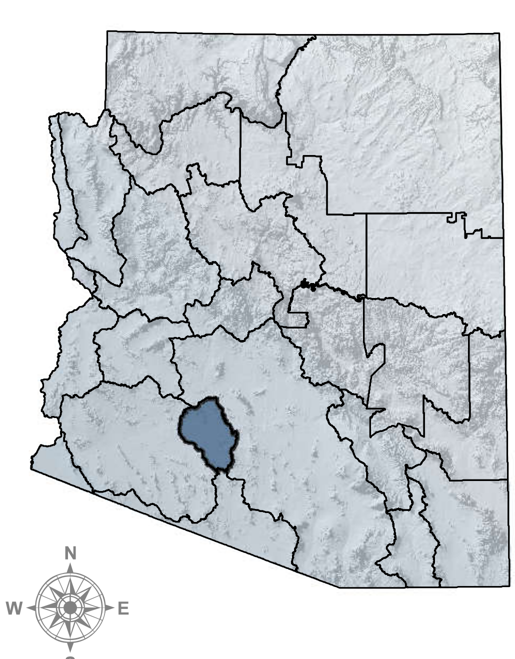
- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- River or Stream (ASLD)
- Interstate (ADOT)
- Population Center (GNIS)
- Mine (ADMMR, ADWR)
- Hydroelectric Power Plant (ADEQ, ADWR)
- Thermoelectric Power Plant (ADEQ, ADWR)
- Agriculture (SWReGAP, 2004)
- Federal Conservation Land (USFS, BLM, 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.10-1

Gila Bend 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)

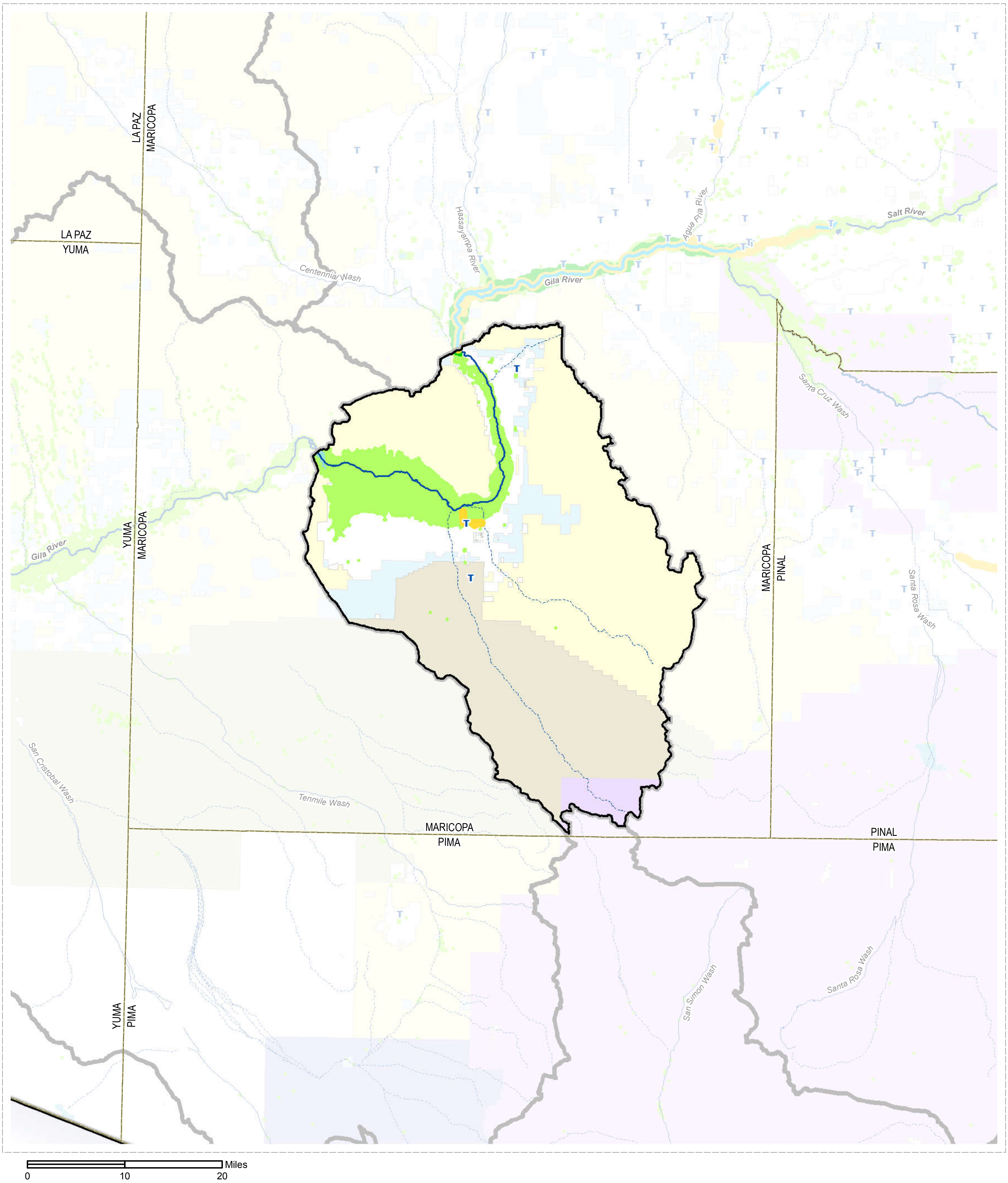
Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

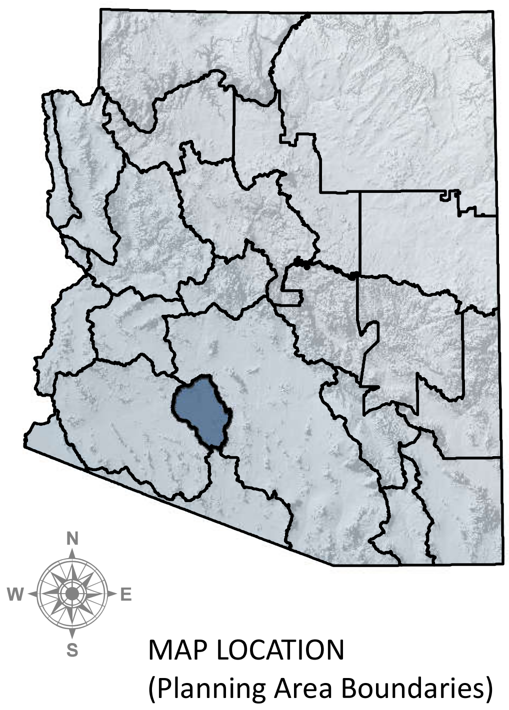
* Data provided by ADWR

Figure P.A.10-2

Gila Bend 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)

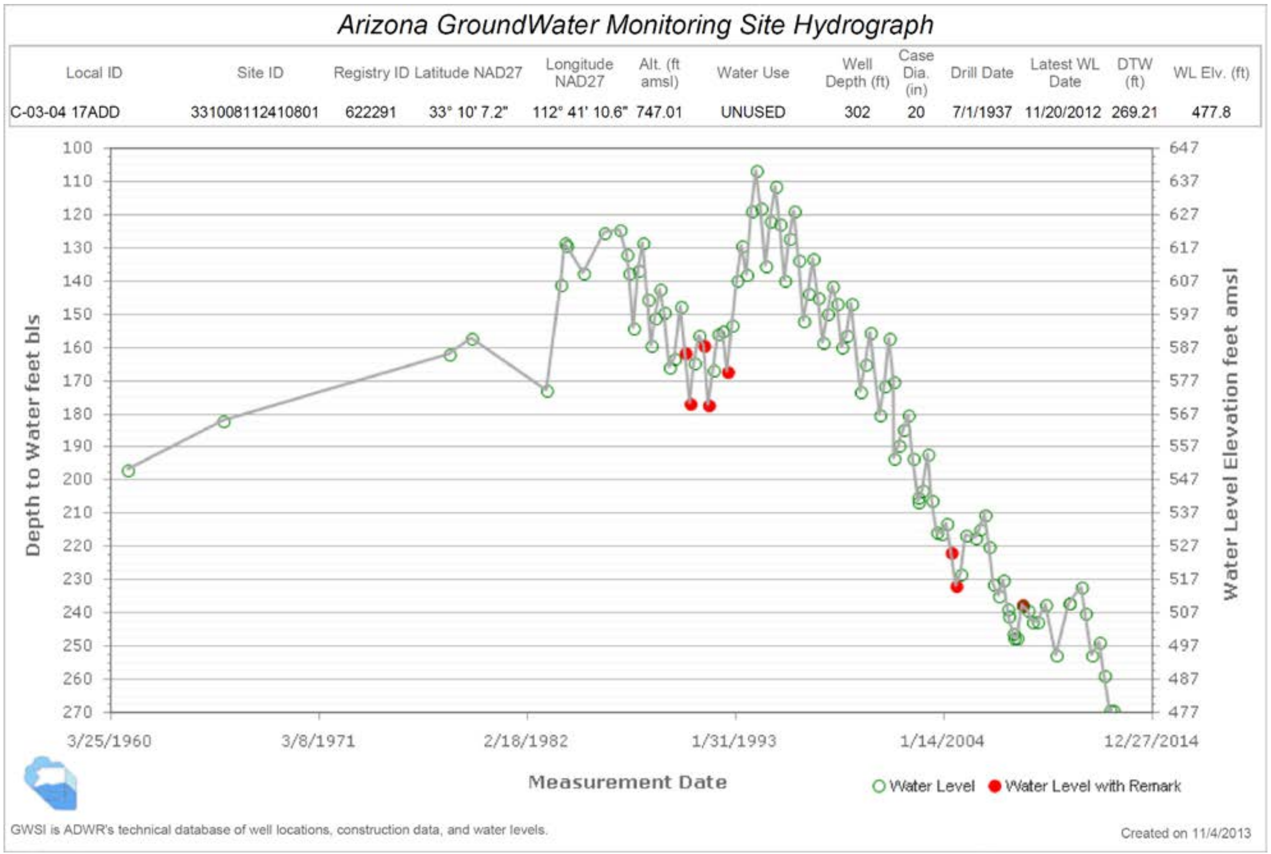
- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- Reservoir or Lake (NHD)
- Waste Water Treatment Plant (ADEQ)
- Major Spring (ADWR, Pima County)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ASLD)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- Instream Flow 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

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

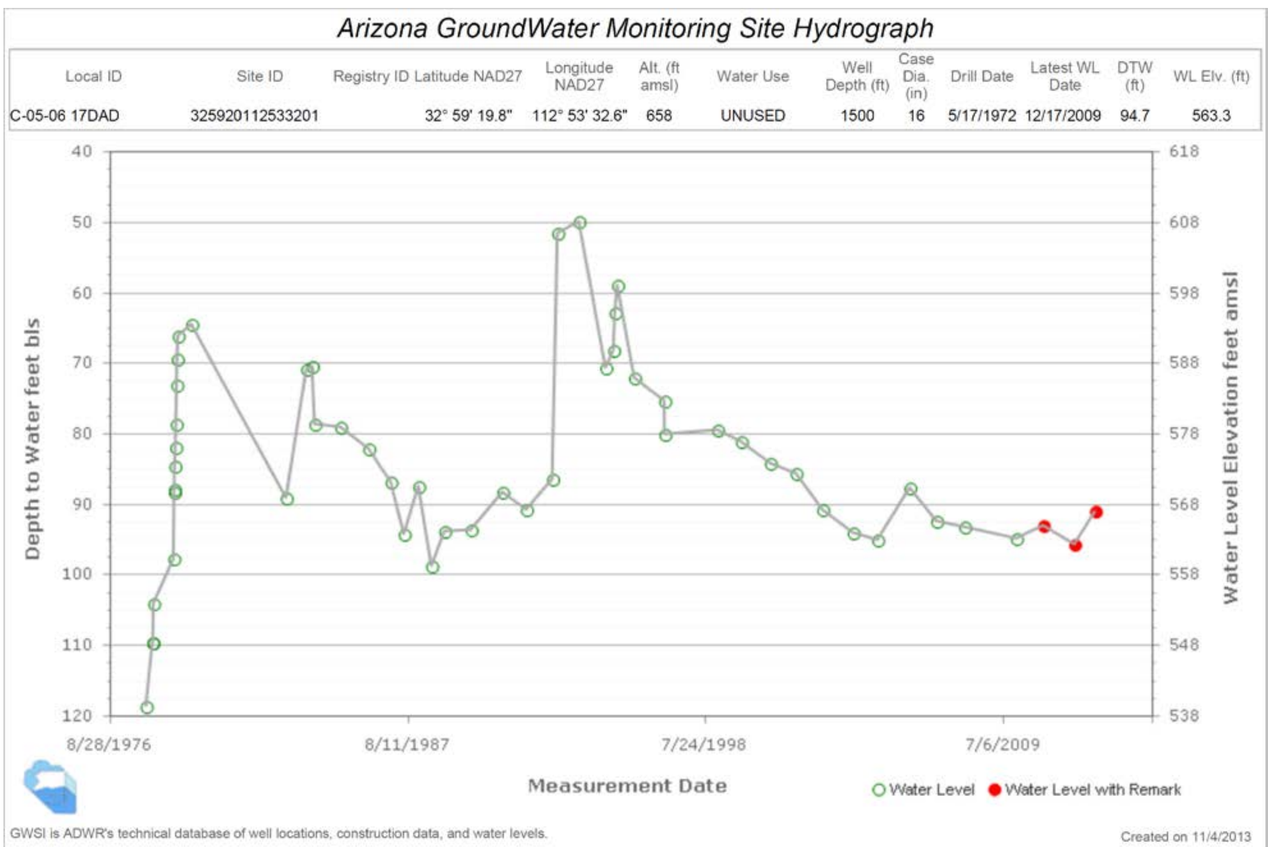
Figure P.A.10-3

Gila Bend
Surface Water and Natural Features

Gila Bend Basin – Gila Bend Planning Area



C-03-04 17 ADD – Gila bend basin. – about 8 miles N of Gila Bend along Gila River.



C-05-06 17DAD – Gila Bend basin -- 5 miles north of Theba in the Paloma Ranch area near the Gila River.

[HASSAYAMPA/AGUA FRIA PLANNING AREA]

Hassayampa/Agua Fria Planning Area

Background

The Hassayampa/Agua Fria Planning Area is located in the central portion of the State, immediately adjacent to the northern boundary of the Phoenix AMA. Lands within the Planning Area are located primarily within Yavapai County. A very small portion at the southern extent of the Planning Area is located within Maricopa County. The Hassayampa/Agua Fria Planning Area is contained within the northern portion of the Agua Fria-Lower Gila River Watershed. The Planning Area encompasses entirely both the Upper Hassayampa and Agua Fria groundwater basins. Notable communities within the Planning Area are Wickenburg, Congress, Black Canyon City, and Mayer.

The majority of the land within this Planning Area is federally owned and managed by two agencies, the USDA Forest Service (Forest Service) and the US Bureau of Land Management (BLM) (*see Figure P.A. 11-1*). The Forest Service manages land as part of the Prescott National Forest. Land uses are recreation, livestock grazing and timber production. Castle Creek and a portion of Pine Mountain Wilderness Areas are located within Forest Service lands. BLM lands include the Agua Fria National Monument and the Hassayampa River Canyon and Hells Canyon Wilderness Areas. Land uses are recreation and livestock grazing. State Trust Lands are located throughout the Planning Area. Livestock grazing is the primary land use on the State Trust Lands. Private land is located throughout the Planning Area interspersed with State, BLM, and Forest Service lands. There are also numerous small private land in-holdings in the Prescott National Forest. Private land uses include domestic, commercial, and livestock grazing.

Water Supply Conditions

Groundwater

The northern portion of the Hassayampa/Agua Fria Planning Area is located in the Transition Zone Physiographic Province. The mountainous terrain of this region have aquifers that consist of relatively thin alluvial aquifers, and in fractured crystalline, sedimentary, and volcanic rock. The southern portion of the 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.

Overall, minor water level fluctuations have been observed in wells within both the Agua Fria and Upper Hassayampa basins (*see Figure P.A. 11-2*). In much of the northern half of the Planning Area, groundwater occurs in volcanic rocks that yield small volumes of water. One water level hydrograph in this region near Mayer has shown steady water levels over the last several years.

In the southern portion of the Planning Area, basin-fill deposits that have relatively high water yields are typically encountered. Hydrographs of water level measurements in wells near Wickenburg and Black Canyon City have also remained relatively constant over the past 30 years.

No State or federal water quality remediation sites have been identified within the Planning Area. Groundwater quality issues related to naturally occurring arsenic and fluoride have been encountered in multiple locations in the Planning Area.

<u>Surface Water</u>
The two primary surface water features in the Agua Fria-Hassayampa Watershed are the Agua Fria and Hassayampa Rivers (*see Figure P.A. 11-3*). Both rivers generally flow north to south in the Planning Area. Lake Pleasant, which is impounded by New Waddell Dam, is located at the southern boundary of the Agua Fria Basin and stores water flows from the Agua Fria River (the reservoir is also used to store CAP water for the operations of the project). The Agua Fria River is perennial along several reaches within the Planning Area.

There are three active streamgage stations along the Agua Fria River. The minimum and maximum annual flow in the Agua Fria River near Rock Springs (upstream of Lake Pleasant) was 1,528 acre-feet (1975) and 360,541 acre-feet (1992), respectively. There are currently no operating streamflow gages along the Hassayampa River.

<u>Reclaimed Water</u>
There is limited reclaimed water production within the Planning Area. The largest volume of reclaimed water is produced at the Wickenburg WWTP. Reclaimed water from this facility is discharged to unlined impoundments for aquifer recharge. Reclaimed water disposal methods from the other small wastewater treatment facilities within the Planning Area either discharge to watercourses or are unknown.

<u>Ecological Resources</u>
The Agua Fria River and its tributaries support riparian systems, and drain into Lake Pleasant—a popular recreation area for boating and fishing (*see Figure P.A. 11-3*). Many important aquatic and riparian wildlife species occur within the riparian forests and along the shores of Lake Pleasant. Critical habitat is designated for the Gila Chub and Mexican Spotted Owl. The Nature Conservancy Hassayampa River Preserve and several federally-managed Wilderness Areas are located within the Planning Area. Much of the southern portion of the Upper Hassayampa Basin is identified as an important wildlife linkage for the Bighorn Sheep, Badger, Mountain Lion, Mule Deer, Black-tailed Jackrabbit, Desert Tortoise, Gila Monster, hawks and several fish species.

Water Budget
Table P.A. 11-1, below, presents the baseline and projected water demands for the Hassayampa/Agua Fria Planning Area. Municipal use is the largest water demand sector and the volume is projected to double by 2060. Population growth in the northern section of the Phoenix metropolitan area will likely expand into the Planning Area as current communities such as Wickenburg grow and State Trust Lands are sold and developed. Although this demand sector is projected to double, the overall demand estimate is anticipated to be approximately 9,200 acre-feet per year by 2060. Other demand sectors have minimal current or projected water use. In 2060, municipal use is anticipated to represent approximately 75% of the total water use in the Planning Area.

TABLE P.A 11-1. Projected Water Demands (in acre feet) - Hassayampa/Agua Fria Planning Area

Sector	2010	2035	2060
Agriculture	1,800	1,800	1,800
Dairy	786	786	786
Feedlot	0	0	0
Municipal	4,595	7,547	9,239
Other Industrial	0	0	0
Mining	0		
High		0	0
Low		0	0
Power Plants	0		
High		0	0
Low		0	0
Rock Production	2		
High		455	555
Low		189	231
Turf	0		
High		0	0
Low		0	0
Total (High)	**7,183**	**10,588**	**12,380**
Total (Low)	**7,183**	**10,322**	**12,056**

Characteristics Affecting Future Demands and Water Supply Availability

Reclaimed Water

The storage of reclaimed water from the Wickenburg WWTP helps to recharge the aquifer which provides water management benefits to this community.

CAP Water

The Mayer Domestic Water Improvement District (DWID) originally contracted for a 332 acre-feet of CAP entitlement to be used via an exchange with entities in the CAP service area (Maricopa, Pinal and Pima counties) for rights to local surface water supplies. The Mayer DWID instead chose to sell and transfer their subcontract to the City of Scottsdale in the Phoenix AMA Basin. Monies resulting from the sale of this entitlement were placed in a trust fund account, with oversight by ADWR, to ensure that trust fund monies are used to defray expenses associated with "designing, constructing, acquiring and/or developing an alternative water supply in an amount which may include, but is not limited to, a combined net increase" in the subcontractor's "water system capacity to replace the CAP allocation" transferred to Scottsdale. Mayer has been exploring utilizing its funds for the development of local groundwater supplies.

Groundwater Availability

Compared to the deep alluvial basins found in the southern part of Arizona, high elevations, steep topography and extensive areas of bedrock in the northern portion of the Hassayampa/Agua Fria Planning Area translate into relatively minimal groundwater storage capabilities and high runoff. These conditions result in limited, drought-sensitive water supplies for some communities, such as Mayer. The geologic formations near Black Canyon City yield relatively small volumes of water to wells. Additionally, arsenic and fluoride concentrations at levels that equal or exceed drinking water standards have been detected in springs and wells near Black Canyon City and at Castle Hot Springs. Areas of relatively high water yield include basin-fill deposits near Wickenburg in the Upper Hassayampa Basin.

Strategies for Meeting Future Water Demands

Because projected water demand increases are still relatively small for this Planning Area, no strategies are being developed at this time. However, because of the potential increases in municipal water demands, increased monitoring of aquifer conditions would support development of a comprehensive hydrologic model to better understand the long-term sustainability of the groundwater supplies in this area. Opportunities to partner with communities in the neighboring AMAs for augmenting local water supplies and wellhead treatment for water quality issues should be explored as well.

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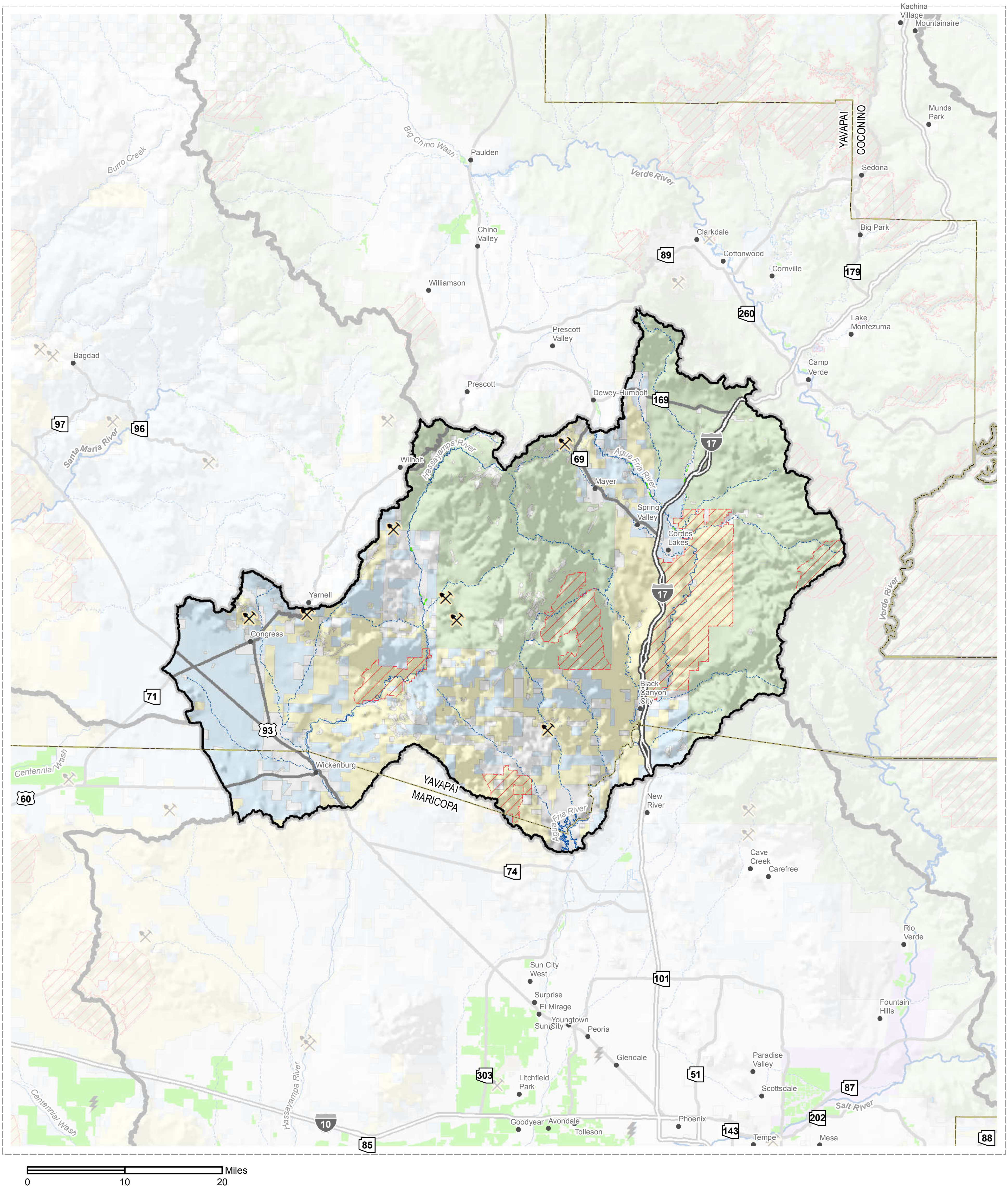

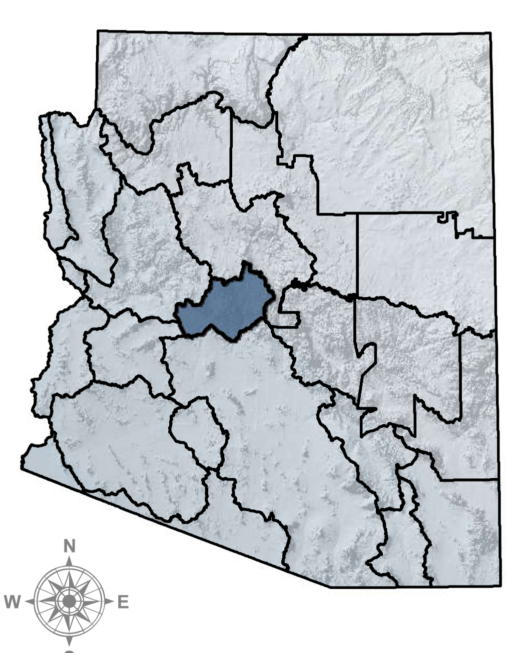

MAP LOCATION
(Planning Area Boundaries)

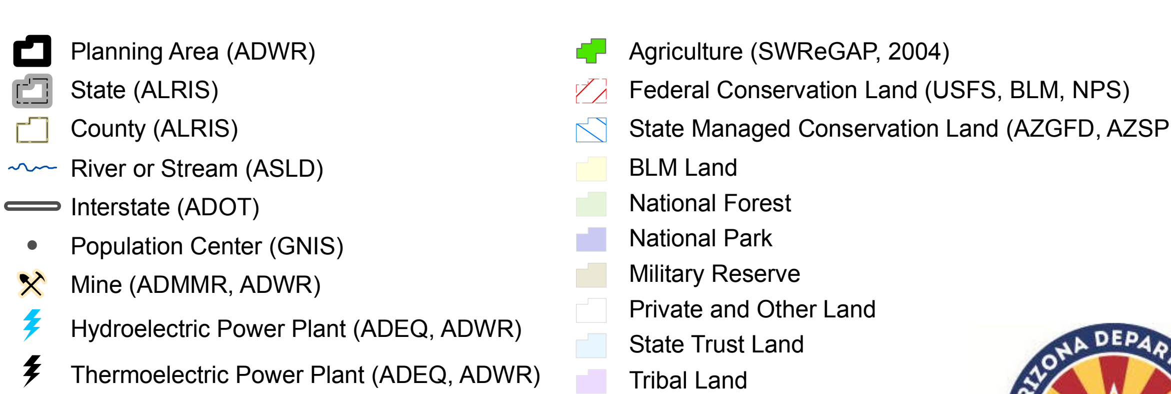

Figure P.A.11-1

Hassayampa/Agua Fria Land Ownership

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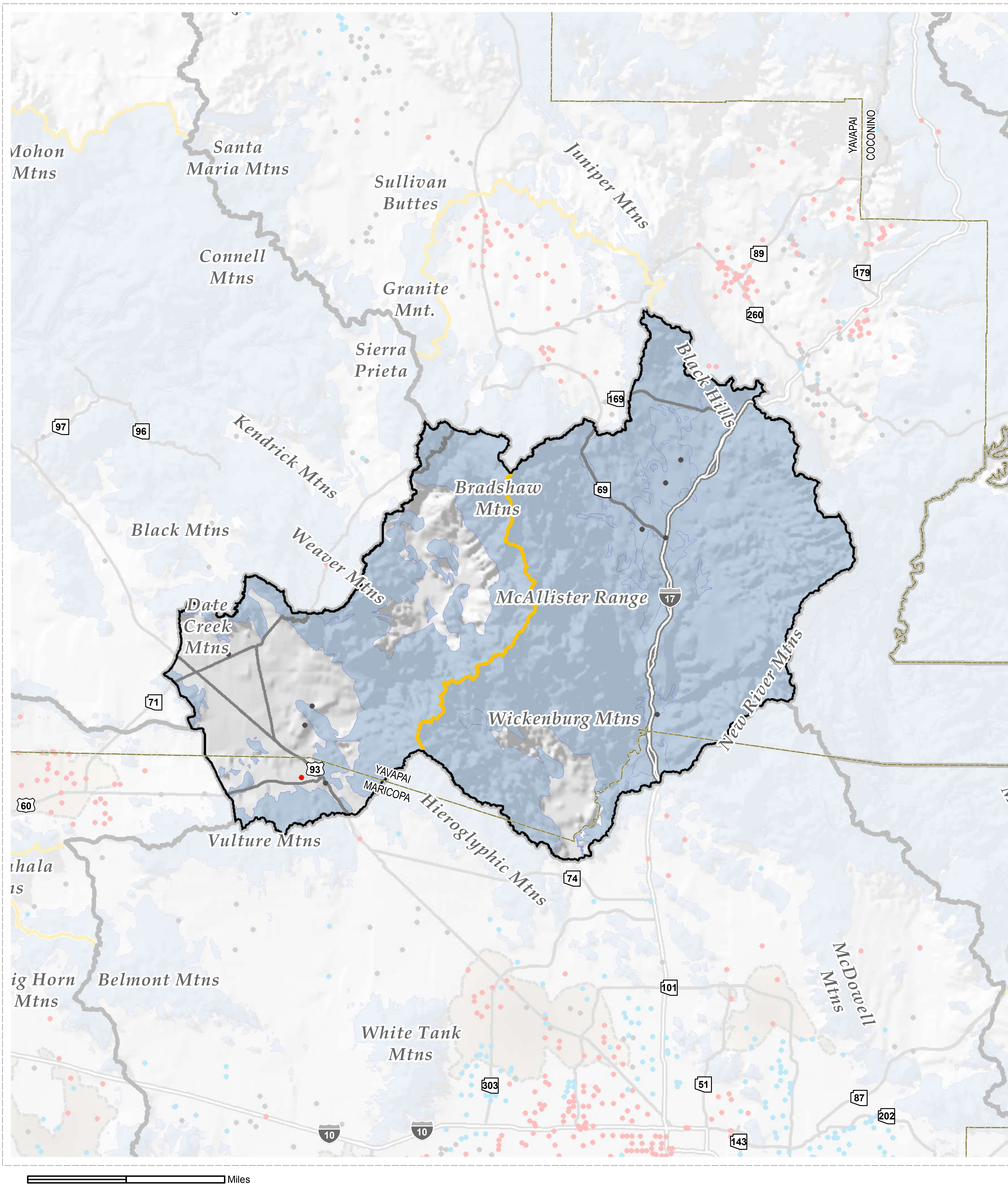
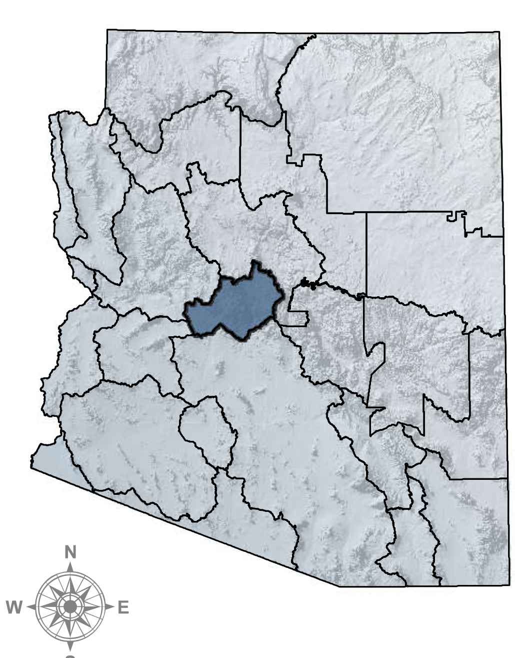




MAP LOCATION
(Planning Area Boundaries)

- 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)

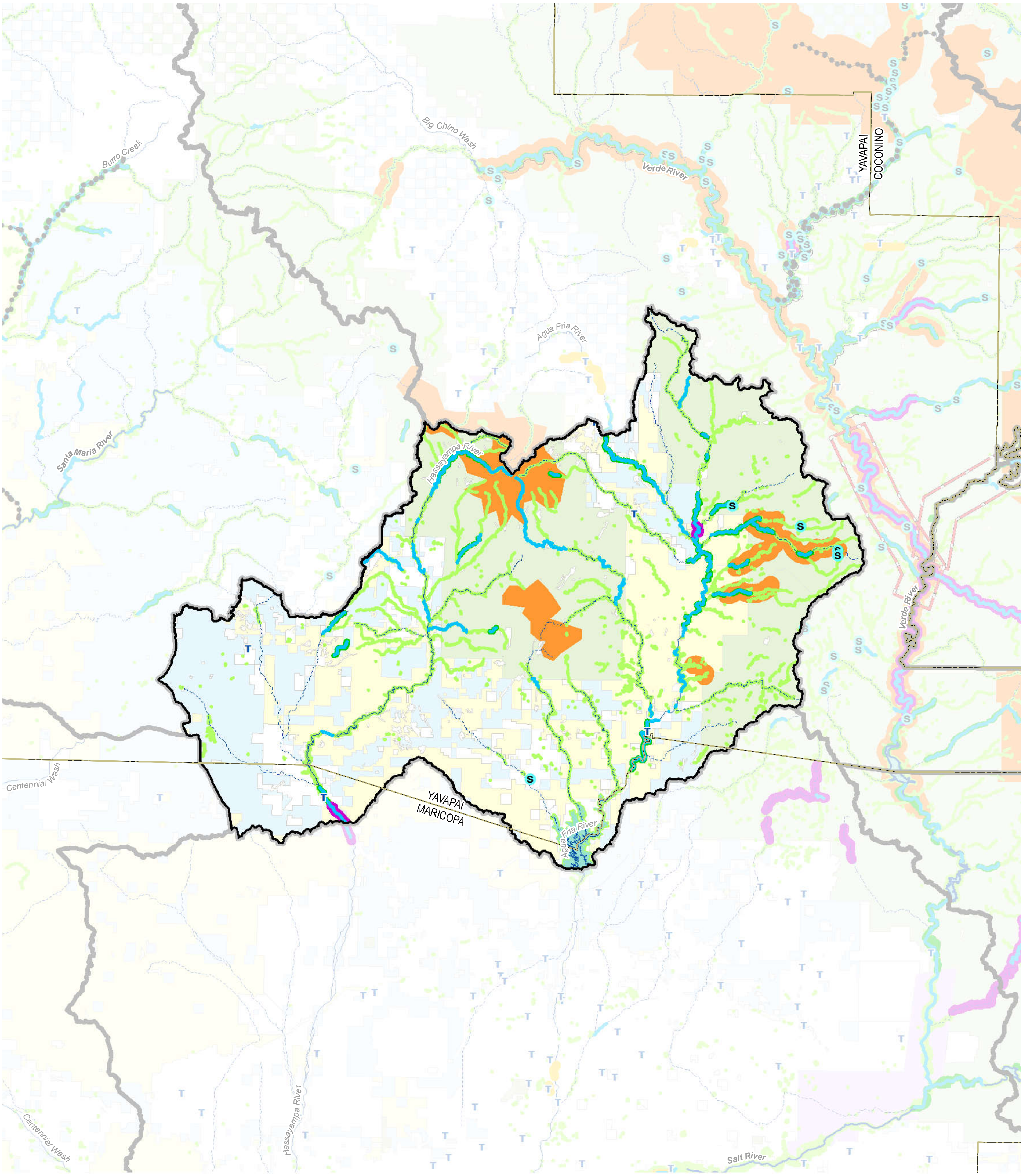
- Minor WL Change +5' to -5'
- Negative
- Positive

* Data provided by ADWR

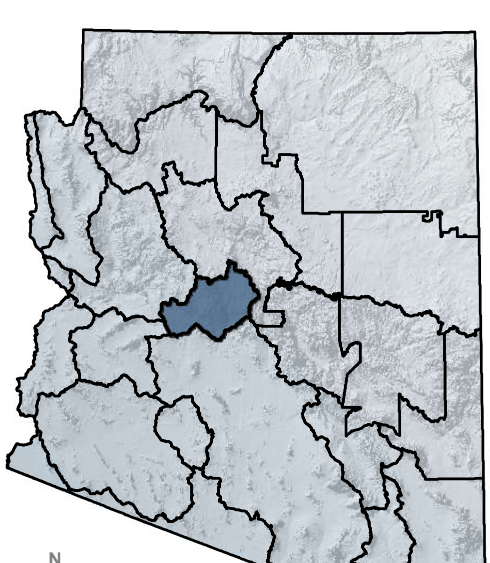
Figure P.A.11-2

Hassayampa/Agua Fria 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.



0 10 20 Miles



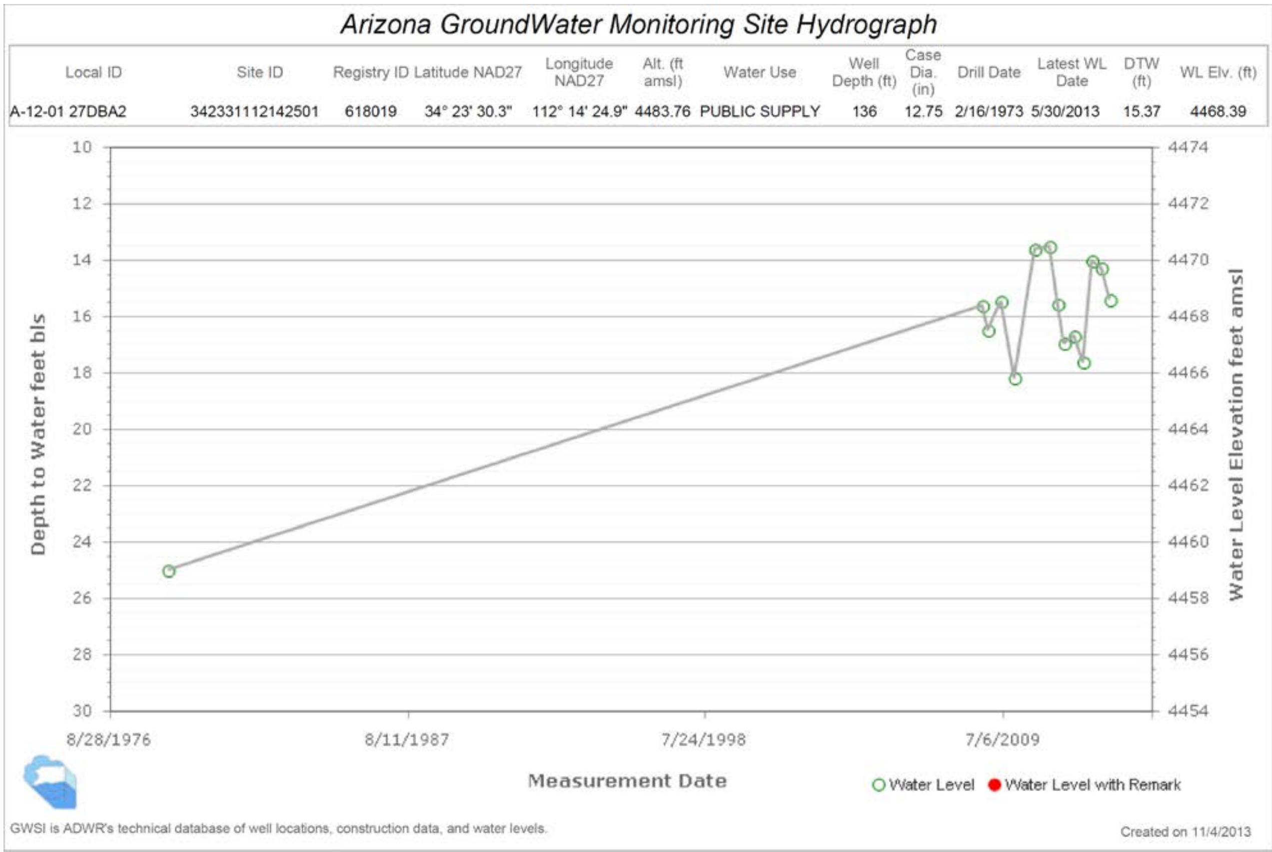
MAP LOCATION
(Planning Area Boundaries)

- 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

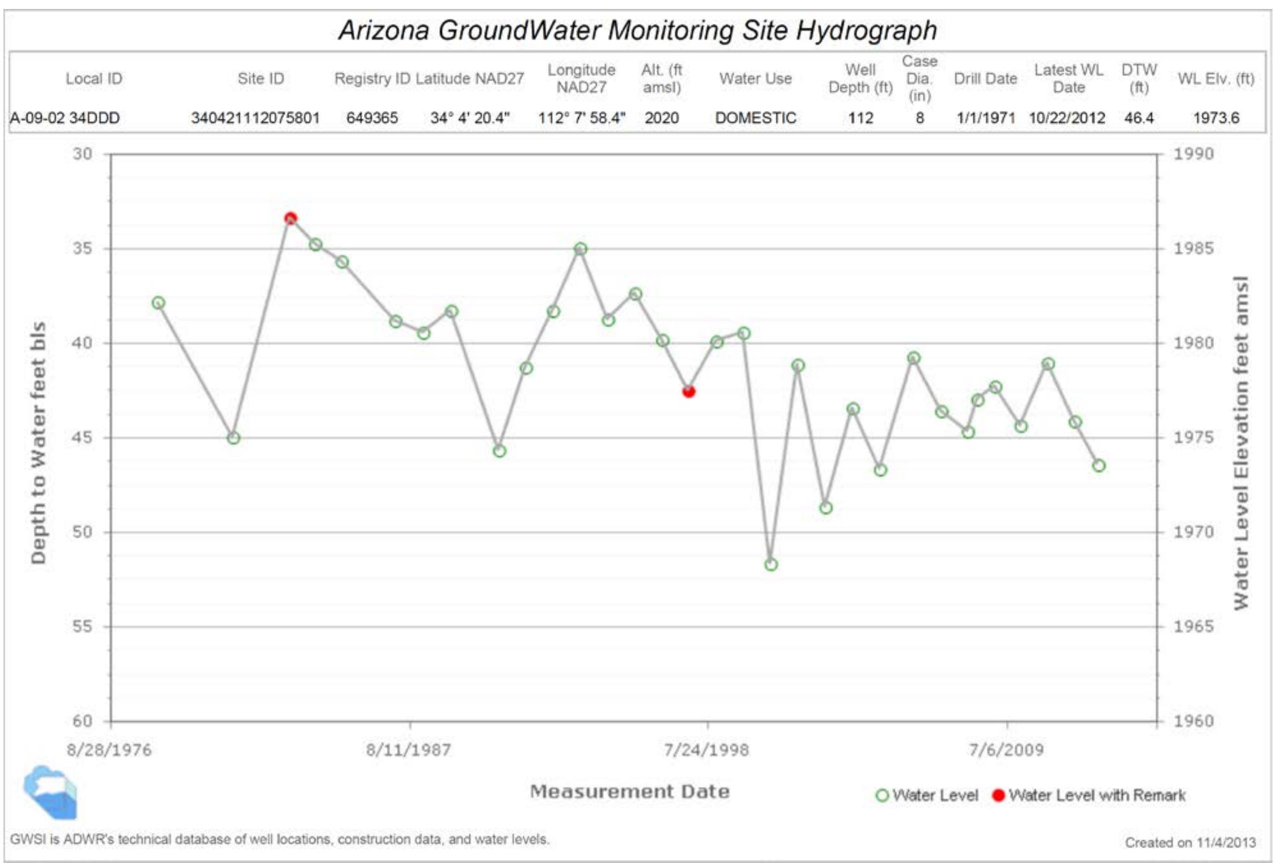
Figure P.A.11-3

Hassayampa/Agua Fria Surface Water and Natural Features

Agua Fria Basin – Hassayampa and Agua Fria Planning Area

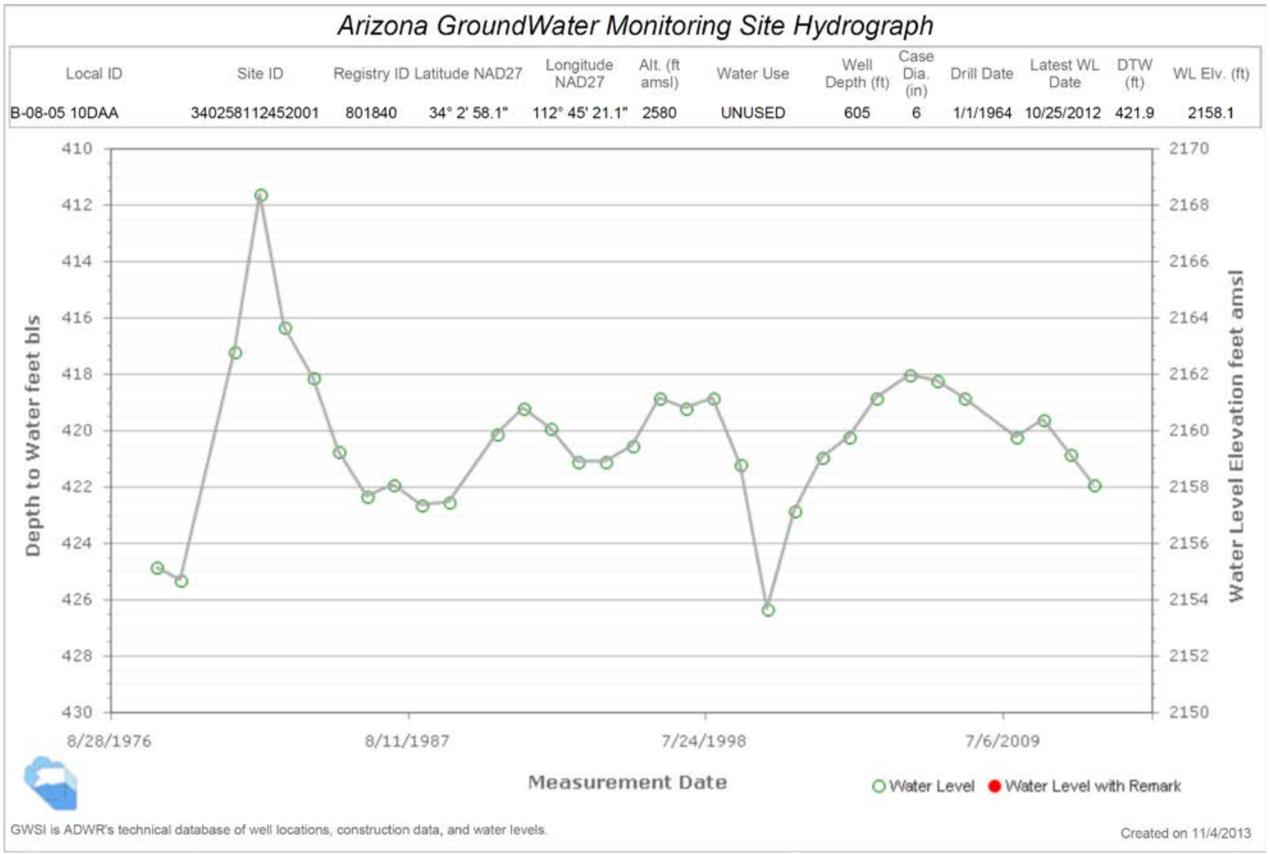


A-12-01 27DBA2 Agua Fria basin Mayer area.

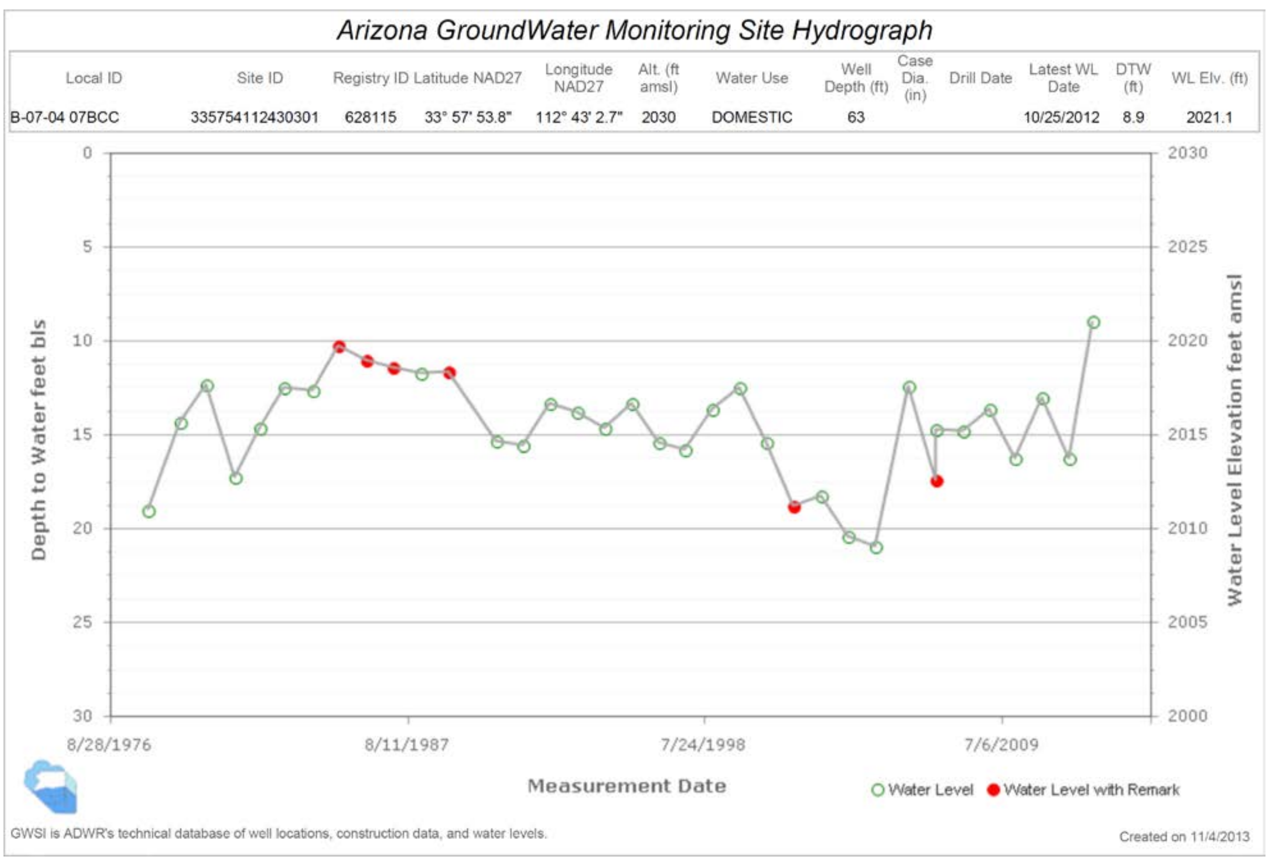


A-09-02 34DDD Agua Fria basin Black Canyon City area.

Upper Hassayampa Basin – Hassayampa and Agua Fria Planning Area



B-08-05 10DAA Upper Hassayampa basin 1 mile west of Hassayampa River and about 5.5 miles north of Wickenburg.



B-07-04 07BCC Upper Hassayampa basin Wickenburg area near Hassayampa River. Water.

[LOWER GILA PLANNING AREA]

Lower Gila Planning Area

Background

The Lower Gila Planning Area is located in the southwestern corner of Arizona and encompasses portions of Maricopa, Pima, Yuma, and La Paz counties. The Planning Area includes the entire Lower Gila Groundwater Basin comprised of three sub-basins: Childs Valley, Dendora Valley, and Wellton-Mohawk Valley. Communities include Why, Ajo, Sentinel, Hyder, Dateland, Tacna, Wellton, Dome and Fisher's Landing. A portion of the Tohono O'odam Indian Reservation is included in in the far southeastern portion of the Planning Area.

The majority of the land (86 percent) within the Lower Gila Planning Area is owned and managed by the federal government (*see Figure P.A. 12-1*). The Tohono O'odham Indian Reservation includes just over two percent of these federal lands with larger holdings by the US Military at the Yuma Proving Grounds and the Barry M. Goldwater Air Force Range (approximately 38 percent). Other federal lands include national wildlife refuges and wilderness areas (approximately 23 percent) for resource conservation, wildlife protection and recreation; the US Bureau of Land Management (BLM) owns nearly 21 percent primarily used for livestock grazing, resource conservation and recreation; and the National Park Service (nearly four percent). State Trust Lands comprise just over four percent of the lands in the Planning Area and private lands (nearly 6 percent) are interspersed across the remainder of the Planning Area, primarily along the central corridor of the Basin between Interstate-8 to the south and Antelope Hill/Hyder Road to the north.

Water Supply Conditions

<u>Groundwater</u>

The Lower Gila 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 groundwater within the Lower Gila Basin is usually found within productive basin-fill areas and in recent stream alluvium deposits. Prior to development, groundwater flow was from north and southeast toward the Gila River and then downstream to the southwest, generally paralleling the Gila River. Groundwater flow has been impacted by groundwater pumping at some locations in the Basin.

Groundwater levels in the Gila River floodplain in the western part of the basin historically ranged from 10 to 20 feet below land surface and the streambed alluvium served as the primary source of groundwater (*see Figure P.A. 12-2*). As irrigation activity increased in the 1930s, groundwater levels declined and salinity levels increased. To provide a dependable water supply for irrigation, Colorado River water was imported into to the area in 1952 with completion of the Wellton-Mohawk canal system and groundwater pumping for irrigation ceased. Incidental recharge 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.

Estimates of natural groundwater recharge range from 9,000 to 88,000 acre-feet per year, primarily from infiltration of runoff in washes and the Gila River floodplain. Underflow from the Painted Rock

Dam on the Gila River at the eastern boundary of the Planning Area and releases from the dam during and immediately following flood events also contributes to groundwater recharge. By example, water releases from Painted Rock Dam (located upstream in the Gila Bend Planning Area) in 1975 resulted in an estimated 59,500 acre-feet of recharge along the Gila River floodplain. In the far western portions of the Basin, incidental recharge from agricultural activities is the largest source of groundwater recharge. Groundwater in storage is estimated to be nearly 144 MAF.

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 characterized by elevated TDS concentrations as well as fluoride and arsenic.

<u>Surface Water</u>

The main surface drainage feature within the Planning Area is the Gila River which is intermittent, bisecting the central portion of the Planning Area from east to west (*see Figure P.A. 12-3*). Gila River flows in the Planning Area are highly variable, generally flowing now only in response to precipitation events, irrigation return flows, or releases from upstream dams. Near its confluence with the Colorado River, the Gila River near Dome, the stream gage recorded a maximum annual flow of over 4.7 MAF in 1993. Median annual flows at the Gila River near Dome are less than 4,800 acre-feet.

On the far western edge of the Planning Area, The Colorado River is perennial (*see Figure P.A. 12-3*). Imperial Dam is located on the Colorado River and is used primarily for diversion of Colorado River water for irrigation purposes in Arizona and California. The Gila Gravity Main canal delivers Colorado River water from Imperial Dam to the Wellton-Mohawk Irrigation and Drainage District (IDD) (water is also diverted through the Gila Gravity Main to irrigation districts in the Colorado Main Stem South Planning Area in the Yuma Basin). The majority of Colorado River water within the Wellton-Mohawk Irrigation and Drainage District is used for agricultural irrigation. A small portion is diverted for domestic and municipal uses in the Town of Wellton.

<u>Reclaimed Water</u>

There are several wastewater treatment facilities in the Lower Gila Basin. The total volume of reclaimed water generated, however, is minimal, less than 300 acre-feet per year. Most disposals are through evaporation and infiltration ponds, but one golf course, the Links at Coyote Wash in Wellton, is irrigated with reclaimed water.

<u>Ecological Resources</u>

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 flows support riparian vegetation consisting of a narrow band of cottonwood trees and dense tamarisk along the channel (*see Figure P.A. 12-3*). Protected areas in this Planning Area include portions of the following:

- Organ Pipe Cactus National Monument;
- Cabeza Prieta National Wildlife Refuge, the third largest refuge in the contiguous United States with an area of over 860,000 acres primarily designated as wilderness (including lands in the Western Borderlands Planning Area);
- Kofa National Wildlife Refuge, at 665,400 acres, also primarily designated as wilderness (including lands within the West Basins and Colorado Main stem South Planning Areas); and

- Imperial National Wildlife, at almost 25,800 acres, of which 15,000 acres is designated wilderness Refuge (including lands within the Colorado Main Stem South Planning Area).

Additional BLM wilderness areas include the Eagletail Mountains Wilderness, Muggins Mountains Wilderness, Woolsey Peak Wilderness and Signal Mountain Wilderness.

Water Demands

Table P.A. 12-1 below illustrates baseline and projected water demands in the Lower Gila Planning Area. Agriculture is the dominant use sector in the Lower Gila Planning Area. In the eastern portion of the Planning Area, groundwater makes up the majority of the agricultural supply, predominantly around Hyder. In the western portion of the Planning Area, Colorado River water is the predominant agricultural water supply. The Wellton-Mohawk IDD irrigates approximately 63,000 acres and currently has a Priority 3 Colorado River entitlement for consumptive use of approximately 278,000 acre-feet per year. In the western portion of the Planning Area, shallow groundwater, a consequence of incidental recharge from agricultural irrigation, has required dewatering pumping for removal via drainage canals. Agricultural demands were projected by the WRDC to decline through 2060, although district officials have stated that this assumption may be overstated, as such for purposes of this document it is projected that agricultural uses will remain stable through the planning period.

Industrial demands in the Planning Area are primarily dependent on groundwater and includes approximately 3,600 acre-feet per year for dairies and feed lots. The largest industrial demand is a feed lot operation east of Wellton, the McElhaney Cattle Company, which custom feeds up to 100,000 head at one time. Water use for dairies and feedlots are projected to increase significantly through the planning period.

Municipal uses primarily rely upon groundwater, although a small portion uses surface water within the Wellton-Mohawk IDD as noted above. Municipal groundwater demand is about 2,000 acre-feet per year, and is projected to increase slightly through the planning period.

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, particularly in the eastern portion of this Planning Area, will make it difficult to identify strategies for meeting the projected water demands.

Land Ownership

Because of the large areas of land in federal ownership, it is not anticipated that significant development will occur outside of the current population centers. Much of the federally-owned lands include portions of several Wilderness Areas. Wilderness areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition. These designations have the potential to significantly limit water supply development and growth in this Planning Area.

Table P.A. 12-1. Projected Demands (in acre feet) – Lower Gila Planning Area

Sector	2010	2035	2060
Agriculture	393,000	393,000	393,000
Dairy	246	5,281	13,814
Feedlot	3,421	6,781	6,781
Municipal	2,028	2,676	3,184
Other Industrial	0	0	0
Mining	0		
High		18,000	18,000
Low		0	0
Power Plants	0		
High		1,642	2,955
Low		1,313	2,364
Rock Production	0		
High		200	238
Low		83	99
Turf	0		
High		0	0
Low		0	0
Total (High)	**398,695**	**427,580**	**437,972**
Total (Low)	**398,695**	**409,134**	**419,242**

Colorado River Entitlement Priority

Rights to Colorado River water in Arizona are based on the following priority levels:

a. 1st Priority: Satisfaction of Present Perfected Rights as defined in the Arizona v. California decree (pre-1928);
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 Arizona entitlement; and
f. 6th Priority: Surplus water

Within the Planning Area, there are no entitlement holders with a 1st Priority or Present Perfected Rights. Second (2nd) and 3rd priority entitlement holders (which are coequal), include the Imperial and Cibola National Wildlife Refuges, Yuma Proving Grounds, and the Wellton-Mohawk IDD.

Salinity and Mexican Treaty Compliance

Portions of the irrigated lands in the Planning Area must have either natural or artificial drainage to remove excess water that would otherwise "waterlog" the land, and also to dispose of the salts which accumulate through evapotranspiration. Long-term irrigation with Colorado River water, combined with naturally elevated salt concentrations in groundwater and soil, require salts to be leached from the soil through irrigating in excess of the crop consumptive use and removal of the leached water to prevent waterlogging. In addition, occasional flooding on the Gila River raises groundwater levels to depths within crop root zones. The Wellton-Mohawk IDD operates 90 drainage wells spaced about a mile apart with an average depth of 100 feet to control rising groundwater levels below the root zone of crops. About 120,000 acre-feet of brackish groundwater is pumped annually. Three-hundred observation wells monitor groundwater levels[1]. 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 MAF.

Because the high salinity of the Wellton-Mohawk IDD return flows increased the salinity of the Colorado River, a number of actions were undertaken to achieve the salinity standards for delivery to Mexico specified in Minute 242 of the 1944 Mexican Water Treaty. The drainage water is pumped into a dedicated concrete-lined channel (Main Outlet Drain and Extension, "MODE"), which allows it to be either diverted to the main channel of the Colorado River above Morelos Dam, or bypass the dam through a canal to the Cienega de Santa Clara in Mexico. The US also built a $250 million dollar desalination plant in Yuma to treat Wellton-Mohawk IDD drain water, so that it could be returned to the mainstem of the Colorado River for delivery to Mexico. The facility was completed in 1992, operated briefly in 1993, and then placed in standby status. The Wellton-Mohawk IDD 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[2].

The reestablishment of a wetland in the Mexican Delta was a consequence of the annual bypass of the saline irrigation return flow to the Cienega de Santa Clara. Currently, there is significant interest on both sides of the border to maintain this wetland. However, delivering this water to Mexico via the bypass each year without crediting it against the Treaty obligation requires the U.S. to release an equal volume of water from storage in Lake Mead to meet the required 1.5 MAF entitlement to Mexico. These releases for delivery to Mexico increase the risk of shortage, particularly to the CAP and other 4th priority water users in Arizona. After more than a decade of drought in the Colorado River Basin, the potential for shortage has been further amplified.

Water Management

The Lower Gila Planning Area is not within any AMA, or INA that requires additional water management or reporting. However, because of the relatively high priority Colorado River entitlement in the Wellton-Mohawk Irrigation and Drainage District, some entities may be exploring the potential for water

[1] http://www.wmidd.org/irrigation.html
[2] http://www.wmidd.org/irrigation.html

transfers from Wellton-Mohawk IDD for use within other parts of the state. While it is legal to transfer Colorado River water within Arizona, it does require consultation with ADWR, a recommendation from ADWR to the Secretary of the Interior, and approval of the transfer by the Secretary. Consultation and recommendations by ADWR are required by A.R.S. §45-107(D) and are executed through its *Policy and Procedures for Transferring an Entitlement of Colorado River Water*[3]. Generally, the policy requires the following: irrigation district approval for proposed transfers of water associated with lands located within the district; consideration of city and/or county economic impacts; and possible environmental compliance.

Groundwater Availability

While waterlogging conditions exist in the western portion of the Planning Area, water levels in the eastern portion of the Planning Area do not benefit from connection to, and use of, Colorado River water. As stated earlier, groundwater flow was from north and southeast toward the Gila River and then downstream to the southwest prior to development. Groundwater flow has been altered by the development of cones of depression formed by groundwater pumping at some locations in the Basin. Historically, cones of depression occurred in irrigated areas north of Hyder, east of Dateland and in the Palomas Plain west of Hyder. Historic groundwater level declines up to 15 feet per year were recorded in irrigated areas north and west of Hyder and east of Dateland. ADWR continues to monitor wells in these areas.

Strategies for Meeting Future Water Demands

Sufficient groundwater and Colorado River supplies are expected to be available to meet the projected demands in the Lower Gila Planning Area. Resolution of the Gila River General Stream Adjudication will support long-term certainty of water supply availability in this Planning Area.

[3] http://www.azwater.gov/AzDWR/StateWidePlanning/CRM/documents/CR7new.pdf

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.

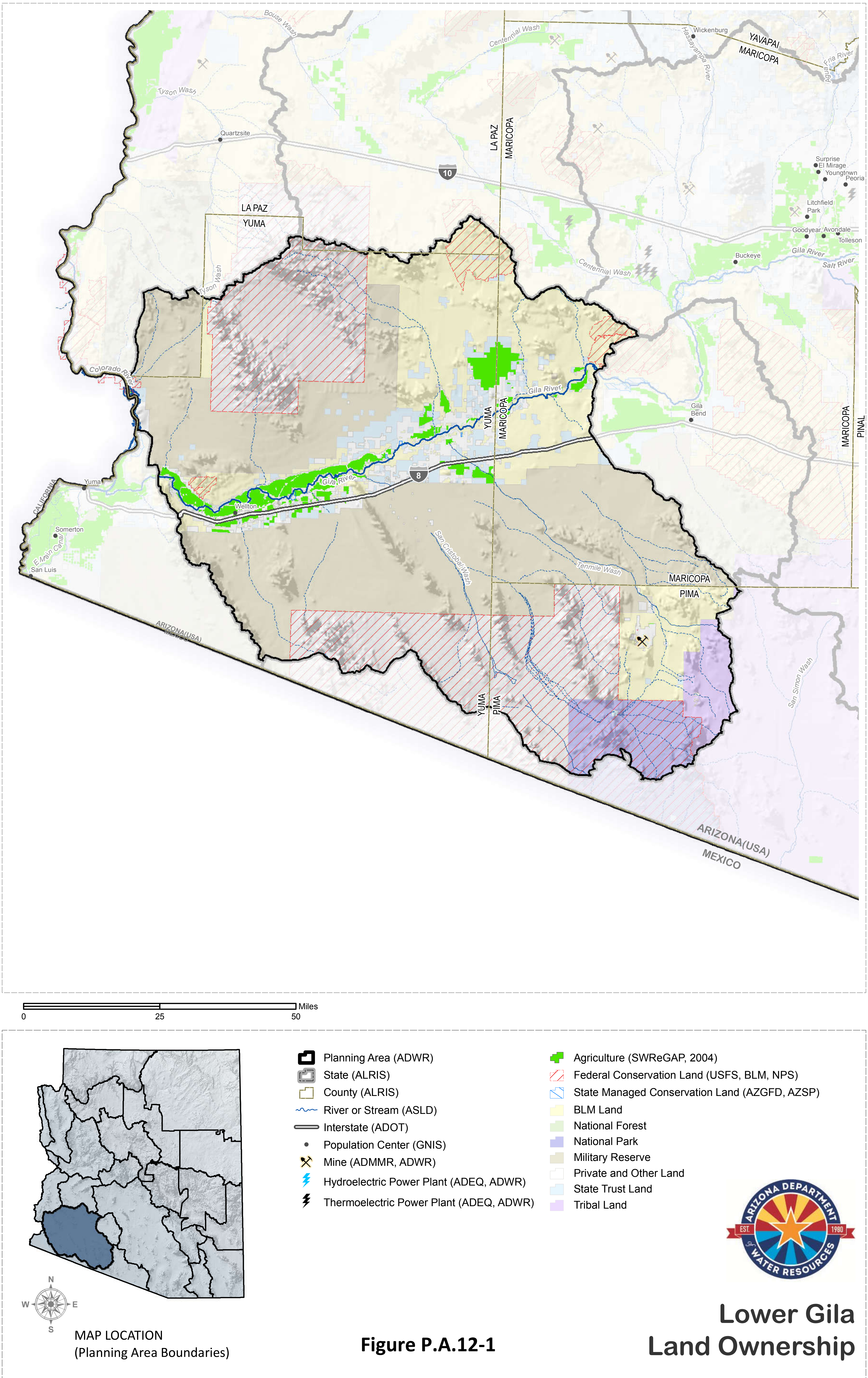
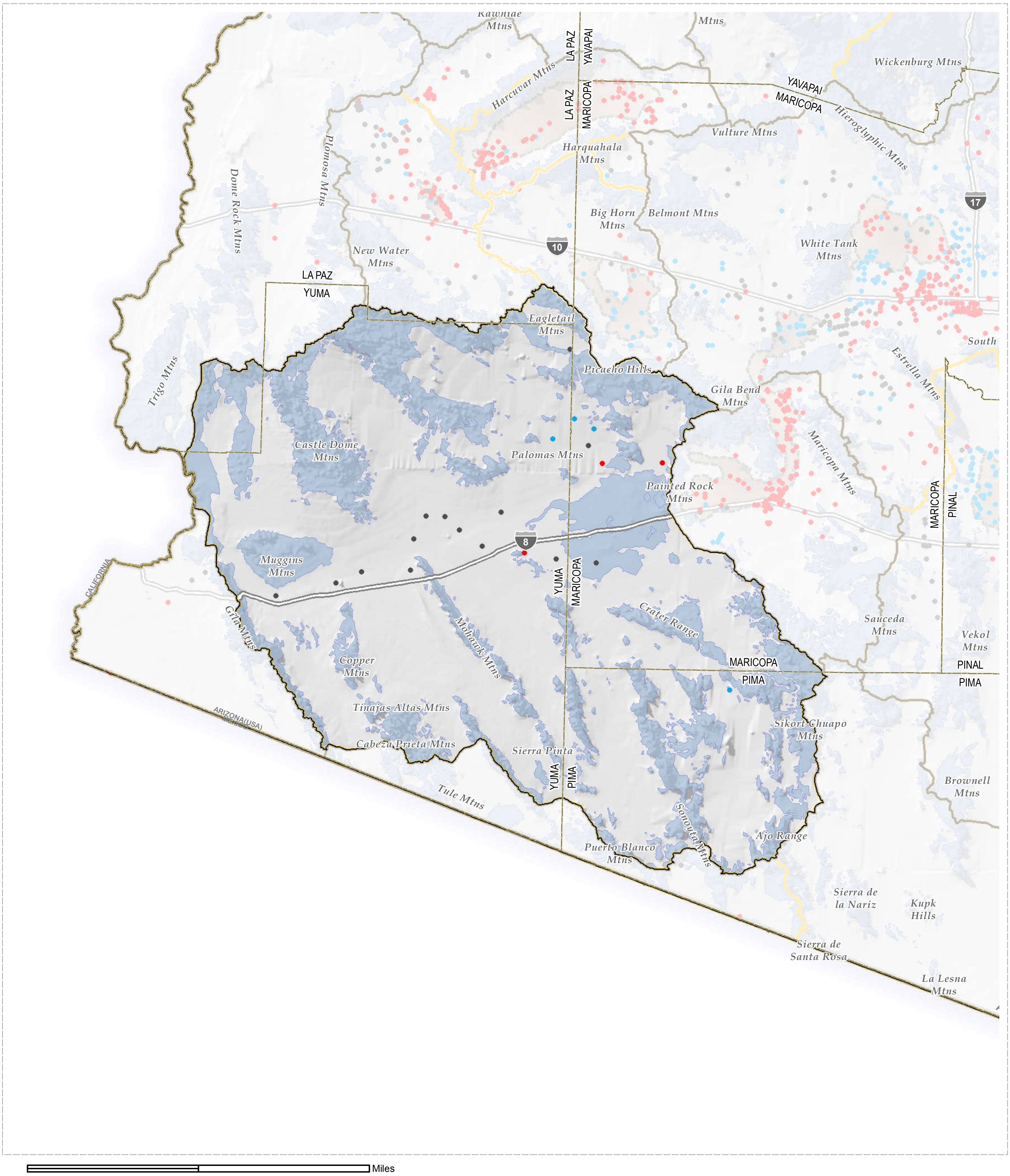
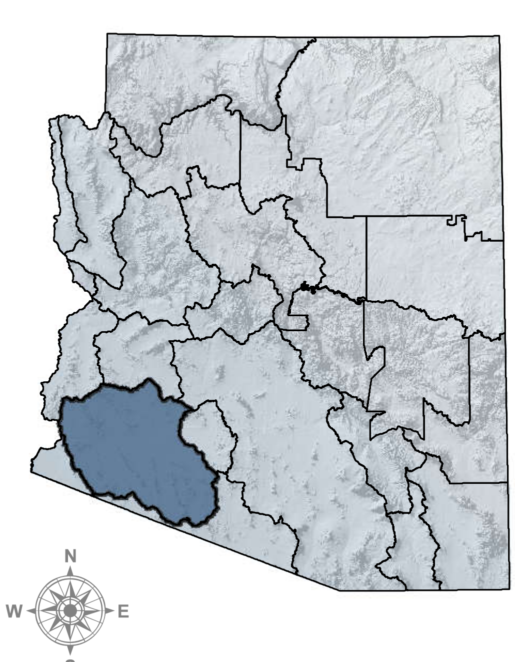


Figure P.A.12-1

Lower Gila 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)

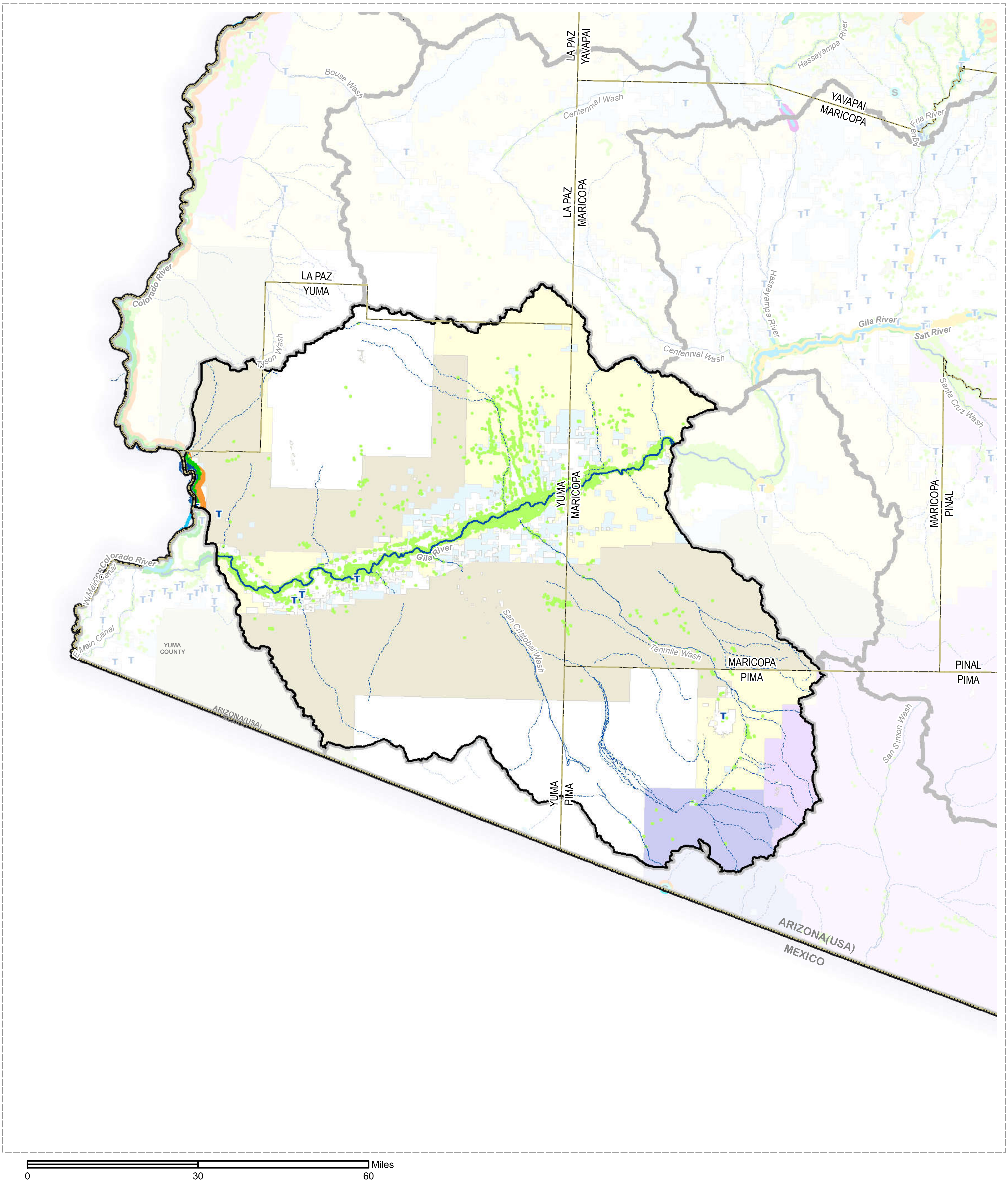
Recent Water Level Change * (1990's through 2000's)
Minor WL Change +5' to -5'
Negative
Positive

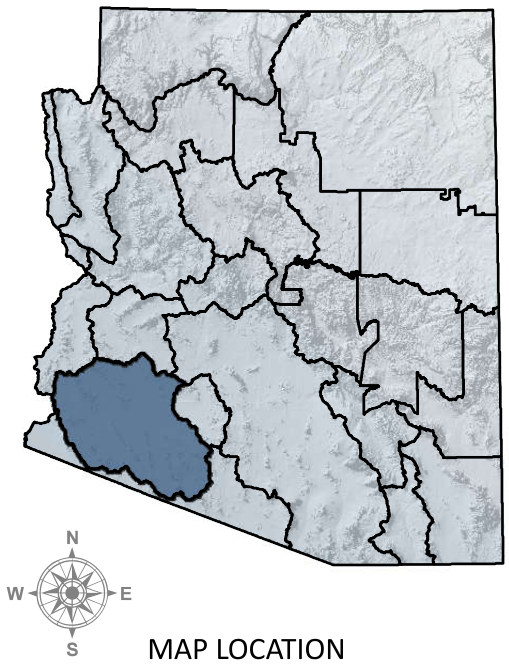
* Data provided by ADWR

Figure P.A.12-2

Lower Gila 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.





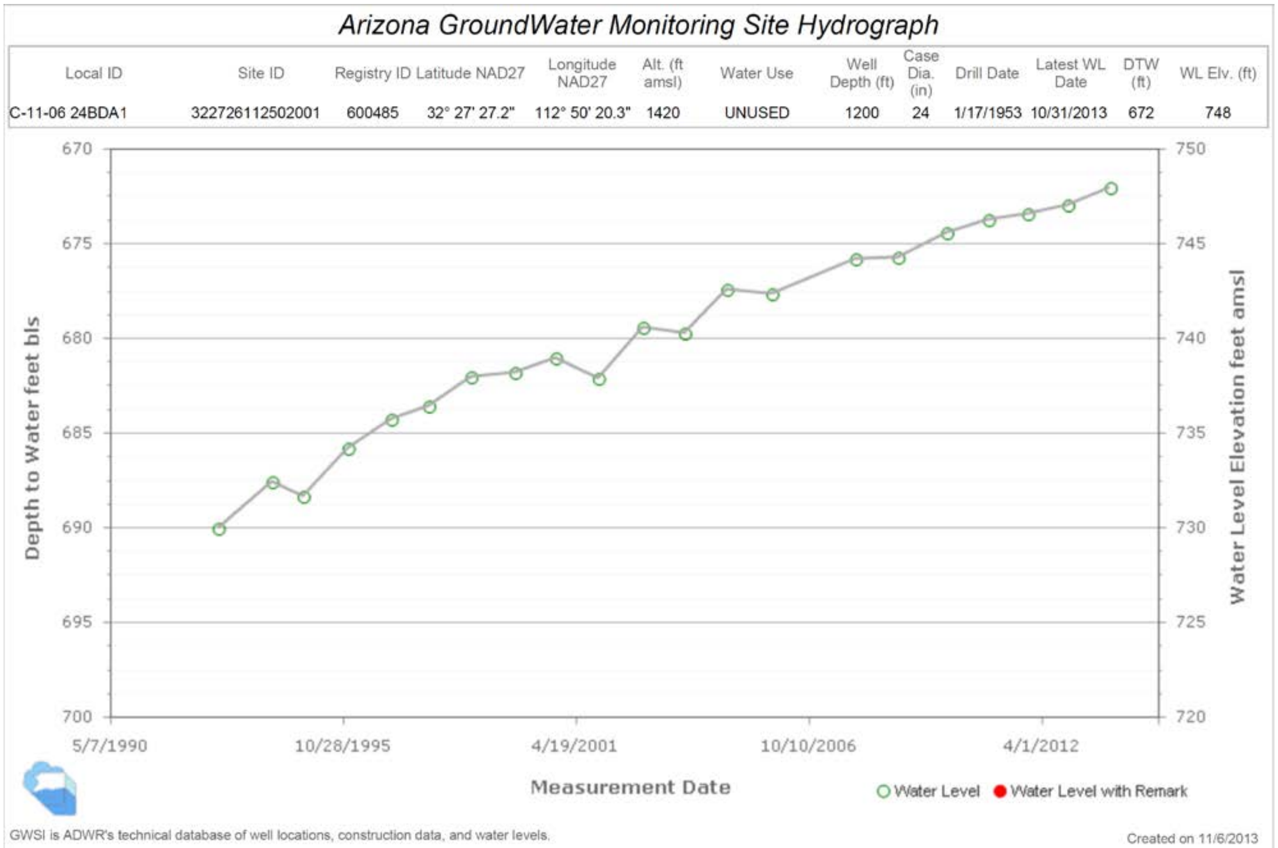
MAP LOCATION
(Planning Area Boundaries)

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

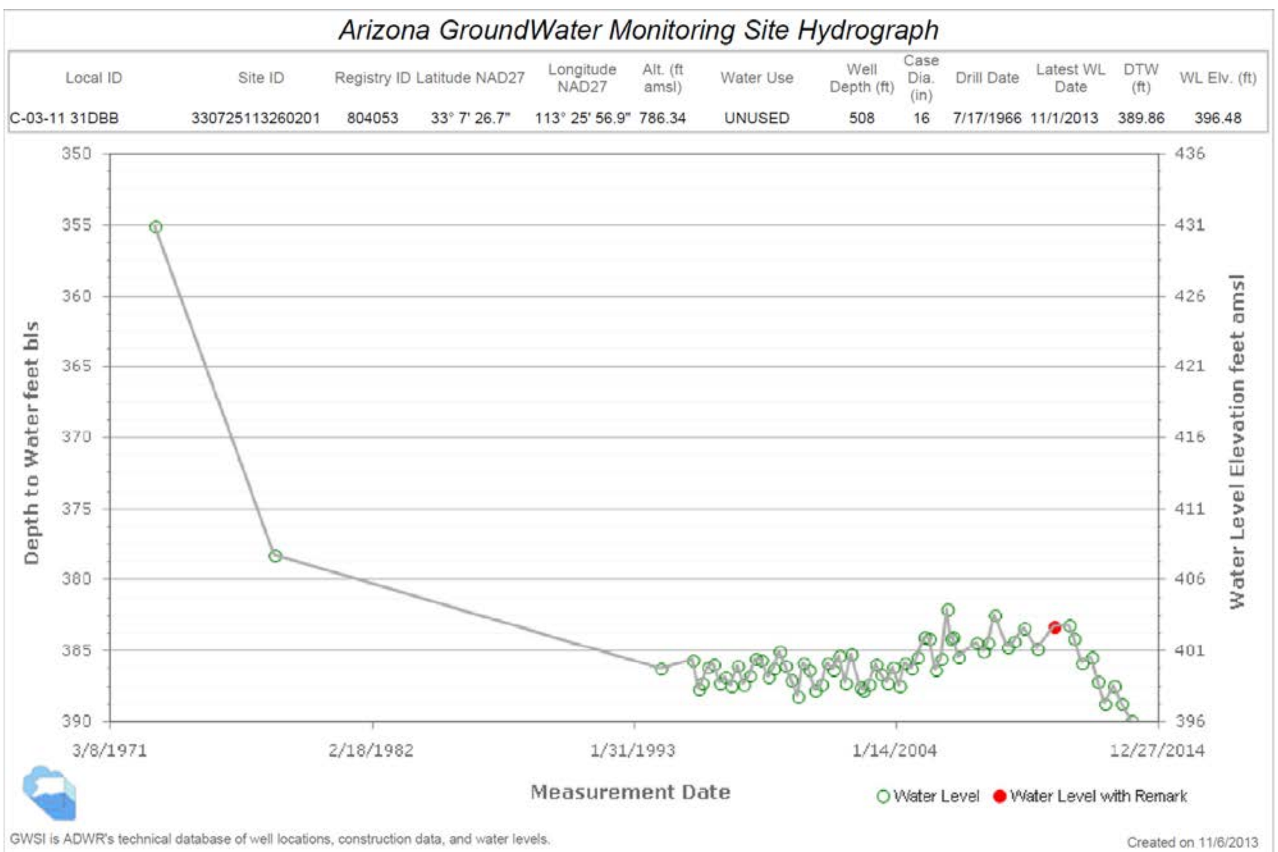
Figure P.A.12-3

Lower Gila
Surface Water and Natural Features

Lower Gila Basin – Lower Gila Planning Area



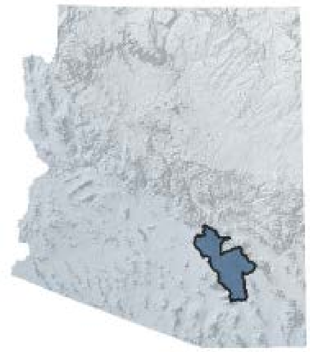
C-11-06 24BDA1 – Lower Gila basin – Childs Valley sub-basin 5 miles North of Ajo.



C-03-11 31DBB -- Lower Gila basin – Wellton – Mohawk sub-basin about 8 miles NW of Hyder.

[LOWER SAN PEDRO PLANNING AREA]

Lower San Pedro Planning Area



Background

The Lower San Pedro Planning Area is contained within portions of Cochise, Pima, Pinal and Graham counties, in the southeast portion of the State. The Planning Area encompasses the majority of the Lower San Pedro Groundwater Basin, all of the Donnelly Wash and Aravaipa Canyon Basins, and those portions of the Dripping Springs Wash Groundwater Basin that are not within the boundaries of the San Carlos Apache Reservation (Apache Panning Area). Communities within the Planning Area include Oracle, Reddington, San Manuel, Mammoth, Dudleyville, Winkelman, Kearny, and Ray.

Land ownership within the Lower San Pedro Planning Area is diverse, including State, federal, and private lands (*see Figure P.A. 13-1*). Approximately 48 percent of land in this Planning Area is held as State Trust Lands. The majority of these State Trust Lands are in contiguous blocks with livestock grazing as the principal land use.

Federal land ownership is significant in the Planning Area. The USDA Forest Service (Forest Service) manages approximately 15 percent of land. These discontiguous holdings are largely comprised of the mountain ranges that form the periphery of each groundwater basin. Livestock grazing, recreation and timber production are the primary land uses on these portions of the Coronado National Forest. Additionally, a small portion of the Tonto National Forest is located in the northern portion of the Planning Area. The US Bureau of Land Management (BLM) manages roughly 17 percent of land in the Lower San Pedro Planning Area. Primary land uses on these lands are wildlife habitat, recreation and livestock grazing. The National Park Service (NPS) owns and manages a small portion of the Saguaro National Park in the southern extent of the Planning Area.

Approximately 17 percent of the land in the Lower San Pedro Planning Area is privately owned. Private lands are largely fragmented within the Planning Area with continuous strips running along highways and within populated communities. There are some private land in-holdings in the Coronado National Forest and amidst the BLM lands. Primary land uses are private domestic, municipal, mining, livestock grazing and agriculture.

Water Supply Conditions

<u>Groundwater</u>

The Lower San Pedro 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, which may be suitable for artificial underground storage and recovery of renewable water supplies.

The groundwater system in the Lower San Pedro Planning Area is largely housed in the basin-fill sediments and the stream alluvium that has been deposited atop the older basin-fill deposits. Depth to groundwater varies significantly across the Lower San Pedro Planning Area (*see Figure P.A. 13-2*). Shallow groundwater, approaching the land surface, is encountered in the floodplain

aquifers along the San Pedro and Gila rivers and the lower portion of Aravaipa Creek. Water levels in this shallow system respond to water supply conditions along these water courses and have remained relatively stable.

The principal sources of natural recharge in the Planning Area are underflow from the Upper San Pedro Groundwater Basin, mountain-front recharge and streambed infiltration. Estimates of natural recharge for the Lower San Pedro Basin range from 24,000 to 29,000 acre-feet per year. Estimated natural recharge for the Aravaipa Canyons Basin is estimated to average between 7,000 and just less than 17,000 acre-feet per year. Estimates for Donnelly Wash and Dripping Springs Wash[1] basis are 3,000 and between 3,000 and 9,000 acre-feet per year, respectively. Artesian conditions exist in the center of the Planning Area south of Mammoth. Groundwater in storage estimates for the Lower San Pedro Basin range from 11 to 27 MAF to a depth of 1,200 feet. The Aravaipa Canyons Basin has an estimated 5.0 MAF in storage. Estimates for Donnelly Wash range from 140,000 acre-feet to 2.0 MAF and storage in the Dripping Springs Wash Basin is estimated to be between 150,000 acre-feet and 1.0 MAF.

Surface Water

The San Pedro River flows from south to north in the center of the Planning Area entering from the Upper San Pedro Planning Area, serving as the predominant hydrologic feature of the Planning Area (*see Figure P.A. 13-3*). The San Pedro River is joined by its tributary, Aravaipa Creek south of Dudleyville, and continues north joining the Gila River at Winkelman. The Gila River then flows northwest to west, bisecting the Donnelly Wash Basin. There are both perennial and intermittent reaches of the San Pedro River in the Planning Area. Other perennial waters include portions of Aravaipa Creek through and downstream of the Aravaipa Wilderness. Additional perennial stream reaches, including Redfield Canyon, emanate from the headwaters of the Galiuro Mountains.

Reclaimed Water

There are limited population centers in the Lower San Pedro Planning Area. No facilities directly recharging reclaimed water to the regional aquifer are located within the Planning Area. The wastewater treatment plant at Winkelman discharges directly to the Gila River following treatment. The limited population in the Lower San Pedro is largely reliant upon septic systems for wastewater treatment and disposal, although a few smaller wastewater treatment plants are located within the Planning Area.

Ecological Resources

Important ecological features located within the Planning Area include Aravaipa Canyon Wilderness Area and a portion of the Redfield Canyon Wilderness, managed by the BLM, and portions of the Galiuro, Santa Teresa, and the Rincon Mountain Wilderness Areas, managed by the Forest Service. Significant portions of the Lower San Pedro Planning Area have been designated as critical habitat under the Endangered Species Act (*see Figure P.A. 13-3)*. These areas include all but the southernmost reach of the San Pedro River, all of the Gila River, those portions of Aravaipa Creek through and downstream of the Aravaipa Wilderness, portions of

[1] Estimates include a portion of the Basin within the Apache Planning Area.

headwater streams tributary to the Gila and San Pedro Rivers, and portions of the mountain ranges that form the periphery of the Planning Area.

Water Demands

Table P.A. 13-1 below presents the baseline and projected water demands for the Lower San Pedro Planning Area. Mining is the single largest water using sector in the Planning Area, estimated to use 15,790 acre-feet in 2010. These uses are projected to grow to as much as 27,000 acre-feet by 2035. Agricultural water use is estimated at 4,700 acre-feet and is projected to remain stable through 2060. These uses are generally located along the San Pedro and Gila Rivers and Aravaipa Creek immediately above the confluence with the San Pedro River. Municipal uses are limited and distributed in the population centers throughout the Planning Area. Municipal demand in the Planning Area is projected to decline from the 3,200 acre-feet in 2010 to less than 2,900 acre-feet in 2035 and then is projected to increase to just under 4,800 acre-feet in 2060.

Table P.A. 13-1. Projected Demands (in acre feet) – Lower San Pedro Planning Area

Sector	2010	2035	2060
Agriculture	4,700	4,700	4,700
Dairy	0	0	0
Feedlot	0	0	0
Municipal	3,234	2,963	4,786
Other Industrial	0	0	0
Mining	15,790		
High		27,000	27,000
Low		6,900	12,600
Power Plants	0		
High		0	0
Low		0	0
Rock Production	423		
High		243	392
Low		102	163
Turf			
High	0	0	0
Low	211	211	343
Total (High)	**24,147**	**34,906**	**36,878**
Total (Low)	**24,358**	**14,876**	**22,592**

Characteristics Affecting Future Demands and Water Supply Availability

<u>Projected Demands</u>

The relatively limited current and projected agricultural and municipal water uses in the Lower San Pedro Planning Area are largely served by local groundwater supplies without appreciable impacts, such as the development of cones of depression. By their nature, mining uses are located in regions of hard rock geology and do not typically enjoy close proximity to productive regional aquifer systems. Mines commonly import water supplies to meet their on-site needs. Many of the mines in the region have been closed, including Mammoth and San Manuel. The future of these, and other potential, mining operations are projected to have the most significant water supply influence in the future for the Planning Area.

<u>General Stream Adjudication</u>

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 this Planning Area will make it difficult to identify strategies for meeting the projected water demands.

<u>Unresolved Indian Water Rights Claims - San Carlos Apache Gila River Claims</u>

A portion of the water rights claims of the San Carlos Apache Tribe were settled through congressional enactment of the San Carlos Apache Tribe Settlement Act of 1992. The water right claims of the San Carlos Apache Tribe to portion of the reservation within the Upper Gila River watershed will be the subject of separate negotiations or litigation. Indian settlements are related to the General Stream Adjudication and quantification of these rights is a key element in resolving the Gila River Adjudication. Until these claims are quantified and settled, uncertainty regarding the extent and priority of water rights in this Planning Area will make it difficult to identify strategies for meeting the projected water demands.

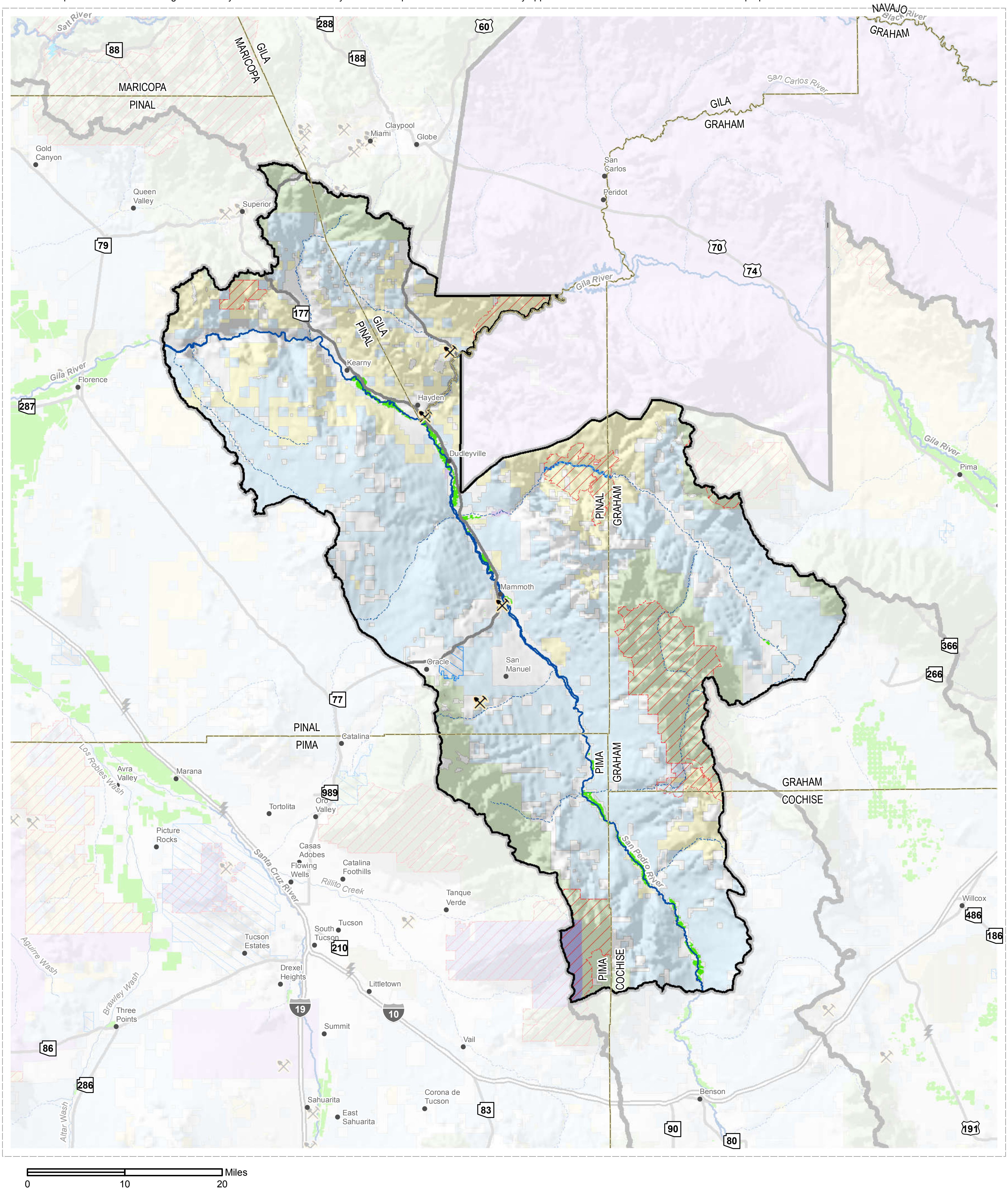
<u>Protected Species and Habitat</u>

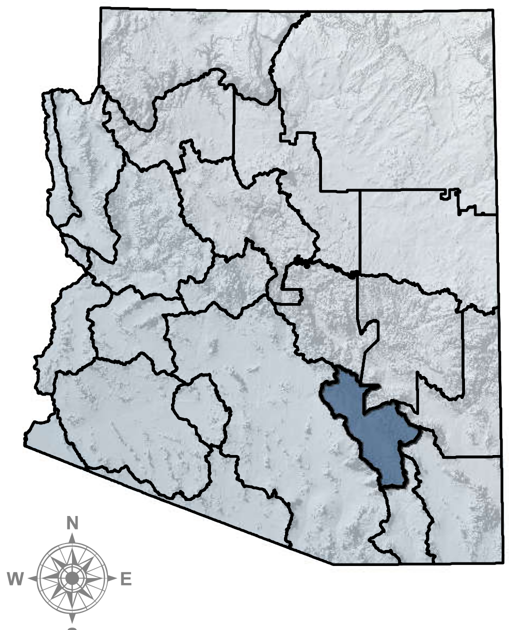
The presence of a listed species may be a critical consideration in water resource management and supply development in a particular area. This Planning Area has significant land holdings under federal ownership, almost exclusively BLM and National Forest, including Wilderness Areas. These designations have the potential to significantly limit water supply development and growth in this Planning Area.

Strategies for Meeting Future Water Demands

Groundwater supplies are expected to be available to meet the projected growth in the Lower San Pedro Planning Area and thus no additional strategies are needed at this time. However, resolution of Indian water claims and the Gila River General Stream Adjudication are essential for ensuring long-term certainty of water supply availability to water users in this 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.





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.13-1

Lower San Pedro Land Ownership

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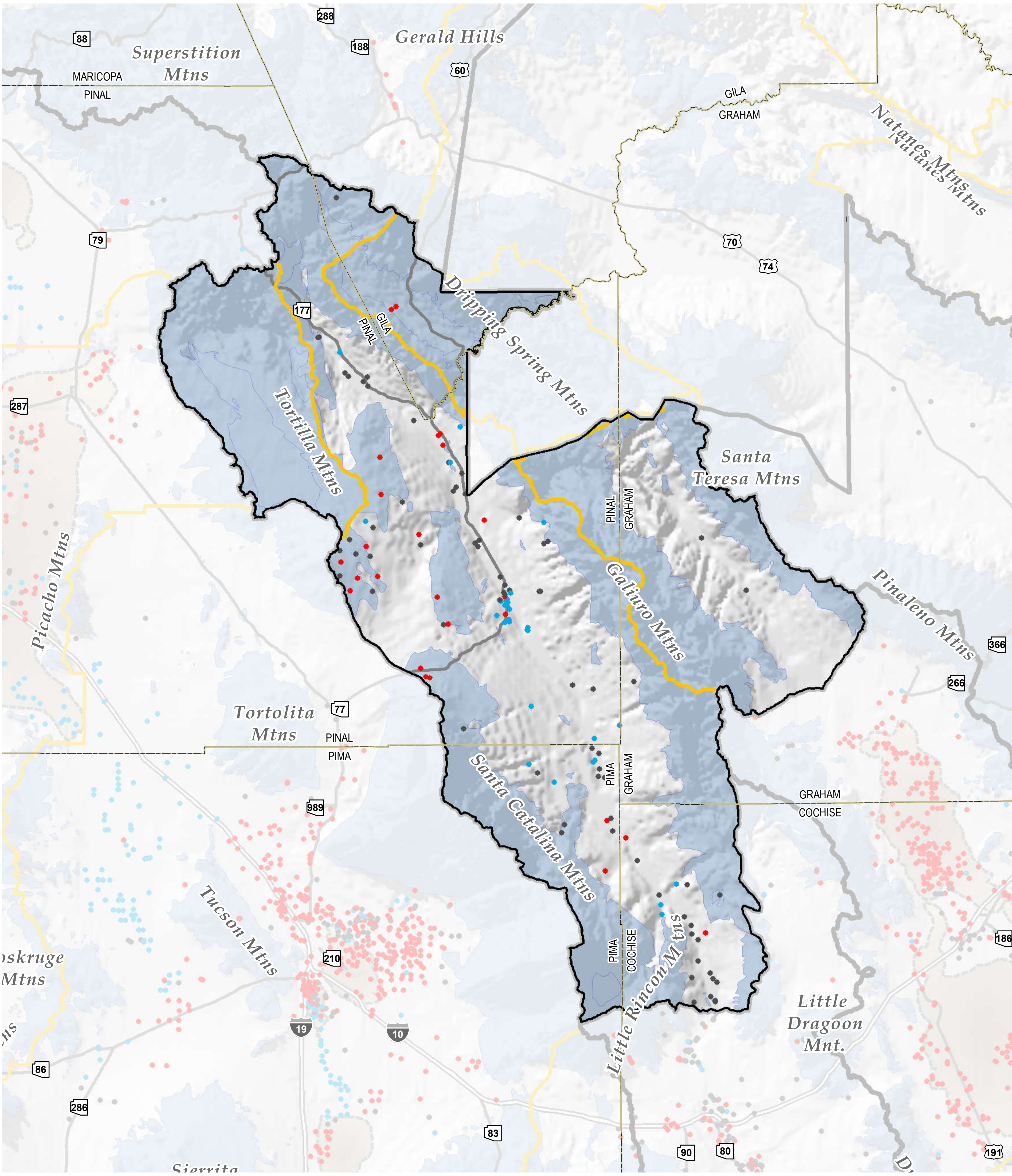
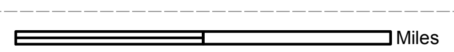
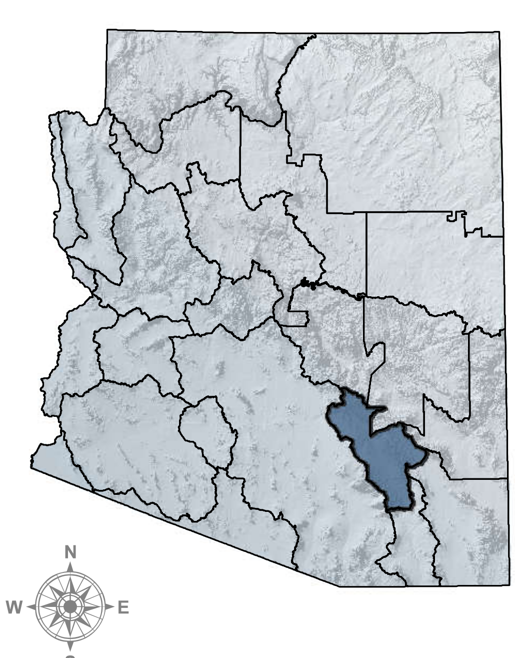




Planning Area (ADWR)
State (ALRIS)
County (ALRIS)
Groundwater Basin (ADWR)
Area of Active Land Subsidence (ADWR)
Hard Rock Geology (AZ Bureau of Mines, UofA)
Interstate (ADOT)

Recent Water Level Change * (1990's through 2000's)
Minor WL Change +5' to -5'
Negative
Positive

* Data provided by ADWR

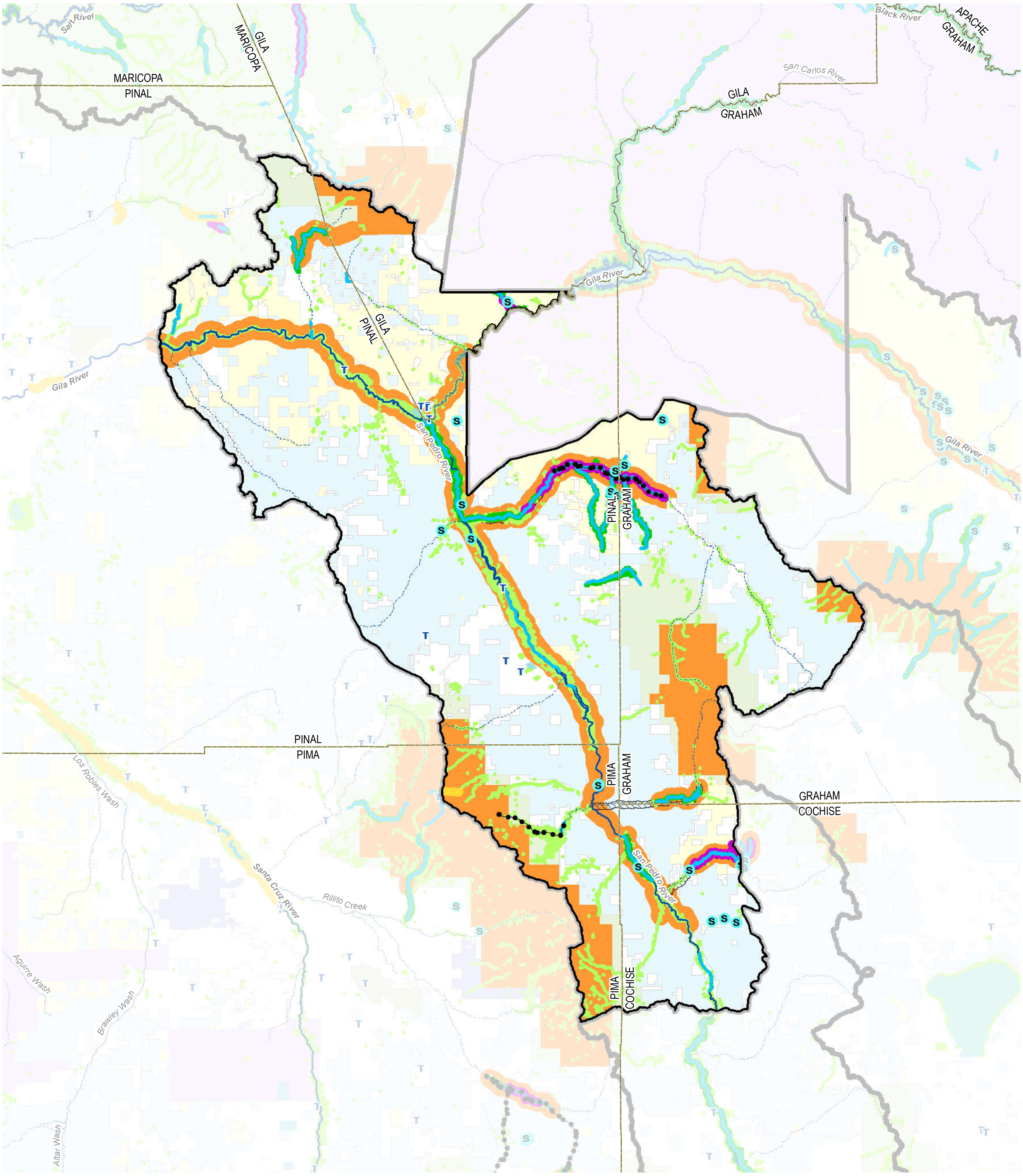


MAP LOCATION
(Planning Area Boundaries)

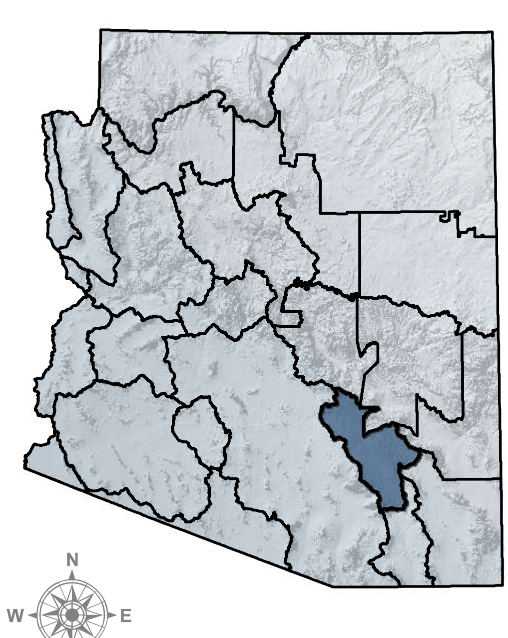
Figure P.A.13-2

Lower San Pedro 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.



0 10 20 Miles



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

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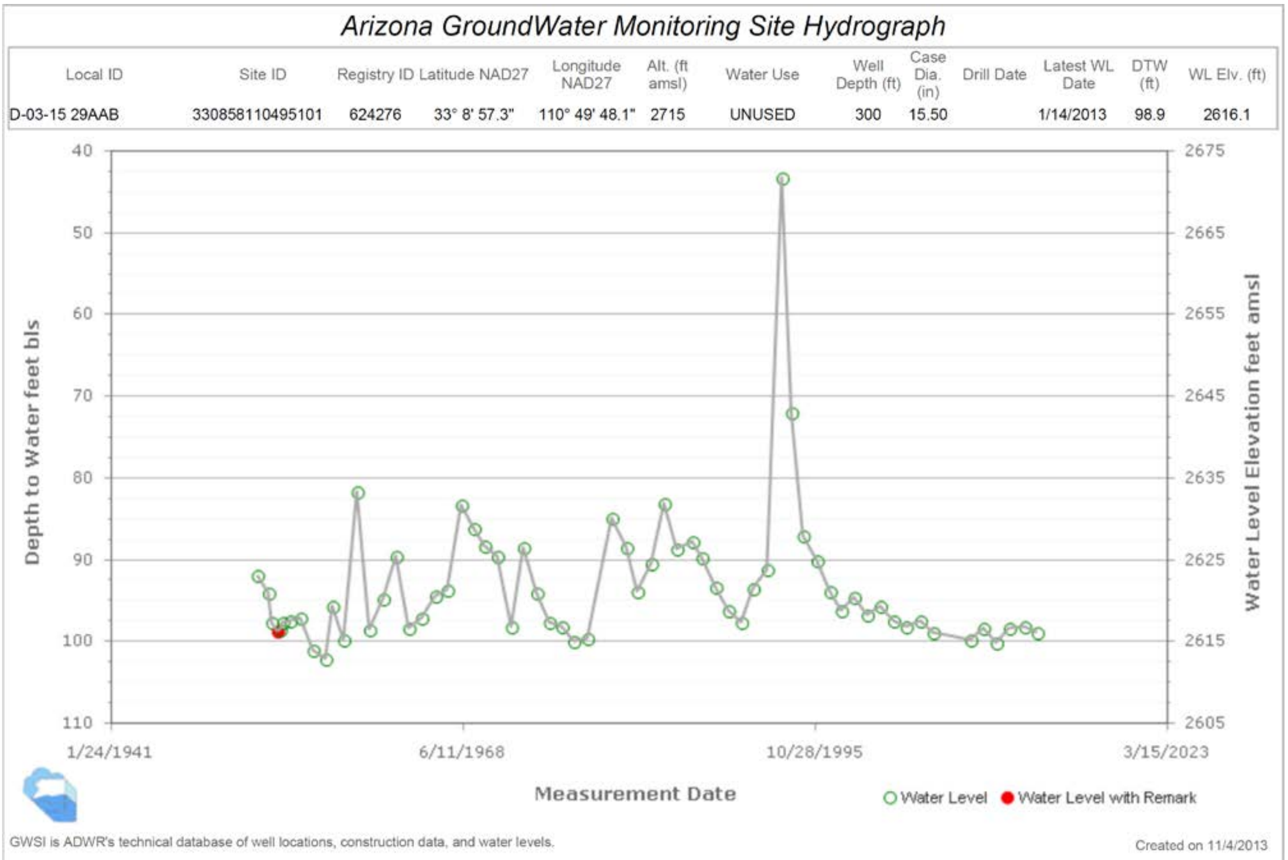
Figure P.A.13-3

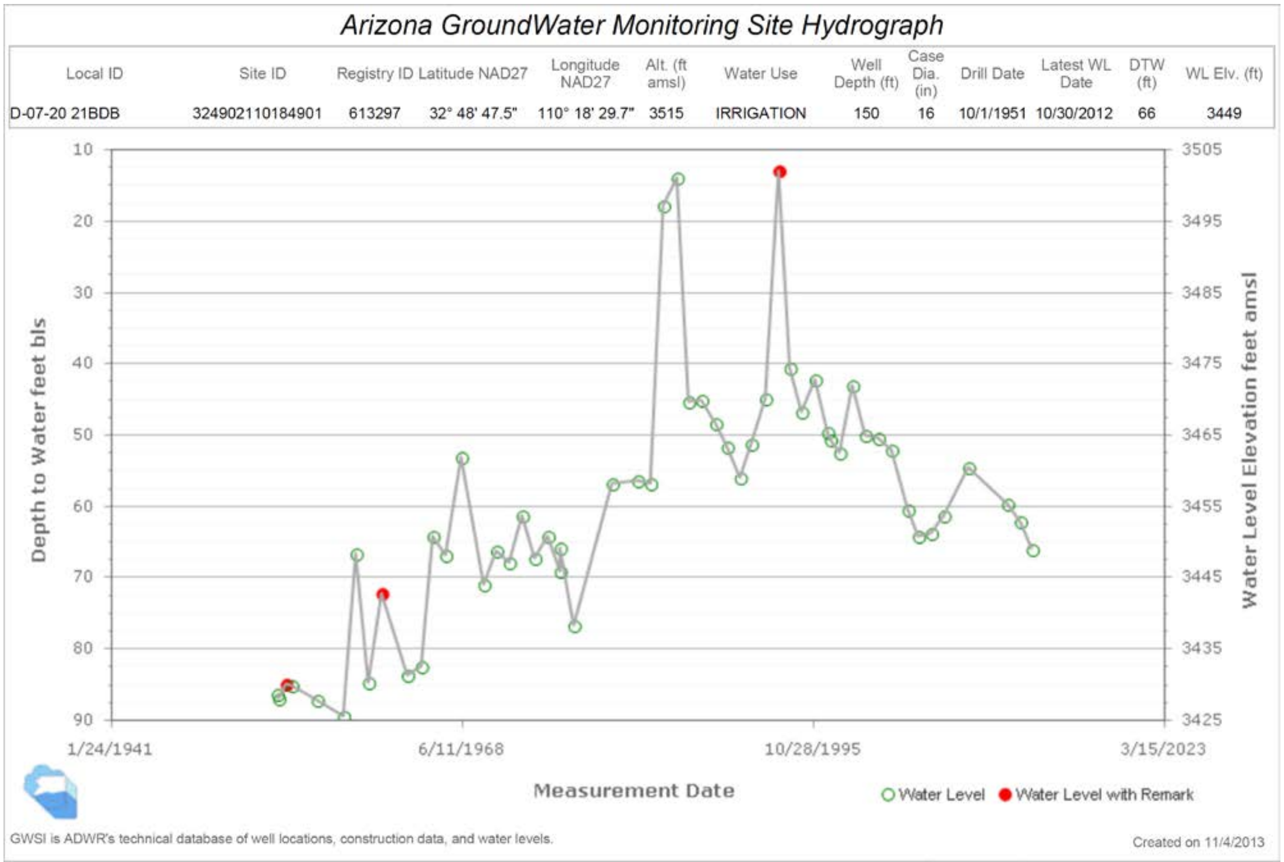
Lower San Pedro
Surface Water and Natural Features

Dripping Springs Basin – Lower San Pedro Planning Area



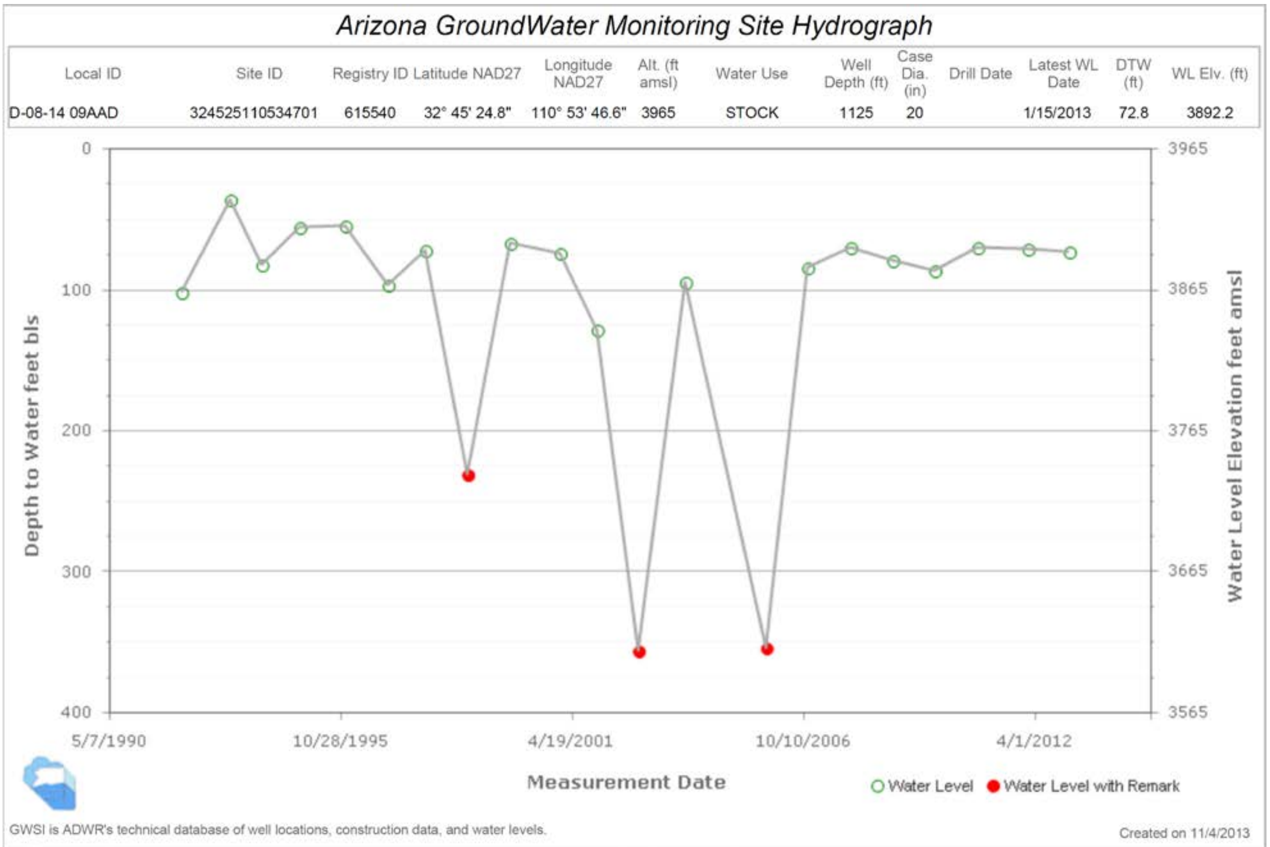
D-03-15 29AAB –Dripping Springs Wash basin about 7 miles NE of Kelvin.

Aravaipa Canyon Basin – Lower San Pedro Planning Area

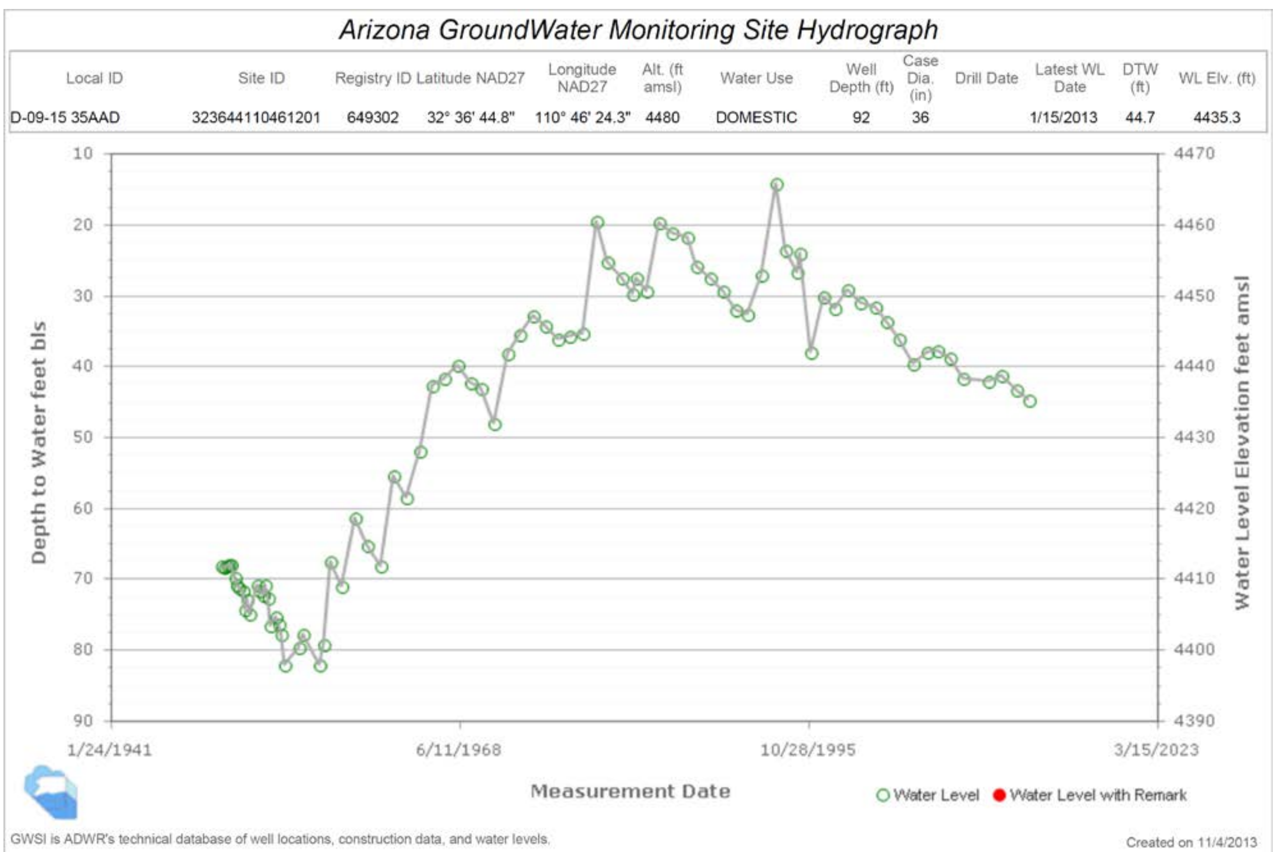


D-07-20 21BDB – Aravaipa basin – about 2 miles SE of Klondyke along Aravaipa Creek.

Lower San Pedro Basin – Lower San Pedro Planning Area



D-08-14 09AAD Lower San Pedro basin – Camp Grant sub-basin about 3 miles NE of Oak Wells.



D-09-15 35AAD – Lower San Pedro basin – Mammoth sub-basin Oracle area.

[NAVAJO/HOPI PLANNING AREA]

Navajo/Hopi Planning Area

Background

The Navajo/Hopi Planning Area is located in the far northeast corner of the State. The Planning Area includes both the Hopi Reservation and the Navajo Nation, and the City of Page. San Juan Southern Paiute tribal members also occupy lands located within the Navajo Nation. The Planning Area is comprised of portions of Coconino, Navajo, and Apache counties. There are portions of five watersheds within the Navajo/Hopi Planning Area: Little Colorado, Lower San Juan, Upper Colorado-Dirty Devil, Upper San Juan, and Lower Colorado. The Planning Area encompasses a large portion of the Little Colorado River Plateau Groundwater Basin and a small portion of the Coconino Plateau Groundwater Basin. Population centers include the City of Page, the Navajo communities of Tuba City, Window Rock, Chinle, and Kayenta, and Hopi communities Moenkopi, Shongopovi, Kykotsmovi, and Second Mesa.

Nearly all of the land within this Planning Area is under tribal ownership (*see Figure P.A. 14-1*). Navajo Nation lands within the Planning Area total approximately 14,600 square miles while the Hopi Reservation encompasses about 2,500 square miles. The primary land uses are livestock grazing, farming, and mining. The City of Page immediately south of the Arizona-Utah border in the northwestern part of the Planning Area encompasses approximately 24 square miles of land.

Water Supply Conditions

<u>Groundwater</u>

The Navajo/Hopi Planning Area is located within the Colorado Plateau Physiographic Province, characterized by mostly level, horizontally stratified sedimentary rocks that have been eroded into canyons and plateaus, and some high mountains. This province contains regional aquifers within sandstone and limestone layers and relatively thin deposits of alluvium that support unconfined aquifers along streams.

Water levels in the Planning Area have generally declined due to groundwater pumping (*see Figure P.A. 14-2*). Groundwater level declines of 1.7 feet per year were observed for the period from 1984 to 2004 near Kayenta (Black Mesa area) as a result of groundwater pumping for a coal slurry pipeline and other coal mining operations, and for municipal purposes. However, since the closure of the Mohave Generating Station in Laughlin, Nevada, the coal slurry pipeline is no longer operating and groundwater withdrawals have decreased significantly. Water level declines have also been observed near Tuba City and in some areas of the Hopi Reservation and the western Black Mesa drainage area. Near Page, water levels declined significantly in some wells that are hydraulically connected to the surface water level of Lake Powell which, in recent years, has dropped to historic low levels since its complete filling and high-water mark in 1980. In December, 2013, the reservoir was at 43 percent of full capacity.

Groundwater in much of the Planning Area is highly mineralized and the quality is marginal to unsuitable for domestic use due to high concentrations of dissolved solids and other parameters

that exceed drinking water standards. Nevertheless, it is utilized in the north-central parts of the Planning Area for domestic use.

Surface Water

The Little Colorado River Watershed covers most of the Planning Area and extends west into the Coconino Plateau Basin where it drains to the Colorado River. The Little Colorado River is the major surface drainage in the Watershed, originating in the White Mountains and flowing northwest to its confluence with the Colorado River in the Grand Canyon National Park (*see Figure P.A. 14-3*). The maximum recorded annual flow in the watershed was 816,449 acre-feet at the active gage on the Little Colorado River near Cameron. The median annual flow at this station is 138,315 acre-feet.

Within the watershed, reaches of the Little Colorado River have impaired water quality due to levels of turbidity, lead, copper and silver in excess of use standards. In addition, eight lakes are impaired due primarily to concentrations of mercury exceeding use standards.

The Lower San Juan River Watershed drains most of the northeastern portion of the Planning Area (*see Figure P.A. 14-3*). Chinle Creek is the major drainage, collecting most of the surface water runoff in the area that originates primarily in the Chuska Mountains and the Defiance Plateau. The Watershed drains northward toward Utah and the San Juan River, which in turn is tributary to the Colorado River. Currently, only one of the four stream gages is active; a real-time gage at Chinle Creek near Mexican Water south of the Utah border. The maximum recorded flow in the watershed was measured at this remaining active gage with a flow of almost 67,700 acre-feet in 1982. Median flow at this gage is about 15,500 acre-feet per year.

Arizona has a 50,000 acre-foot entitlement to the Upper Basin of the Colorado River[1]. At the present time, this water supply is utilized by: (1) the Navajo Nation for irrigated agriculture, reservoirs, domestic use and livestock related uses; (2) the City of Page for domestic uses; (3) the Glen Canyon National Recreation Area; and (4) Salt River Project for the Navajo Generating Station (NGS). Table P.A. 14-1 shows Arizona's total consumptive use of Colorado River water in the Upper Basin from 1996 through 2010[2]. At this time, the US Environmental Protection Agency (EPA) and the owners of the NGS are negotiating alternatives to meet compliance with EPA Clean Air standards. If the currently proposed alternative - to shut down one of the units at NGS - is adopted, the use of Colorado River water at NGS is expected to decrease, possibly making some of this Upper Colorado River Basin entitlement available to meet other demands in the Planning Area.

Reclaimed Water

Many of the communities on the Navajo Nation and the Hopi Reservation are served by wastewater treatment plants. Based on aerial image review, it appears that that the majority of this potential reclaimed water supply is disposed of through evaporation ponds. Most of the City of Page is served by a centralized wastewater treatment system. Reclaimed water from this facility is delivered for reuse on the Lake Powell National Golf Course.

[1] This is in addition to the 2.8 MAF Lower Basin entitlement which is diverted below Hoover Dam.
[2] US Bureau of Reclamation

Table P.A. 14-1. Provisional Arizona Upper Colorado River Utilization, 1996-2010

Colorado River Water Supplied											
Year	Navajo Generating Station	City of Page - Diversion	City of Page - Depletion	Diversion to Depletion Ratio	Le Chee	Navajo Irrigation	Reservoir Evaporation	Stockpond Evaporation	Reservoir and Stockpond Evaporation	Glen Canyon Recreation Area	Subtotal
1996	21,427	3,060	2,152	1.422	100	426	5,806	682	6,488	348	30,941
1997	22,364	2,613	1,723	1.517	95	399	5,687	686	6,373	378	31,332
1998	25,017	2,589	1,779	1.455	95	463	5,234	897	6,131	336	33,821
1999	26,697	2,567	1,800	1.426	89	486	4,927	866	5,793	445	35,310
2000	28,709	2,768	1,903	1.455	99	649	4,470	920	5,390	265	37,015
2001	27,620	3,837	1,833	2.093	90	515	4,359	900	5,259	387	35,704
2002	28,415	2,641	1,848	1.429	86	436	3,606	693	4,299	369	35,453
2003	26,284	2,550	1,770	1.441	101	488	3,784	734	4,518	318	33,479
2004	27,375	2,283	1,588	1.438	103	580	3,620	918	4,538	198	34,382
2005	26,200	2,028	1,376	1.474	98	609	3,523	873	4,396	280	32,959
2006	26,660	2,262	1,638	1.381	97	572	3,655	780	4,435	338	33,740
2007	27,604	2,321	402	5.774	95	835	3,523	867	4,390	338	33,664
2008	26,334	2,321	402	5.774	95	1,047	3,467	897	4,364	338	32,580
2009	26,073	2,240	318	7.044	95	916	3,751	735	4,486	334	32,222
2010	23,948	2,096	1,459	1.437	91	1,640	3,303	920	4,223	258	31,619
2000-2010 Average	***26,838***	***2,486***	***1,322***	***2.794***	***95***	***753***	***3,733***	***840***	***4,573***	***311***	***33,892***
1996-2010 Average	***26,048***	***2,545***	***1,466***	***2.437***	***95***	***671***	***4,181***	***825***	***5,006***	***329***	***33,615***

Ecological Resources

There are many environmental resources located within the Planning Area (*see Figure P.A. 14-3*). Critical habitat has been designated for federally listed threatened or endangered species including the Apache Trout, Mexican Spotted Owl, Little Colorado Spinedace, Navajo Sedge, and the Southwestern Willow Flycatcher. Native fish reintroductions have occurred in several streams. Several riparian areas have been mapped in the northeastern portion of the Planning Area. In addition, Canyon de Chelly and Navajo National Monument are located within the Planning Area on the Navajo Nation.

Water Demands

Table P.A. 14-2 below presents the baseline and projected water demands for the Navajo/Hopi Planning Area. The Navajo Generating Station (NGS) is currently the largest single water user in the Planning Area. NGS is cooled by a portion of Arizona's 50,000 acre-foot entitlement of Upper Basin Colorado River water diverted from Lake Powell. NGS was estimated to consume nearly 24,000 acre-feet of Colorado River water in 2010. Projections WRDC included in Table P.A. 14-2 project power plant use to increase to the full volume of Arizona's Upper Basin entitlement. Given the potential reduction to only two of the three units at NGS, pursuant to the proposed alternative being discussed with EPA (August 2013), these projections may be higher than what is now being anticipated.

Municipal use represents the second highest water use in the Navajo/Hopi Planning Area and is projected to increase by 2060. The City of Page relies on a portion of Arizona's of Upper Basin allocation through on diversions from Lake Powell, reporting diversions of 2,096 acre-feet in 2010. The balance of municipal demand in the Planning Area is groundwater served and distributed among the communities of the Navajo Nation and Hopi Tribe.

Table P.A. 14-2. Projected Water Demands (in acre feet) - Navajo/Hopi Planning Area

Sector	2010	2035	2060
Agriculture	1,963	1,963	1,963
Dairy	0	0	0
Feedlot	0	0	0
Municipal	19,022	23,093	26,402
Other Industrial	0	0	0
Mining	601		
High		750	750
Low		750	750
Power Plants	23,948		
High		50,000	50,000
Low		40,205	46,425
Rock Production	132		
High		1,818	2,149
Low		756	895
Turf	738		
High		705	703
Low		670	704
Total (High)	**46,404**	**78,328**	**81,966**
Total (Low)	**46,404**	**67,436**	**77,140**

Characteristics Affecting Future Demands and Water Supply Availability

Unresolved Indian Water Rights Claims

Conflicts between the Hopi and Navajo and between the tribes and non-Indian water users, including water supply issues, have proven difficult to resolve. Water rights settlement discussions with the tribes, the federal government and State parties had been the primary focus through 2012 in resolving these issues. Legislation was introduced in the fall of 2012 by Arizona Senators Jon Kyl and John McCain that would have provided groundwater projects for the Navajo and Hopi Tribes in exchange for dismissal of the tribes' claims to water from the Little Colorado River and provided a framework for future settlement to the tribes' claims to the Lower Colorado River. The legislation was removed at the request of the Navajo Nation and the Hopi Tribe as a result of further discussions with their respective tribal councils.

In June of 2013, the Navajo Nation re-initiated litigation originally filed on March 14, 2003. In this action, the Navajo Nation alleges that various federal agencies and entities have failed to consider the water rights of the Navajo Nation, or protect their interests in the Lower Colorado River when operational decisions were made, resulting in detriment to the Navajo Nation's water rights. The State of Arizona is an intervener in this action. This re-initiation of litigation followed the failure to reach a settlement, as described above. As is typical in litigation, uncertainty regarding the outcome of this case creates significant uncertainty for both tribes and the State parties with respect to development of water supplies to meet both current and projected demands.

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 14,000 claimants and water users are joined in the Little Colorado 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 this Planning Area will make it difficult to identify strategies for meeting the projected water demands.

Infrastructure and Dispersed Population Centers

The residents of the Navajo/Hopi Planning Area are largely traditional peoples. It is an arid land with limited vegetative cover and limited available water supplies. Many of the settlements date to a time prior to the advent of centralized water distribution systems and rely on local springs or intermittent and ephemeral surface water flows to sustain the traditional lifestyles of their residents. Aside from the major population centers and smaller communities located in this Planning Area, population is widely dispersed across approximately 17,100 square miles in Arizona. The relatively sparse population distribution across both the Navajo Nation and Hopi lands increases the technical and financial challenges of meeting the needs of an underserved population, due to the distances that water may need to be transported and the limited demands to be served. The Navajo Department of Water Resources estimated that approximately 30 percent of the households on the Navajo Reservation are without direct access to public water systems and haul water long distances to provide water for their families[3]. It is assumed that the same holds true for the Hopi lands, but the extent of water hauling is at this time unknown.

Groundwater is believed to be available in quantities that are likely to be sustainable at current and projected municipal and domestic demands within the Navajo/Hopi Planning Area. Unfortunately, it is not commonly found in locations that are convenient to the current points of demand, nor available from depths that are economically feasible for the current population. Additionally, concentration of groundwater pumping at the larger demand centers has resulted in declines in local water levels. As discussed above, portions of the Navajo/Hopi Planning Area exhibit water quality challenges for potable use, including TDS and uranium.

Strategies for Meeting Future Water Demands

Resolution of Indian and Non-Indian Water Rights Claims

Reaching resolution of water rights claims of the Navajo Nation, the Hopi Tribe and the Southern Paiute is the single most important step in ensuring long-term water supply sustainability for this region, as well as providing water supply certainty for other planning areas reliant on the Little Colorado and Colorado rivers. For example, mainstem Colorado River water and Colorado River water delivered through the CAP canal are important water sources for the Basin and Range AMAs, Colorado Mainstem – North and Colorado Mainstem – South Planning Areas. The outcome

[3] The Navajo Nation's Department of Water Resources prepared a Draft Water Resource Development Strategy for the Navajo Nation (July, 1011) http://www.tribesandclimatechange.org/docs/tribes_357.pdf). The report addressed a large range of alternatives including: regional water supply projects; local-scale projects; and providing assistance to water haulers, who serve upwards of 30 percent of residents on the Reservation.

of any settlement or litigation of tribal water right claims has the potential to impact the supply availability to these areas. This is especially true of the CAP service area within the Basin and Range AMA Planning Area because CAP is a junior priority holder to Colorado River supplies.

Currently, water rights settlement negotiations have stalled and the Navajo Nation has decided to proceed with its litigation against the United States on issues related to operations in the Lower Colorado River Basin. Settlement negotiations are typically more productive than litigation and result in outcomes that can provide federally financed infrastructure to deliver water to Indian communities, or alternatives that guarantee water supplies are used within the State to benefit Arizona citizens. ADWR believes that efforts should be made to resume settlement discussions and resolve claims in a manner beneficial to tribal communities within Arizona. Correspondingly, resolution of the Little Colorado River Adjudication is essential to provide long-term certainty for water users in Arizona dependent on water supplies from the Little Colorado River. 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.

The Omnibus Public Land Management Act of 2009 provided authorization to construct the Navajo-Gallup Water Supply Project. The San Juan Navajo Water Rights Settlement was signed by the Secretary of the Interior, the Navajo Nation President and the state of New Mexico in 2010. A major component of that settlement was the financing and construction of the Navajo-Gallup Pipeline Project. Once constructed, the project will convey a reliable municipal and industrial water supply from the San Juan River to the eastern section of the Navajo Nation in New Mexico. The project includes approximately 280 miles of pipeline, several pumping plants, and two water treatment plants and, in 2007, was estimated to cost $865 million to construct.

The Arizona Water Settlements Act of 2004 requires the Secretary of Interior to reallocate 6,411 acre-feet per year of Non-Indian agricultural priority CAP water to the Navajo Nation for use in Arizona[4]. The most recent settlement proposal, rejected in December of 2012 by the Navajo and Hopis, would have facilitated the use of this water to serve communities within the Navajo Nation near the Arizona-New Mexico border (primarily Window Rock) by diverting water from the San Juan River in New Mexico, delivering the water through the Navajo-Gallup Water Supply Project. The project would have been financed by the US. Unfortunately, the settlement discussions were suspended in December of 2012, but this option is an example of what could be done under a successful settlement of the claims.

Increase Access to Locally Available Groundwater

ADWR believes that enhanced access to the groundwater resources within the Navajo/Hopi Planning Area can serve to meet current and projected water demands throughout much of the Planning Area. This strategy includes the development or rehabilitation of many small to moderate scale production, transmission, and distribution projects. For areas where expansive distribution systems are currently infeasible, community wells and watering points need to be constructed or upgraded to improve access for water haulers, perhaps utilizing commercial water

[4] The United States and the State of Arizona are each required to firm 50 percent of the NIA priority CAP water to the equivalent of M&I priority CAP water until January 1, 2108.

hauling services. Additionally, measures such as wider distribution of groundwater pumping, increased local aquifer replenishment, or replacing pumping with renewable supplies, such as surface water or reclaimed water, would serve to lessen the rates of decline seen near the large demand centers. Meeting local demands in the Planning Area may also require either construction of wells in a manner that isolates poor quality supplies from higher quality local sources, or construction and operation of treatment works, likely either wellhead treatment or point of use systems.

Leveraging existing hydrogeologic information with additional studies, drilling and testing of wells, planning and development of water delivery and storage infrastructure, and monitoring and modeling will provide a basis for prudent use and ideal locations of potential groundwater supplies. Regional projects will maximize the number of water users that can have reasonable access to the mainline delivery systems; however, cooperation across political boundaries may be necessary to successfully implement some of these options.

Reclaimed Water Reuse

Diversions of Colorado River water by the City of Page are offset by reclaimed water discharges to the Colorado River. These discharges are monitored and used by Reclamation to determine the City's consumptive use of Colorado River each year. With the exception of turf irrigation at Lake Powell National Golf Course in Page, there is limited reuse of reclaimed water in the Navajo/Hopi Planning Area. The use of reclaimed water is limited due to low demand for on-site non-potable supplies and lack of centralized sewer systems. However, reclaimed water could be made available for restoration of environmental resources and industrial or appropriate agricultural water uses. Increasing the utility of this resource would likely require upgrading wastewater treatment works throughout the Planning Area to produce reclaimed water of a quality suitable for reuse or aquifer enhancement.

Expanded Monitoring & Data Collection

Monitoring of water use within the Navajo/Hopi Planning Area is conducted by tribal and federal authorities. The monitoring and reporting is not consolidated within Arizona's statewide programs, such as the Community Water System Reports (City of Page). Monitoring water conditions and metering and reporting water use across the Planning Area would serve to improve analysis of current hydrologic conditions. Data collection is a crucial element in the development of groundwater models, which have proven to be invaluable tools throughout the State in developing more thorough understanding of regional hydrologic systems and evaluating future conditions and projecting potential impacts of new uses and/or alternative water management strategies. In addition, exploration drilling and testing will increase understanding of the local groundwater systems, in addition to augmenting available supplies and mitigating local pumping impacts.

Watershed Management

According to the Navajo Department of Water Resources (NDWR), almost all of the watersheds on the Navajo Nation are degraded due to historic land use practices that have had a major impact on the watersheds. The result of this degradation is an increase in the intensity of runoff events, which produce additional sediment loads in local streams and reservoirs. These events incise

channels, which de-waters alluvial groundwater and, in turn, negatively impacts riparian areas and reduces the carrying capacity of the watershed.

The NDWR has received Arizona Water Protection Fund grants for watershed restoration - the Tsaile/Canyon del Muerto Watershed Restoration Demonstration Project and the Red Lake Wash Watershed Restoration/Demonstration Project. Additional projects that have been initiated include: 1) the National Fish and Wildlife Asaayi Habitat Restoration Project; 2) the Rio Puerco Watershed Bluewater Restoration Project; and 3) Restoration of the Pueblo Colorado upstream of Hubbell's Trading Post, which was funded by the US Bureau of Indian Affairs (BIA). The work in the Rio Puerco Watershed was conducted under the Bureau of Land Management's Rio Puerco Watershed Act. With watershed improvements, floods can be attenuated, natural recharge can be increased, and wetland values can also be enhanced and, with proper grazing management, forage production can be increased.

Summary

Development and delivery of renewable water supplies, such as proposed by the Navajo-Gallup Pipeline Project, is only practical for specific large population centers and has limited application across much of the Planning Area. A more cost-effective and long-term approach for this Planning Area, due to the dispersed location of water users, is strategically located groundwater projects. These projects can be located in or near population centers, or in areas that can serve remote populations, either directly or through commercial water hauling services. Long-term groundwater supplies may need to be developed in deep aquifer systems and may require additional water treatment to acceptably serve intended uses. However, it is also important to develop these projects in areas that do not imperil existing springs that serve as important local sources of water supplies for habitat and people.

Most importantly, to ensure long-term protection and to provide secure Federal financing for these projects, a comprehensive water rights settlement is imperative to develop the water supplies necessary to improve the quality of life within the Planning Area and support the long-term economic viability of this region.

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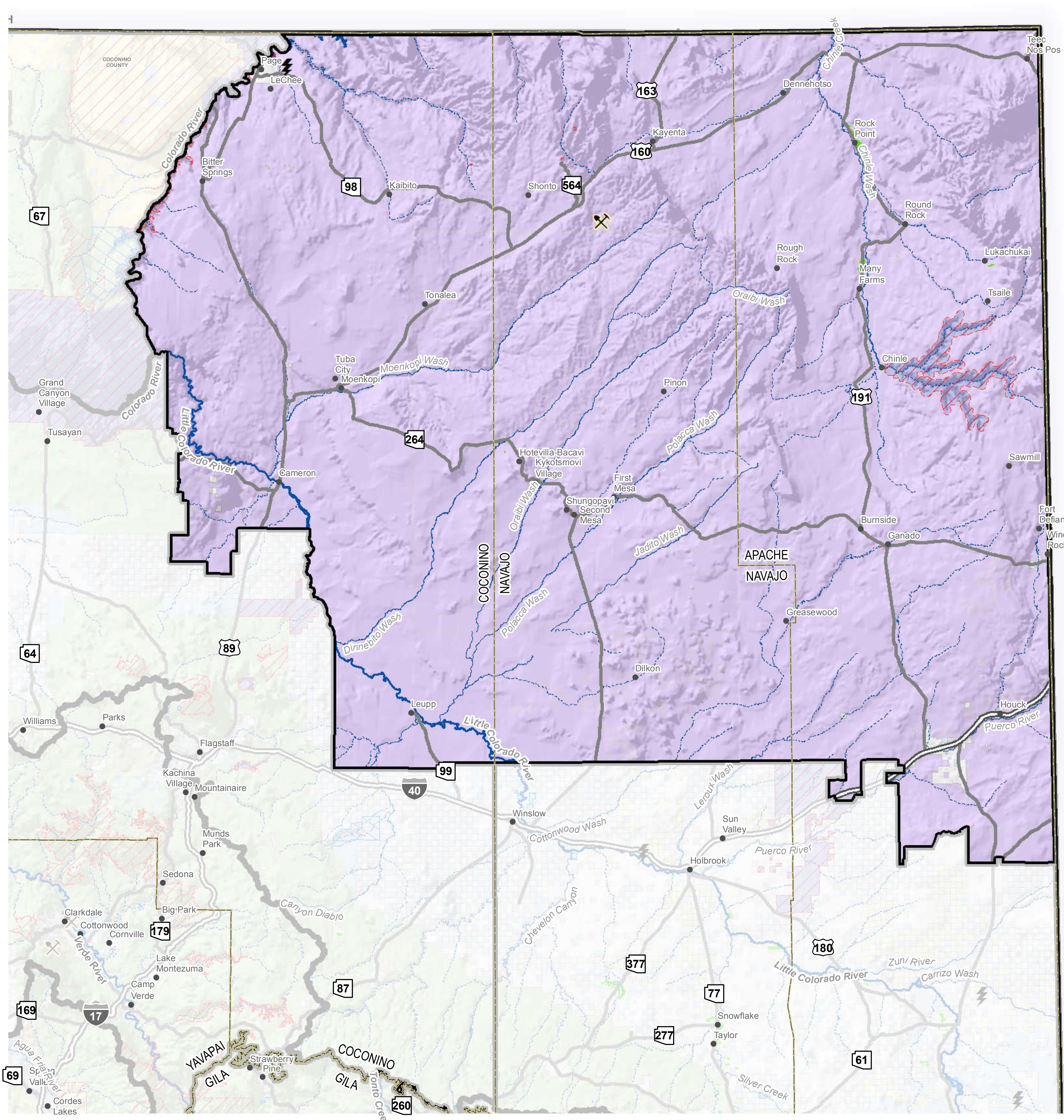

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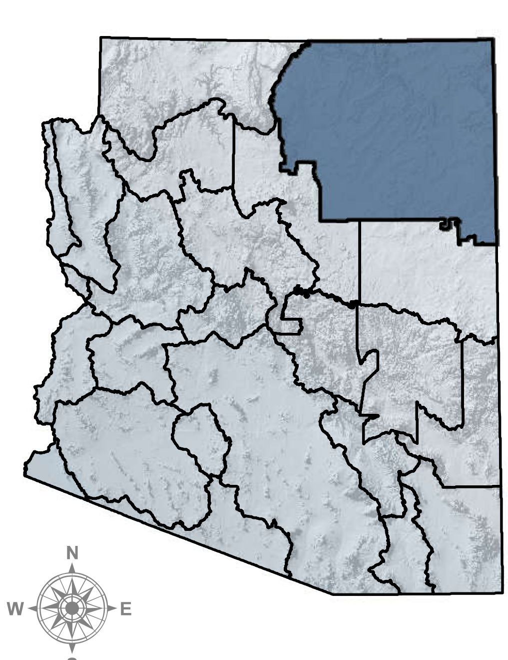


MAP LOCATION
(Planning Area Boundaries)

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)

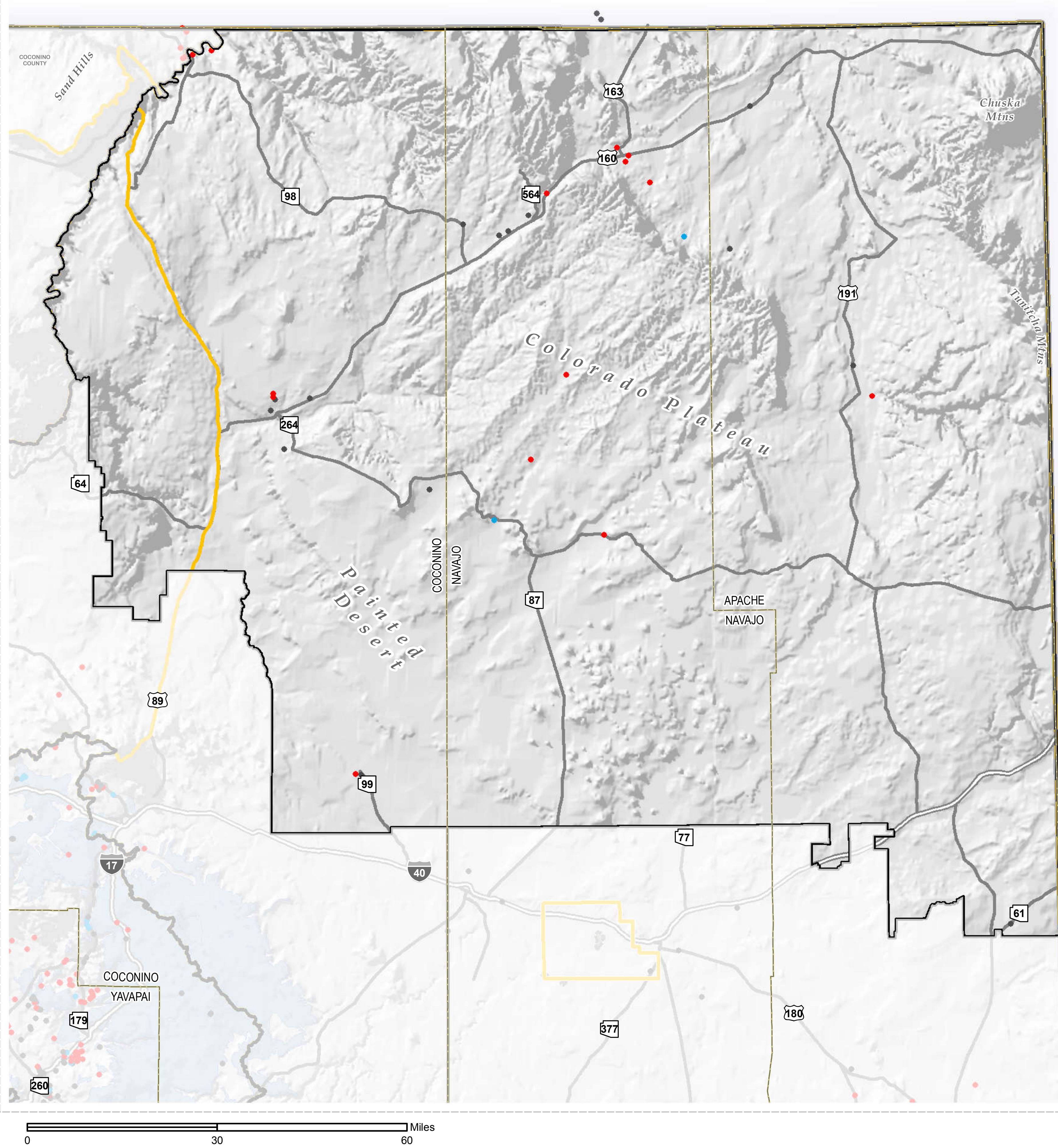
Agriculture (SWReGAP, 2004)
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation Land (AZGFD, AZSP)
BLM Land
National Forest
National Park
Military Reserve
Private and Other Land
State Trust Land
Tribal Land

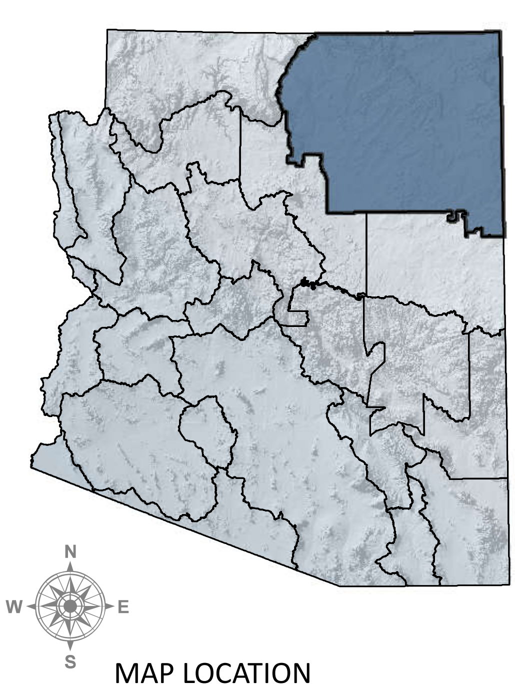
ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.14-1

Navajo / Hopi 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)

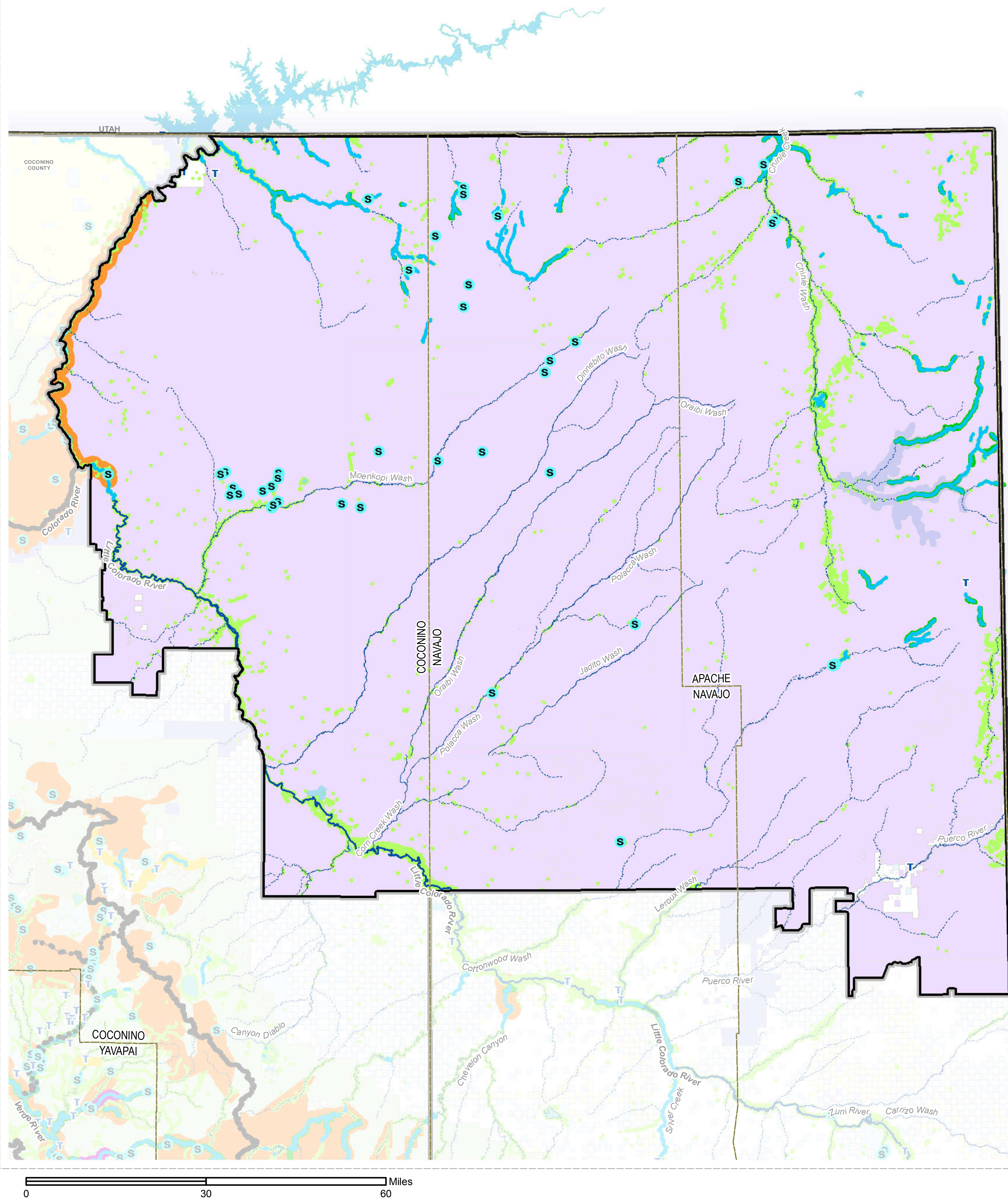
Recent Water Level Change * (1990's through 2000's)
Minor WL Change +5' to -5'
Negative
Positive

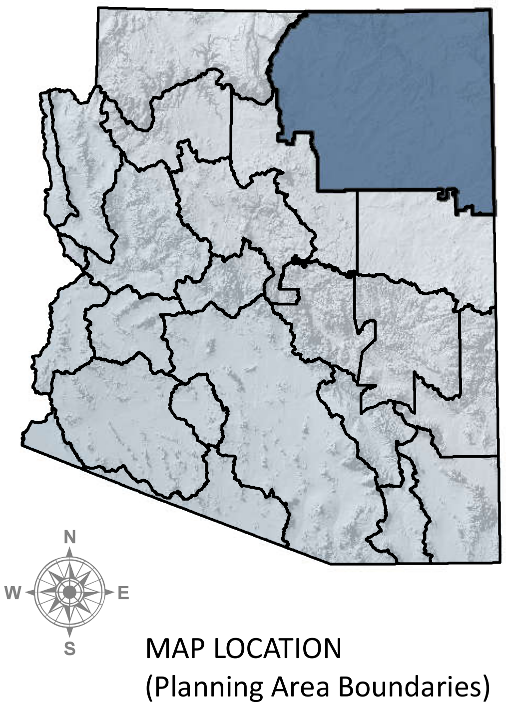
* Data provided by ADWR

Figure P.A.14-2

Navajo/Hopi 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

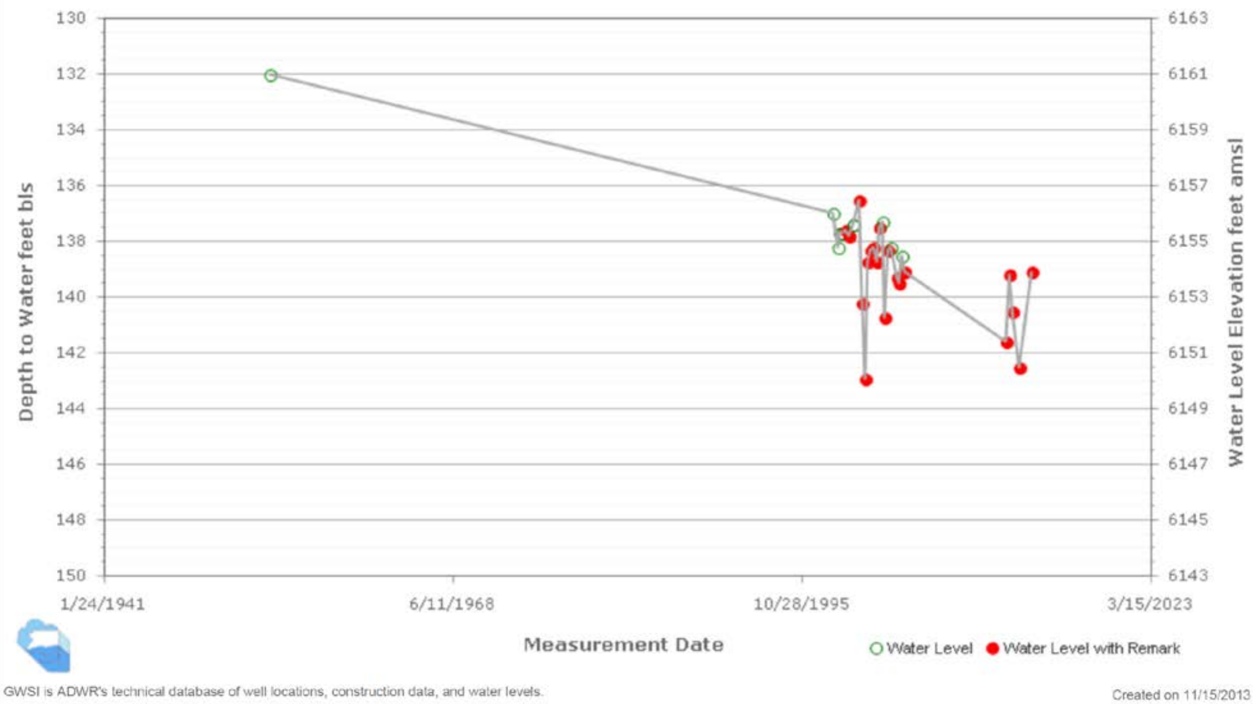
Figure P.A.14-3

Navajo/Hopi
Surface Water and Natural Features

Little Colorado River Plateau Basin – Navajo/Hopi Planning Area

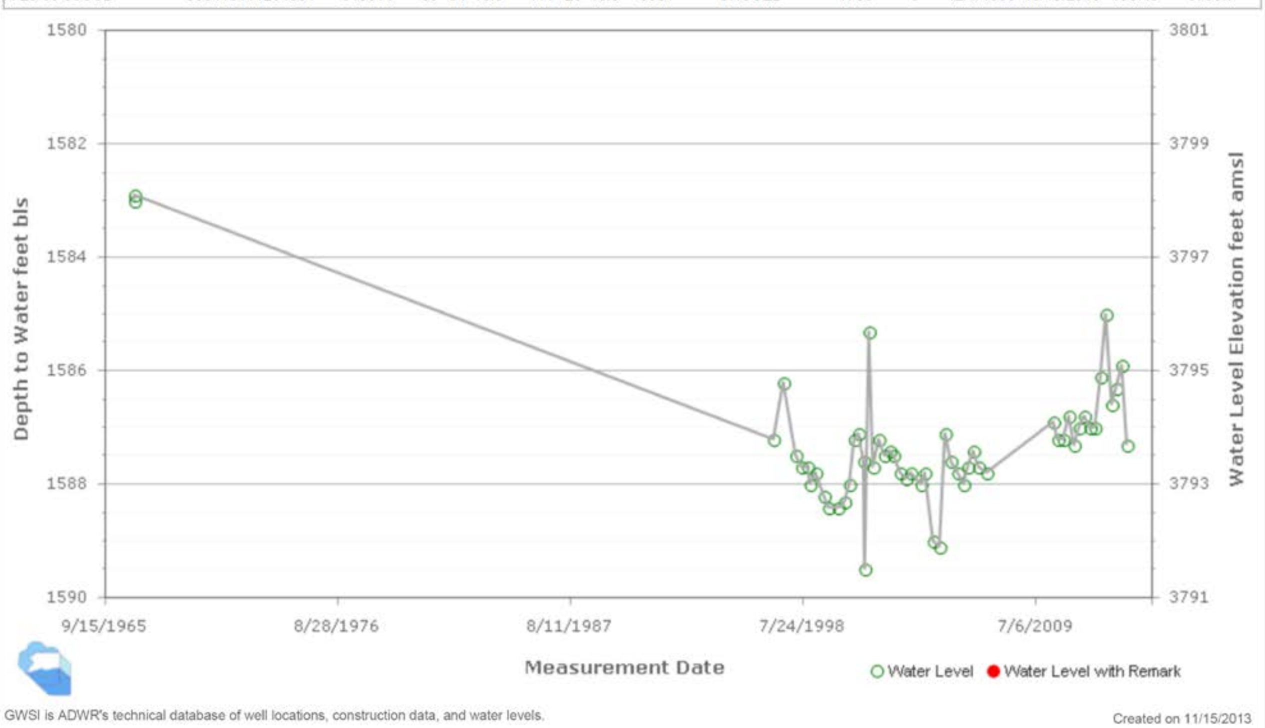
Arizona GroundWater Monitoring Site Hydrograph

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)
17 110-04.68X02.91	354229109345801		35° 42' 29.5"	109° 34' 57.9"	6293	STOCK	249	8	1/5/1954			



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)
A-25-09 06CCD	353410111284001	649814	35° 34' 10.9"	111° 28' 46.0"	5381	UNUSED	1788	8	12/1/1966	10/15/2013	1587.3	3793.7



Arizona GroundWater Monitoring Site Hydrograph

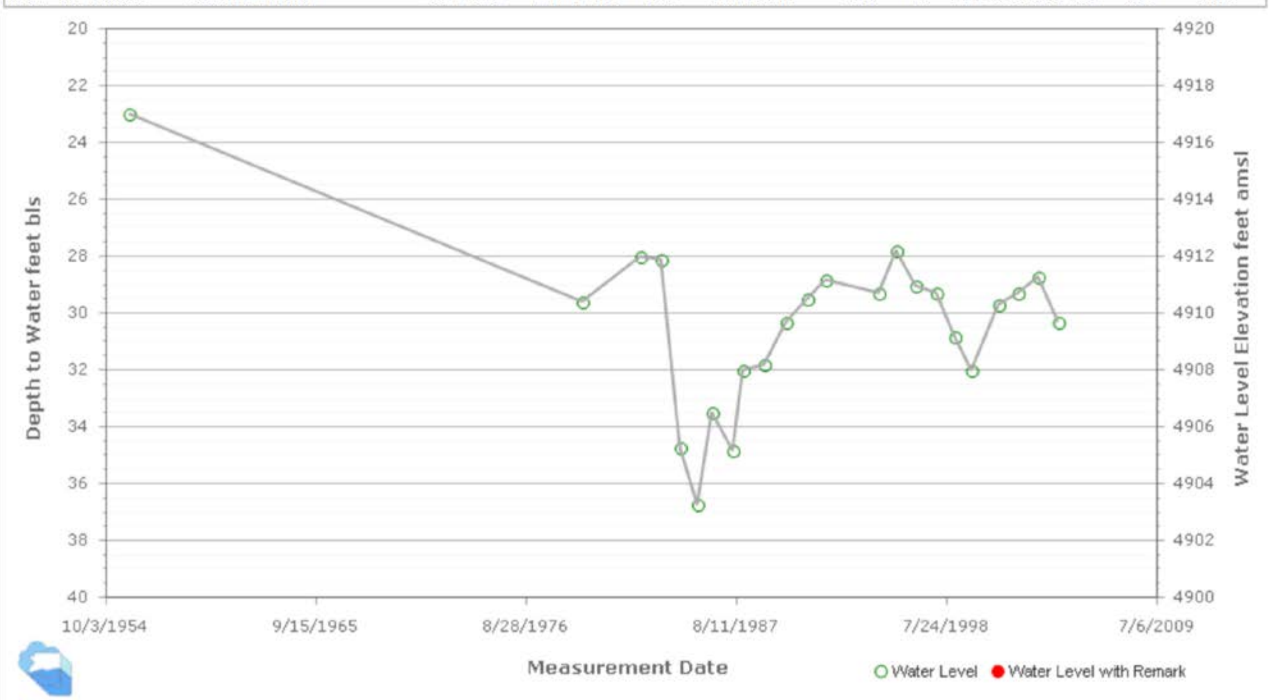
Local ID	Site ID	Registry ID	Latitude NAD27	Longitude NAD27	Alt. (ft amsl)	Water Use	Well Depth (ft)	Case Dia. (in)	Drill Date	Latest WL Date	DTW (ft)	WL Elv. (ft)
08 039-00.70X01.57 B	364338110154601		36° 43' 38.0"	110° 15' 45.0"	5724	UNUSED	868		7/13/1959	6/16/2004	155.1	5568.9

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

Created on 11/15/2013

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)
03 077-13.77X08.52	360734111144801		36° 7' 34.0"	111° 14' 48.0"	4940	DOMESTIC	229	10	12/2/1955	5/10/2004	30.3	4909.7



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

Created on 11/15/2013

[NORTHWEST BASIN PLANNING AREA]

Northwest Basins Planning Area

Background

The Northwest Basins Planning Area is located in the far northwest portion of the State and comprised of the Detrital, Hualapai, Meadview, and Sacramento Valley Groundwater Basins. The Planning Area lies within Mohave County. The City of Kingman is the largest community in the Planning Area.

The majority of the land in this Planning Area is owned and managed by federal agencies (*see Figure P.A. 15-1*). The exception is in the Hualapai Valley Basin, where a significant portion of the land (43 percent) is privately held. Federal land uses include a portion of the Lake Mead National Recreation Area, spanning portions of the Meadview, Hualapai Valley and Detrital Basins, portions of the Hualapai Indian Reservation in the Meadview Basin, and the Mount Tipton and Mount Wilson Wilderness Areas located in the Detrital Basin. The largest landowner in the Planning Area is the US Bureau of Land Management (BLM). Ownership is also often fragmented, with federal, State, and private land holdings assembled in a "checkerboard" fashion that often complicates the development and implementation of comprehensive land management strategies.

Water Supply Conditions

<u>Groundwater</u>

The Northwest Basins 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, which may provide opportunities for artificial storage and recovery. Groundwater conditions within the Planning Area are variable (*see Figure P.A. 15-2*). Groundwater in storage in the Meadview Basin is estimated to be 1 MAF with groundwater levels generally declining at approximately 1 foot per year. Groundwater in storage in the Hualapai Valley Basin is estimated to be 5 MAF with groundwater levels generally declining at 0.9 foot per year. Groundwater in storage in the Detrital Valley Basin is estimated to be 1 MAF with groundwater levels declining at 0.8 foot per year. Groundwater in storage in the Sacramento Valley basin is estimated to be 7 MAF. Groundwater levels in the Sacramento Valley Basin are rising at less than 1 foot per year.

<u>Surface Water</u>

Other than the Colorado River, in the northernmost portion of the Planning Area, there are no perennial streams in the Planning Area (*see Figure P.A. 15-3*). One intermittent stream, Sawmill Canyon, is located in the northeastern portion of the Sacramento Valley Basin. Lake Mead also borders the northern portion of the Hualapai Valley and Detrital Valley basins and a small portion of Lake Havasu borders the western tip of the Sacramento Valley Basin.

<u>Reclaimed Water</u>

Centralized wastewater collection to treatment systems is limited to the larger population centers in the Planning Area. In many areas water users rely upon exempt wells (those wells with a pump capacity of 35 gallons per minute or less) for their water supplies and septic systems for wastewater treatment and disposal. Currently, the City of Kingman operates the Hilltop and Downtown wastewater treatment

plants (WWTP) that together produce over 2,000 acre-feet of reclaimed water per year, the majority of this is produced from the Hilltop WWTP. At present, reclaimed water is not reused and is discharged into a watercourse, evaporations ponds and an artificial wetlands area[1].

<u>Ecological Resources</u>

The Northwest Basins Planning Area includes a portion of the Lake Mead National Recreation Area, to the north and all or portions of five wilderness areas including, Mt. Tipton, Mt. Wilson, Warm Springs, Wabayuma Peak, and Aubrey Peak Wilderness areas. These areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition.

Water Demands

Table P.A. 15-1 illustrates the projected demands in the Northwest Basins Planning Area. Agricultural land uses within the Planning Area are very limited. Livestock grazing, dependent upon precipitation for forage, occurs on public lands and dominates agricultural uses in the Planning Area.

The largest potential for growth is in the municipal, mining and electrical power generation sectors. Several large master planned developments have been proposed in the northern portions of the Detrital and Hualapai Valleys. These master planned communities were envisioned to serve the greater Las Vegas metropolitan area as transportation connections were improved and affordable housing needs were sought for the Las Vegas area. Recent economic downturns in the real estate sector have placed these development plans on hold.

Because of the extensive availability of BLM lands, it is anticipated that this area may be a focus for expansion of renewable energy development in the future. BP Wind is pursuing development of a wind farm within the Planning Area northwest of Kingman. Following construction, this facility will not use water beyond the domestic and sanitary needs of the small maintenance workforce.

Characteristics Affecting Projected Water Demands and Supply Availability

<u>Expanded Urbanization</u>

Limited concentrated urbanization has occurred in the Planning Area, centered primarily in and nearby the City of Kingman. Dispersed development, or low density "wild cat" development is generally scattered through the privately held lands in the Planning Area. Current and planned municipal demands are anticipated to remain dependent upon groundwater.

<u>Water Management</u>

The Planning Area is not within any AMA or INA that requires additional water management. No reporting requirements, other than the Community Water System reporting requirement exist within the Planning Area. The Mohave County Water Authority (MCWA) is a water management entity of note that operates in the Planning Area, and which acquired Kingman's entitlement of Colorado River water, for use by on-river communities outside the Planning Area, in exchange for providing funds to Kingman to develop its groundwater resources.

[1] http://www.cityofkingman.gov/pages/depts/publicworks/wastewater.asp

Table P.A. 15-1 Projected Demands (in acre feet) – Northwest Basins Planning Area

Sector	2010	2035	2060
Agriculture	0	0	0
Dairy	76	76	76
Feedlot	0	0	0
Municipal	12,782	22,638	28,260
Other Industrial	0	0	0
Mining	90		
High		12,000	12,000
Low		8,000	8,000
Power Plants	1,300		
High		5,944	7,623
Low		4,346	5,351
Rock Production	9		
High		1,263	1,577
Low		526	657
Turf	0		
High		422	422
Low		0	0
Total (High)	**14,257**	**42,343**	**49,958**
Total (Low)	**14,257**	**35,586**	**42,344**

Strategies for Meeting Future Water Demands

Groundwater

In response to concerns about the impacts of groundwater development by local governments, water providers and citizens groups, ADWR in collaboration with the US Geological Survey (USGS), with funding assistance from Mohave County, began conducting hydrogeologic investigations in 2005 to improve the understanding of water resources in three basins within the Planning Area; the Detrital, Hualapai and Sacramento valley basins. These investigations are focused on: (1) assessing existing data collection networks and examining the current state of knowledge of the groundwater system; (2) improving understanding of geologic units and their relationship to groundwater storage and movement; (3) improving knowledge of groundwater budget factors including recharge and storage; (4) evaluating groundwater quality; (5) establishing a hydrologic monitoring network for on-going assessment of the aquifer; and (6) informing the hydrologic community and area residents about hydrologic conditions. To date, several reports have been completed including preliminary estimates of groundwater in storage for the Detrital Valley Basin[2] and the Sacramento Valley Basin[3]. In addition, the

[2] Mason and others, 2007
[3] Conway and Ivanich, 2008

USGS released a report in 2007 on groundwater occurrence, movement and water level changes in all three basins[4].

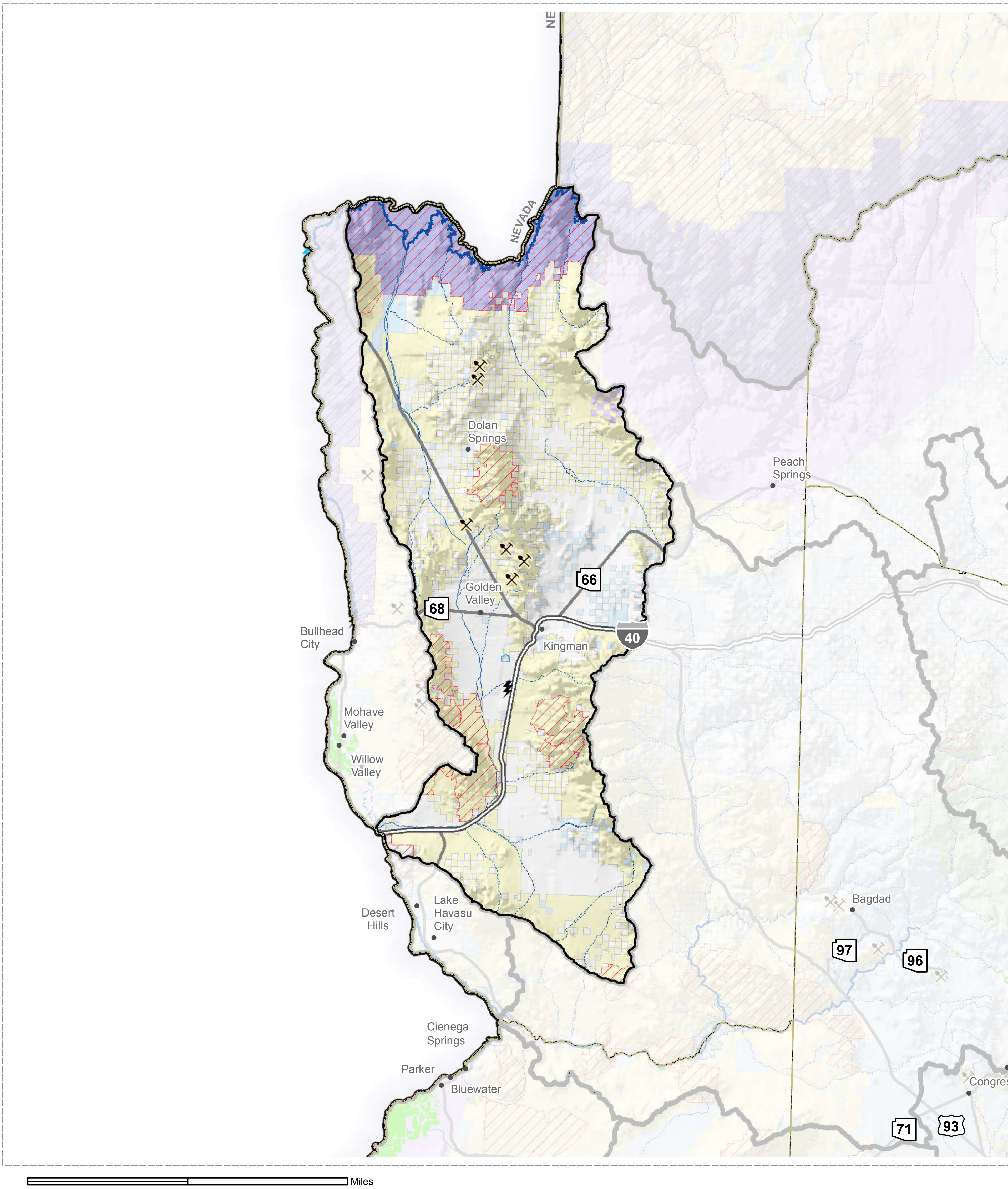
Continuation of this effort (both technically and financially) is essential for this region to achieve its water demand projections, and will be especially important for future renewable energy development. Funds could be established to ensure the completion of this effort through ADWR's Rural Water Study Program.

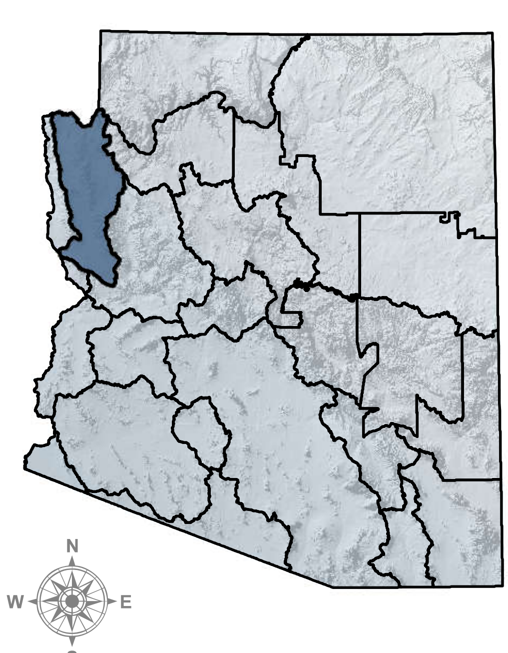
Reclaimed Water Reuse

The majority of the low-density, wild-cat style development scattered through the Planning Area relies primarily on exempt wells and septic systems for water and wastewater treatment, limiting the development of reclaimed water. Additionally, the City of Kingman currently has two WWTP's producing approximately 2,000 acre-feet annually. The permitted capacity of these facilities is nearly 5.7 MGD (6,407 acre-feet per year). The plants are currently operating at about half of their treatment capacity. Potential exists to meet the expanded needs of this community and to provide opportunities for permitted recharge to augment aquifer water supplies, as well as direct uses for landscape watering, golf course irrigation and industrial process and cooling. Several large master planned communities in the north end of the Hualapai and Detrital valleys offer the option of central wastewater collection and reuse either directly through landscape watering, golf course watering, and industrial cooling, or aquifer management through recharge and recovery.

[4] Anning and others, 2007

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.



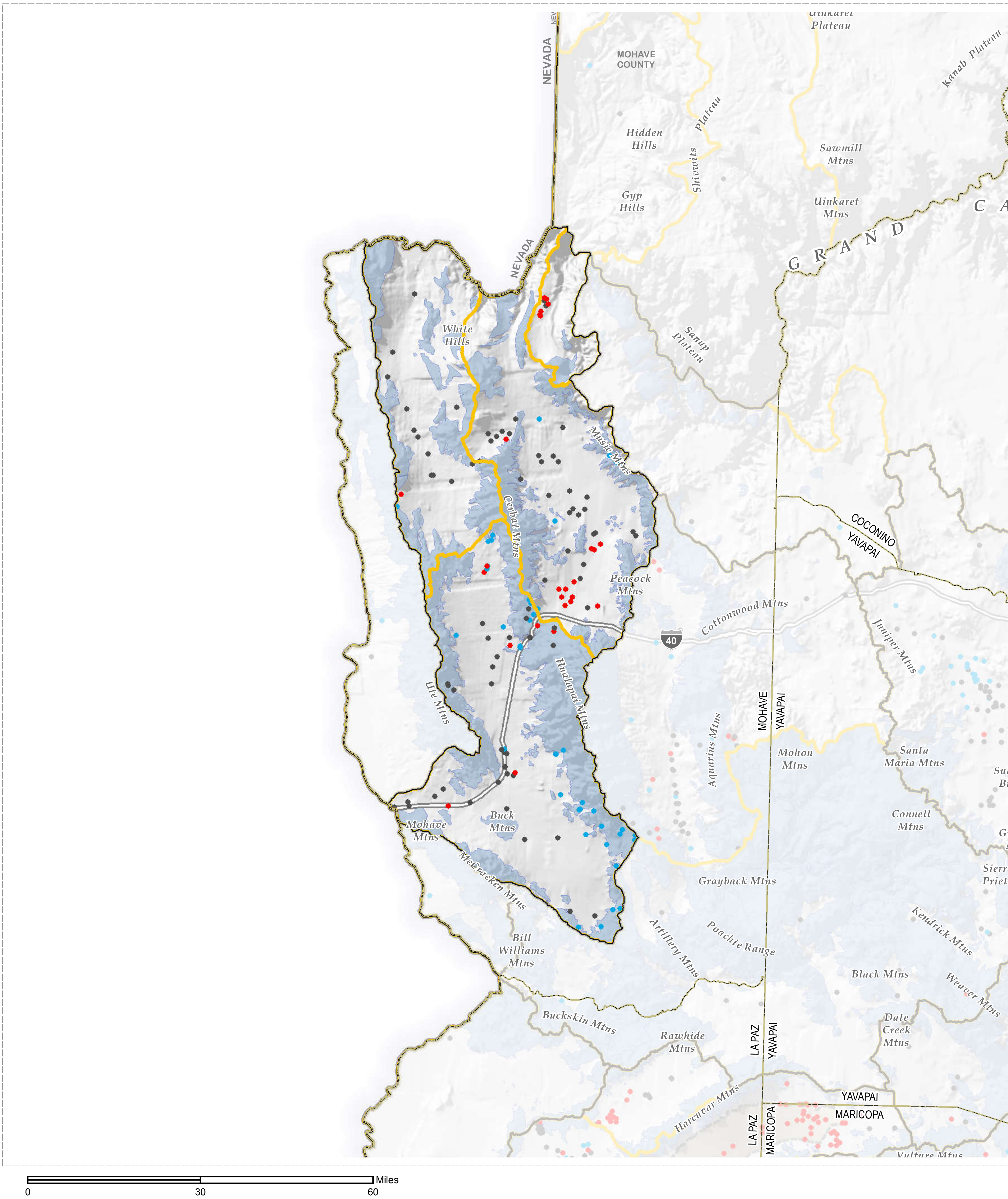


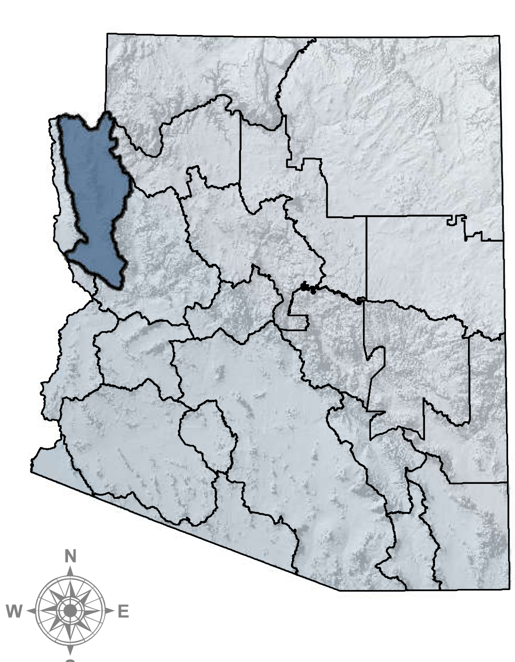
MAP LOCATION
(Planning Area Boundaries)

Figure P.A.15-1

Northwest Basins 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)

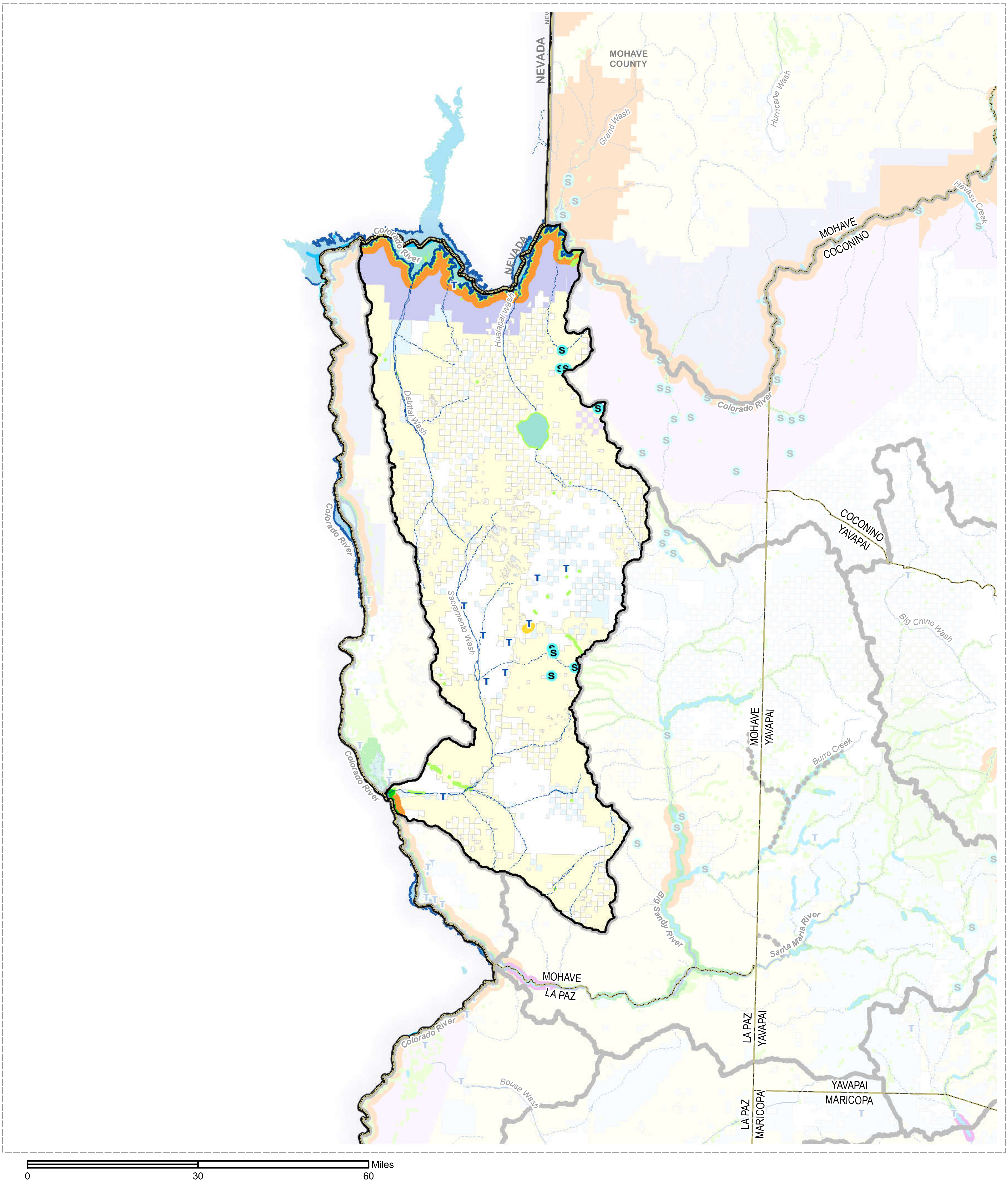
- Minor WL Change +5' to -5'
- Negative
- Positive

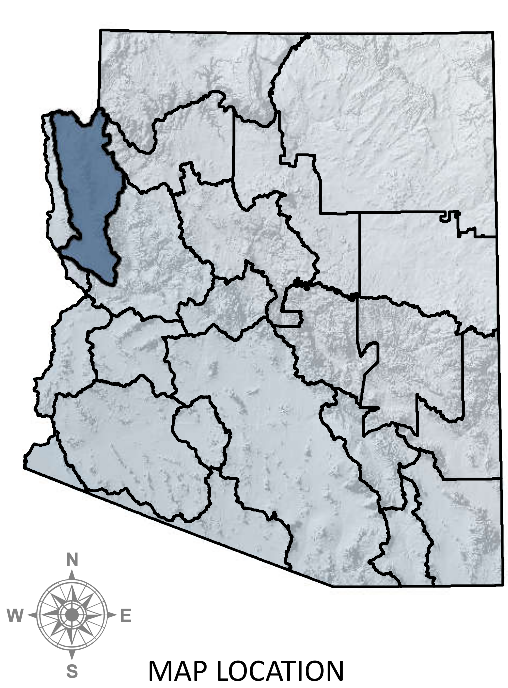
* Data provided by ADWR

Figure P.A.15-2

Northwest Basins 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.





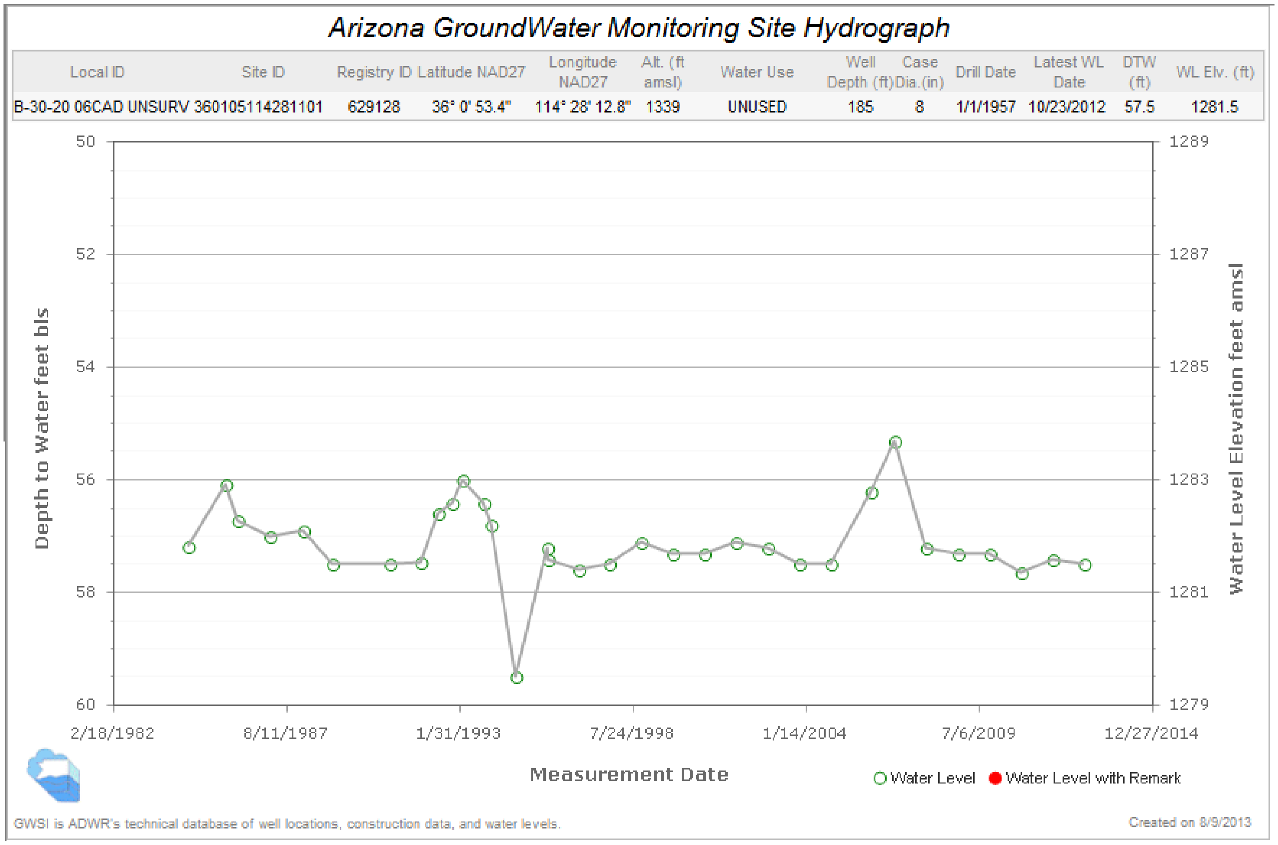
MAP LOCATION
(Planning Area Boundaries)

- 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

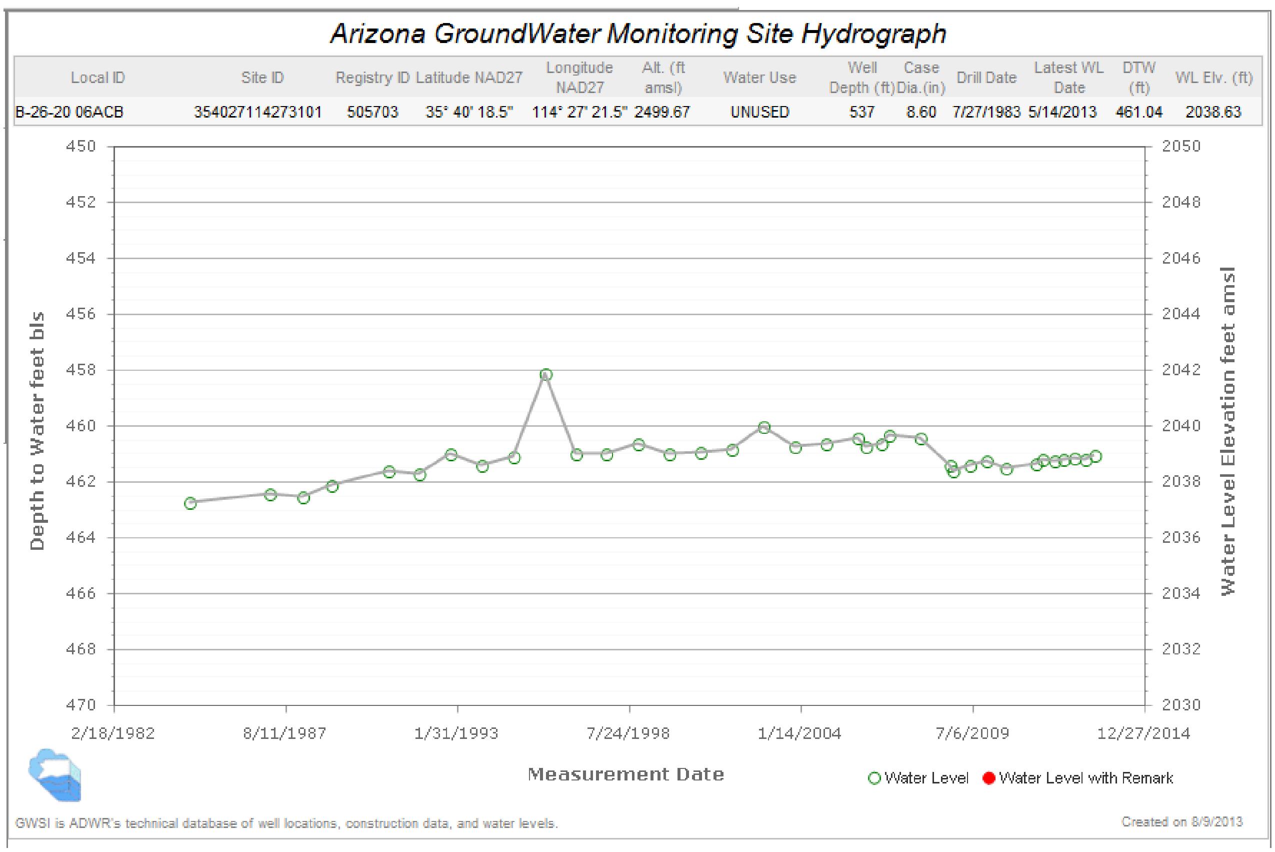
Figure P.A.15-3

Northwest Basins
Surface Water and Natural Features

Detrital Valley Basin – Northwest Basins Planning Area

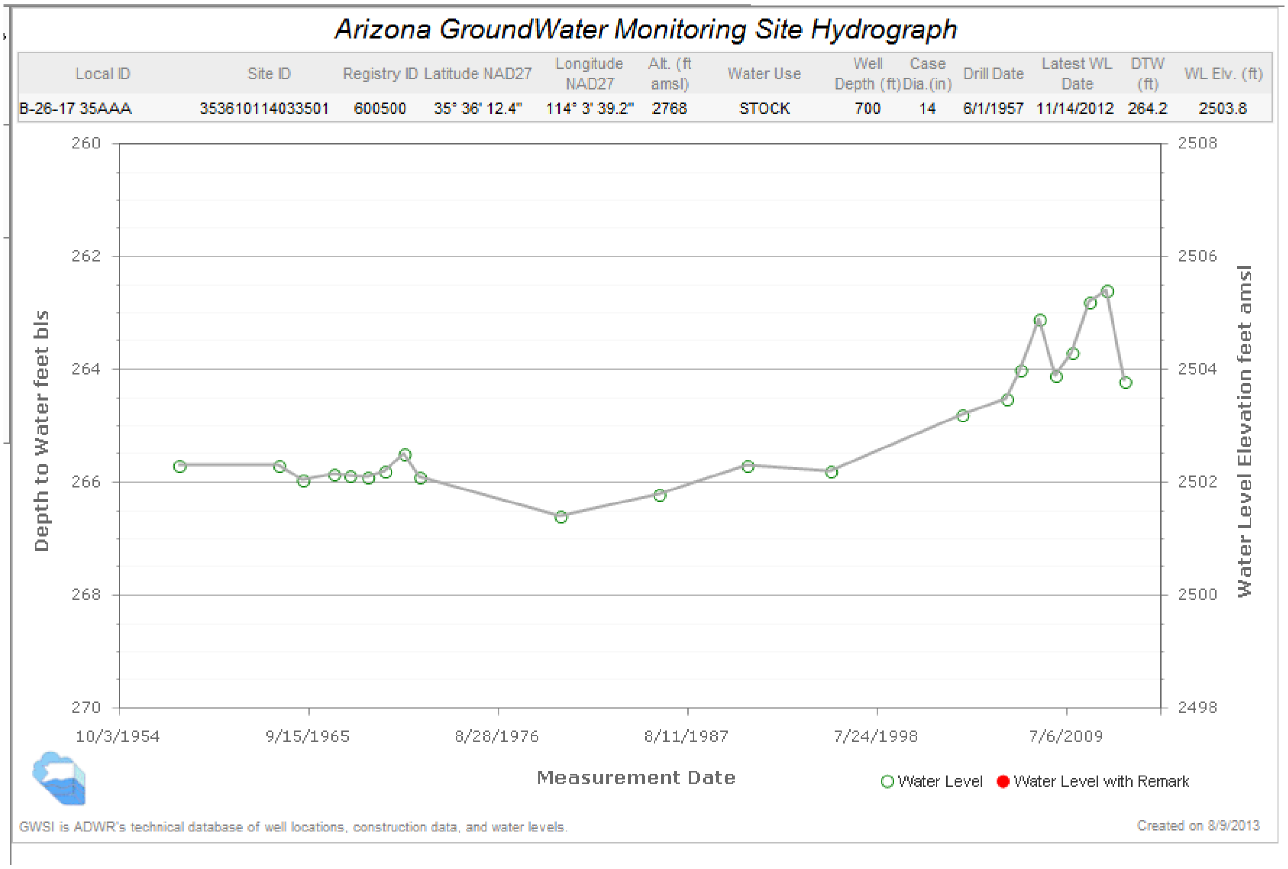


B-30-20 06CAD UNSURV Detrital Valley basin northern portion of basin along Detrital Wash at AZ268.



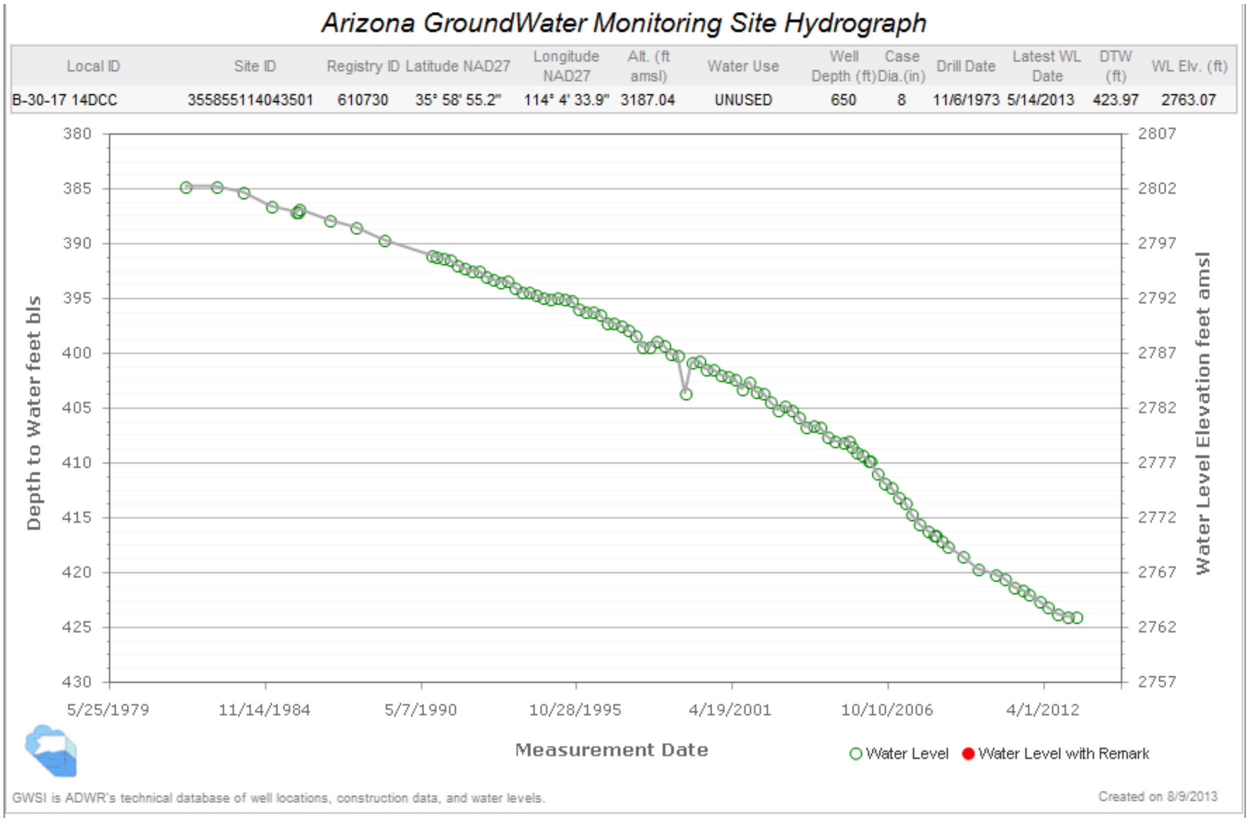
B-26-20 06ACB Detrital Valley basin central part of basin near Detrital Wash.

Hualapai Valley Basin – Northwest Basins Planning Area



B-26-17 35AAA Hualapai Valley basin, central portion of basin about 2 miles south of Red Lake.

Meadview Basin – Northwest Basins Planning Area



B-30-17 14DCC Meadview basin at Meadview. Overall water level decline due to local pumping.

Sacramento Valley Basin – Northwest Basins Planning Area

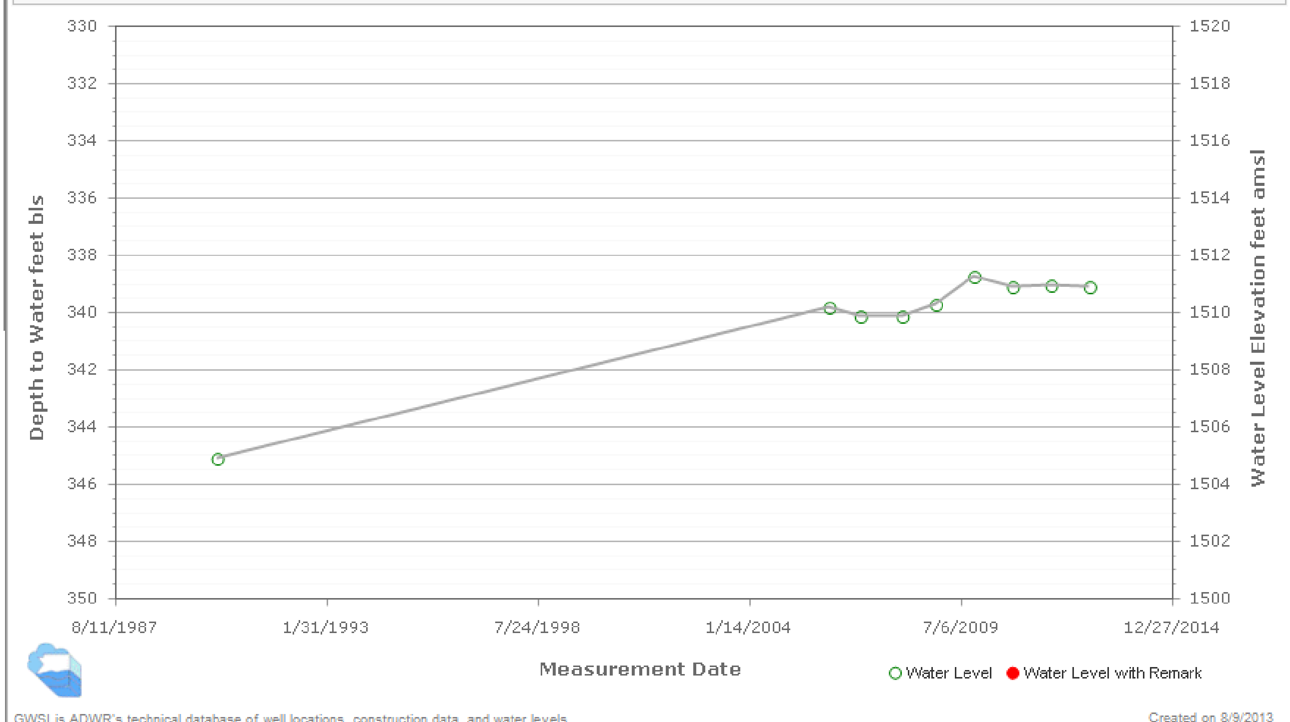
Arizona GroundWater Monitoring Site Hydrograph

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)
B-21-18 09BBA	351340114125401	610757	35° 13' 39.8"	114° 12' 54.6"	2832	PUBLIC SUPPLY	1518	16	5/2/1962	10/23/2012	1042	1790

B-21-18 09BBA Sacramento Valley basin northern part of basin in Golden Valley 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)
B-17-18 12ACB1	345232114084601	600262	34° 52' 33.5"	114° 8' 44.7"	1850	UNUSED	350	8		10/23/2012	339.1	1510.9



B-17-18 12ACB1 Sacramento Valley basin at Yucca.

[ROOSEVELT PLANNING AREA]

Roosevelt Planning Area

Background

The Roosevelt Planning Area is located within portions of Gila, Maricopa, and Pinal counties in the central portion of the State, immediately adjacent to the eastern extent of the Phoenix AMA Basin. The Roosevelt Planning Area contains portions of three watersheds, the Salt, Verde, and a small portion of the Upper Gila. The Planning Area includes portions of four groundwater basins: Salt River, Tonto Creek, Verde River, and a small portion of the Safford Basin. There is limited population in the Planning Area, largely residing in several moderately populated communities. The primary communities within the Planning Area are Payson, Star Valley, Globe, Miami, Strawberry, Pine, and Young. The Town of Payson is the largest community in the Planning Area.

Nearly all of the land within this Planning Area is federally owned and managed by the USDA Forest Service (Forest Service) as part of the Tonto National Forest (*see Figure P.A. 16-1*). Land uses on the Tonto include resource conservation, recreation, livestock grazing, watershed management and timber production. A small portion of the federal land includes the Tonto Apache Indian Reservation just south of Payson. The Tonto Apache Indian Reservation is the smallest land base reservation in Arizona at 85 acres. Principal water demands are associated with the Mazatzal Casino and restaurant, and tribal offices. The largest private land holdings in the Planning Area are in the vicinity of Payson and Globe. There are also numerous small private land in-holdings within the boundaries of the Tonto National Forest. Land uses include mining, domestic, commercial, livestock grazing, and limited irrigated agriculture. A small amount of land in the vicinity of Globe is owned and operated by the US Bureau of Land Management (BLM) and used for mining and livestock grazing.

Water Supply Conditions

<u>Groundwater</u>

The Roosevelt Planning Area is located in the Central Highlands Transition Zone Physiographic Province. The groundwater system within this mountainous terrain includes relatively thin alluvial aquifers, and limited volumes of groundwater flowing in fractured crystalline, sedimentary, and volcanic rock. A unique geographic feature of the Planning Area is the Mogollon Rim, the escarpment that defines the northern boundary of the Planning Area and the southern boundary of the Colorado Plateau within Arizona.

In 2012, there were 21 municipal wells serving the communities of Globe, Miami and Claypool in the southeast part of the Planning Area. Total groundwater withdrawals from these wells in 2012 totaled approximately 2,450 acre-feet. Wells in the Globe, Miami and Pinal Creek areas in the western portion of the Salt River basin showed significant declines along Pinal Creek due to groundwater remediation pumping for the Pinal Creek Water Quality Revolving Fund (WQARF) site (*see Figure P.A. 16-2*).

Water levels have risen or remained constant in most of the wells located in the Tonto Creek Basin (*see Figure P.A. 16-2*), with the exception of the northern portion of the Basin in the Star Valley/Payson area where water levels have generally declined in areas where municipal and industrial pumping exceeded natural recharge.

In the Payson area of the Verde River Basin, groundwater levels declined in six of the seven wells measured over the period from 1990 to approximately 2009 (*see Figure P.A. 16-2*). Payson's groundwater supply comes from a fractured rock aquifer and yields only small volumes of water to wells; therefore the supply is drought sensitive. The overall water level declines in the Payson area wells measured by ADWR were in excess of 2 feet/year over this period. However, recent short-term water level trends show some wells with recovering or stabilized water levels. The more recent recovery or stabilization trend observed in some Payson area wells is believed to be mainly a result of distributing municipal pumping over a broader area and adding well capacity.

There are several water quality issues within the Planning Area. The Pinal Creek WQARF Site has groundwater and surface water contamination, a consequence of the mining and mineral processing in the area since 1878. There are two WQARF sites in the Payson area, the Payson PCE site and the Tonto & Cherry site, being monitored for tetrachloroethene (PCE) and trichloroethene (TCE). Additionally, many of the wells monitored in the Payson area equaled or exceeded the standards for arsenic, beryllium, cadmium, lead, semi-volatile organic compounds and selenium.

Surface Water

The major surface water features in the Salt River Watershed in the Planning Area includes the Salt River, which flows toward the southwest (*see Figure P.A. 16-3*). The Salt River is the largest tributary of the Gila River with a drainage area of about 5,980 square miles. The headwaters of the Salt River include the White and Black rivers, originating in the high elevations of the Salt River Basin in the White Mountains where winter snow accumulation is critical to downstream water supplies. Tonto Creek is tributary to the Salt River in the Planning Area. Surface water from both the Salt and Tonto Creek watersheds are impounded in Roosevelt Lake behind Theodore Roosevelt Dam and subsequently released to a series of downstream reservoirs operated by SRP along the Salt River outside of the Planning Area. Annual streamflow of the Salt River fluctuates widely. The minimum and maximum annual flow in the Salt River upstream of Roosevelt Lake was 152,798 acre-feet (2002) and 2,422,315 acre-feet (1916), respectively. The minimum and maximum annual flow in Tonto Creek upstream of Roosevelt Lake was 2,852.4 acre-feet (2002) and, 455,665 acre-feet (1993), respectively.

The East Verde River drains the northwest portion of the Roosevelt Planning Area (*see Figure P.A. 16-3*). It flows to the Verde River which flows from north to south in the western portion of the Planning Area near the southern extent of the Verde River Watershed. There are two impoundments on the Verde River in the Planning Area upstream of its confluence with the Salt River, Horseshoe and Bartlett reservoirs operated by SRP. The Verde River is perennial throughout its length. The minimum and maximum annual flow in the Verde River upstream of Horseshoe Lake was 131,073 acre-feet (2002) and 1,583,014 acre-feet (1993), respectively.

Reclaimed Water

The majority of the reclaimed water produced in the Planning Area is generated at several municipal wastewater treatment facilities serving Globe, Miami, Strawberry/Pine, Payson, and Star Valley. Principal reclaimed water disposal methods include turf irrigation, discharge to a watercourse, and golf course irrigation. The residents of the Town of Payson have made substantial investment in reclaimed water infrastructure for a variety of turf irrigation projects and groundwater recharge, including the Green Valley Lake project. The 48-acre Green Valley Park was developed jointly by the Town of Payson Water Department and the Northern Gila County Sanitary District. Treated reclaimed water from the

district's water treatment plant fills a 10.5-acre lake used for adjacent irrigated areas and recreational facilities[1].

Ecological Resources

There are multiple environmental and recreational resources within the Planning Area in the Salt River and Verde River watersheds (*see Figure P.A. 16-3*). Along Fossil Creek, two hydroelectric power plants were decommissioned, natural water flows restored, and native fish species were reestablished. Fossil Creek has been designated as a Wild and Scenic River. There are numerous riparian corridors along the two major rivers and their tributaries. Critical habitat has been designated for numerous species throughout the Planning Area. The watercourses, lakes, and National Forests within the Planning Area are used extensively for outdoor recreation.

Water Demands

Table P.A. 16-1, below, presents the baseline and projected water demands for the Roosevelt Planning Area. Mining is the largest water demand sector and it is projected to increase during the planning period, specifically at an underground block cave mine proposed by Resolution Copper Mining on lands within the Tonto National Forest, located approximately four miles east of Superior. Mining would take place 7,000 feet below ground and is estimated to extract one cubic mile of copper ore. Increased production and water use are also anticipated at other operating mines within the Planning Area. Municipal use is currently projected to increase and almost double by the year 2060. Population growth is expected within the limited lands surrounding the existing population centers within the Planning Area, such as Payson, are popular second home and retirement locations. Agricultural water use in the Planning Area is not expected to increase over the planning period.

Characteristics Affecting Projected Water Demands and Supply Availability

Resolution of Indian and Non-Indian Water Rights Claims

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. Additionally, claims of the Tonto Apache Tribe have yet to be resolved. Until the adjudication process and settlement of tribal claims are complete, uncertainty regarding the extent and priority of water rights in this Planning Area will make it difficult to identify strategies for meeting the projected water demands.

Land Ownership

This Planning Area is almost entirely under federal ownership, almost exclusively Forest Service including all or portions of seven Wilderness Areas, including all of the Salome, Hellsgate, Sierra Ancha and Four Peaks Wilderness Areas and significant portions of the Superstition, Matazal and Salt River Canyon Wilderness Areas. Wilderness areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition. These designations have the potential to significantly limit water supply development and growth in this Planning Area.

[1] Payson Regional Economic Development Corporation, 2006

TABLE P.A. 16-1 Projected Water Demands (in acre feet) – Roosevelt Planning Area

Sector	2010	2035	2060
Agriculture	2,685	2,685	2,685
Dairy	0	0	0
Feedlot	0	0	0
Municipal	7,105	11,333	13,681
Other Industrial	0	0	0
Mining	15,457		
High		48,400	48,400
Low		28,000	28,000
Power Plants	0		
High		0	0
Low		0	0
Rock Production	355		
High		724	869
Low		302	362
Turf	587		
High		831	853
Low		551	643
Total (High)	**26,189**	**63,973**	**66,489**
Total (Low)	**26,189**	**42,871**	**45,372**

Protected Species and Habitat

The presence of a listed species may be a critical consideration in water resource management and supply development in a particular area. In the Salt River watershed, SRP has developed the Roosevelt Habitat Conservation Plan (HCP) to minimize and mitigate the impacts of operation of Roosevelt Dam to the southwestern willow flycatcher, bald eagle, and other listed and candidate species. Under the HCP, SRP will acquire and protect at least 1,500 acres of riparian habitat in perpetuity along the San Pedro, Verde, and Gila rivers, or other river systems in Arizona, and implement other conservation measures to protect up to 750 additional acres of habitat. The Plan also includes rescue of bald eagle eggs and nestlings whose nests are threatened by inundation and monitoring of the species and habitat at Roosevelt Lake and in the mitigation areas.

An HCP has also been adopted for Horseshoe and Bartlett reservoirs on the Verde River. Low reservoir levels from drought conditions resulted in establishment of riparian species in the Horseshoe storage space that became colonized by a population of southwestern willow flycatchers and other covered species that may be adversely impacted by refilling the reservoir. The HCP will minimize and mitigate for take of the covered species by actions including, but not limited to, operating Horseshoe to maintain the riparian forest and acquiring 200 acres of replacement habitat.

Downstream Water Demands

This Planning Area lies within a portion of the watershed that is essential to the Phoenix area - through the Salt River Project. Management of this watershed for forest health and water supply development is important to ensuring a secure water supply for the Phoenix area, while at the same time balancing the needs of the water users in the Roosevelt Planning Area. Certain legal agreements and settlements that operate within the Planning Area allow for the movement of surface water to other Planning Areas. For example, surface water stored in the Salt and Verde reservoirs is primarily allocated for downstream use outside of the Planning Area. The C.C. Cragin Reservoir, located north of Payson outside of the Planning Area in Coconino County, was acquired by SRP as part of the Arizona Water Settlement Act. Water from this reservoir is used to satisfy obligations to the Gila River Indian Community, supplements SRP's supplies, and, upon completion of water delivery and treatment infrastructure, will improve the water supply availability in northern Gila County and Payson. The majority of the pipeline is located on federal lands. The Town of Payson has a 3,000 acre-foot allocation for water from the reservoir that will supply the town's foreseeable future water demands.

Wildfire

There were several major wildfires either within or nearby this Planning Area that have impacted local water supplies. The Rodeo-Chediski Fire in 2002 consumed about 462,600 acres, much of it in the north-central part of the Salt River Basin. The Willow Fire (2004) burned almost 120,000 acres southwest of Payson in the Tonto Creek and Verde River basins and, most recently, the Wallow Fire burned 538,049 acres in the Apache-Sitgreaves National Forests east of the Planning Area in 2011, becoming Arizona's largest wildfire in recorded history.

In the Southwest, fire can be among the most significant watershed disturbance agents, particularly to peak stream flows. For example, in areas severely burned by the Rodeo-Chediski Fire, peak flows were as much as 2,350 times greater than previously measured - the highest known post-fire peak flow in the Southwest. Increased peak flows can degrade stream channels and make them unstable, increase sediment production and cause flood damage. Wildfire and drought can result in vegetative changes in the Planning Area with implications for runoff, infiltration and watershed yield.

Strategies for Meeting Future Water Demands

Resolution of Indian and Non-Indian Water Rights Claims

Efforts to complete the Gila River General Stream Adjudication are critical to provide long-term certainty for water users in Arizona dependent on water supplies from the Gila River and its tributaries. 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.

Watershed/Forest Management

Watershed management practices aimed at increasing watershed yield have been evaluated in Arizona showing opportunities for success. Due to the significant acreage of forested lands in this area, continuation of this process and implementation of safe and effective strategies are important to water users within and outside of this Planning Area. Combining efforts with other management initiatives (such as the Four Forest Restoration Initiative) may be a cost-effective way to advance this option and provide multiple benefits to this Planning Area and those dependent on its resources. 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[2].

Weather Modification

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

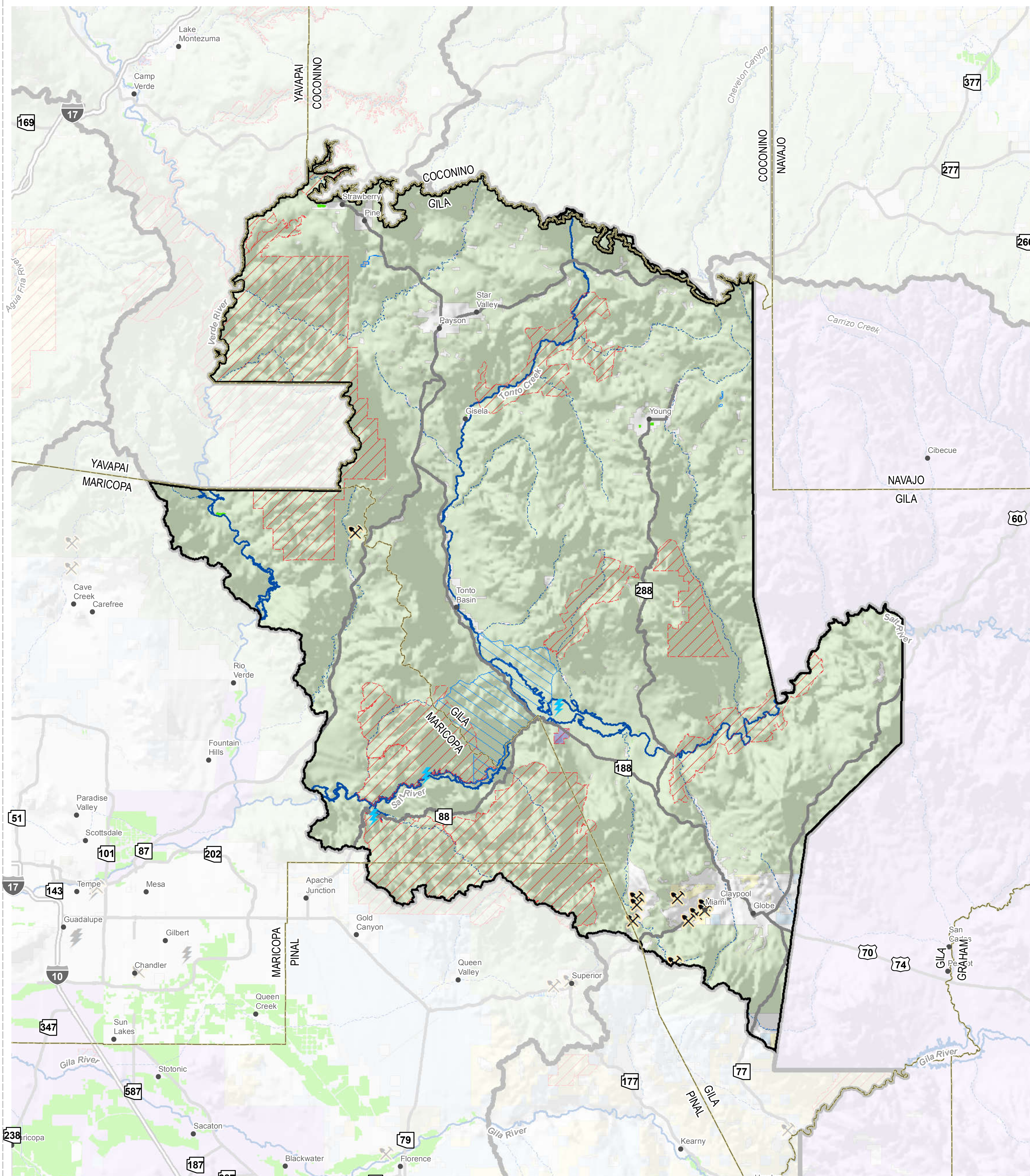
Payson – C.C. Cragin Pipeline Project

The Town of Payson currently relies solely on groundwater as its source of drinking water. Payson has adopted a policy of maintaining a long-term sustainable water supply, the addition of a surface water source is an important component towards meeting that objective. Due to concerns about the long-term viability of locally available groundwater to meet the current and future needs of the community, Payson has entered into an agreement with SRP to acquire a new surface water source from the C.C. Cragin Reservoir. The proposed pipeline will extend 14.5 miles to deliver 3,000 acre-feet of water annually to Payson[3]. Gila County has also agreed to participate in the project for an additional 500 acre-feet of water for other parts of northern Gila County, including Star Valley. Ensuring that Payson (the largest municipal demand in this Planning Area) has the economic resources to complete this project will significantly reduce the impact on groundwater supplies in this location of the Planning Area.

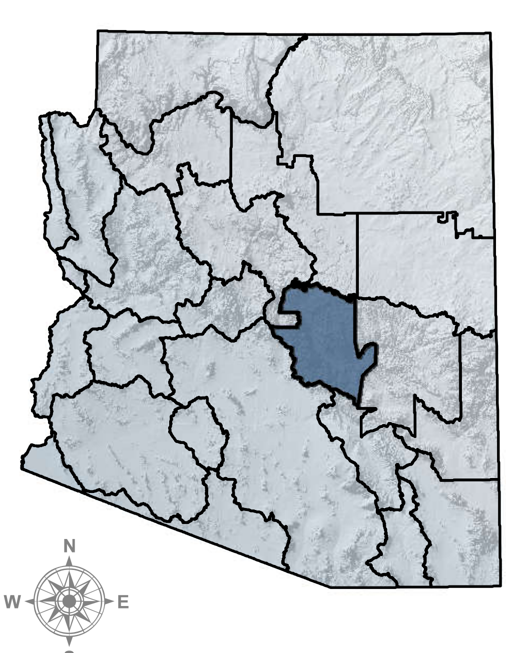
[2] http://www.4fri.org/

[3] http://www.egovlink.com/public_documents300/payson/published_documents/Water%20Department/Informational%20Brochures/Blue%20Ridge_Fact%20Sheet.pdf

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 10 20



MAP LOCATION
(Planning Area Boundaries)

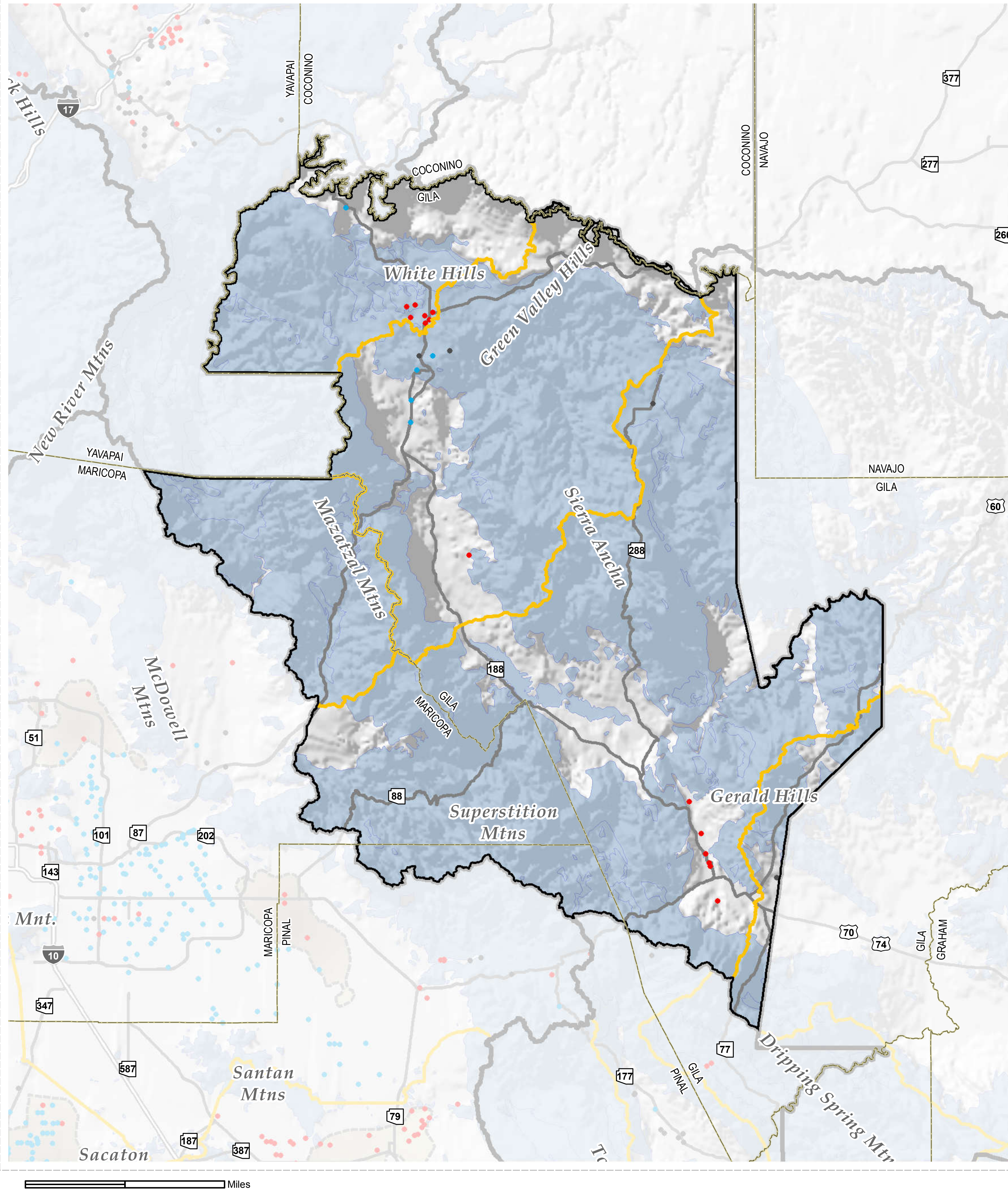
- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- River or Stream (ASLD)
- Interstate (ADOT)
- Population Center (GNIS)
- Mine (ADMMR, ADWR)
- Hydroelectric Power Plant (ADEQ, ADWR)
- Thermoelectric Power Plant (ADEQ, ADWR)
- Agriculture (SWReGAP, 2004)
- Federal Conservation Land (USFS, BLM,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

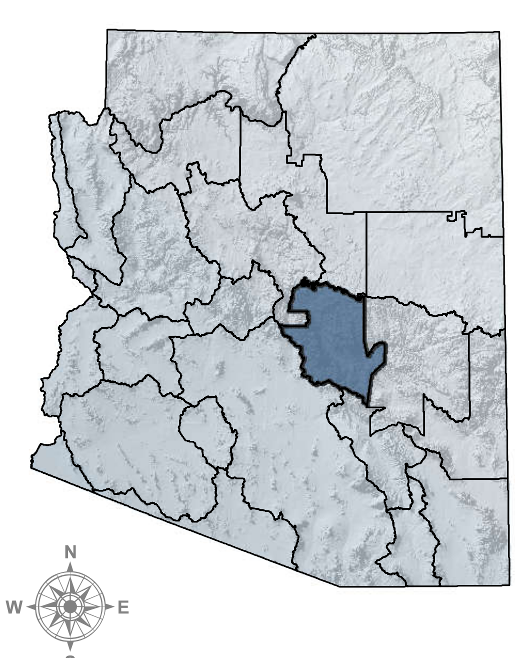
ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.16-1

Roosevelt 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)

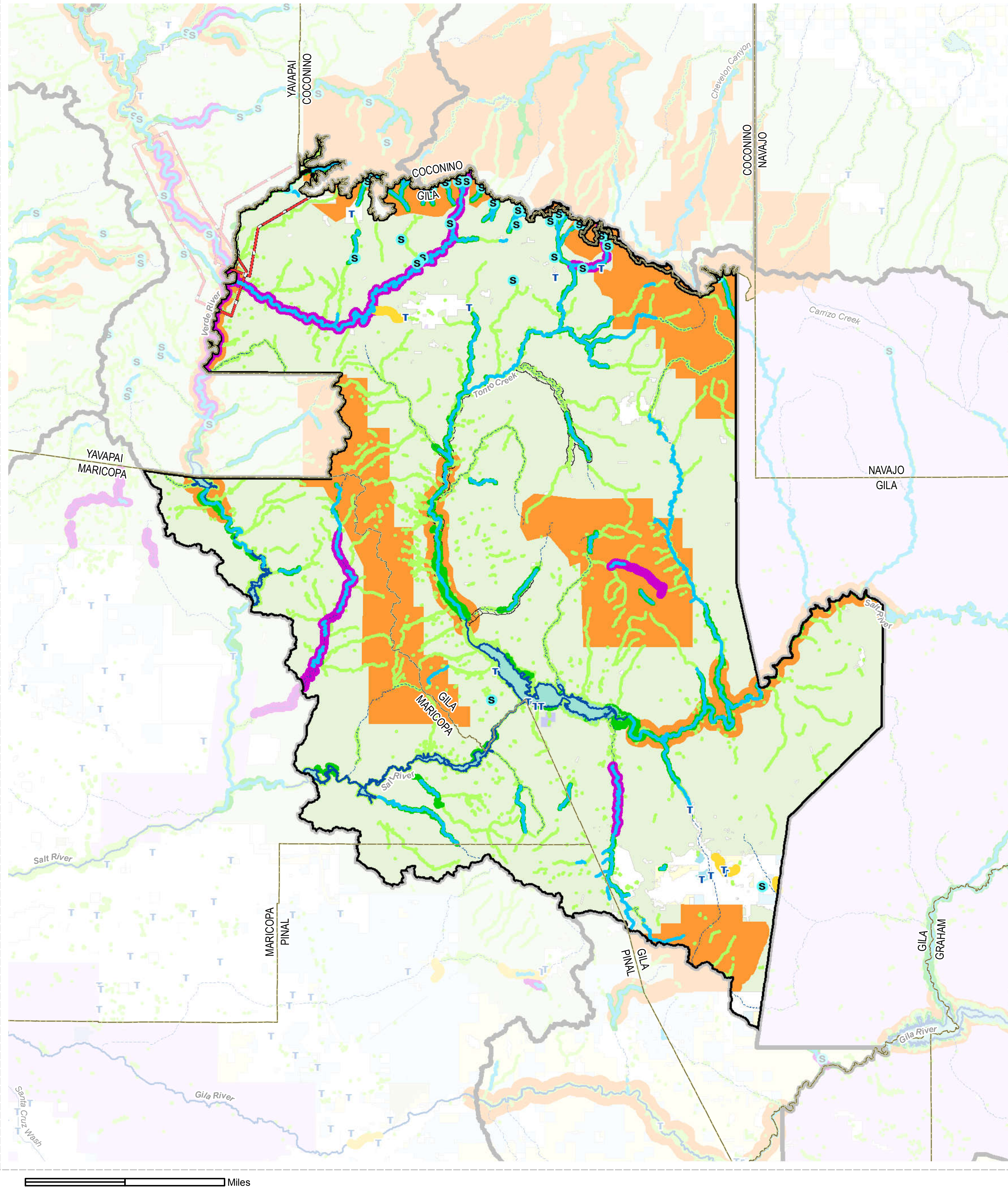
Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

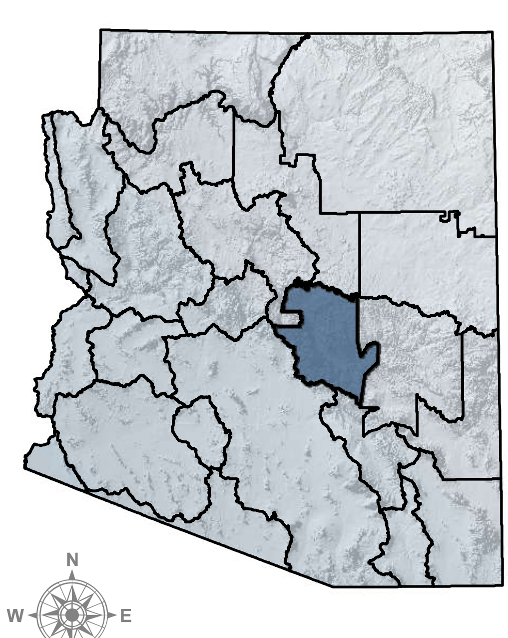
* Data provided by ADWR

Figure P.A.16-2

Roosevelt 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)

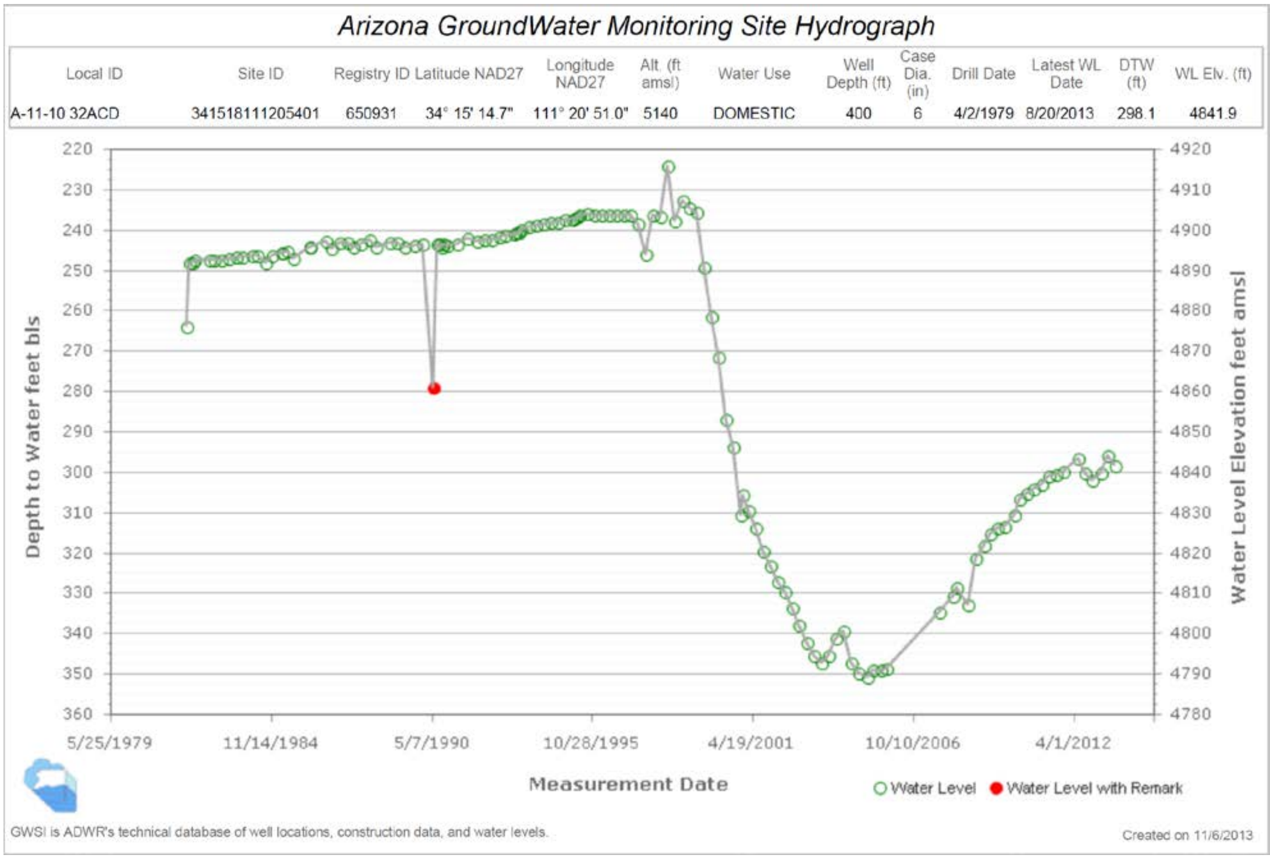
Planning Area (ADWR)
State (ALRIS)
County (ALRIS)
Reservoir or Lake (NHD)
Waste Water Treatment Plant (ADEQ)
Major Spring (ADWR, Pima County)
Perennial Flow (ADEQ, USGS)
River or Stream (ASLD)
Outstanding Arizona Water (ADEQ)
Effluent Dependent Stream (ADWR, NEMO)
Instream Flow Certificate (ADWR)
1993 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

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

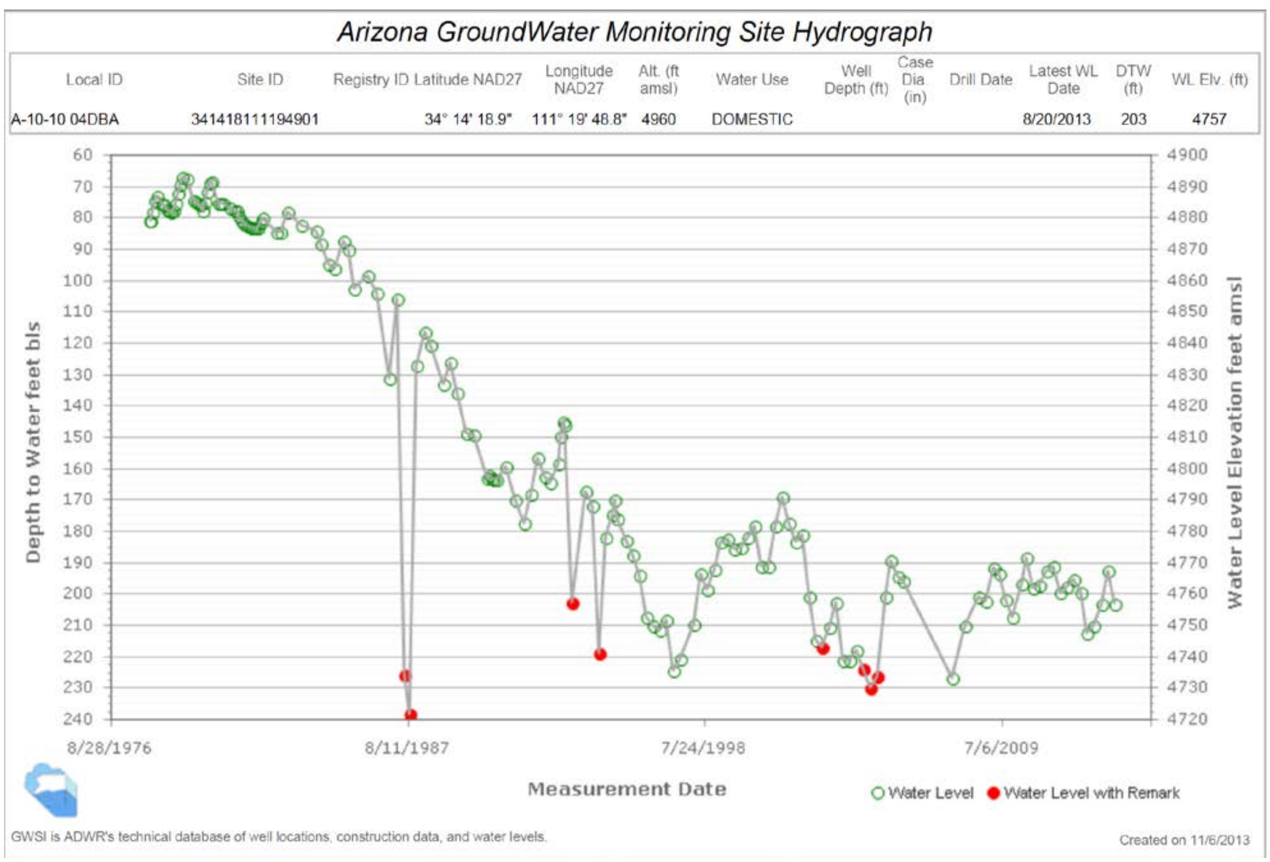
Figure P.A.16-3

Roosevelt
Surface Water and Natural Features

Verde River Basin – Roosevelt Planning Area

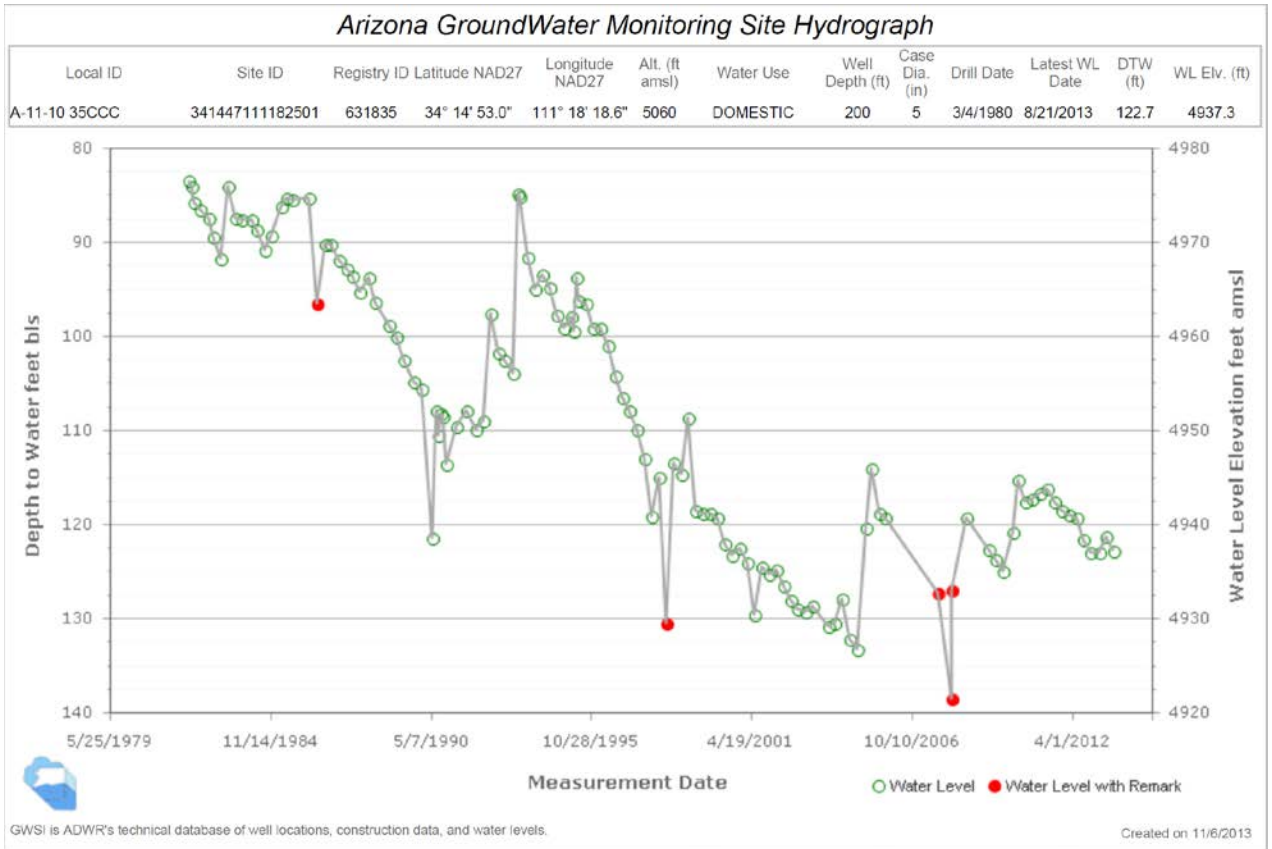


A-11-10 32ACD Verde River basin - Verde Canyon sub-basin NW Payson Airport area.

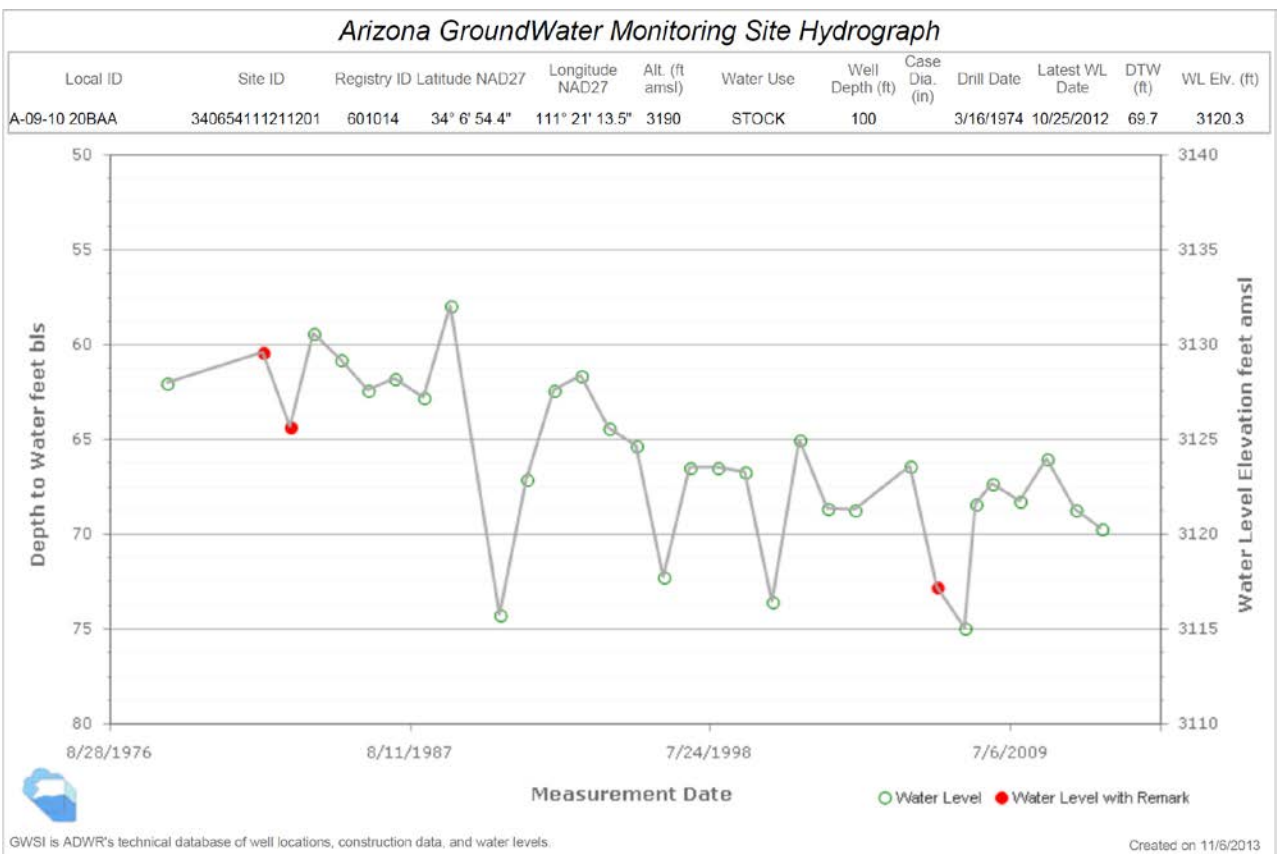


A10-10 04DBA Verde River basin – Verde Canyon sub-basin central Payson area.

Tonto Creek Basin – Roosevelt Planning Area

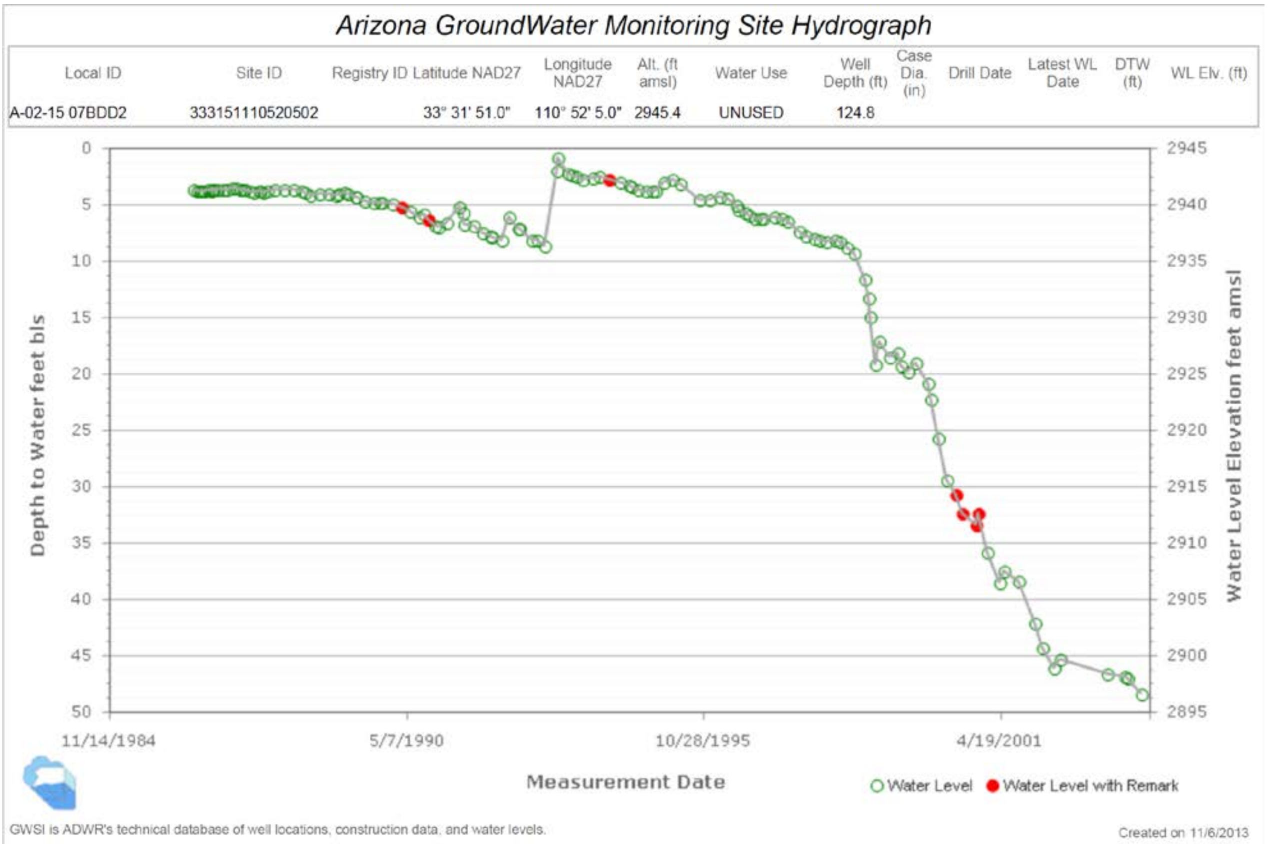


A-11-10 35CCC Tonto Creek basin, east Payson area.

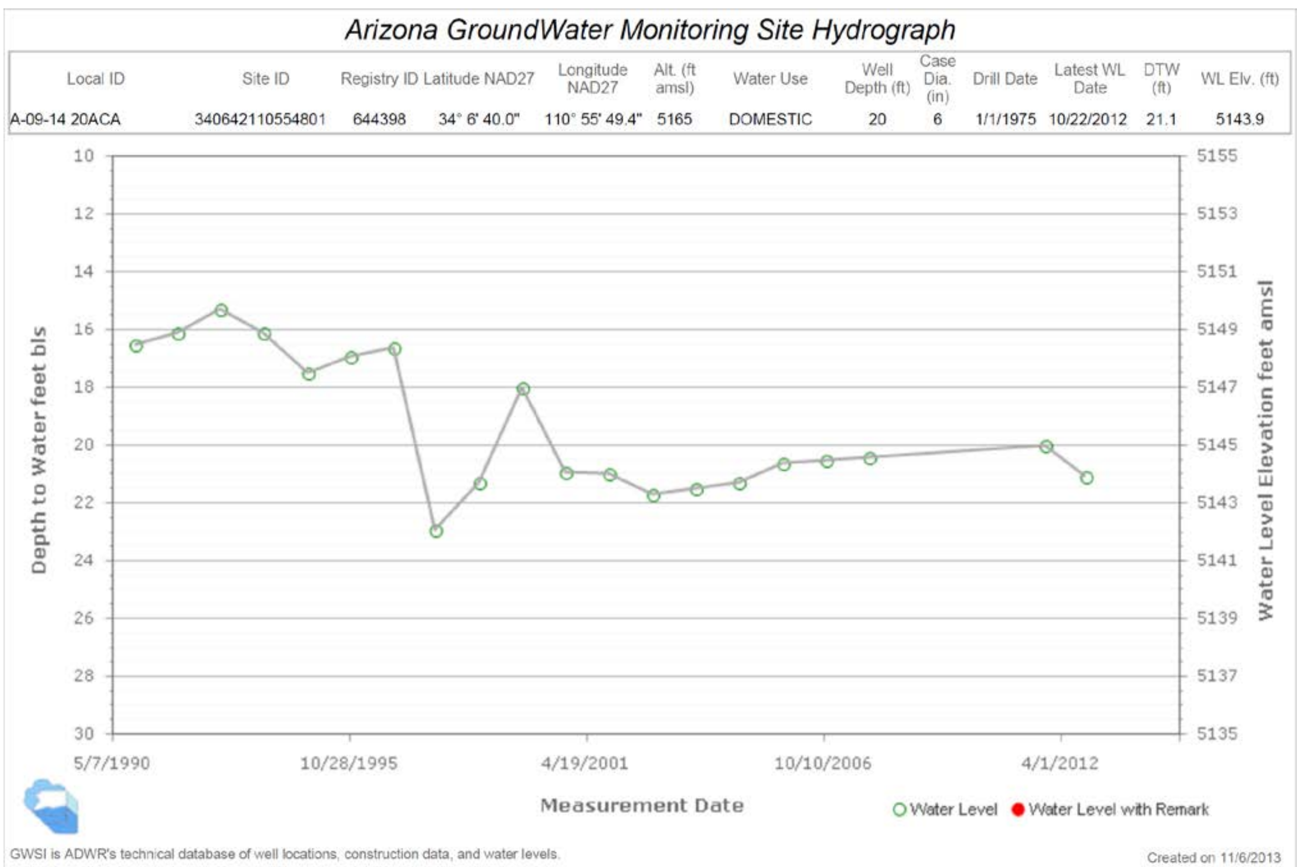


A-09-10 20BAA Tonto Creek basin at Rye.

Salt River Basin – Roosevelt Planning Area

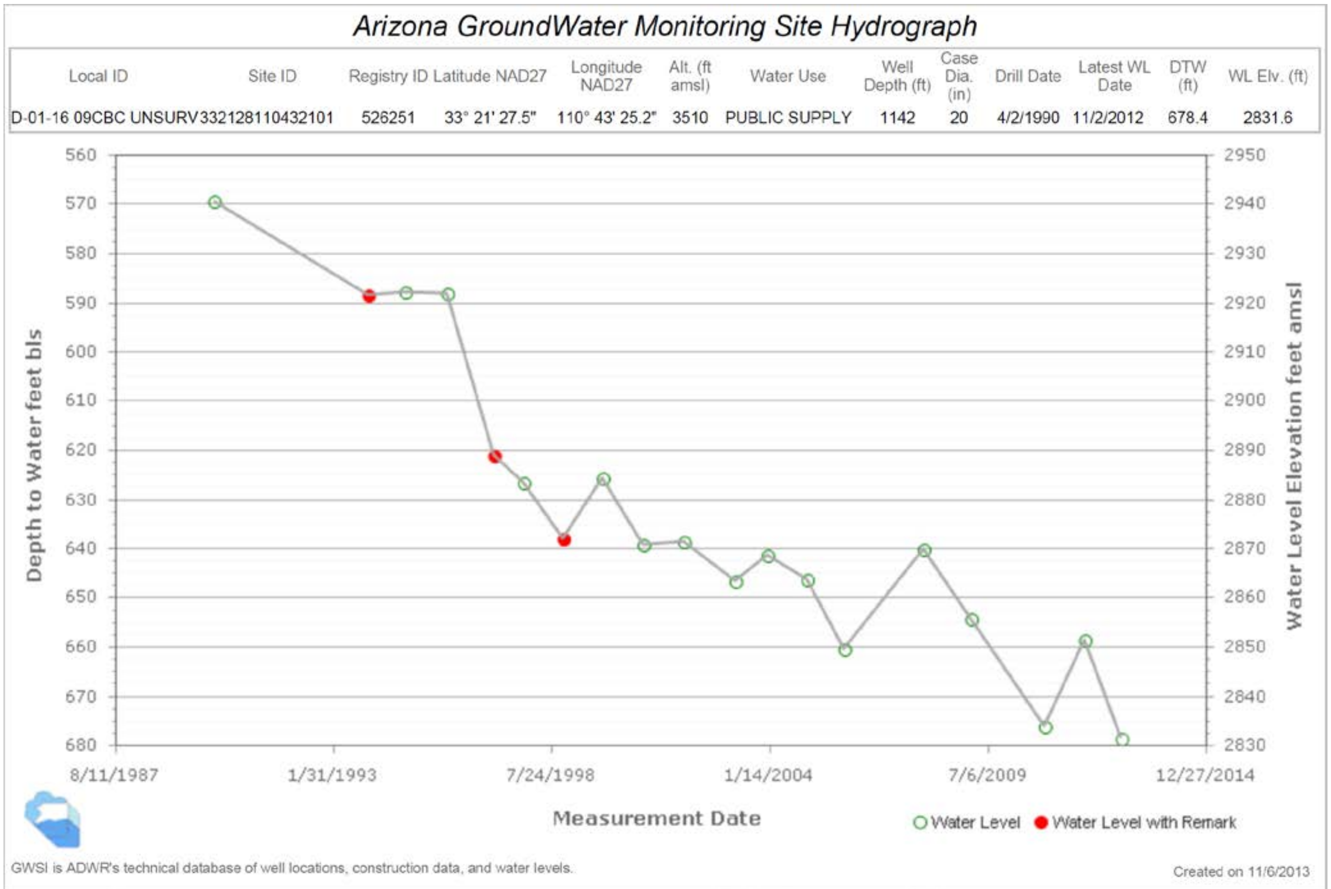


A-02-15 07BDD2 Salt River Lakes basin located on Pinal Creek 8 miles north of Claypool.



A-09-14 20ACA Salt River Canyon basin 2 miles northeast of Young.

Safford Basin – Roosevelt Planning Area



D-01-16 09CBCUNSURV – Safford basin -- San Carlos Valley sub-basin about 4 miles west of Cutter.

[UPPER GILA PLANNING AREA]

Upper Gila Planning Area

Background

The Upper Gila Planning Area is comprised of portions of Greenlee and Graham counties and located in the east central portion of the State. The Upper Gila Planning Area is contained within the Upper Gila River Watershed and encompasses large portions of the Safford and Morenci groundwater basins, nearly all of Duncan Valley Groundwater Basin, and a very small portion of Bonita Creek Groundwater Basin. The largest communities within the Planning Area are Safford, Thatcher, Clifton, and Morenci.

The majority of the land in the Planning Area is owned and managed by the federal government. The two largest federal landowners in the Planning Area are the US Bureau of Land Management (BLM) and USDA Forest Service (Forest Service) (*see Figure P.A. 17-1*). BLM manages multiple conservation areas for resource protection and has other lands where the primary land uses are livestock grazing and recreation. Forest Service lands include portions of two national forests, the Apache-Sitgreaves and Coronado. The primary land uses on Forest Service lands are timber production, livestock grazing and recreation. A US Military Reserve is located near Swift Trail Junction. A significant portion of land is held as State Trust Lands. Most of these lands are located in the Safford and Duncan Valley groundwater basins. Livestock grazing is the primary land use.

Large continuous blocks of private land are located along Highway 70 in vicinity of Safford and Highway 75 in Greenlee County north of Duncan. Land uses include irrigated agriculture, livestock grazing, domestic, commercial and mining.

Water Supply Conditions

<u>Groundwater</u>

The majority of the Planning Area is located within the Basin and Range physiographic province, which is characterized by northwest-southeast trending mountain ranges separated by broad alluvial valleys. The Mexican Highland section is a higher elevation area of the province with valleys ranging from 2,500 to 4,000 feet above sea level. The extreme northern portion of the Planning Area falls within the Transition Zone Physiographic Province. The mountainous terrain of this region have aquifers that consist of relatively thin alluvial aquifers, and in fractured crystalline, sedimentary, and volcanic rock.

Most of the groundwater development in the Safford Basin is in the Gila Valley Sub-basin, which contains the Basin's major population and agricultural centers. The boundaries of the Gila Valley Sub-basin generally correspond to those of the Safford Basin portion of the Planning Area. Water level changes for the period from 1990 to 2008 in the Gila Valley Sub-basin ranged from a maximum decline in one well of 11 feet to a maximum rise in another well of about 28 feet (*see Figure P.A. 17-2*). In general, most wells measured were near the Gila River and showed water level changes that were in the range of +/- 5 feet over the same time period. Water quality conditions vary in the Safford Basin, although fluoride and arsenic concentrations consistently exceed drinking water standards. Other parameters commonly equaled or exceeded are TDS, nitrates, and lead.

In the Morenci Basin, water level measurements in single well between Morenci and Alpine indicate water levels have slightly increased over the past 30 to 40 years. Water quality data shows metal contamination in the vicinity of the Morenci Mine.

Water levels dropped slightly in a few wells measured in the Duncan Valley Basin over the period from 1990 to 2007 (*see Figure P.A. 17-2*). Groundwater conditions in the Duncan Valley Basin are mainly affected by variations in Gila River flows and the volume of groundwater pumping. Arsenic and fluoride concentrations exceeding drinking water standards have been measured at a number of wells in this Basin.

Water levels are relatively shallow in the few wells measured in the southern portion of the Bonita Creek Basin. Water quality and water level change data are lacking in this Basin.

Surface Water

The major surface water feature in the Upper Gila Planning Area is the Gila River, which originates in New Mexico (*see Figure P.A. 17-3*). Gila River water flows into the San Carlos Reservoir located downstream and outside of the Planning Area. An average of 160,000 acre-feet per year of Gila River water flows into Arizona from New Mexico. Flows in the Gila River become intermittent farther downstream due to diversions and seasonal variations in flow. The minimum and maximum annual flow in the Gila River near Solomon was 48,953 acre-feet (1956) and 1,559,116 acre-feet (1993), respectively. Tributary inflows from the San Francisco River are significant, typically over 150,000 acre-feet per year. The City of Safford uses water collected in an infiltration gallery along Bonita Creek in the Bonita Creek Basin, which typically provides 80 to 90 percent of the City's water supply[1].

In the Safford Basin, a six-mile reach of the Gila River exceeded the water quality standard for E.coli and turbidity. In the Morenci Basin, water quality standards were exceeded at Luna Lake and in a 13-mile reach of the San Francisco River near Alpine. A 15-mile reach of the Gila River in the Duncan Valley Basin is impaired due to elevated selenium concentrations.

Reclaimed Water

In the Upper Gila Planning Area, there are five wastewater treatment plants (WWTP) serving the communities of Safford, Thatcher, Pima, and the Arizona State Prison Complex in Safford. The City of Safford WWTP serves the largest population and delivers reclaimed water to the Mt. Graham Municipal Golf Course for irrigation. Other reported methods of disposal for the other WWTPs include evaporation ponds, discharge to Bennett Wash, and irrigation. The Town of Duncan operates a WWTP that serves a very small community population. The reported disposal method is through evaporation ponds. The Town of Clifton owns the municipal Clifton WWTP that disposes of reclaimed water through discharge to a watercourse. Reclaimed water at the Morenci Water and Electric Co. is generated by the copper mining process and is reused for industrial purposes.

Ecological Resources

There are extensive reaches of riparian vegetation throughout the Planning Area (*see Figure P.A. 17-3*). Riparian areas have been mapped along the Gila, San Francisco, and Blue Rivers, as well as, Bonita, Eagle, Willow and Cienga Creeks. The Upper Gila Planning Area contains one National Conservation Area and two Wilderness Areas. The 22,000 acre Gila Box Riparian National Conservation Area was established in November 1990 with the principle objective to "conserve, protect, and enhance" the

[1] http://www.eacourier.com/drought-forcing-water-conservation-move/article_ddc98a62-cae5-11e1-a663-0019bb2963f4.html?mode=jqm

riparian and associated values of the area. The Fishhooks and Santa Teresa Wilderness Areas are located in the northwest portion of the Planning Area and total approximately 37,280 acres. The Planning Area also contains the Cluff Ranch Wildlife Area, owned and managed by the Arizona Game and Fish Department for wildlife protection and recreation.

Water Demands

Table P.A. 17-1, below, presents the baseline and projected water demands for the Upper Gila Planning Area. Agriculture is the largest water demand sector and an important component of the regional economy and is projected to remain constant through 2060.

Industrial use related to mining operations totaled over 7,000 acre-feet in 2010. Freeport-McMoRan's Morenci and Safford Mines generated an estimated $365.4 million in economic benefits for Greenlee and Graham Counties in 2012[2]. Factors such as the price of metals in the marketplace, environmental regulations, and improved mining technology may affect the demands in this sector resulting in wide range (from a minimum of 14,800 acre-feet per year to a maximum of 64,800 acre-feet per year) in the projected demands through 2060.

Municipal use represents the third highest water use in the Upper Gila Planning Area. Some population growth is expected through 2060 that would increase municipal demand slightly from approximately 7,800 acre-feet in 2010 to an estimated 9,700 acre-feet in 2060.

Table P.A. 17-1. Projected Water Demands (in acre feet) - Upper Gila Planning Area

Sector	2010	2035	2060
Agriculture	127,340	127,340	127,340
Dairy	93	93	93
Feedlot	0	0	0
Municipal	7,875	8,408	9,713
Other Industrial	0	0	0
Mining	7,333		
High		64,800	64,800
Low		14,800	14,800
Power Plants	0		
High		0	0
Low		0	0
Rock Production	154		
High		563	648
Low		235	269
Turf	594		
High		597	599
Low		597	599
Total (High)	**143,389**	**201,801**	**203,193**
Total (Low)	**143,389**	**151,473**	**152,814**

[2] http://www.fcx.com/sd/pdf/fast_facts/2013/MorenciSafford_EI_2013.pdf

Characteristics Affecting Future Demands and Water 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 this Planning Area will make it difficult to identify strategies for meeting the projected water demands.

Unresolved Indian Water Rights Claims

Claims of the San Carlos Apache Tribe to on-reservation Gila River tributary water currently remain unresolved. Until these claims are quantified and settled, uncertainty regarding the extent and priority of water rights in this Planning Area will make it difficult to identify strategies for meeting the projected water demands.

Water Rights

Several court determinations, including the Doan and Jenkes decrees, involve landowners, canal companies and irrigation water users in the Safford Valley. The Ling Decree in the San Francisco River Valley and Duncan Valley, and the Globe Equity No.59 Decree affect the legal availability of water supplies in the Upper Gila Planning Area. Most notable was the US District Court's consent decree (Globe Equity No. 59) lodged in 1935, which addressed all diversions of the mainstem of the Gila River from its confluence with the Salt River to the headwaters in New Mexico, including the Gila River and San Carlos Apache reservations, and non-Indian landowners below and above Coolidge Dam. The Globe Equity No. 59 Decree awarded rights to use water on lands within the Gila River Indian Community (located in the Basin and Range AMAs Planning Area) with a priority date of "time immemorial" and also awarded rights to the San Carlos Apache Tribe (Apache Planning Area) with a priority date of 1846. Rights and priority dates were established for non-Indian land in the San Carlos Project area including the Safford Valley, the Duncan Valley and the Winkelman Valley.

The Arizona Water Rights Settlement Act of 2004 (P.L. 108-45) includes settlement of the Gila River Indian Community's water rights claims in Title II of the Act. This settlement affects the volume and utilization of groundwater and surface water upstream from the Community in parts of the Upper Gila Planning Area.

Vulnerability to Drought

Nearly two decades of persistent drought conditions in the Southwest have significantly impacted the reliability of surface water supplies, resulting in increased demands and competition for locally available groundwater supplies. The Gila River is a primary source of water for the Upper Gila Valley, supplying water for agricultural, municipal and other water users. The Gila River and its tributaries originate in the higher elevations in western New Mexico and eastern Arizona in Apache and Greenlee Counties primarily as snow and rain. Due to severe drought conditions for the past 18 years, the Bonita Creek water source was cited by the University of Arizona's Climate Assessment for the Southwest (CLIMAS), in July of 2012, as being 18 percent below normal[3]. The need to switch to local groundwater supplies to meet demands has caused increased competition between the irrigators in the Gila Valley and the City of Safford as the wells used for groundwater production are in close proximity for both uses and forced the Mayor and City Council to declare a state of emergency requiring mandatory water use restrictions.

[3] http://www.climas.arizona.edu/swco/aug2012/arizona-drought-status

On August 22, 2013, the City issued a Stage 3 Emergency due to drought conditions, continuing its mandatory water restrictions[4]. The City is actively pursuing alternative sites for groundwater development to supplement its main source of water from Bonita Creek, but has faced obstacles. The City is surrounded by federal land (primarily BLM) and has been unsuccessful in securing consent for access from the federal government to allow groundwater development on these lands. The City is still exploring other options and continues to meet with BLM to resolve these issues.

Strategies for Meeting Future Water Demands

Water Supply Study

A comprehensive water supply study and development of a hydrological model for the Upper Gila Planning Area (including municipal, agricultural, environmental, and downstream tribal needs) is needed to address not only water demands in normal years but also drought vulnerabilities in shortage years.

Resolution of Indian and Non-Indian Water Rights Claims

Efforts to complete the San Carlos Apache Tribe's claims to the Gila River, as well as the Gila River General Stream Adjudication, is essential to not only provide a secure water supply for the tribe, but also to provide long-term certainty for water users in Arizona dependent on water supplies from the Gila River. 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.

Reclaimed Water Reuse

Reclaimed water has been an important source of supply in this Planning Area. However, many areas are still reliant on septic systems, which reduce the amount of water that could be reclaimed and reused. In order to meet the long-term water needs in this Planning Area, efforts should focus on continuing to maximize the use of reclaimed water for non-potable uses and exploring opportunities for direct potable reuse. Additionally, moving customers currently on septic systems, where practical, to centralized reclaimed water systems and using artificial recharge in the winter months to store excess reclaimed water supplies will help stretch locally available supplies to meet future water needs.

Watershed/Forest Management

Watershed management practices aimed at increasing watershed yield have been evaluated in Arizona show promise for success. Due to the significant acreage of Ponderosa Pine forest in this area, continuation of this process and implementation of safe and effective strategies are important to water users within and outside of this Planning Area. Combining efforts with other management initiatives (such as the Four Forest Restoration Initiative) may be a cost-effective way to advance this option and provide multiple benefits to this Planning Area and those dependent on its resources. 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[5].

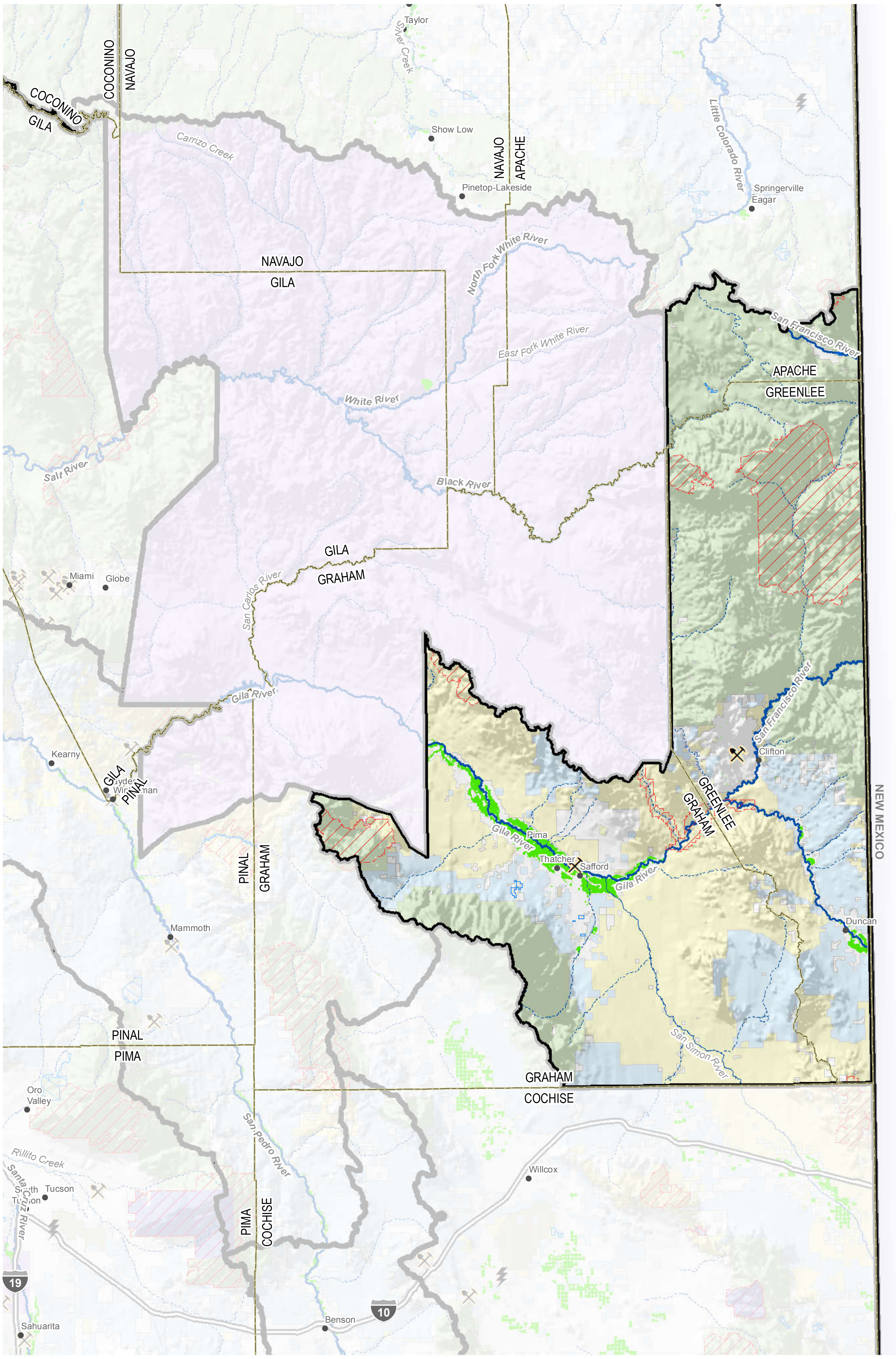
[4] http://www.cityofsafford.us/AlertCenter.aspx?AID=Mandatory-Water-Restrictions-Stage-3-Wat-5
[5] http://www.4fri.org/

One possible strategy for this Planning Area includes joint exploration with the State of New Mexico and the Forest Service for a watershed management project at the headwaters of the Gila River in the Gila National Forest in New Mexico and the Apache-Sitgreaves National Forest in Arizona. Joint development of a project to increase the water yields into the Gila River could be used in New Mexico to meet local needs. At the same time, the strategy could also supplement water supplies in the Safford area and possibly provide water for other downstream water users including the San Carlos Apache Tribe to assist in settlement of their outstanding claims.

Weather Modification

Weather modification, or cloud seeding, is a potential strategy to either augment local water supplies or mitigate the impacts of groundwater development. Specifically, water developed through a joint weather modification project with the State of New Mexico and the Forest Service (in conjunction with a watershed management project, as described above, or as a stand-alone project) at the headwaters of the Gila River in the Gila National Forest in New Mexico could be employed to increase water yields in the Gila River to provide water in New Mexico. At the same time, water from this project could increase flows to the Safford area to supplement water supplies and possibly provide water for other downstream water users including the San Carlos Apache Tribe to assist in settlement of their outstanding claims.

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.



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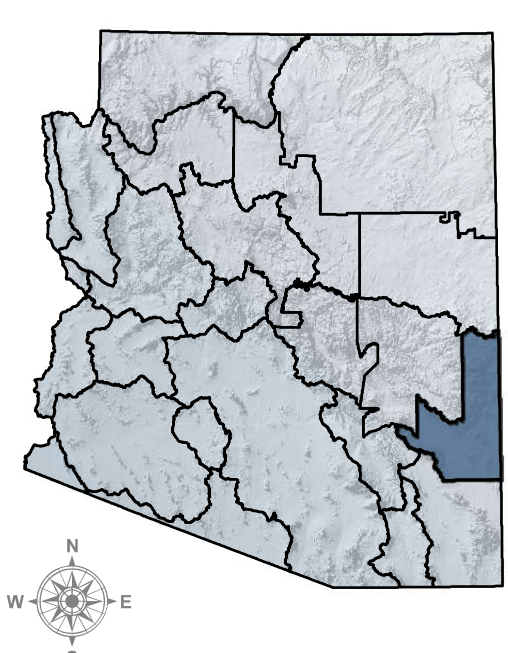

MAP LOCATION
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ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.17-1

Upper Gila
Land Ownership

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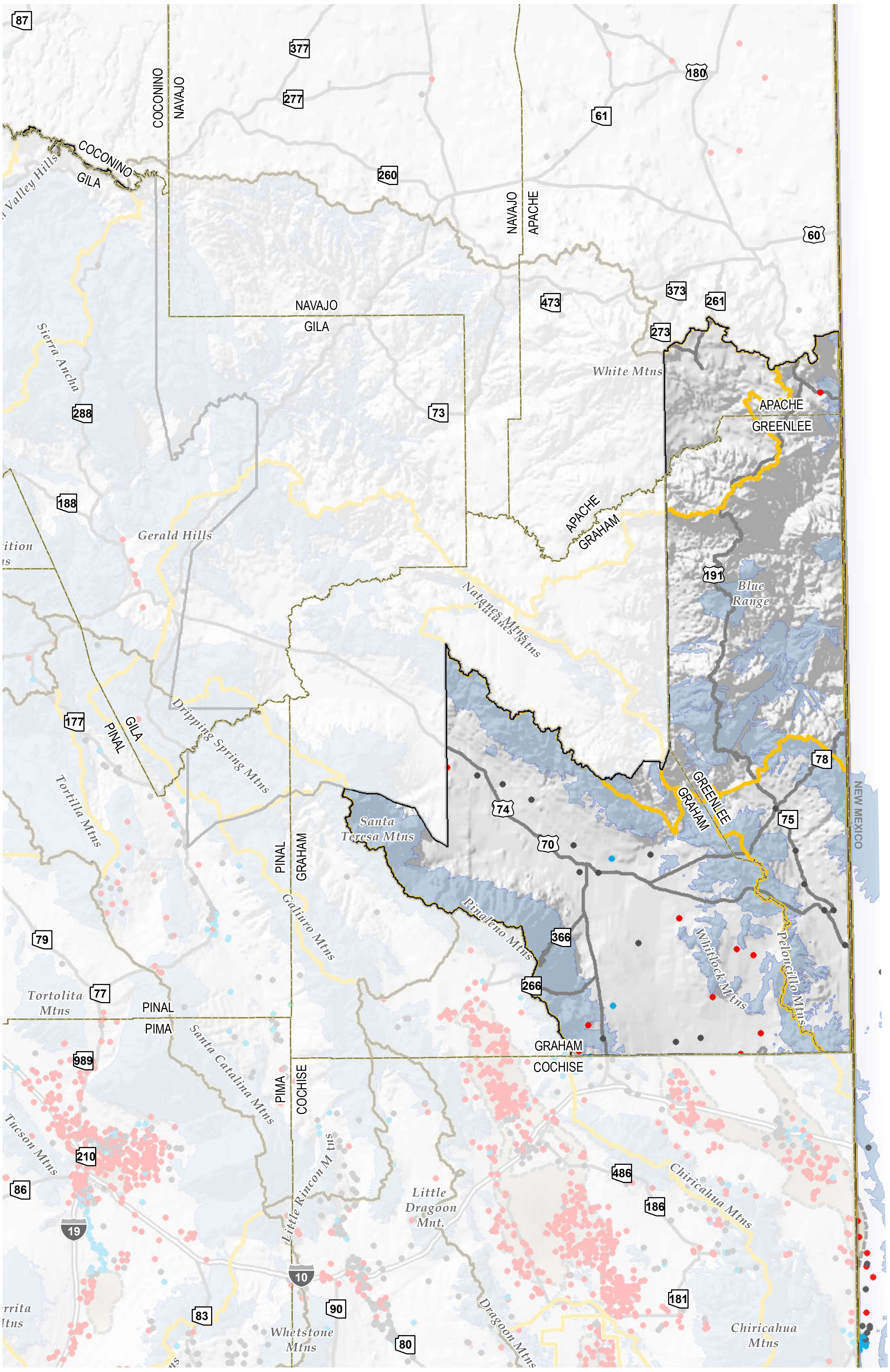

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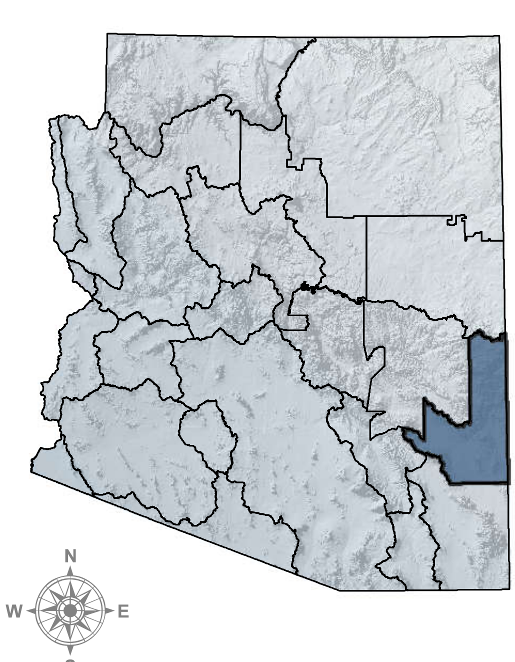

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- Groundwater Basin (ADWR)
- Area of Active Land Subsidence (ADWR)
- Hard Rock Geology (AZ Bureau of Mines, UofA)
- Interstate (ADOT)

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

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

* Data provided by ADWR

ARIZONA DEPARTMENT OF WATER RESOURCES EST. 1980

Figure P.A.17-2

Upper Gila Groundwater Hydrology

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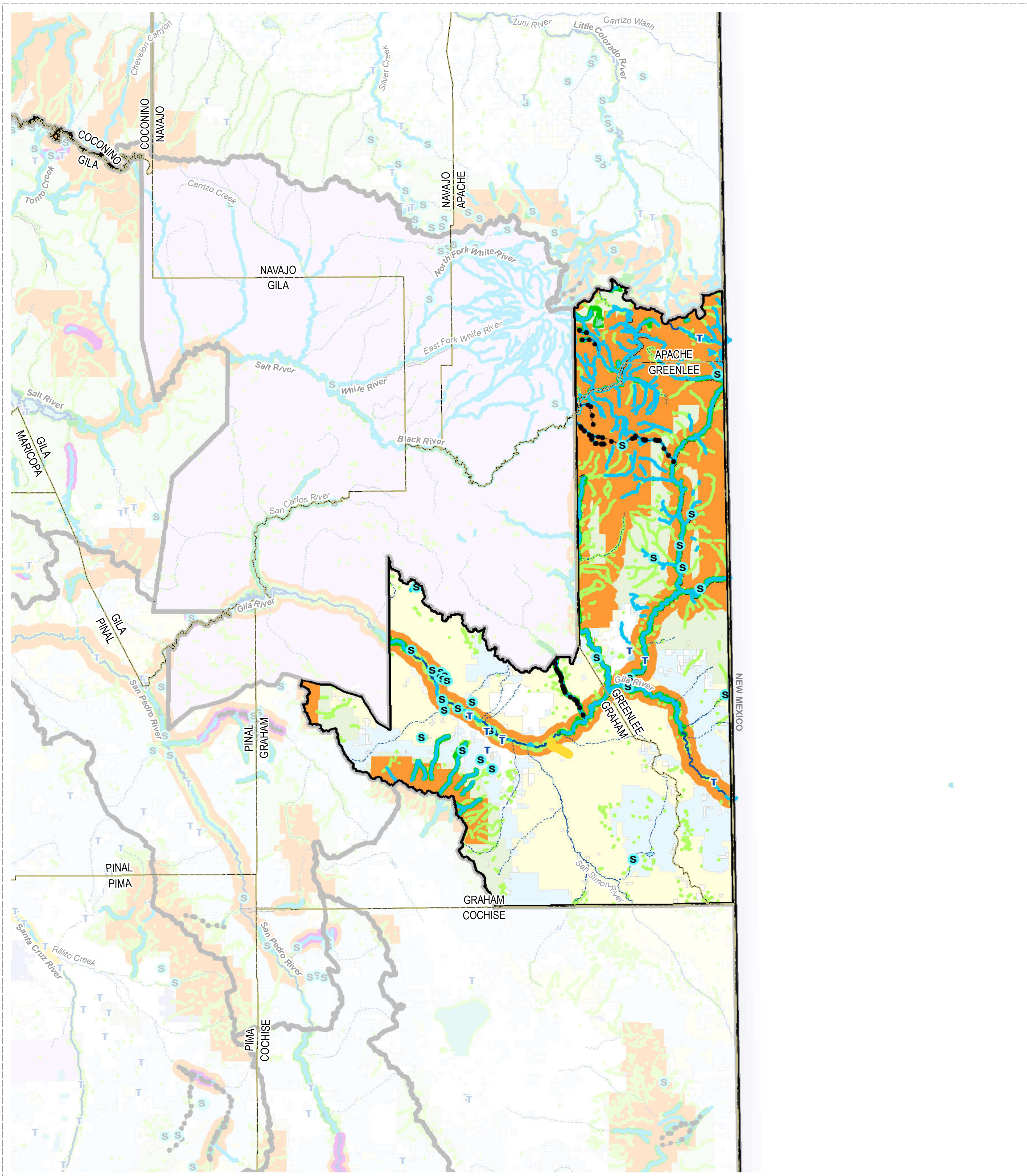

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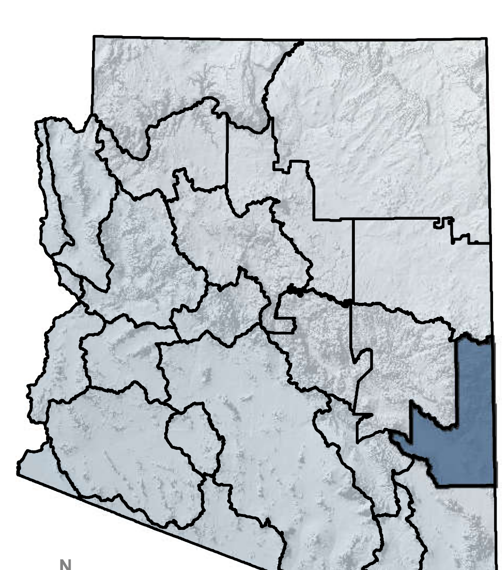

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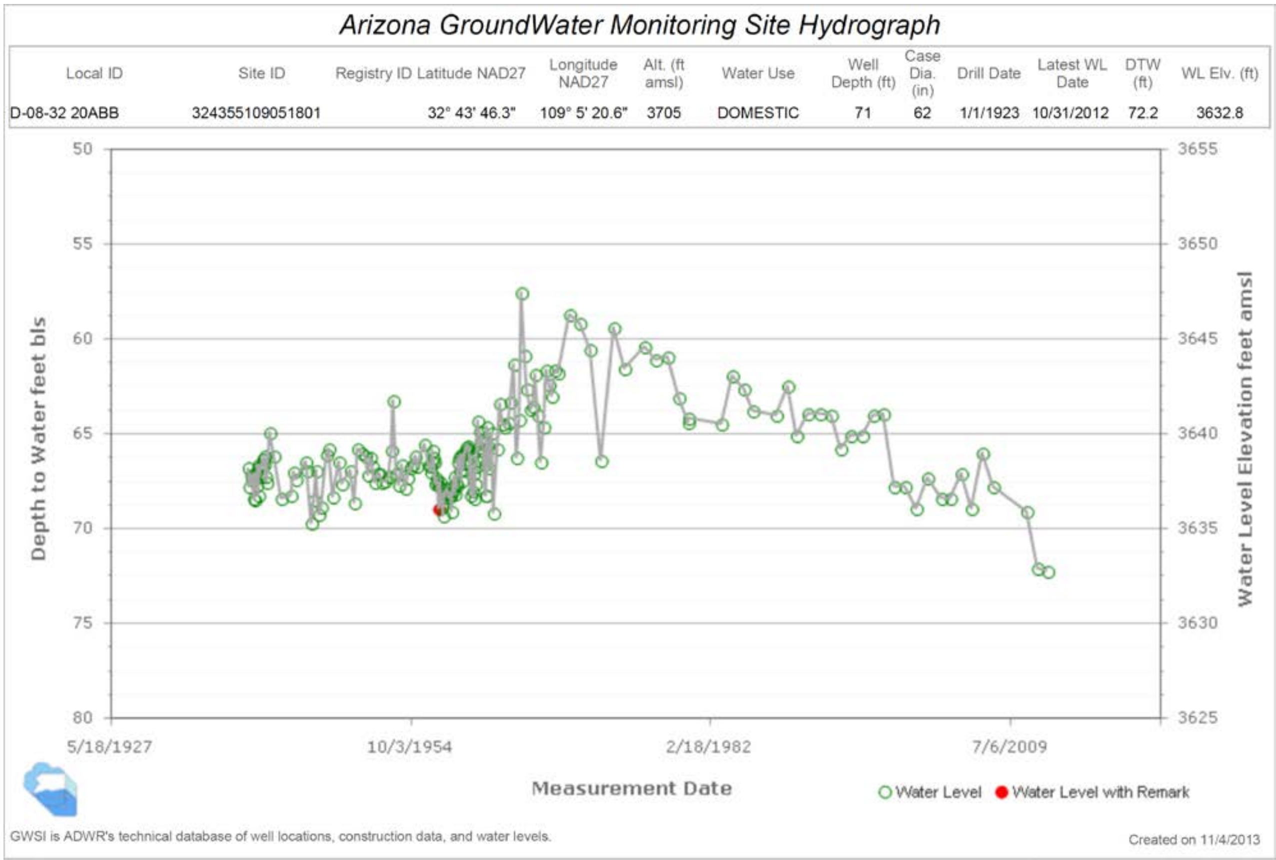
Figure P.A.17-3

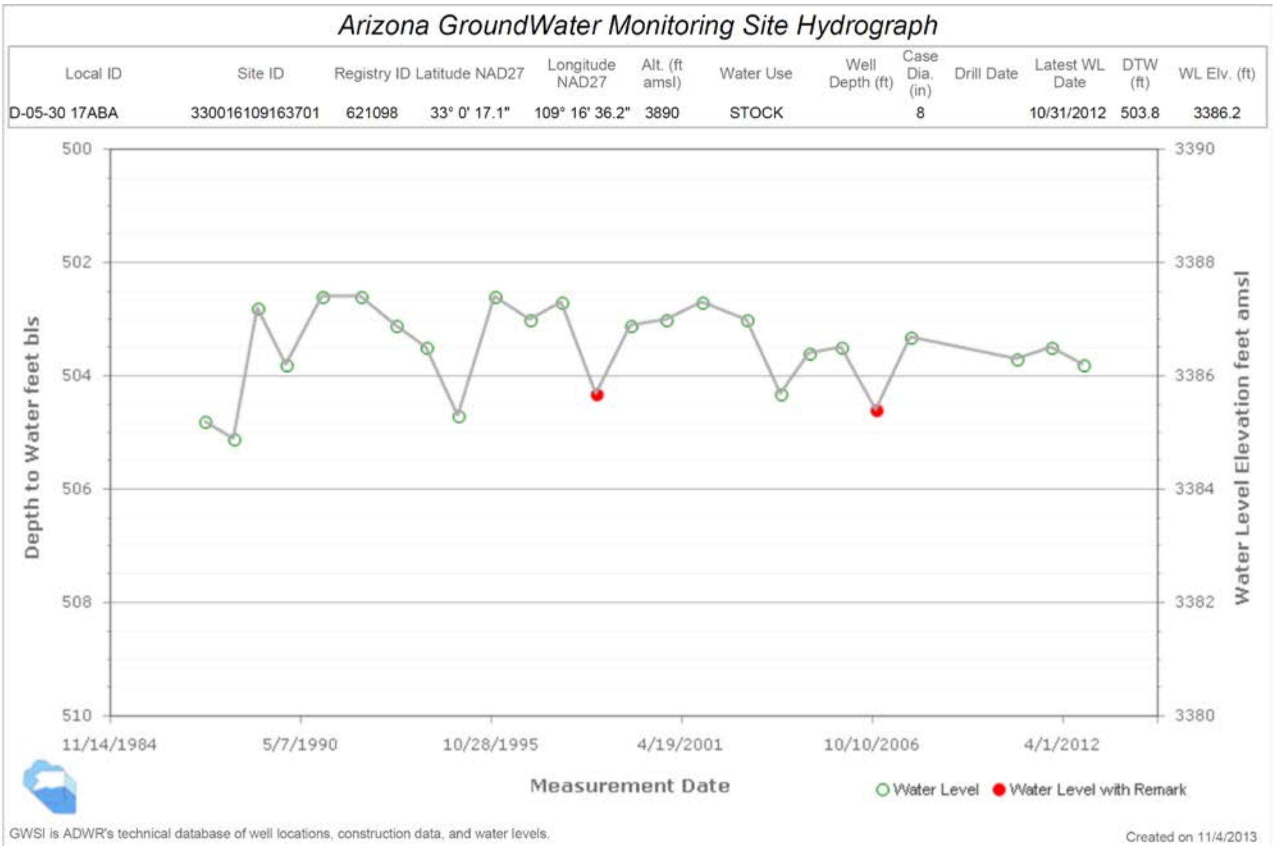
Upper Gila
Surface Water and Natural Features

Duncan Valley Basin – Upper Gila Planning Area

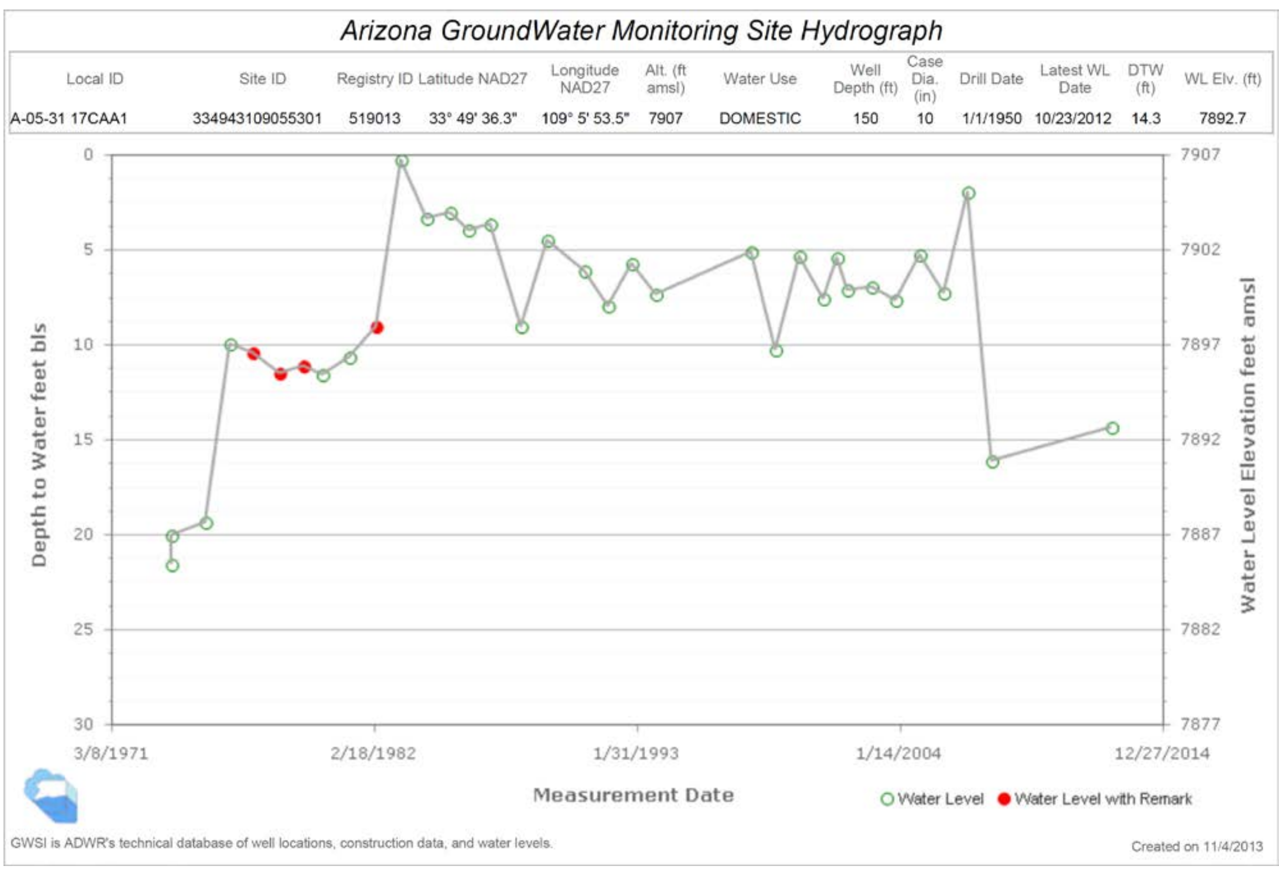


D-08-32 20ABB - Duncan Valley basin about 1 mile NE of Duncan and .5 mile east of Gila River.

Morenci Basin – Upper Gila Planning Area

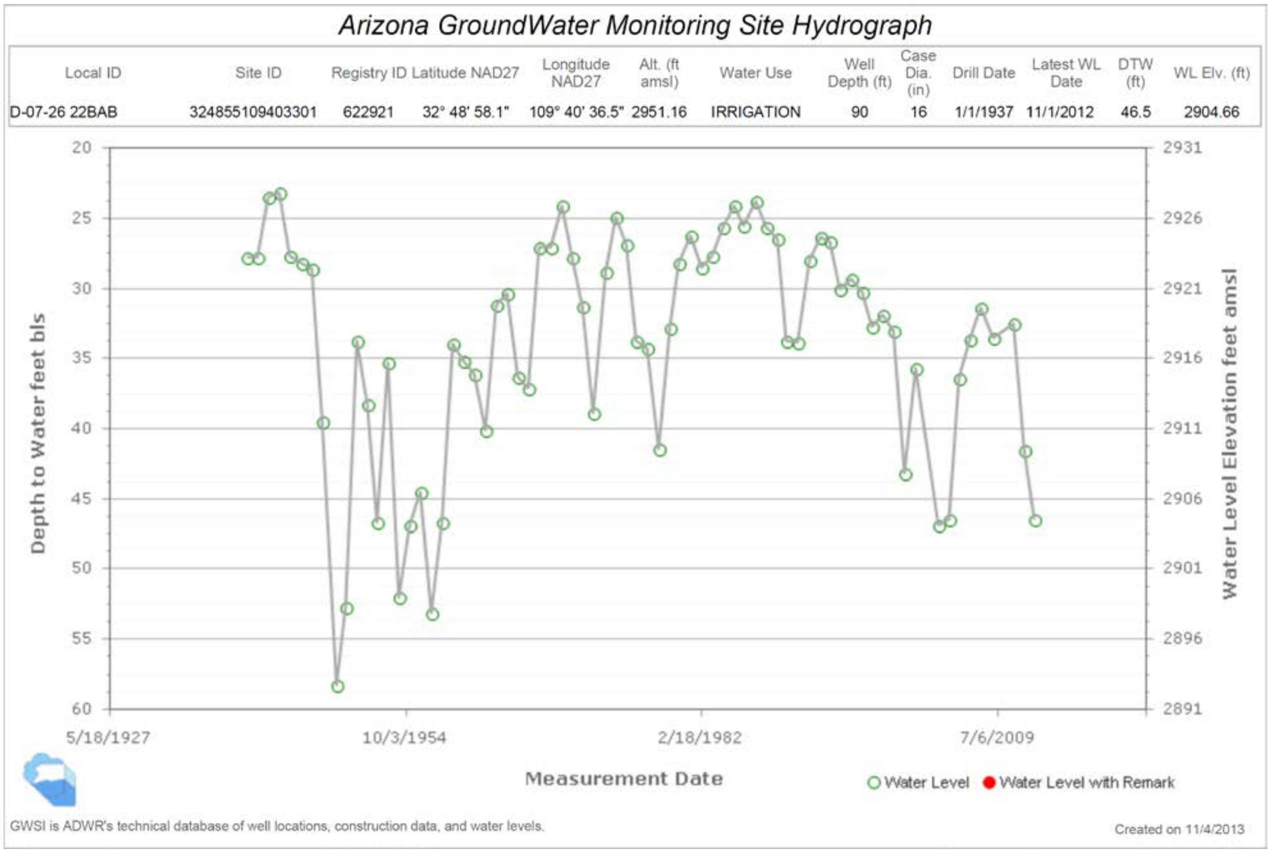


D-05-30 17ABA – Morenci basin about 3 miles south of Morenci.

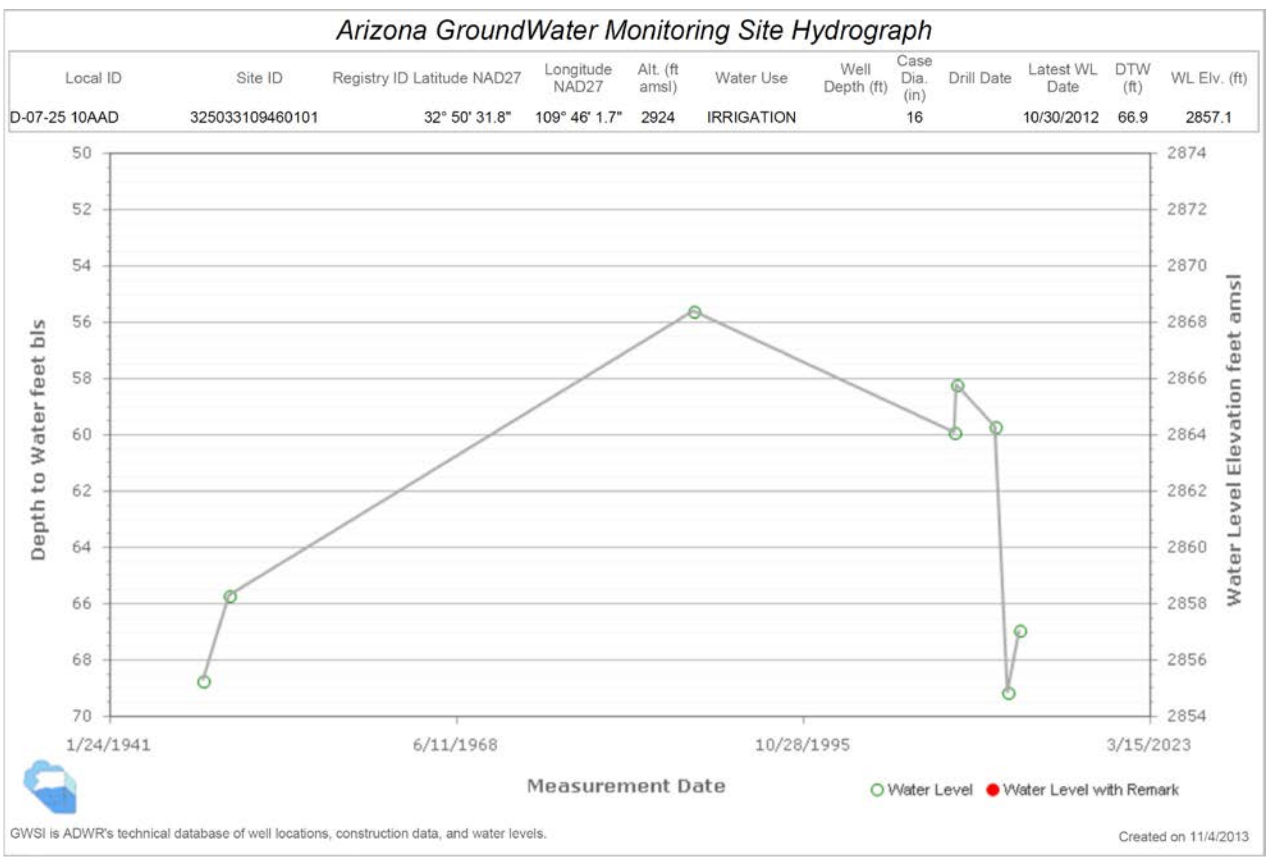


A-05-31 17CAA1 – Morenci basin about 3 miles SE of Alpine along the San Francisco River.

Safford Basin – Upper Gila Planning Area



D-07-26 22BAB – Safford basin – Gila Valley sub-basin about 2 miles SE of Safford and 1.5 miles south of Gila River.



D-07-25 10AAD -- Safford basin – Gila Valley sub-basin about 2 miles SW of Thacher and 3 miles SW of the Gila River.

[UPPER SAN PEDRO PLANNING AREA]

Upper San Pedro Planning Area

Background

The Upper San Pedro Planning Area is located in the southeast portion of the State. The boundaries for this Planning Area are coincident with the Upper San Pedro Groundwater Basin. The Planning Area is largely within Cochise County. Small portions of the western limits of the Planning Area are with eastern Santa Cruz and southwestern Pima counties and a small portion of the northern most reach of the Planning Area is within Graham County. Communities within the Planning Area, all of which are located in Cochise County, include Hereford, Sierra Vista, Huachuca City, Tombstone, and Benson. The Town of Bisbee is located on the Groundwater Basin divide in the southeast portion of the Planning Area. While most of Bisbee's population resides in the Cochise Planning Area, its water supplies are largely derived from wells located in the Upper San Pedro Basin. Additionally, Fort Huachuca, a US Army installation located in Sierra Vista, houses significant population and economic activity.

Land ownership within the Upper San Pedro Planning Area is diverse, including State, federal, and private lands (*see Figure P.A. 18-1*). Thirty-nine percent of lands in this Planning Area are State Trust Lands with livestock grazing as the principal.

Federal land ownership is comprised of USDA Forest Service (Forest Service), US Bureau of Land Management (BLM), and US Army facilities. Forest Service lands comprise just over 11 percent of land in the Upper San Pedro Planning Area. These discontiguous holdings are largely comprised of the mountain ranges that form the periphery of the Basin, including portions of the Miller Peak and the Rincon Mountain Wilderness Areas. Livestock grazing, recreation and timber production are the primary land uses on the portions of the Coronado National Forest not designated as Wilderness Areas in the Planning Area.

The BLM manages nearly nine percent of land in the Upper San Pedro Planning Area. The majority of the BLM land in this Planning Area is within the San Pedro Riparian National Conservation Area (SPRNCA), the nation's first federal riparian reserve. Portions of the Las Cienegas National Conservation Area and the Redfield Canyon Wilderness are within the Planning Area. Primary land uses on BLM lands are wildlife habitat, recreation and livestock grazing.

Approximately seven percent of land is managed by the US Military at Fort Huachuca. The Fort was established in 1877 and has existed as a military outpost, with varied missions, since that time. Primary land use is military training and preparedness activities.

The National Park Service (NPS) owns and manages less than one percent of land within the Planning Area at the Coronado National Memorial, located along the southern flank of the Huachuca Mountains north of the Mexican border, and a small portion of Saguaro National Park in the northwestern portion of the Planning Area.

One third of the land in the Upper San Pedro Planning Area (33.3 percent) is privately owned. Much of the private land is interspersed with state owned land and, to a lesser extent, BLM lands. Contiguous private lands exist south of Sierra Vista, north of Fort Huachuca, southeast of Benson and in the vicinity of Benson. Primary land uses are private domestic, municipal, commercial, industrial, livestock grazing and farming.

Water Supply Conditions

Groundwater

The Upper San Pedro 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, which may be suitable for artificial underground storage and recovery of renewable water supplies.

The groundwater system in the Upper San Pedro Planning Area is largely housed in the basin-fill sediments and the stream alluvium that has been deposited atop older basin-fill deposits. Depth to groundwater varies significantly across the Upper San Pedro Planning Area (*see Figure P.A. 18-2*). Shallow groundwater, approaching the land surface, is encountered in the floodplain aquifer along the San Pedro River. Water levels in this shallow system respond to water supply conditions along the River and have remained relatively stable. Deep groundwater levels are found in the vicinity of Sierra Vista where a cone of depression has formed in response to groundwater pumping to serve Sierra Vista and Fort Huachuca. Rates of decline in this deep system have been reported in excess of 2.2 feet per year. Similar declines have been experienced in the basin-fill aquifer in the vicinity of Benson's supply wells, which are largely located west of town near the intersection of Interstate-10 and Highway 90.

The principal sources of natural recharge are mountain-front recharge and streambed infiltration, estimated to be 35,750 acre-feet per year in the Planning Area. Groundwater flow is away from these areas of recharge along the periphery toward the center of the Basin and then generally flows parallel and proximate to the axis of the San Pedro River from south to north. Artesian conditions exist in the center of the Basin, primarily in the vicinity of St. David and Benson. Groundwater in storage estimates for the Basin range from 19.8 MAF to 59 MAF to a depth of 1,200 feet below land surface.

Surface Water

The Planning Area is drained by the San Pedro River which flows from south to north in the center of the valley (*see Figure P.A. 18-3*). The headwaters of the San Pedro River are in Mexico near the mining community of Cananea. The River is perennial through much of the reach from the border to a diversion dam, located in the northern portion of the SPRNCA, operated by the St. David Irrigation District. Additional perennial stream reaches include those found in the headwaters in the Huachuca Mountains in Miller, Carr and Ramsey Canyons. Reaches of the Babocomari River are also perennial, immediately above the confluence with the San Pedro River and upstream in the western portion of Planning Area.

Reclaimed Water

There are several wastewater treatment plants (WWTP) in the Upper San Pedro Planning Area serving the communities of Benson, Fort Huachuca, Hauchuca City, Naco, Sierra Vista and Tombstone. Approximately 5,000 acre-feet of reclaimed water is generated from these facilities. Two of these facilities recharge reclaimed water to the regional aquifer. The City of Sierra Vista Storage Facility is a permitted Underground Storage Facility (USF) with a permitted maximum annual storage limit of 4,149 acre-feet. Fort Huachuca also operates an artificial recharge facility using its reclaimed water for aquifer recharge. Direct reuse is practiced on golf courses from reclaimed water generated in Ft. Huachuca and Benson. Additionally, there are two reclaimed water treatment wetlands: 1) a wetland at the Apache Nitrogen Products facility was constructed as part of a Superfund clean-up site and 2) a wetland at the Sierra Vista WWTP Plant is operated in conjunction with the recharge facility. A large portion of the remaining population is dispersed throughout the Planning Area primarily reliant upon septic systems for wastewater treatment and disposal.

Ecological Resources

Ecological resources are an important part of the economy in the Upper San Pedro Planning Area. Significant portions of the Planning Area have been designated as critical habitat under the Endangered Species Act (*see Figure P.A. 18-3)*. These areas include lands along the San Pedro River within SPRNCA. Established in November 1988, SPRNCA contains about 40 miles of riparian habitat along the San Pedro River in the Upper San Pedro Basin. It includes over 58,000 acres of land between the international border with Mexico and the community of Saint David south of Benson. The primary purpose for the designation is to protect and enhance the desert riparian ecosystem. Higher elevation critical habitat has also been designated within portions of the Huachuca and Whetstone mountains and the Canelo Hills.

All or portions of four wilderness areas are located in the planning area: Galiuro, Miller Peaks, Redfield Canyon and Saguaro. Wilderness Areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition. A small part of the Las Cienegas National Conservation Area conservation area extends into the Upper San Pedro Planning Area. Established in December 2000, the conservation area was designated to protect aquatic, wildlife, vegetative and riparian resources, although livestock grazing and recreation are allowed to continue in "appropriate" areas.

An important State resource is Kartchner Caverns State Park. Located southwest of Benson in the Whetstone Mountains, the "wet cave" is supported by a limestone aquifer that is recharged by infiltration from ephemeral washes.

The Nature Conservancy (TNC) has also acquired property in the Planning Area for habitat protection, including the Ramsey Canyon Preserve in the Huachuca Mountains.

Water Demands

Table P.A. 18-1 below presents the baseline and projected water demands for the Upper San Pedro Planning Area. Agricultural annual water use is estimated at 8,800 acre-feet and is projected to remain stable through 2060. These uses are largely located on the San Pedro River and rely on both near-stream groundwater pumping and surface water diversions.

Municipal use is distributed in the population centers throughout the Planning Area and demands are projected to increase from nearly 20,000 acre-feet in 2010 to over 31,000 acre-feet by 2060. These estimates include water use at Fort Huachuca and the individual domestic wells in the Planning Area. The majority of the growth is projected to occur within the Sierra Vista and Benson areas which are currently largely groundwater served.

While no mining use is active in the Planning Area today, according to estimates provided by industry representatives to the WRDC, mining activity is projected to grow to between 2,000 and 12,000 acre-feet annually.[1]

Table P.A. 18-1. Projected Demands (in acre feet) – Upper San Pedro Planning Area

Sector	2010	2035	2060
Agriculture	8,800	8,800	8,800
Dairy	42	42	42
Feedlot	0	0	0
Municipal	19,168	26,226	31,062
Other Industrial	288	288	288
Mining	0		
High		12,000	12,000
Low		2,000	2,000
Power Plants	0		
High		0	0
Low		0	0
Rock Production	75		
High		1,489	1,764
Low		620	735
Turf	1,552		
High		1,675	1,731
Low		1,552	1,734
Total (High)	**29,925**	**50,520**	**55,687**
Total (Low)	**29,925**	**39,528**	**44,661**

Characteristics Affecting Future Demands and Water 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. ADWR has, at the request of the

[1] Estimate provided by local mining interests (FMC) during WRDC process.

Adjudication Court, mapped a proposed subflow zone to identify the extent of the surface water system. This proposal has been reviewed and vetted with the parties and is under revision. Until the adjudication process is complete, uncertainty regarding the extent and priority of water rights in this Planning Area will make it difficult to identify strategies for meeting the projected water demands.

Protected Species and Habitat

The presence of a listed species and protected habitat may be a critical consideration in water resource management and supply development in a particular area. A notable example is the City of Tombstone, which has historically used water derived from springs located in the Miller Peak Wilderness Area and transmitted to Tombstone via a pipeline, constructed to support the burgeoning mining community in the 1880s, to supplement its water supplies. In 2011, the Monument Fire burned over 30,000 acres in the Hauchuca Mountains and parts of Sierra Vista. After the fire, monsoon-triggered flooding caused damage to this pipeline. Tombstone and the Forest Service have been at odds over accessing the sites necessary to make the repairs. Tombstone argues that it should have unlimited access to their water system, and needs this access to provide a secure water supply for its citizens. Because the pipeline is located in the Miller Wilderness Area, the Forest Service asserts that Tombstone must submit plans for NEPA and ESA compliance review. According to Tombstone, this review could potentially delay repairs for a significant amount of time which could negatively impact its ability to meet demands.

Water Management - Groundwater/Surface Water

The basin-fill aquifer system, while experiencing water level declines in response to municipal pumping in the Upper San Pedro Planning Area, is believed to be sufficiently robust to sustain current and projected demands beyond the timeframe of this evaluation. The most controversial water management issue facing the Planning Area is ongoing controversy over the long-term impacts of groundwater pumping. Concerns have been raise by some that pumping from the regional aquifer system has the potential to diminish baseflows in the San Pedro River and degrade the riparian habitat along the River.

The Upper San Pedro Planning Area is not located within in State administered water management region, such as an AMA or INA. As such, aside from community water systems, individual water users are not required to meter or report water use to ADWR. Well impact analyses are not required for issuance of new well permits, the use of which is only governed by legal concept of reasonable beneficial use.

Cochise County has adopted mandatory water adequacy requirements under ARS §45-108.01 requiring all new subdivisions to demonstrate to ADWR the existence of a 100-year adequate water supply. While this program ensures that subdivided land has adequate water supplies to meet current and projected water supplies without impacting other municipal water demands in the region, no regulatory framework exists to examine the impact of diversion or pumping to meet these demands on water dependent natural resources. The lack of this framework is largely a consequence of Arizona's bifurcated legal system, regulating surface water and groundwater under separate statutes and rules and the incomplete adjudication process.

Regional initiatives to create a water management framework in the Upper San Pedro Planning Area were rejected by Cochise County voters.

Strategies for Meeting Future Water Demands

Resolution of Indian and Non-Indian Water Rights Claims

Efforts to complete the Gila River General Stream Adjudication are essential to provide long-term certainty for water users in Arizona. 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.

Expanded Monitoring & Data Collection

Limited monitoring and reporting of water use is required in the Upper San Pedro Planning Area. The lack of data on annual water demands hampers analysis, public education, and development of strategies to address projected water demands in the region.

Reclaimed Water Reuse

Reuse and recharge of reclaimed water is already practiced in the Upper San Pedro Planning Area. The USF in Sierra Vista was sited in a location to temper the growth of the cone of depression that has formed in response to the pumping that serves Sierra Vista and Ft. Huachuca. Revising this facility to reduce the water losses in the treatment process would provide additional renewable supplies for recharge.

Converting other lagoon-based treatment works to mechanical plants will serve to reduce water losses in the treatment process and augment locally available water supplies. Strategic conversion of existing septic systems with treatment plant and effluent reuse and recharge systems may serve to improve the resilience and sustainability of local water supplies in the Planning Area.

Enhanced Conservation

Local conservation efforts have resulted in significant reductions in water use in the Upper San Pedro Planning Area. Continuing and expanding these efforts will serve to limit water demands and the impact of meeting those demands and should be encouraged.

Enhanced Stormwater Recharge

Local efforts are underway to evaluate the feasibility of increasing locally available water supplies through modification of stormwater management systems to increase aquifer replenishment. If successful, these efforts may increase the efficiency of local groundwater recharge, capturing flows that would, without these efforts, leave the Basin as flood flows.

Local efforts are focused on technical feasibility. There are concerns expressed by some surface water right holders that inhibiting flows that otherwise would have entered the surface water system may reduce the water availability of supplies to which they have the rights. To address these issues, in 2012 the Arizona legislature passed House Bill 2363 establishing a Joint

Legislative Study Committee on Macro-Harvested water to evaluate the issues arising from the collection and recovery of large-scale harvested water. The process to evaluate this program will be important in determining whether or not these projects can result in significantly enhancing water supplies beyond what is currently available for future uses.

Importation

Several studies have been conducted to evaluate alternatives for meeting the water demands of current and projected users in the Upper San Pedro Planning Area while protecting the baseflows of the River and the habitat of the riparian corridor. At this time, local efforts are focused on maximizing and augmenting locally available supplies with local efforts. Should these efforts prove insufficient to augment local supplies, importation of supplies from outside the basin may be necessary.

The alternative that has received the most attention to date is extension of the CAP canal delivery system to Sierra Vista. Uncertainty exists with regards to the water supply that would be delivered, the source of capital to construct the infrastructure to affect these deliveries, and the economic feasibility of operating this system. An additional alternative may be participation in a joint seawater desalination project by communities in the Upper San Pedro Planning Area, perhaps through extension of the CAP Canal. There are many hurdles, including those associated with the transportation of water and power across the international border, that such a project would need to overcome before it could reasonably be included in a supply portfolio for the Planning Area.

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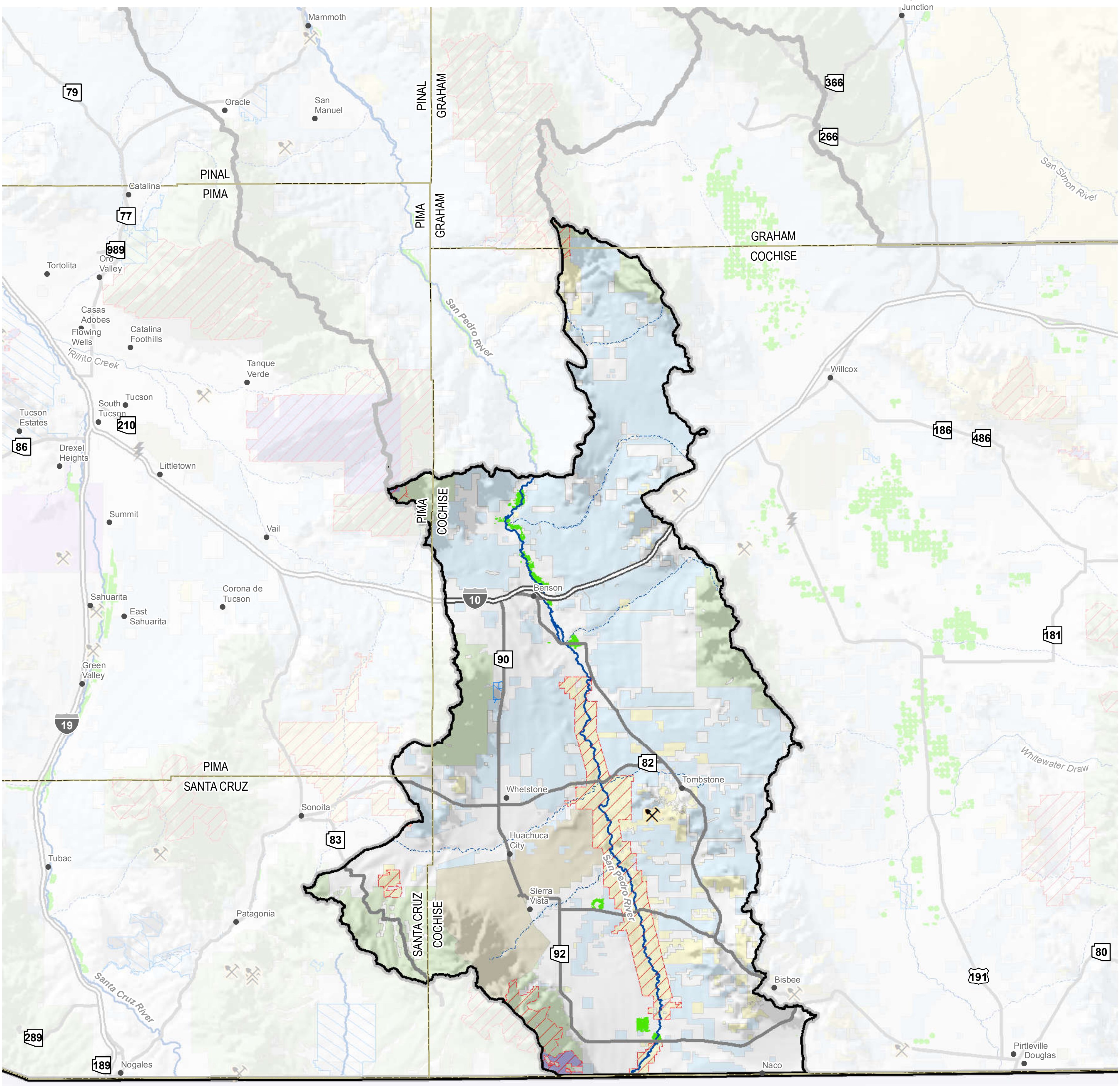

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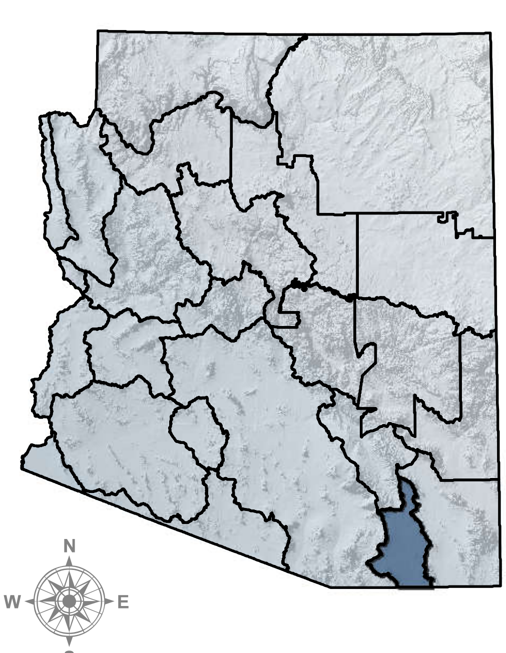

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Figure P.A.18-1

Upper San Pedro Land Ownership

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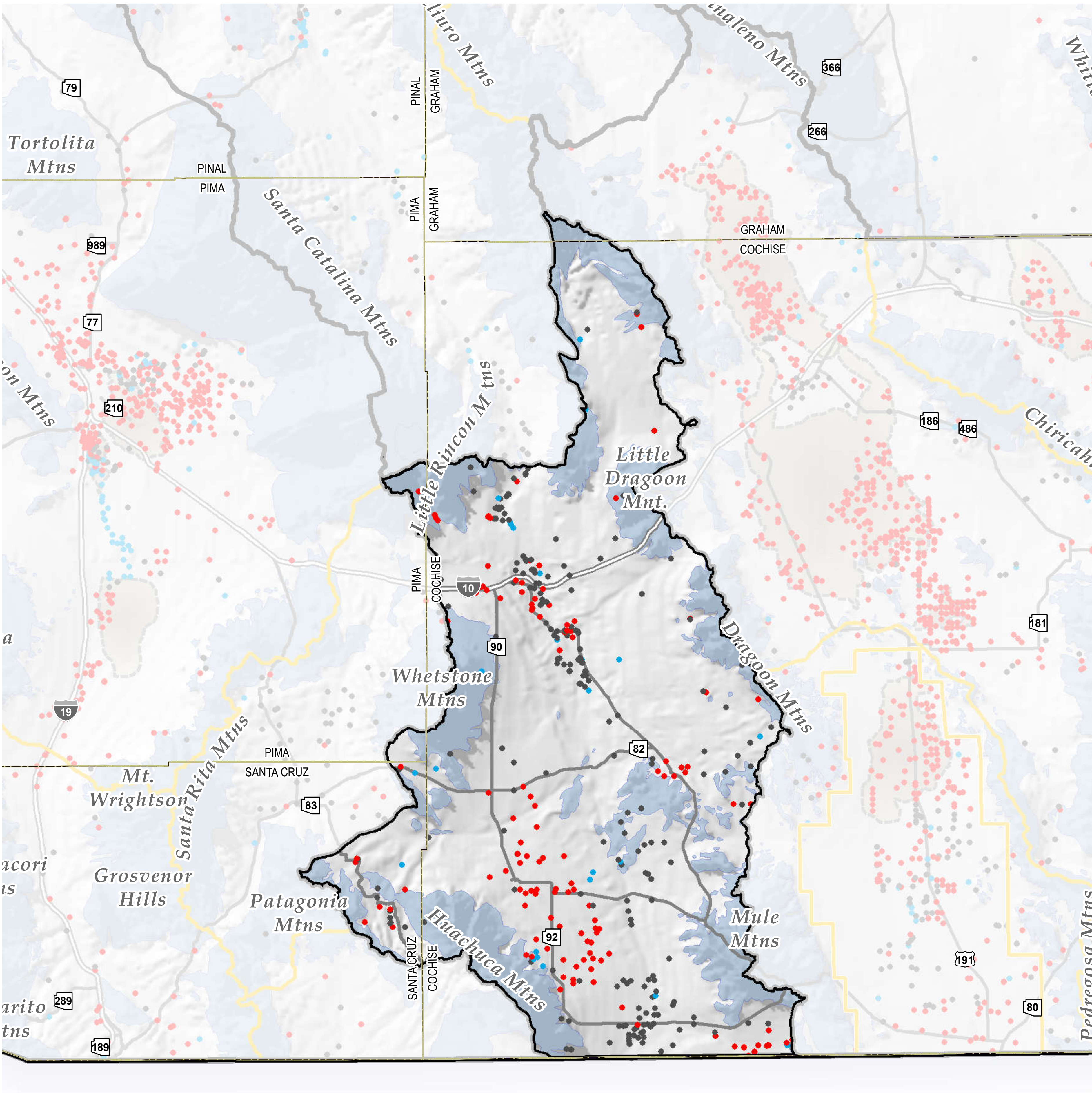

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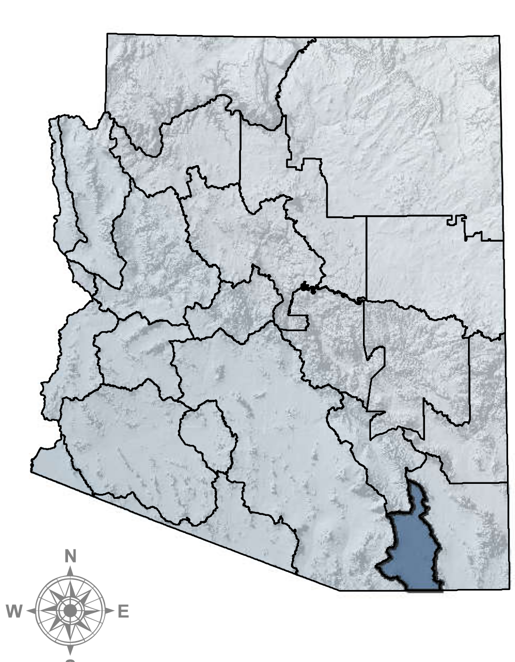
* Data provided by ADWR



MAP LOCATION
(Planning Area Boundaries)

Figure P.A.18-2

Upper San Pedro Groundwater Hydrology

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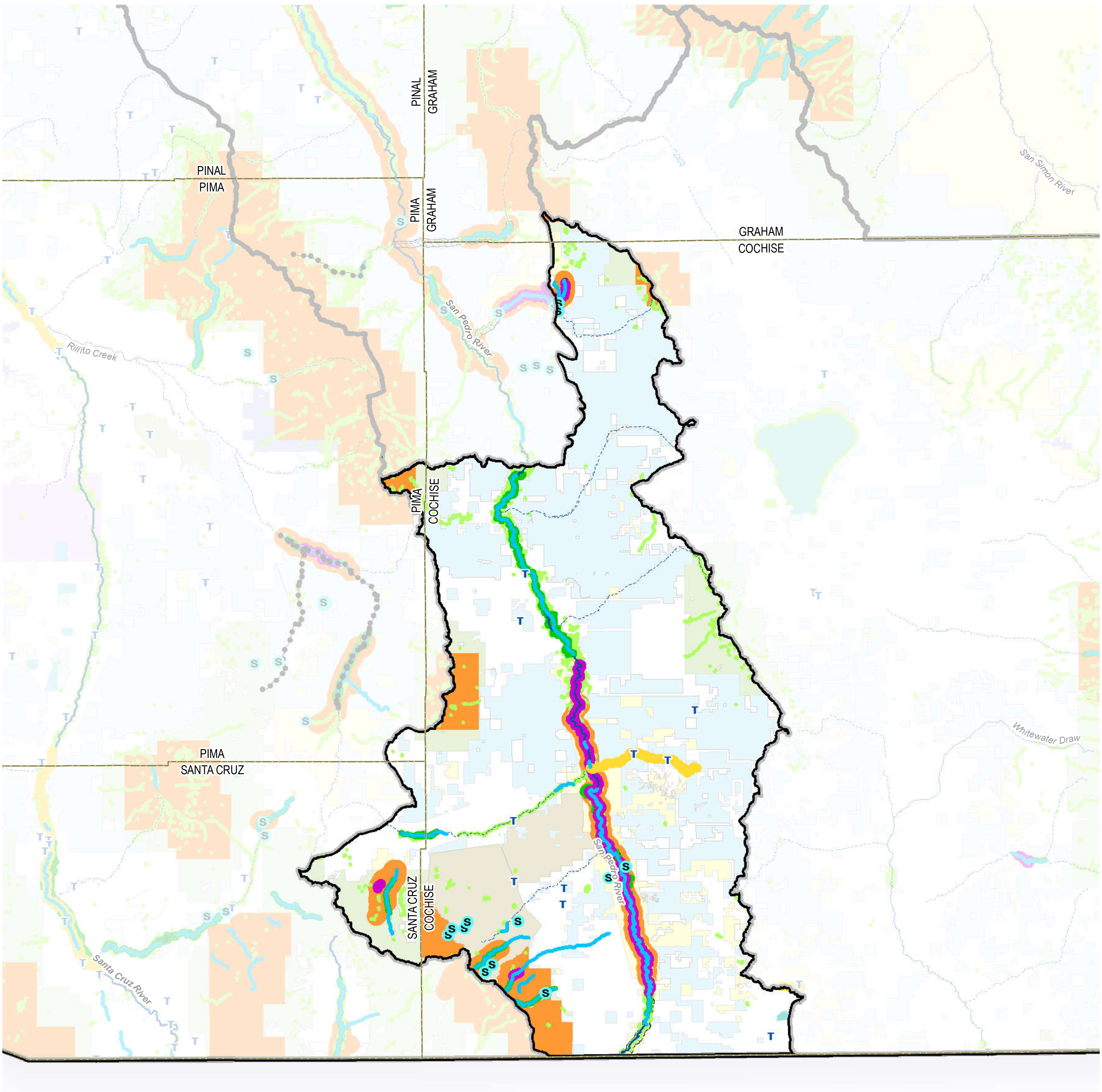

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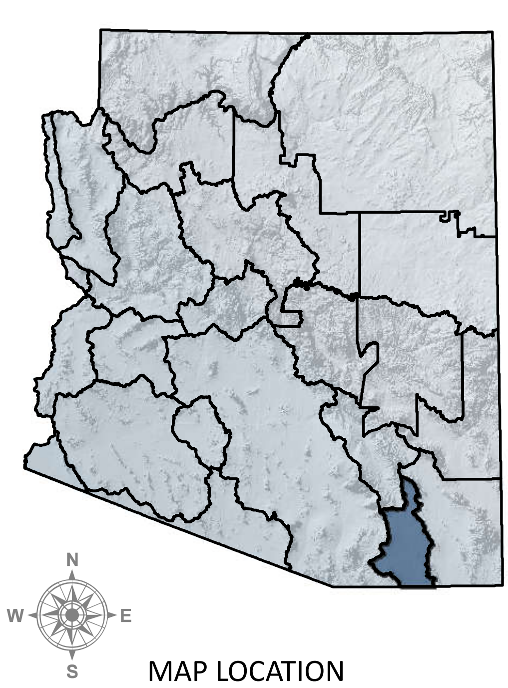

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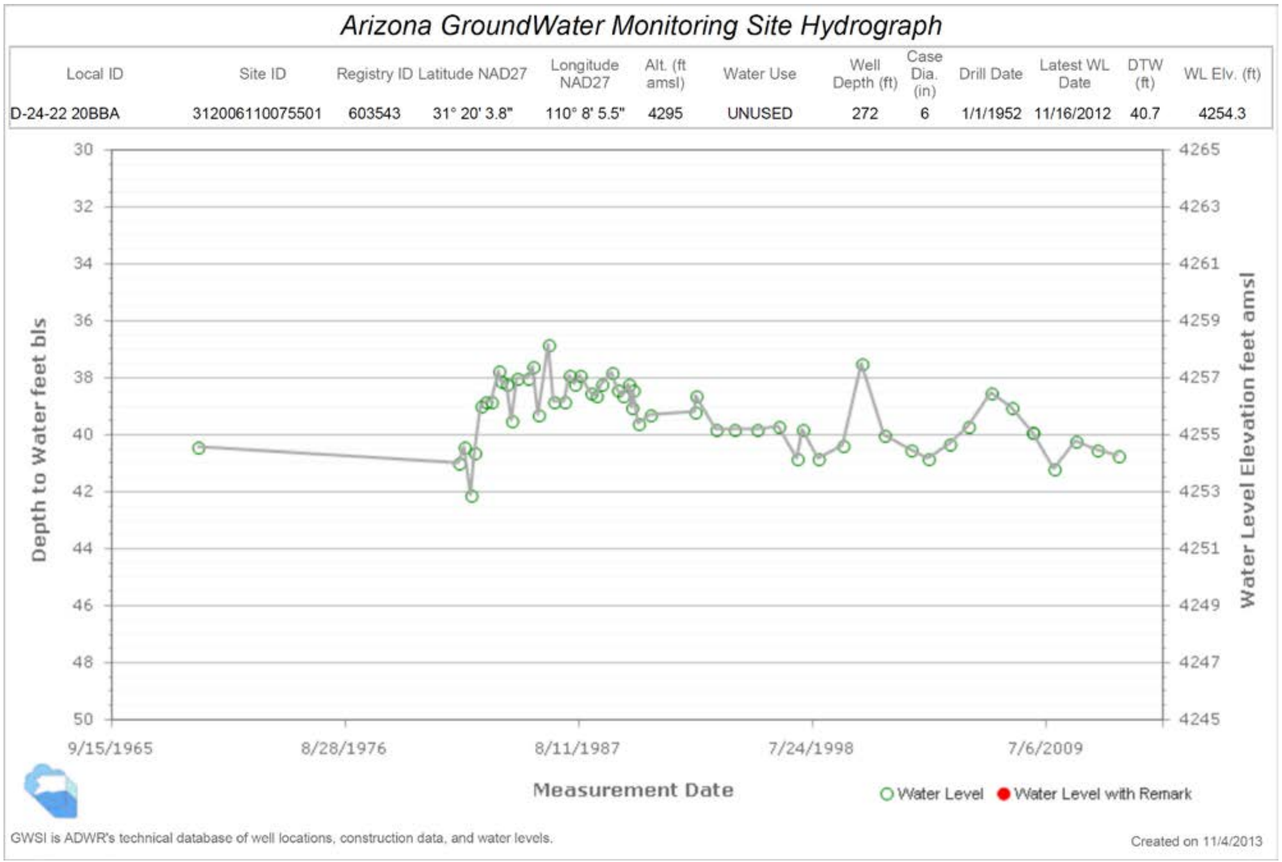
ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

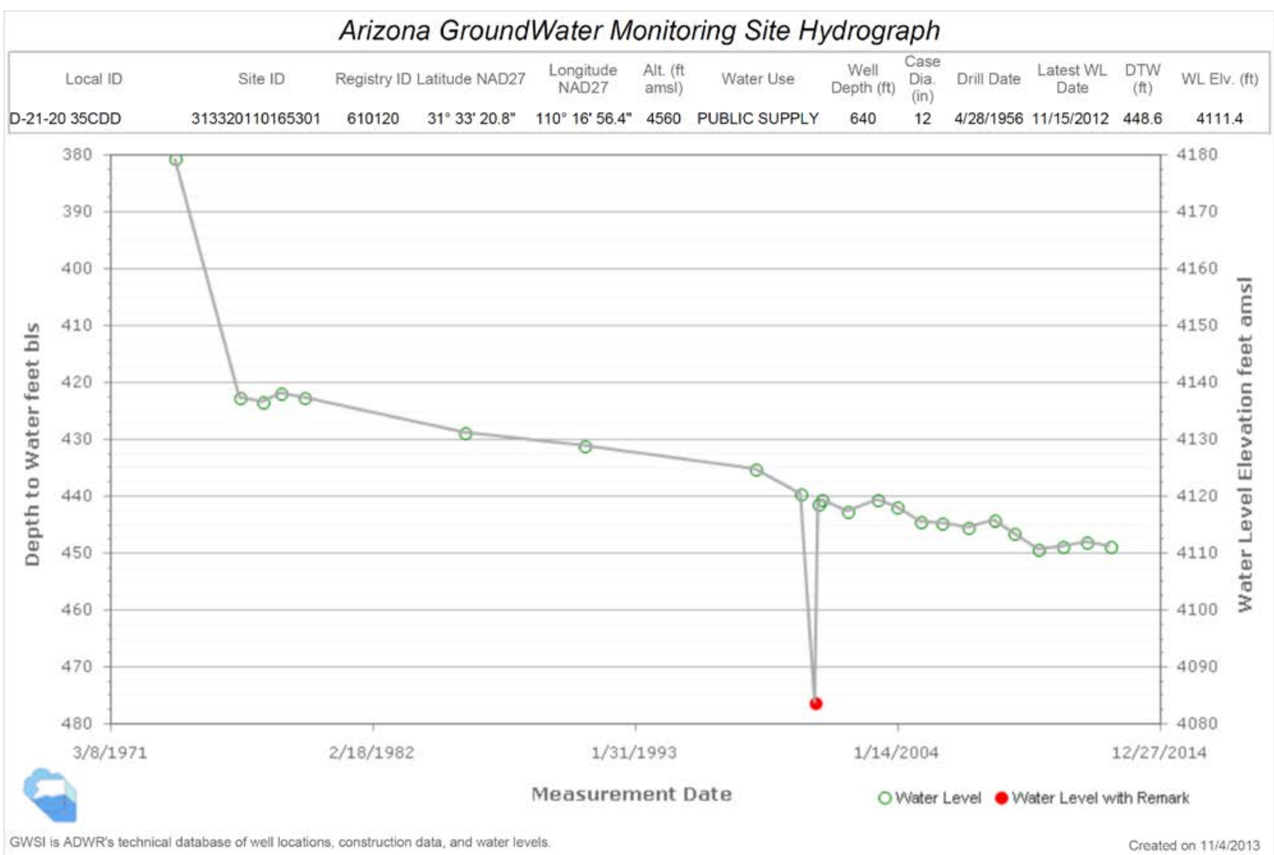
Figure P.A.18-3

Upper San Pedro
Surface Water and Natural Features

Upper San Pedro Basin – Upper San Pedro Planning Area



D-24-22 20BBA -- Upper San Pedro basin – Sierra Vista sub-basin along US/Mexico border 1 mile east of San Pedro River.



D-21-20 35CDD – Upper San Pedro basin – Sierra Vista sub-basin in Sierra Vista.

[VERDE PLANNING AREA]

Verde Planning Area

Background

The Verde Planning Area is located within portions of Yavapai and Coconino counties in the central portion of the State. Nearly all of the Verde Planning Area is located within the Verde River Watershed. The eastern portion of the Planning Area contains a small portion of the headwaters of the Agua Fria River. The Planning Area includes a large portion of the Verde River Groundwater Basin and the entire Prescott Active Management Area (AMA) Groundwater Basin, which is divided into two groundwater Sub-basins: Little Chino and Upper Agua Fria in the north and south, respectively. The primary population centers within the Planning Area are Prescott, Prescott Valley, Chino Valley, Camp Verde, Clarkdale, Cottonwood, and Sedona. The balance of the Planning Area has limited population, largely residing in several relatively small communities.

A large majority of the land within this Planning Area is federally owned and managed by the USDA Forest Service (Forest Service) (*see Figure P.A. 19-1*), including part of the Tonto, Prescott, Coconino, and Kaibab National Forests. Land uses are recreation, livestock grazing and timber production. The majority of the private lands are distributed in a checkerboard pattern in the northwestern portion of the Planning Area and the Prescott AMA Basin. A large block of land is federally owned and operated by the US Military as the Navajo Army Depot, located in the vicinity of Bellemont in the northeastern portion of the Planning Area. Land uses include National Guard training and army equipment storage. There are also numerous small private land in-holdings in all forests, largely along watercourses. Land uses include domestic, commercial, mining, livestock grazing, and limited irrigated agriculture. The majority of State Trust Lands are collocated with the private lands in the checkerboard in the northwestern portion of the Planning Area and Prescott AMA Basin. State Trust Lands are also located in the vicinity of Cottonwood and south of the Navajo Army Depot. Primary land use is livestock grazing. Other small parcels of land are owned by the US Bureau of Land Management (BLM), the Yavapai-Prescott Tribe, Yavapai Apache Nation, National Park Service (NPS), and the Arizona Game and Fish Department.

Water Supply Conditions

Groundwater

The Verde Planning Area is located in the Transition Zone Physiographic Province. The groundwater system within this mountainous terrain is housed in relatively thin alluvial aquifers, and limited volumes of groundwater flowing in fractured crystalline, sedimentary, and volcanic rock. The Mogollon Rim is a notable geographic feature of the Planning Area, the escarpment that defines the southern boundary of the Colorado Plateau and serves as the northeastern border of the Planning Area.

The Verde Planning Area includes the Prescott AMA, one of four original AMAs established upon enactment of the Groundwater Code in 1980. The AMAs were designated as requiring specific, mandatory management practices to preserve and protect groundwater supplies for the future. The management goal for the Prescott AMA is to reach, and thereafter maintain, safe yield by 2025, which is accomplished when no more groundwater is being withdrawn from the AMA than is annually replaced

by natural or artificial means[1]. By statute *(A.R.S. §45-555)*, the City of Prescott can withdraw and transport groundwater from the Big Chino Sub-basin into the Prescott AMA. The volume that can be transported pursuant to the City of Prescott's designation of Assured Water Supply is 8,067.40 acre-feet per year. In addition, cities and towns in the Prescott AMA are allowed to withdraw groundwater associated with historically irrigated acres in the Big Chino Sub-basin of the Verde River Basin and transport that water into the Prescott AMA, although that volume is yet to be quantified.

Water level trends in the Prescott AMA include areas of declining water levels in most of the Prescott AMA Basin and significant recovery of water levels in one area where a major change in municipal pumping patterns occurred (*see Figure P.A. 19-2*). In the northern part of the Little Chino Sub-basin, north of the Town of Chino Valley, water levels were observed to decline by about 20 to 30 feet since 1994. Water level declines in this area were caused mainly by groundwater pumping at the City of Prescott's Chino Valley well field and to local agricultural, minor industrial and domestic pumping. In the southwestern portion of the Little Chino Sub-basin, water levels were observed to decline by 10 to 60 feet, or more, in wells drilled in basin-fill and/or fractured bedrock formations. Water level declines in this area are primarily due to domestic and small water company pumping. One well's hydrograph, (*illustrated in Figure P.A. 19-3 - B-15-02 30DCB*) exhibits a water level decline approaching 100 feet between 1998 and 2012.

In the northern part of the Upper Agua Fria Sub-basin, water levels have recovered by roughly 200 feet in some deep municipal wells located in the Prescott Valley-Santa Fe well field (*see Figure P.A. 19-4 - B-14-01 10DDA*). Recoveries at the Santa Fe well field are due to reductions in pumping from this well field made possible by the construction and operation of several new municipal wells in the Prescott Valley-North well field. Water level declines were observed in most other portions of the central and northern sections of the Upper Agua Fria sub-basin.

Groundwater conditions in the northern portion of the Planning Area (Big Chino Sub-basin) have historically been variable (*see Figure P.A. 19-2*). Water levels generally rose in the central portion of the Sub-basin along Big Chino Wash in the area of the City of Prescott's proposed Big Chino Water Ranch. Water levels in the lower portion of the Big Chino Sub-basin showed minor declines in some wells located near Paulden. Water levels were stable in the Williamson Valley portion of the Sub-basin.

Water levels historically have declined in many areas of the central portion of the Planning Area (Verde Valley Sub-basin of the Verde River Groundwater Basin). In general, water levels have remained stable, or showed only minor overall fluctuations along the Verde River downstream of Camp Verde. Near Cottonwood and Clarkdale, water levels declined by 20 to 40 feet, or more, in many wells. The water level declines in this area are generally due to increased municipal and industrial pumping. Near Lake Montezuma, Rimrock, Red Rock, Sedona and Oak Creek, water levels generally declined from 1994 to 2009. Water levels increased in several wells measured in the Bellemont-Camp Navajo area over this timeframe.

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[1] Pursuant to the 1980 Groundwater Management Act, each AMA was given a statutory management goal. The goal of the Prescott AMA is safe-yield defined in *A.R.S. §45-561(12)* as "…a management goal which attempts to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial recharge in the active management area."

Water quality throughout the Prescott AMA is generally good; however, arsenic levels exceeding water standards have been found in several locations within the AMA and across remaining portions of the Planning Area. One NPL Superfund site, the Iron King Mine and Humboldt Smelter, near Dewey-Humboldt, has arsenic and lead contaminated soil and groundwater. In addition, the Planning Area has one Resource Recovery and Conservation Act (RCRA) site, Camp Navajo, near Bellemont, with both soil and groundwater contamination.

Surface Water

Major surface water features in the Verde River Watershed portion of the Planning Area include the Verde River, which flows southeast to south (*see Figure P.A. 19-5*). Big Chino Wash and Granite Creek are tributaries to the Verde River in the northwest portion of the Planning Area. Several tributaries, including Sycamore Creek and Oak Creek feed the Verde from the north, draining the Mogollon Rim. The Verde River is perennial throughout its length. Springs feed the Verde headwaters near Paulden, below Sullivan Lake Dam. The Verde River flows through two reservoirs, Horseshoe and Bartlett Lakes south of the Verde Planning Area in the far southern portion of the Verde River Watershed, which are important flood control and water supply structures for the Phoenix area (part of the Salt River Project). Stream flows can be substantial and several streamgage stations on the Verde and its tributaries have reported annual maximum flows under flood flow conditions exceeding 1,000,000 acre-feet per year.

The Agua Fria River-Lower Gila River Watershed is located within the Prescott AMA Basin. Major surface water features include the Agua Fria River and its tributary, Lynx Creek. There is one active streamgage station along the Agua Fria River within the Prescott AMA Basin. The minimum and maximum annual flow in the Agua Fria River near Humboldt was 1,335 acre-feet (2003) and 10,911 acre-feet (2005), respectively. The Prescott AMA Basin also has significant local surface water resources, including the headwaters of the Agua Fria River. Flows from Granite Creek, Willow Creek, and Del Rio Springs in the AMA contribute significantly to the flow of the Verde River, whose headwaters is located just outside the boundary of the Prescott AMA Basin at Sullivan Lake. Much of the Verde's base flow is dependent on these creeks and springs.

Reclaimed Water

The majority of the reclaimed water produced is generated at several municipal and privately-owned wastewater treatment facilities. Three communities (Prescott, Prescott Valley, and Chino Valley) in the Prescott AMA have permitted reclaimed water recharge facilities. Reclaimed water is also utilized both directly and through recharge and recovery for multiple golf courses, a park, and a sand and gravel operation. Principal reclaimed water disposal methods in the remaining portions of the Planning Area include irrigation, discharge to a watercourse, evaporation ponds, and golf course irrigation.

Ecological Resources

A number of listed threatened and endangered species may be present in the Verde Planning Area. The Verde River and associated riparian vegetation provide wildlife and fish habitat (*see Figure P.A. 19-5*). The Verde River riparian zone is a critical flyway for migratory birds and supports a high density of breeding birds. Native fish populations in the upper Verde River are among the most diverse in Arizona. Page Springs State Fish Hatchery is located along the banks of Oak Creek and is the state's largest cold water fish hatchery. Watson and Willow Lakes, formed by impoundments on Granite Creek and its tributary Willow Creek, are listed as Important Bird Areas.

The Verde Planning Area has a significant number of acres under federal ownership, including National Forest and all or portions of 12 Wilderness Areas[2]. Wilderness areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition. Two National Monuments that protect prehistoric dwellings are located in the Planning Area - Montezuma Castle and Tuzigoot National Monuments are small sites containing cliff dwellings or pueblos. Additionally, two streams in this Planning Area are designated as Wild and Scenic Rivers. Congress adopted the Wild and Scenic Rivers Act in October 1968 to preserve selected rivers that possess "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values" in their free-flowing condition for the benefit of present and future generations. About 40 miles of the 170-mile long Verde River has been designated a Wild and Scenic River. The Scenic River Area begins about six miles south of Camp Verde and extends to the boundary of the Mazatzal Wilderness; a reach of 18.3 miles. South of this reach, the Wild River Area continues for another 22.2 miles to the Verde's confluence with Red Creek. Under the Act, the river area must be managed in a manner that protects and enhances its "outstandingly remarkable values."

Approximately 1,000 acres of land at the headwaters of the Verde River are protected by the Arizona Game and Fish Department and The Nature Conservancy. These lands include the Verde River Springs Preserve (TNC) and the Upper Verde River Wildlife Area (AZGF). Oak Creek, including the West Fork of Oak Creek in the Verde River Basin, is designated by ADEQ, pursuant to A.C.C. R18-11-112, as a "unique waters," having exceptional recreational or ecological significance and/or providing habitat for threatened or endangered species.

Water Demands

Table P.A. 19-1, below, presents the baseline and projected water demands for the Verde Planning Area. Municipal use is the largest demand sector today and is expected almost double by the year 2060. Industrial uses related to turf irrigation for golf courses is also expected to increase by up to 25 percent by 2060. A significant increase related sand and gravel operations is also anticipated in the future. Mining uses are projected to increase although is contingent on the availability of productive ore bodies.

Characteristics Affecting Future Demands and Water Supply Availability

General Stream Adjudication

The general stream adjudication is a judicial proceeding to determine or establish the extent and priority of water rights in the Gila and Little Colorado River systems. The Verde River is a tributary to the Gila River and, therefore, is part of the Gila River adjudication proceedings. 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 this Planning Area will make it difficult to identify and execute strategies for meeting the projected water demands.

[2] Juniper Mesa, Apache Creek, Granite Mountain, Sycamore Canyon, Red Rock-Secret, Woodshoot, Munds Mountain, West Clear Creek, Wet Beaver Creek, Cedar Bench, Pine Mountain, and Matazal Wilderness Areas.

TABLE P.A. 19-1 Projected Water Demands (in acre feet) – Verde Planning Area

Sector	2010	2035	2060
Agriculture	25,362	23,844	23,844
Dairy	0	0	0
Feedlot	0	0	0
Municipal	33,886	54,265	65,909
Other Industrial	567	567	567
Mining	0		
High		4,000	4,000
Low		1,000	1,000
Power Plants	0		
High		22	28
Low		16	19
Rock Production	1,070		
High		4,019	4,883
Low		1,674	2,035
Turf	3,366		
High		4,013	4,217
Low		3,509	4,223
Total (High)	**64,251**	**90,730**	**103,448**
Total (Low)	**64,251**	**84,876**	**97,597**

Unresolved Indian Water Rights Claims

Resolution of the water rights claims of the Yavapai-Apache Nation is being discussed through a possible settlement. Until these claims are quantified and settled, uncertainty regarding the extent and priority of water rights in this Planning Area will make it difficult to identify and execute strategies for meeting the projected water demands.

Prescott AMA

A portion of this Planning Area includes the Prescott AMA, which has a statutory management goal pursuant to the 1980 Groundwater Management Act to achieve safe-yield by 2025. Although current state law requires new growth in the Prescott AMA to be consistent with the management goal of safe-yield, many existing uses that were in place prior to the declaration that the AMA was out of safe-yield in the late 1990s have allowable groundwater pumping volumes in excess of the safe-yield volume. Additionally, the use of domestic/exempt wells[3] is not subject to AMA management requirements. Exempt well pumping represents a significant percentage of water demand (approximately 25 percent) in the Prescott AMA Basin. This means that, under current regulations, groundwater overdraft may continue and could increase above current rates.

[3] Exempt wells are defined as wells with a pump capacity of not more than 35 gallons per minute.

Groundwater is the primary water source within the Prescott AMA, there is no direct access to CAP water and surface water supplies are limited or inconsistently available. Although the statutes allow for the importation of groundwater from the Big Chino Sub-basin of the Verde River Groundwater Basin and the City of Prescott has demonstrated a Designation of Assured Water Supply for future uses of this supply, there has been significant public opposition to this project. Prescott is now working on a mitigation strategy that includes a monitoring and modeling study of the potential impacts of using this supply in cooperation with SRP. The outcome of those studies will be important to identify the long-term availability of this supply to meet the needs of the AMA.

Downstream Water Demands

The Verde Planning Area contains a portion of the watershed that is essential to the Phoenix area - through the Salt River Project. Verde River water, which originates in this Planning area and stored in the Verde River reservoirs, is primarily allocated for use outside of the Planning Area. Several court determinations govern surface water supply availability in the Planning Area. The Verde Ditch Decree (1909) proportionately divided ownership and maintenance responsibilities of the Verde Ditch, located along the Verde River near Camp Verde, without reference to a priority date or use. It also stipulates that water in the lower portion of the Ditch be one third of the flow of the upper portion to ensure adequate supplies for all ditch owners. The Kent Decree (1910) determined that almost 240,000 irrigable acres in the Salt River Valley (Basin and Range AMAs Planning Area – Phoenix AMA Groundwater Basin) have a right to waters of the Salt and Verde rivers and included certain tribal provisions, but did not establish rights along the Verde River within the Verde Planning Area. The Benson-Allison Decree (1917) concerns lands generally located downstream of the Kent Decree lands in the Phoenix AMA that are entitled to divert water from the Salt, Agua Fria and Gila rivers. Management of this watershed for forest health and water supply protection and development is important to ensuring a secure water supply for the Phoenix area, while at the same time balancing the needs of the water users in the Verde Planning Area.

Wildfire

Several years of drought, combined with high tree densities, resulted in the largest outbreak of pine bark beetle populations ever recorded in Arizona from 2002 through 2004. This outbreak killed millions of piñon and ponderosa pine trees. Data from aerial surveys recorded 2.1 million acres of piñon-juniper woodland and 1.3 million acres of ponderosa pine affected in Arizona and New Mexico during that period.

Wildfire risk increases with the number of dead trees in the landscape, which provide fuel for fires. The Cave Creek Complex Fire (2005) burned 243,800 acres in the Verde River Basin and adjacent areas in east-central part of the Agua Fria Basin and Basin & Range AMAs Planning Area (Phoenix AMA). In the Southwest, fire can be among the most significant watershed disturbance agents, particularly influencing peak stream flows. Wildfire and drought can result in vegetative changes in the Planning Area with implications for runoff, infiltration and the quantity and quality of downstream water supplies.

Protected Species and Habitat

The presence of a listed species and protected habitat may be a critical consideration in water resource management and supply development in a particular area.

Strategies for Meeting Future Water Demands

Resolution of Indian and Non-Indian Water Rights Claims

Efforts to complete the Yavapai-Apache Tribe's claims as well as the Gila River General Stream Adjudication is essential to not only provide a secure water supply for the tribe, but also to provide long-term certainty for water users in Arizona dependent on water supplies from the Gila River. 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.

Watershed/Forest Management

Watershed management practices aimed at increasing watershed yield have been evaluated in Arizona, showing opportunities for success. Due to the significant acreage of forested land in this area, continuation of this process and implementation of safe and effective strategies are important to water users within and outside of this Planning Area. Combing efforts with other management initiatives (such as the Four Forest Restoration Initiative) may be a cost-effective way to advance this option and can provide multiple healthy benefits to this Planning Area and those dependent on its resources. 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[4].

Weather Modification

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

Reclaimed Water Reuse

Reclaimed water has been an important source of supply in this Planning Area. However, many areas are still reliant on septic systems, which reduce the amount of water that could be reclaimed and reused. In order to meet the long-term water needs in this Planning Area, efforts should focus on continuing to maximize the use of reclaimed water for non-potable uses and exploring and implementing options for direct potable reuse. Additionally, 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 address future water needs.

Enhanced Stormwater Recharge

Local efforts are underway to evaluate the feasibility of increasing locally available water supplies through modification of stormwater management systems to increase aquifer replenishment. If successful, these efforts may increase the efficiency of local groundwater recharge, capturing flows that would, without these efforts, leave the Basin as flood flows.

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

Local efforts are focused on technical feasibility. There are concerns expressed by some surface water right holders that inhibiting flows that otherwise would have entered the surface water system may reduce the water availability of supplies to which they have the rights. To address these issues, in 2012 the Arizona legislature passed House Bill 2363 establishing a Joint Legislative Study Committee on Macro-Harvested water to evaluate the issues arising from the collection and recovery of large-scale harvested water. The process to evaluate this program will be important in determining whether or not these projects can result in significantly enhancing water supplies beyond what is currently available for future uses.

Water Management

Currently, the Prescott AMA is the only area with water management requirements that include limitations on groundwater mining, assured water supply requirements for new development, and mandatory implementation of water conservation requirements for municipal, industrial and agricultural water users. While, many municipal water providers have implemented their own water conservation programs and the City of Clarkdale has adopted an ordinance that requires new development to demonstrate a 100-year adequate water supply (*see Appendix III, specifically Statewide Water Advisory Group recommendations*), groundwater mining is occurring in this Planning Area. Outside of the Prescott AMA there are no requirements for industrial or agricultural water users to meter and report their water use or reduce their dependence on groundwater supplies and the significant reliance on small exempt wells throughout the Planning Area continues to stress the groundwater system. Additionally, significant concerns exist in the community regarding the impacts of groundwater mining on the Verde River, which is a very important to the local economy. Continued reliance on groundwater supplies, and the impacts of long-term groundwater mining, may highlight need for State or local management of the existing supplies beyond the Prescott AMA boundaries.

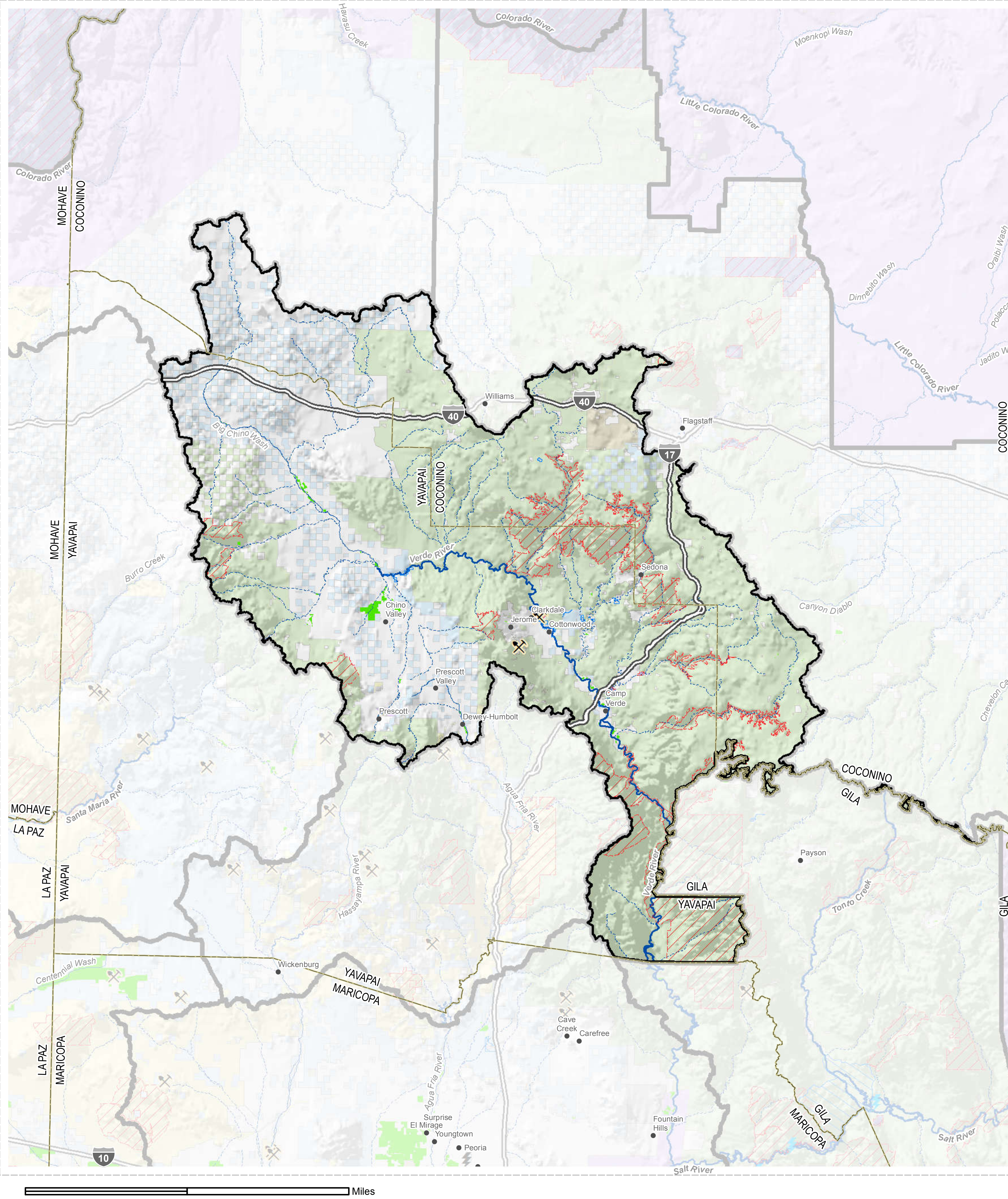
Importation

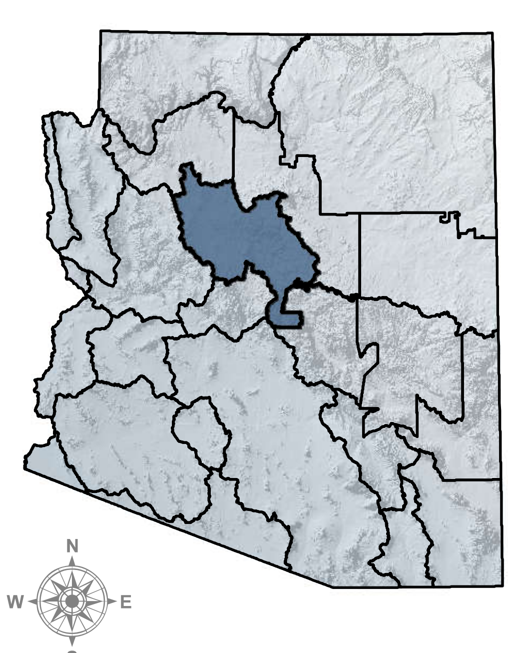
The projected growth in this Planning Area will continue to put stress on the existing limited water supplies. The extensive sensitive ecosystems in this Planning Area will limit the desire and ability to fully utilize resources in this area. While maximizing the direct and indirect use of reclaimed water will alleviate some of this pressure, if these growth projections and the demands associated with this increase are to be realized, importation of water from outside of this area is necessary. The transfer of water to the Prescott area from the Big Chino Sub-basin needs to be thoroughly analyzed and that process is currently underway.

Water transfers from other areas of the State could reduce the imbalance, specifically groundwater from the Harquahala INA, but this may not be a permanent solution.

A more permanent long-term solution may be participation in a seawater desalination plant, either on the Pacific Ocean or in the Sea of Cortez in conjunction with an exchange of Colorado River supplies with an entity that receives water from the Colorado River. To access this supply, a pipeline would have to be constructed to deliver water into the Planning Area. Alternatively, an exchange of Verde River water for the imported water could be considered, but has not been successful in the past due to environmental compliance.

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)

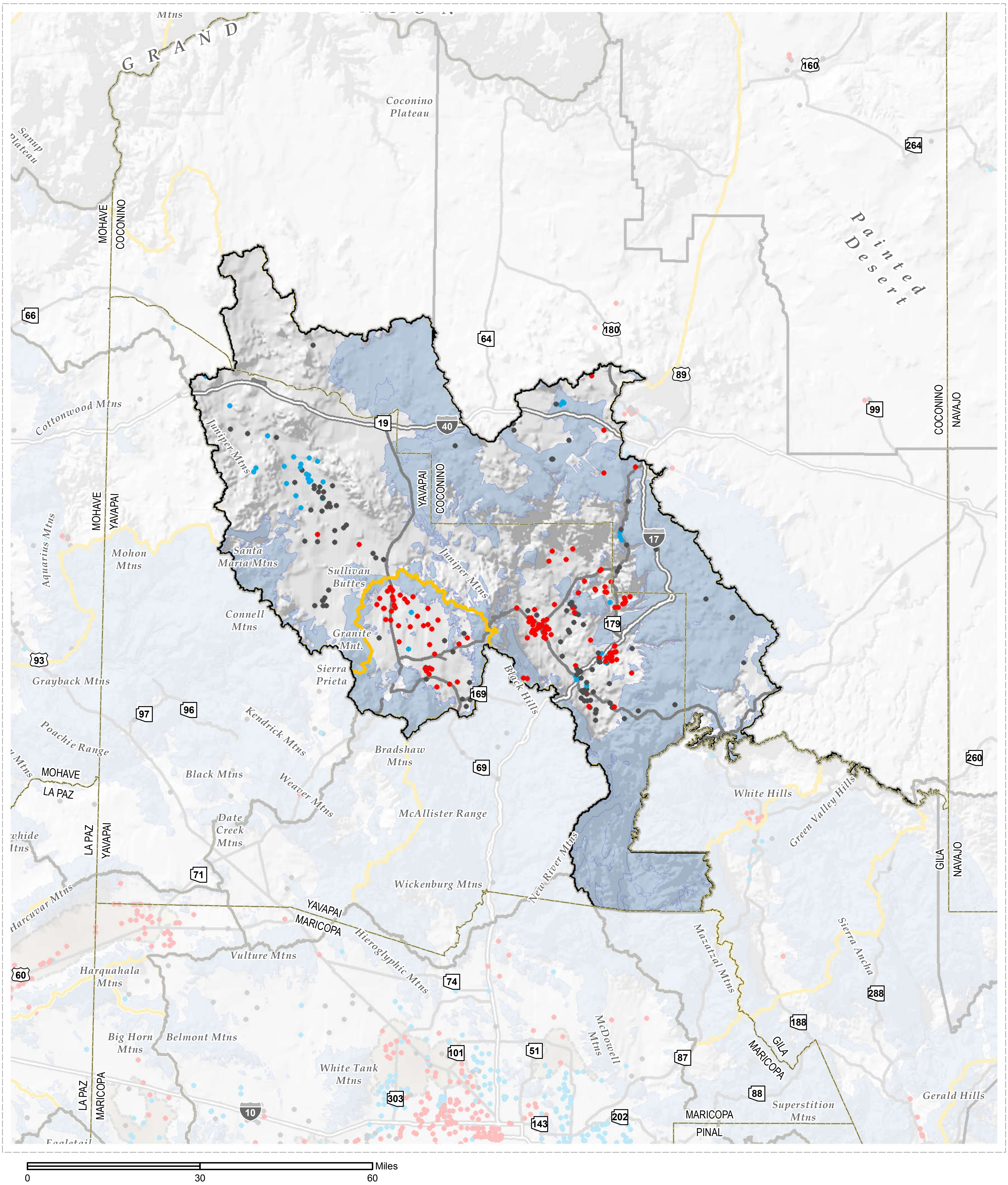
Planning Area (ADWR)
State (ALRIS)
County (ALRIS)
River or Stream (ASLD)
Interstate (ADOT)
Population Center (GNIS)
Mine (ADMMR, ADWR)
Hydroelectric Power Plant (ADEQ, ADWR)
Thermoelectric Power Plant (ADEQ, ADWR)
Agriculture (SWReGAP, 2004)
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation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

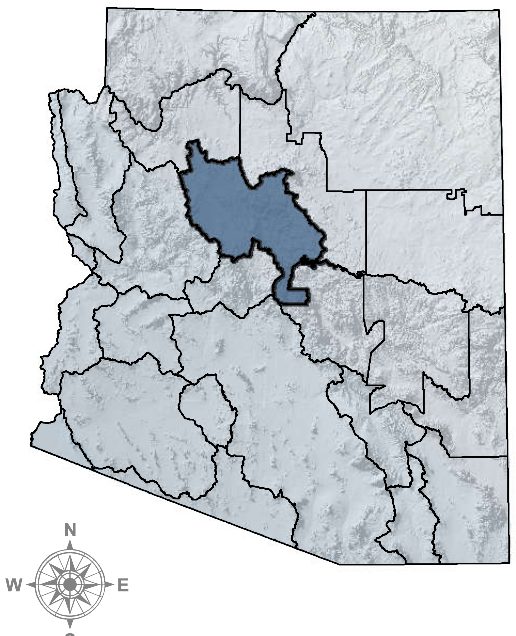
ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.19-1

Verde
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)

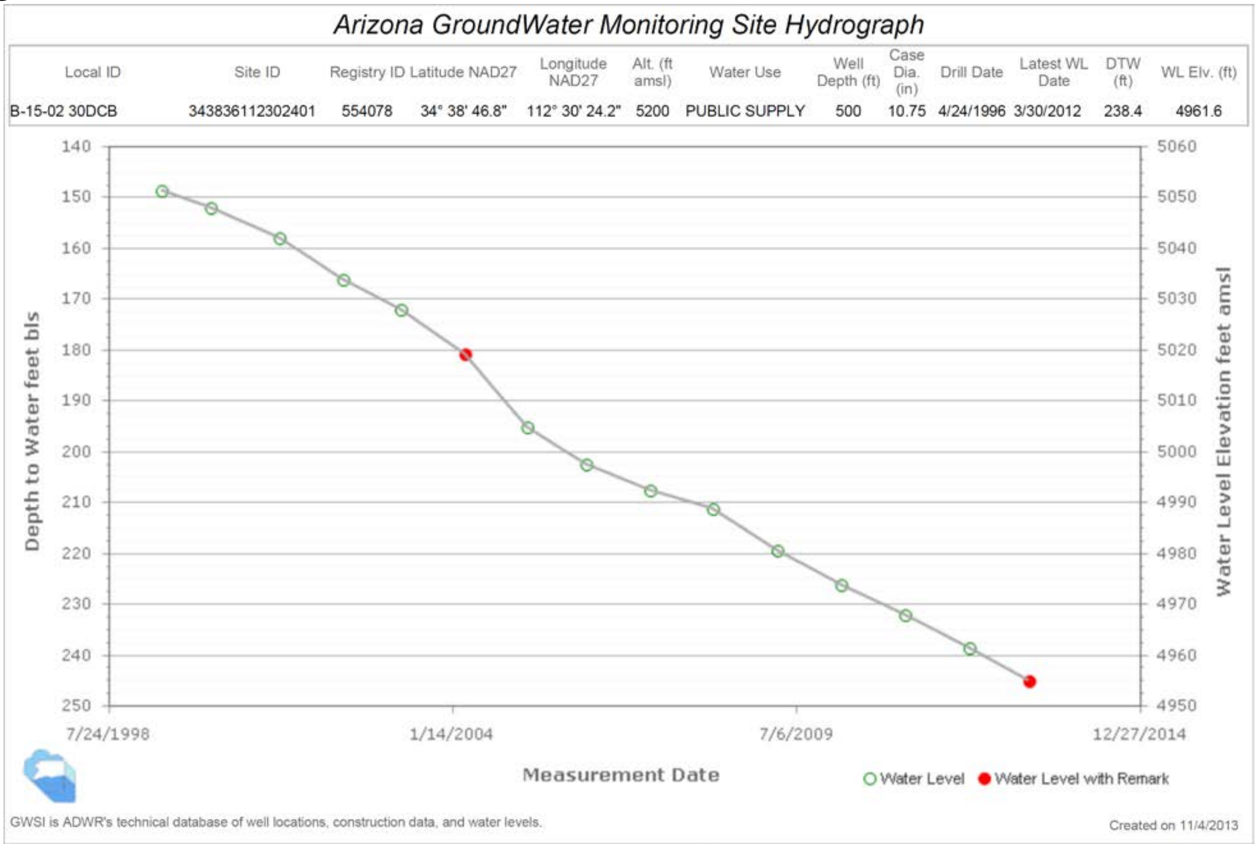
Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

* Data provided by ADWR

Figure P.A.19-2

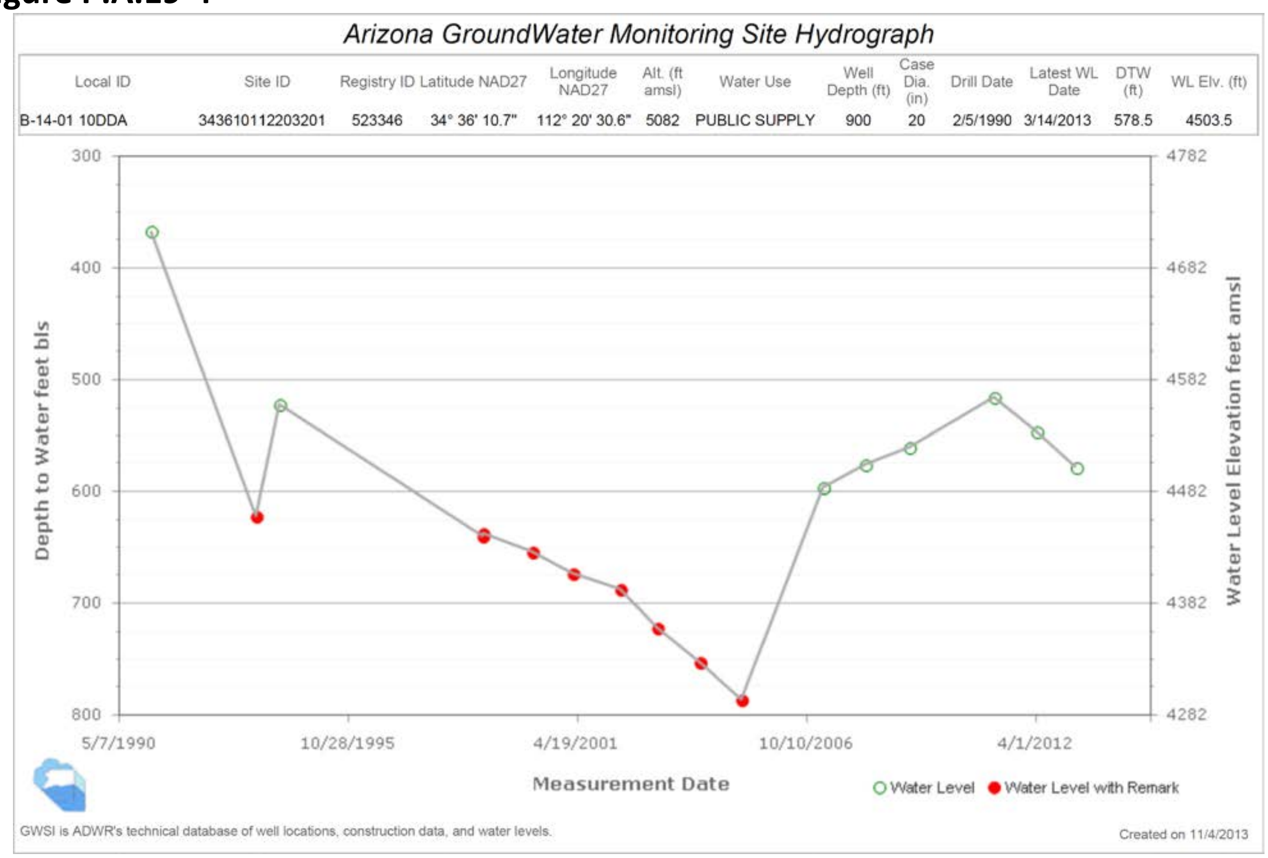
Verde Groundwater Hydrology

Figure P.A.19-3



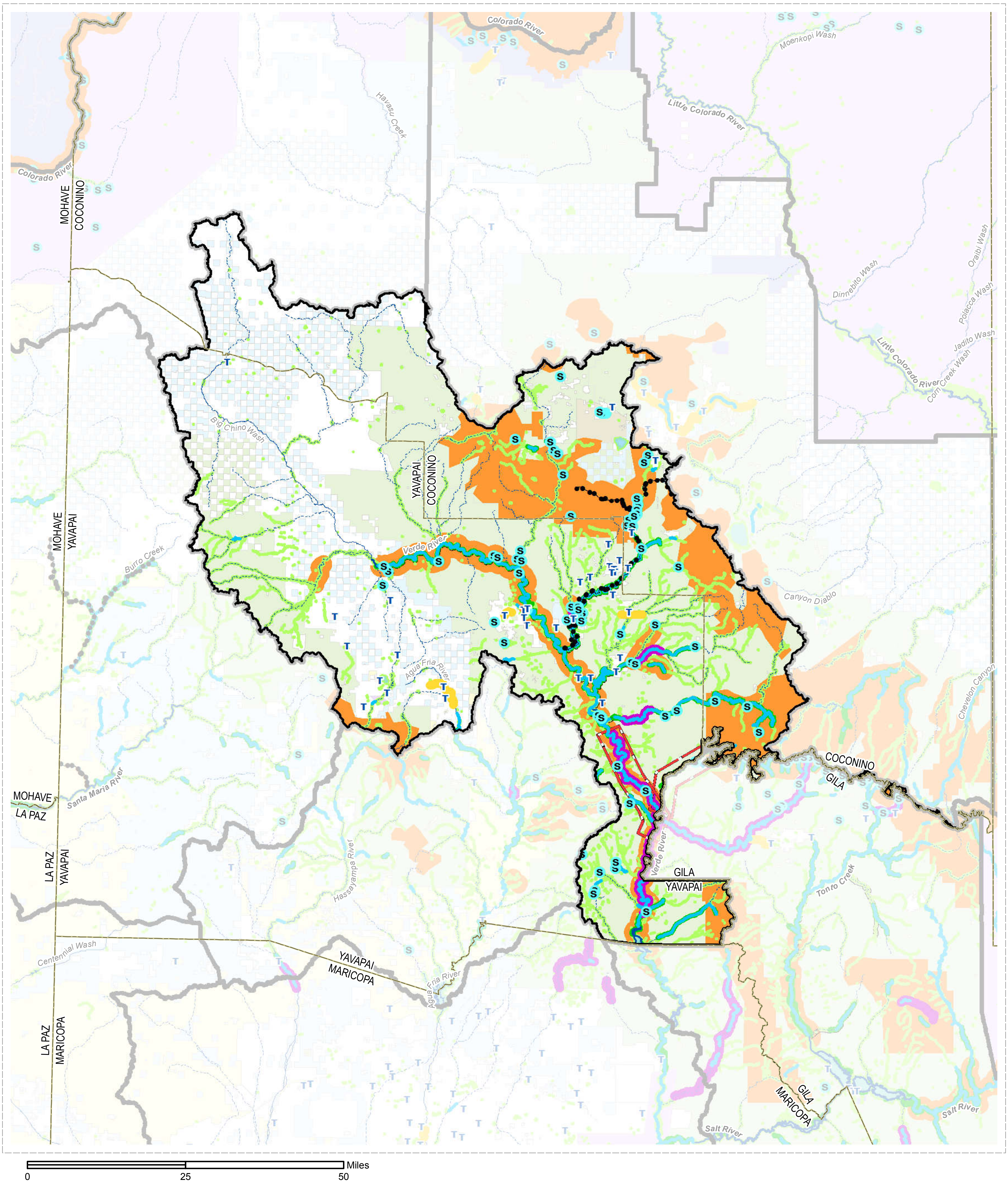
B-15-02 30DCB Prescott AMA – Little Chino sub-basin near Granite Mountain along Williamson Valley Road

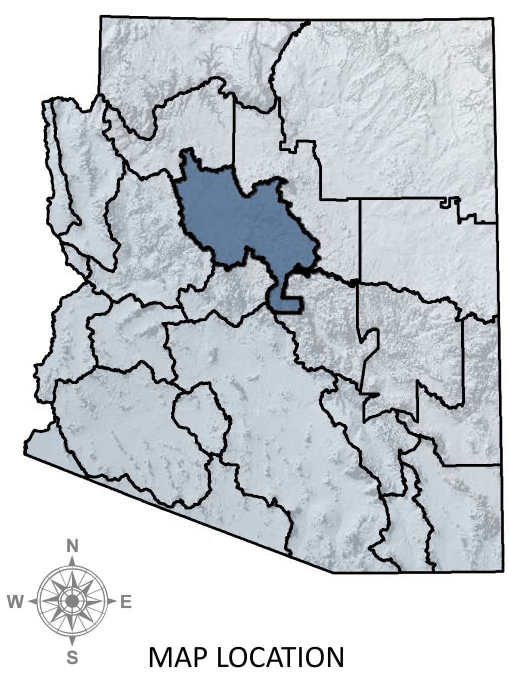
Figure P.A.19-4



B-14-01 10DDA Prescott AMA – Upper Agua Fria sub-basin Prescott Valley Santa Fe well field 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.





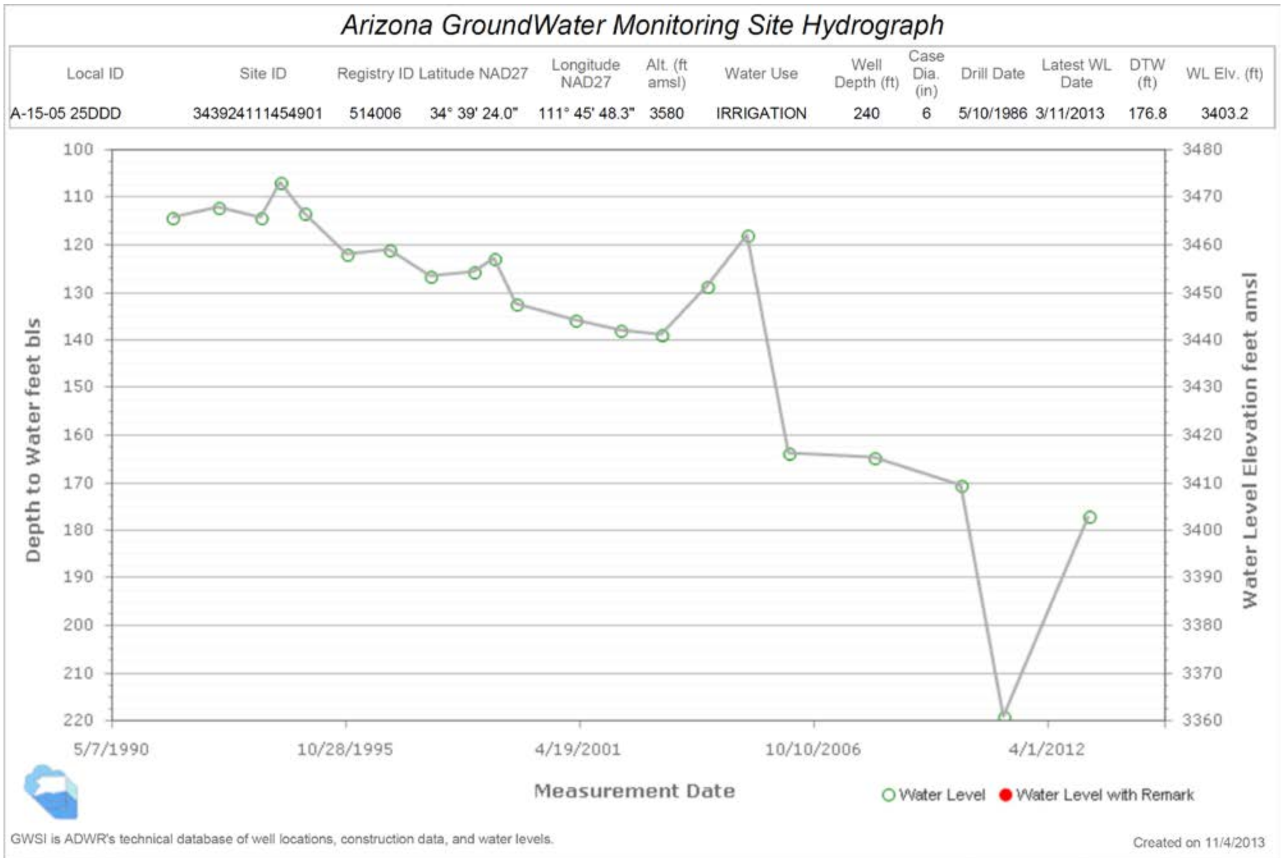
MAP LOCATION
(Planning Area Boundaries)

- 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

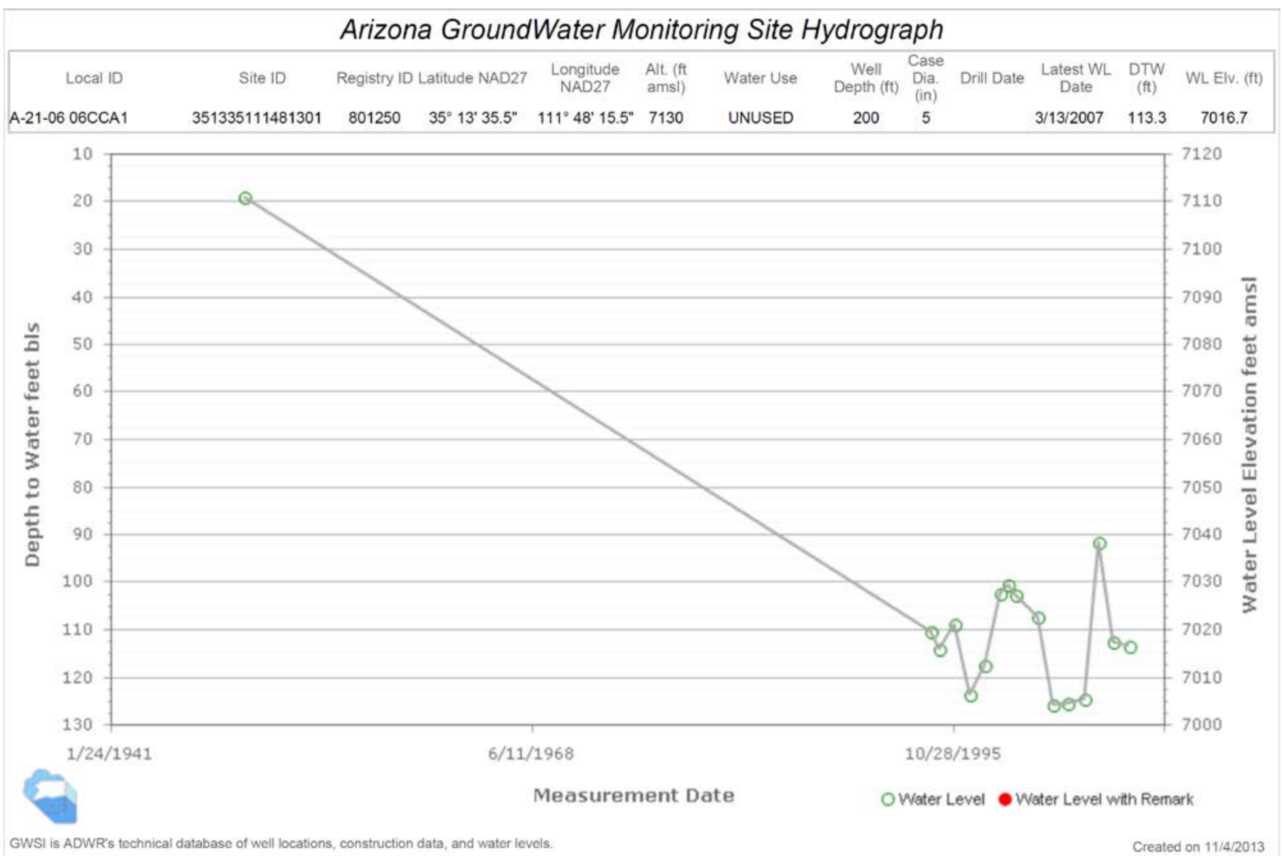
Figure P.A.19-5

Verde
Surface Water and Natural Features

Verde River Basin – Verde Planning Area



A-15-05 25DDD Verde River basin – Verde Valley sub-basin 2 miles NW of Rimrock.



A-21-06 06CCA1 Verde River basin – Verde Valley sub-basin Belmont – Camp Navajo area.

[WEST BASINS PLANNING AREA]

West Basins Planning Area

Background

The West Basins Planning Area is located in the central western portion of the State and is comprised of the Butler Valley, McMullen Valley, Ranegras Plain, Tiger Wash, and Harquahala Valley groundwater basins (the Harquahala Valley Groundwater Basin has been designated as an Irrigation Non-Expansion Area). The Planning Area is within portions of La Paz, Yuma, Yavapai, and Maricopa Counties. Communities within the Planning Area include Aguila in the northeast, Brenda in the southwest, and Vicksburg, Hope, Harcurvar, and Salome in the central portion of the Planning Area. The CAP Canal bisects the Planning Area, crossing from the northeast in the Ranegras Plain Basin and exiting in the western central portion of the Planning Area through the Harquahala Valley Basin.

The majority of the lands in this Planning Area is federally- owned and managed. The largest is the US Bureau of Land Management (BLM) for resources conservation, recreation and livestock grazing. Other federal lands are managed by the US Fish and Wildlife Service (FWS); and a small portion dedicated to the CAP right of way, owned by the US Bureau of Reclamation (*see Figure P.A. 20-1*). State Trust Lands are dominant in the Butler Valley and McMullen Valley basins. Only 10 percent of the lands across this Planning Area are in private ownership, the majority of which is in the Harquahala Valley Basin, primarily used for irrigated agriculture.

Water Supply Conditions

<u>Groundwater</u>

The West Basins 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, which may be suitable for artificial underground storage and recovery of renewable water supplies.

Groundwater in storage in the Butler Valley Basin is estimated to be 6.4 MAF. Groundwater levels are declining at approximately 1-foot per year (*see Figure P.A. 20-2*). The groundwater in storage estimate for the McMullen Valley Basin is 15 MAF. Groundwater levels are declining by approximately 0.3 feet per year in the McMullen Valley Basin. Estimated groundwater in storage for the Ranegras Plain Basin is 9.0 MAF, with groundwater levels declining by approximately 0.9 feet per year in response to groundwater pumping. Groundwater in storage in the Tiger Wash Basin is estimated to be 7 MAF, with groundwater levels rising by approximately 0.3 feet per year. Groundwater in storage in the Harquahala Valley Basin is estimated to be 15.5 MAF, with groundwater levels rising by approximately 1.4 feet per year, largely attributable to CAP use and local recharge. Land subsidence has been documented in the McMullen Valley, Renegras Plain and Harquahala basins.

<u>Surface Water</u>

There are no perennial streams within the planning area (*see Figure P.A. 20-3*). There is one reach of intermittent stream on Browns Canyon Wash in the far northwest corner of the Tiger Wash Basin. CAP water is used within the Harquahala Valley basin primarily for agricultural and

industrial uses and is being artificially recharged into the local aquifer for future recovery. The anticipated beneficiaries of this storage are water users outside of the Planning Area.

Reclaimed Water

There are no large population centers and the absence of concentrated development within the Planning Area limits the existence of centralized wastewater collection and treatment works and, likewise, limits the availability of reclaimed water for reuse. Most domestic water users rely upon septic systems for wastewater treatment and disposal. One known waste water treatment plant exists within the McMullen Valley Basin although the volume and use of the reclaimed water is unknown.

Ecological Resources

The West Basins Planning Area includes significant portions of the Rawhide Mountain, Harcuvar Mountains, Harquahala Mountains, New Water Mountains, and Eagle Tail Mountains Wilderness areas and a portion of the Kofa National Wildlife Refuge (*see Figure P.A. 20-3*).

Water Demands

Table P.A. 20-1 below presents the baseline projected water demands for the West Basins Planning Area. Agricultural irrigation is the majority of the water use in the Planning Area, primarily dependent on groundwater except for agricultural uses in the Harquahala Basin, which uses a combination of CAP water and groundwater. Agricultural demands are projected to remain steady through 2060 at 250,000 acre-feet per year, unless groundwater is transported out of the Harquahala Valley Basin (see below). Municipal demand is expected to increase from 1,016 acre-feet to a little over 2,000 acre-feet per year in 2060. Industrial demand, currently dominated by the Harquahala Generating Station, is expected to increase slightly from an average of 1,500 acre-feet per year to just over 2,000 acre-feet per year in 2060.

Characteristics Affecting Future Demands and Water Supply Availability

Water Management

The Harquahala Irrigation Non-Expansion Area (INA) was established under the 1980 Groundwater Management Act. Creation of the Harquahala INA, overlying only the Harquahala Valley Groundwater Basin, prohibits the addition of new agricultural acreage using groundwater within the INA after its establishment. Additionally, all groundwater withdrawn from wells in the INA with a pumping capacity of 35 gallons per minute or greater (designated as non-exempt wells) must meter and report their annual groundwater use to ADWR.

Groundwater Transportation

Throughout most of the State, groundwater transportation in Arizona is prohibited between basins *(A.R.S. §45-544)*. However, specific exemptions are included in the State law that allow groundwater be transported away from McMullen Valley, Butler Valley, and the Harquahala Valley basins into an initial Active Management Area (AMA). Specific and unique requirements must be met to comply with State law to effectuate transfers from each of these basins (*A.R.S. §45-552, §45-553, and §45-554)*.

Table P.A. 20-1. Projected Demands (in acre feet) – West Basins Planning Area

Sector	2010	2035	2060
Agriculture	250,000	250,000	250,000
Dairy	0	0	0
Feedlot	0	0	0
Municipal	1,016	1,607	2,009
Other Industrial	0	0	0
Mining	0		
High		0	0
Low		0	0
Power Plants	1,107		
High		1,147	2,065
Low		918	1,652
Rock Production	0		
High		124	154
Low		51	65
Turf	0		
High		0	0
Low		0	0
Total (High)	**252,123**	**252,878**	**254,228**
Total (Low)	**252,123**	**252,576**	**253,726**

Strategies for Meeting Future Water Demands

Comprehensive Analysis of Groundwater Transportation

While there are certainly issues related to the transportation of water, the legislature has stated its intent, and has created a statutory mechanism that facilitates transfers from the Harquahala Valley, the McMullen Valley, and the Butler Valley basins. While projected demands within the entire Planning Area are estimated to be as high as 254,000 acre-feet per year, the estimated range of groundwater in storage in the basins identified for transportation (Harquahala Valley, McMullen Valley and Butler Valley) could theoretically support withdrawals between approximately 290,000 and 621,000 acre-feet per over a 100-year period. It should be noted that this estimate is not a guarantee of available water supplies and may not occur in areas that can be accessed due to the significant land area under federal ownership. Additionally, it is unlikely that all of the groundwater in storage could be withdrawn from wells without undesirable consequences, including water quality degradation, land subsidence, and earth fissuring. Development of a comprehensive groundwater model would help to develop more accurate estimates of sustainable groundwater development from available lands.

The statutory exceptions for the three transportation basins, while unique to each basin, require an evaluation of impacts to local water users. The statutes also allow, and generally direct that the acquisition of these water supplies can occur on a piecemeal approach. While this allows for each landowner to decide if they want to participate in such a program, changing conditions over time will increase the complexity of the required impact analysis, increasing costs and reducing regulatory certainty for applicants seeking these water supplies and their investors.

Either a change in statute or policies that allow for a comprehensive approach (within a specific basin) for analysis and/or acquisition, using basin-wide groundwater modeling, will provide protections, not only to existing landowners in making voluntary decisions for the disposition of their lands, but also to investors looking for future water supplies. Without this, the availability of water supplies, and the ability of landowners to benefit from these actions, may be limited.

Reclaimed Water Reuse

The availability of and ability to use reclaimed water is limited by the dispersed population and reliance on septic systems. However, centralization of wastewater and underground storage of all available reclaimed water should be encouraged to enhance local aquifer supplies. Alternatively, reclaimed water could be developed and used in place of transported groundwater to meet the same objective.

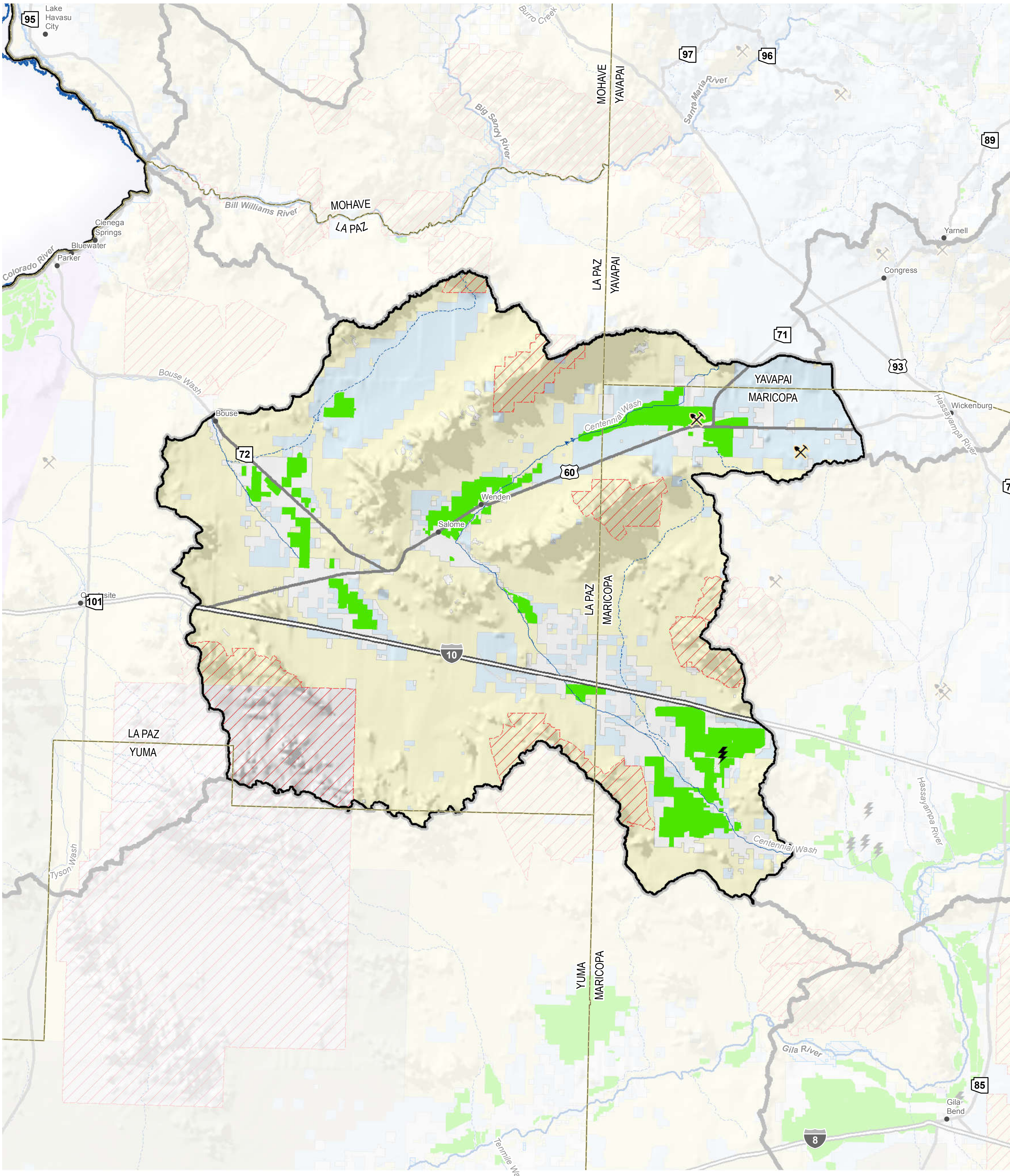
Recharge and Recovery of Excess Colorado River Water or Imported Water Supplies

The proximity of the CAP canal to certain portions of this Planning Area may provide opportunities for the temporary storage of excess Colorado River supplies (if and when they are available). This option should also be evaluated for water supplies that are developed from projects outside of Arizona for the benefit of water users who have CAP canal access, but for which there may not be an immediate use. This temporary storage and the transmission of water supplies through the CAP canal are contingent on available capacity and must be done in a manner that does not harm existing landowners or water users dependent on CAP supplies.

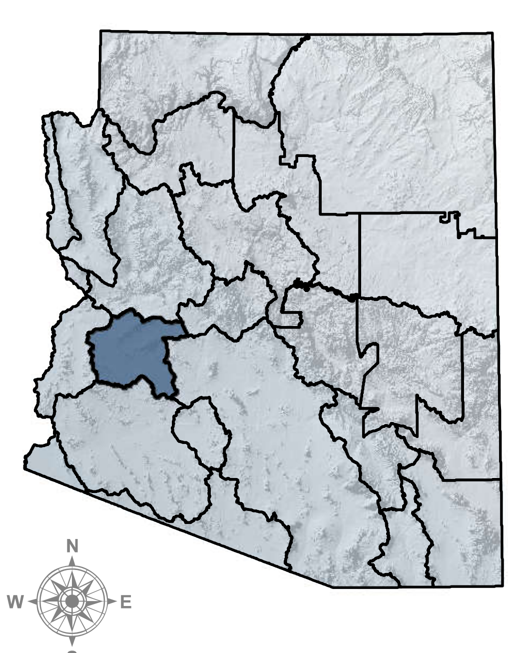
Meeting Future Demands

Because of the relatively small increases in projected demands and the availability of groundwater, it would appear that there are sufficient water supplies to meet projected demands. Vulnerability to drought conditions, potential transportation and declines in water levels will need to be monitored and addressed.

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.



0 10 20 Miles



MAP LOCATION
(Planning Area Boundaries)

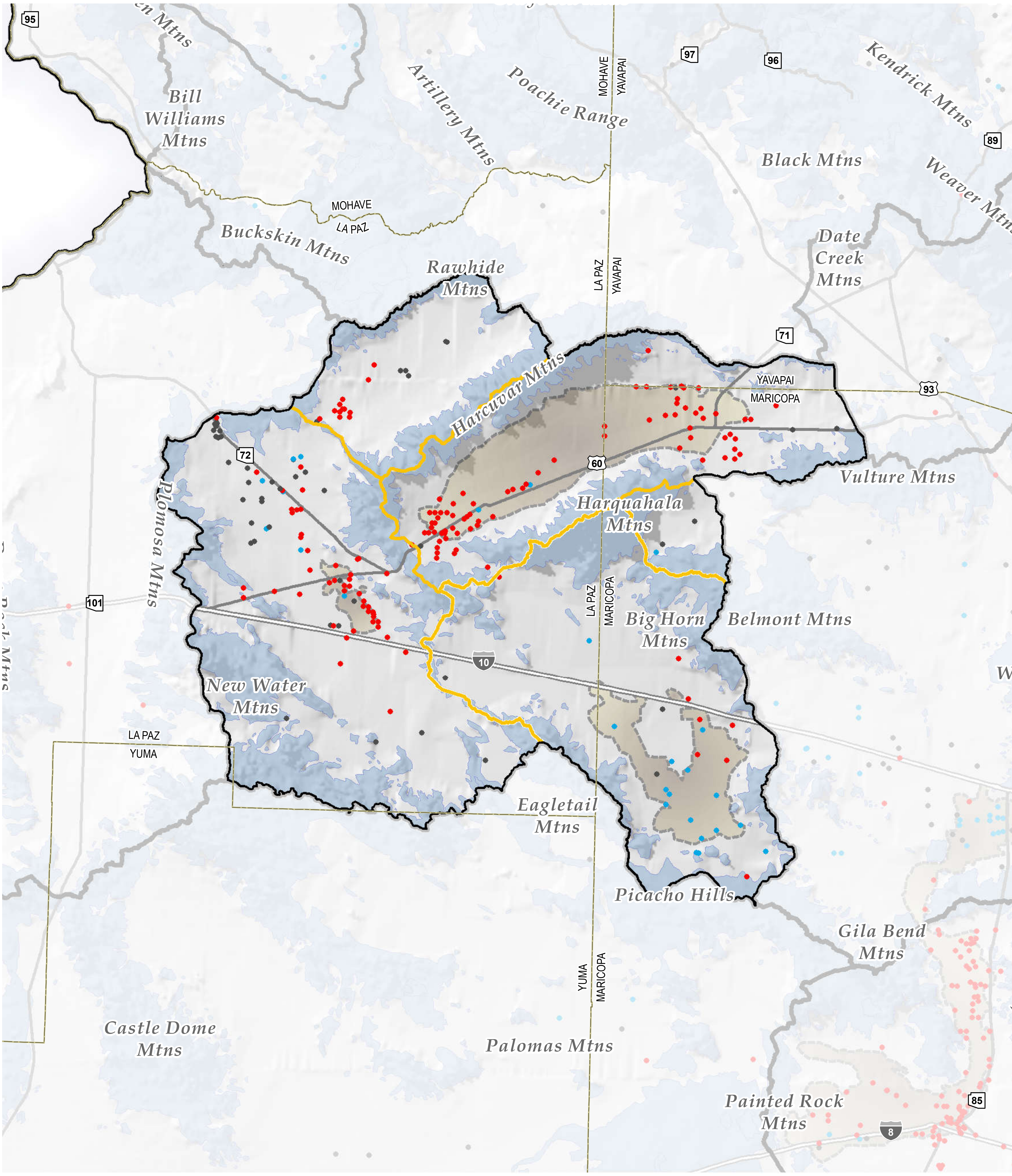
- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- River or Stream (ASLD)
- Interstate (ADOT)
- Population Center (GNIS)
- Mine (ADMMR, ADWR)
- Hydroelectric Power Plant (ADEQ, ADWR)
- Thermoelectric Power Plant (ADEQ, ADWR)
- Agriculture (SWReGAP, 2004)
- Federal Conservation Land (USFS, BLM,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

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

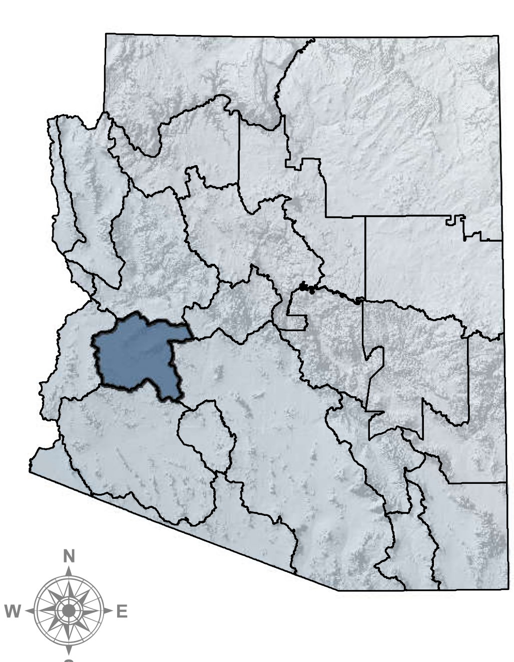
Figure P.A.20-1

West Basins 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.



0 10 20 Miles



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)

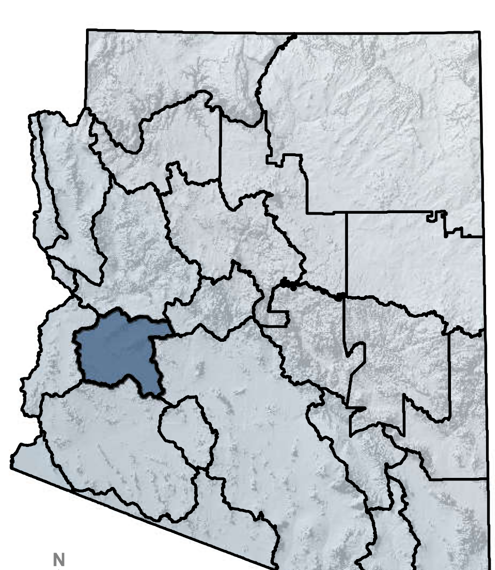
Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

* Data provided by ADWR

Figure P.A.20-2

West Basins 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.



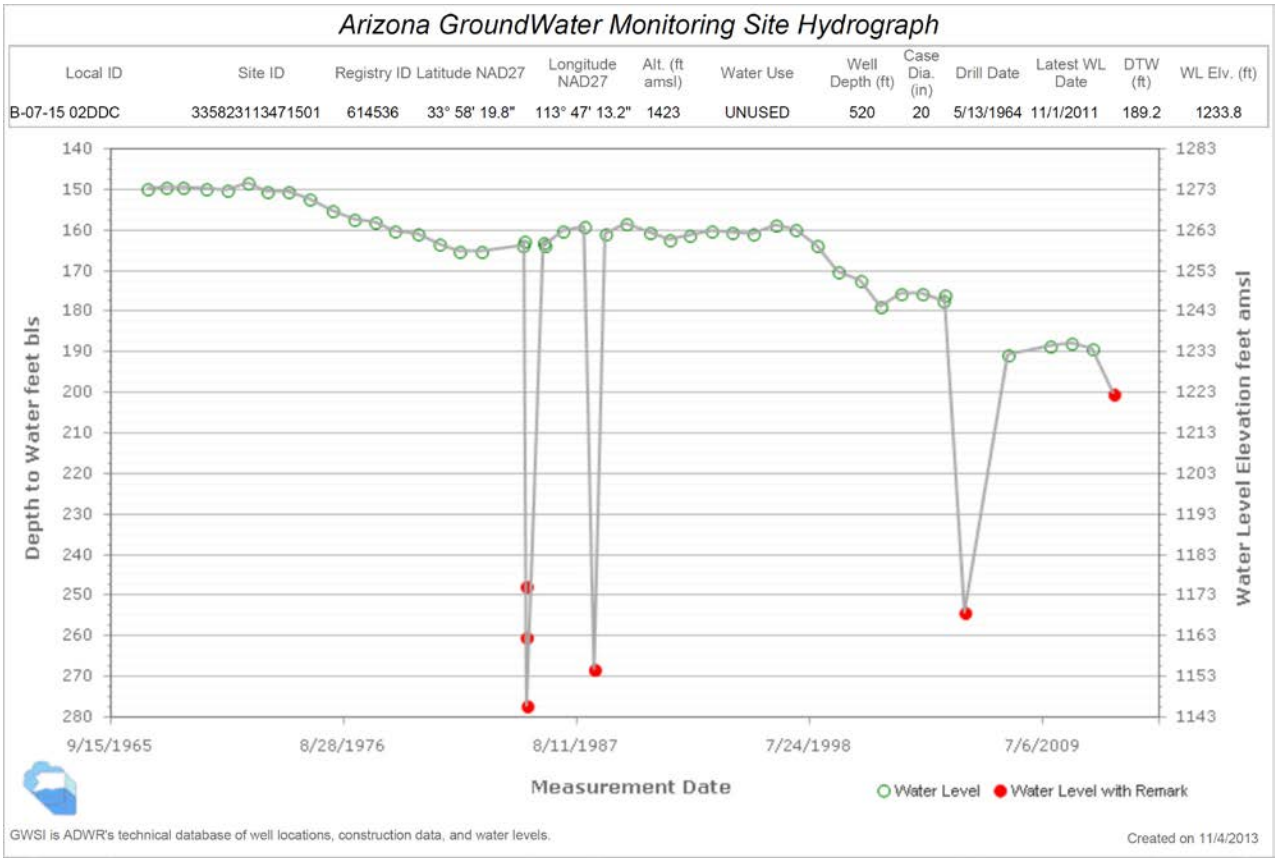
Planning Area (ADWR)
State (ALRIS)
County (ALRIS)
Reservoir or Lake (NHD)
Waste Water Treatment Plant (ADEQ)
Major Spring (ADWR, Pima County)
Perennial Flow (ADEQ, USGS)
River or Stream (ASLD)
Outstanding Arizona Water (ADEQ)
Effluent Dependent Stream (ADWR, NEMO)
Instream Flow Certificate (ADWR)
1993 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

MAP LOCATION
(Planning Area Boundaries)

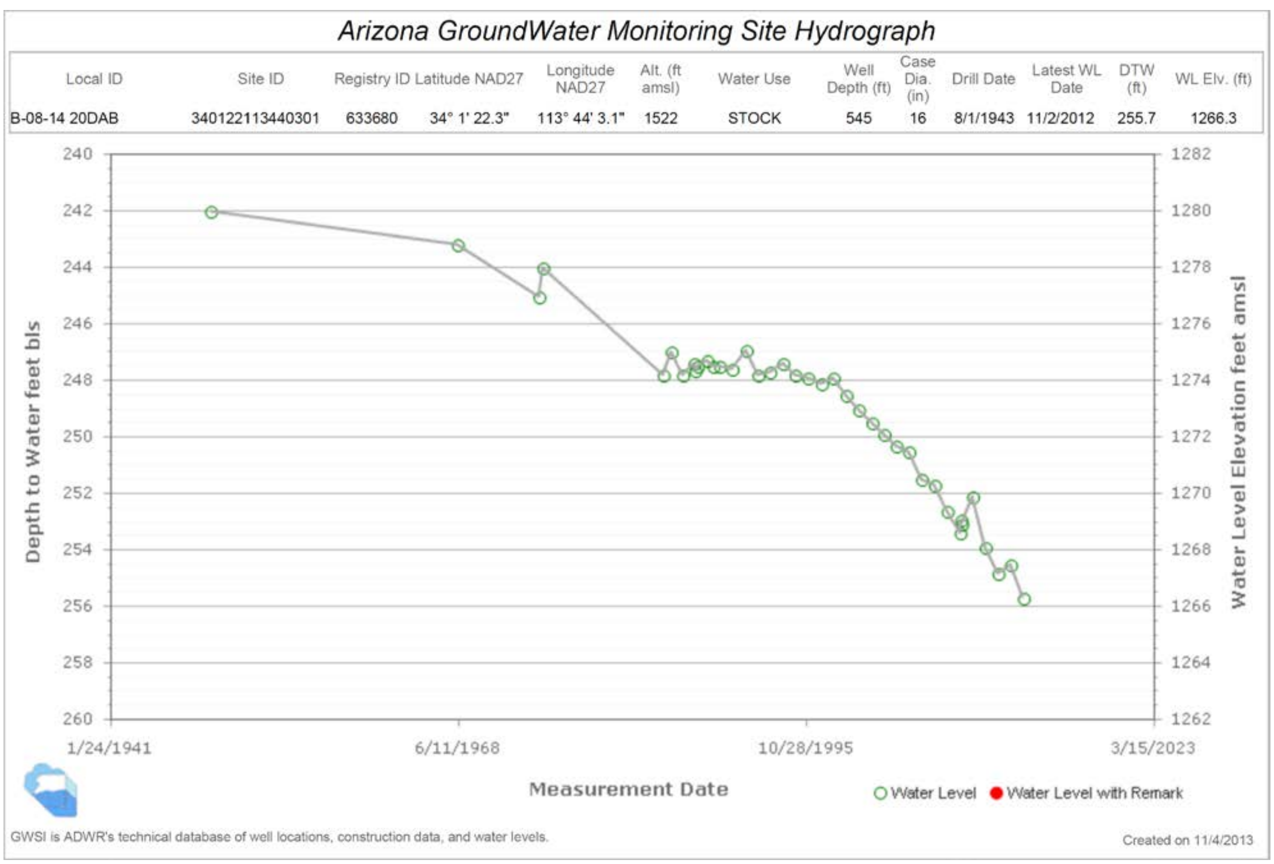
Figure P.A.20-3

West Basins
Surface Water and Natural Features

Butler Valley Basin – West Basins Planning Area

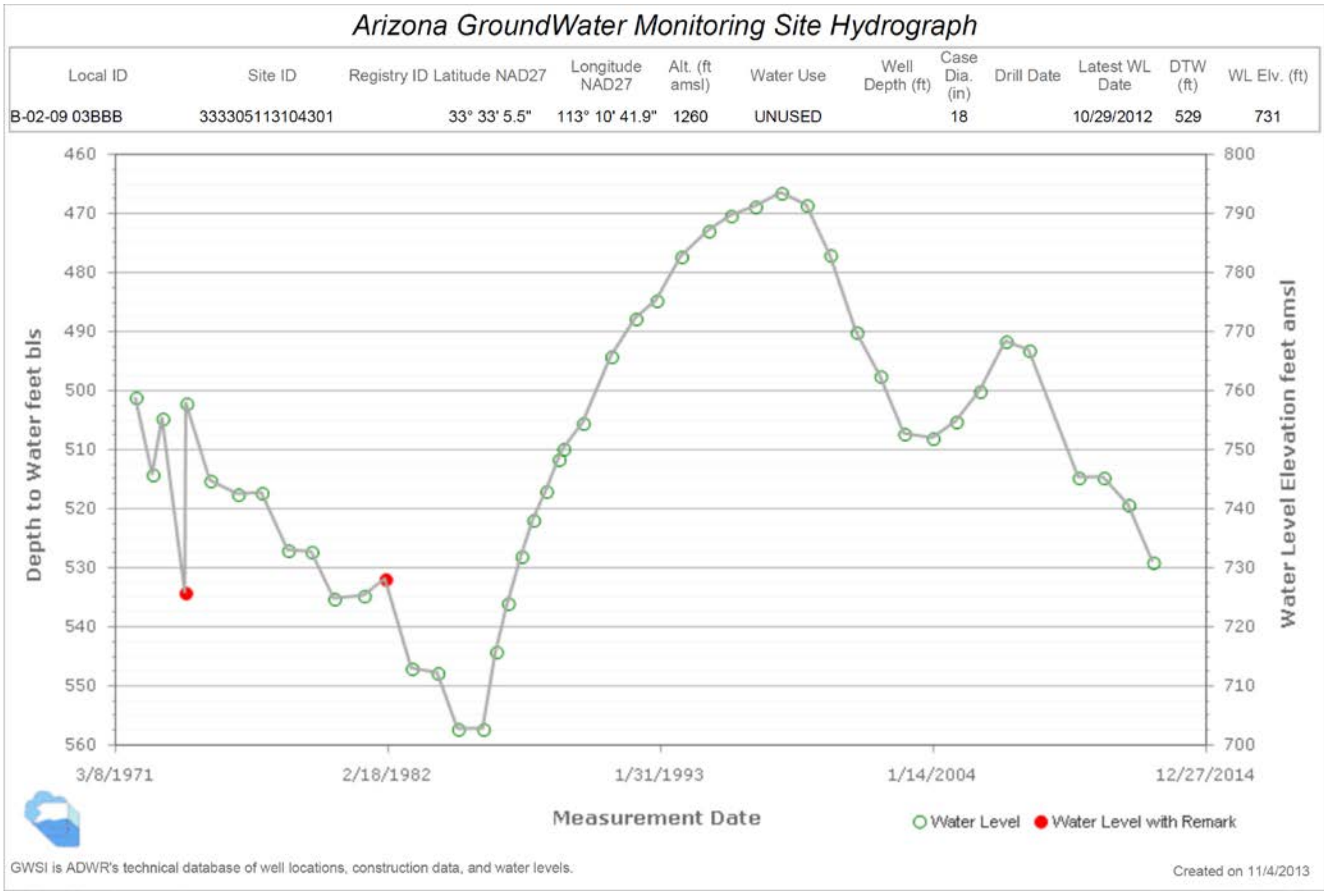


B-07-15 02DDC -- Butler Valley basin SW agricultural area of valley.



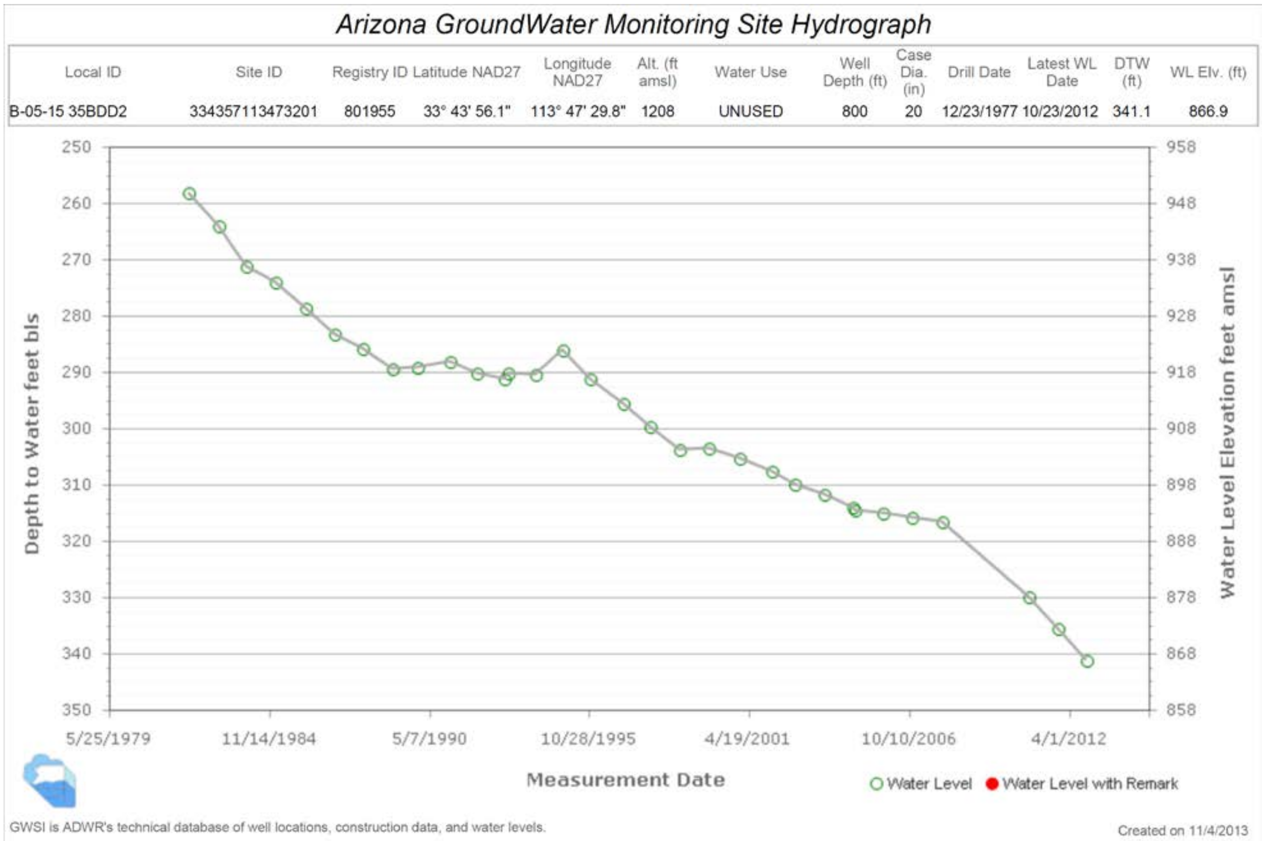
B-08-14 20DAB – Butler Valley basin central Butler Valley.

Harquahala INA – West Basins Planning Area

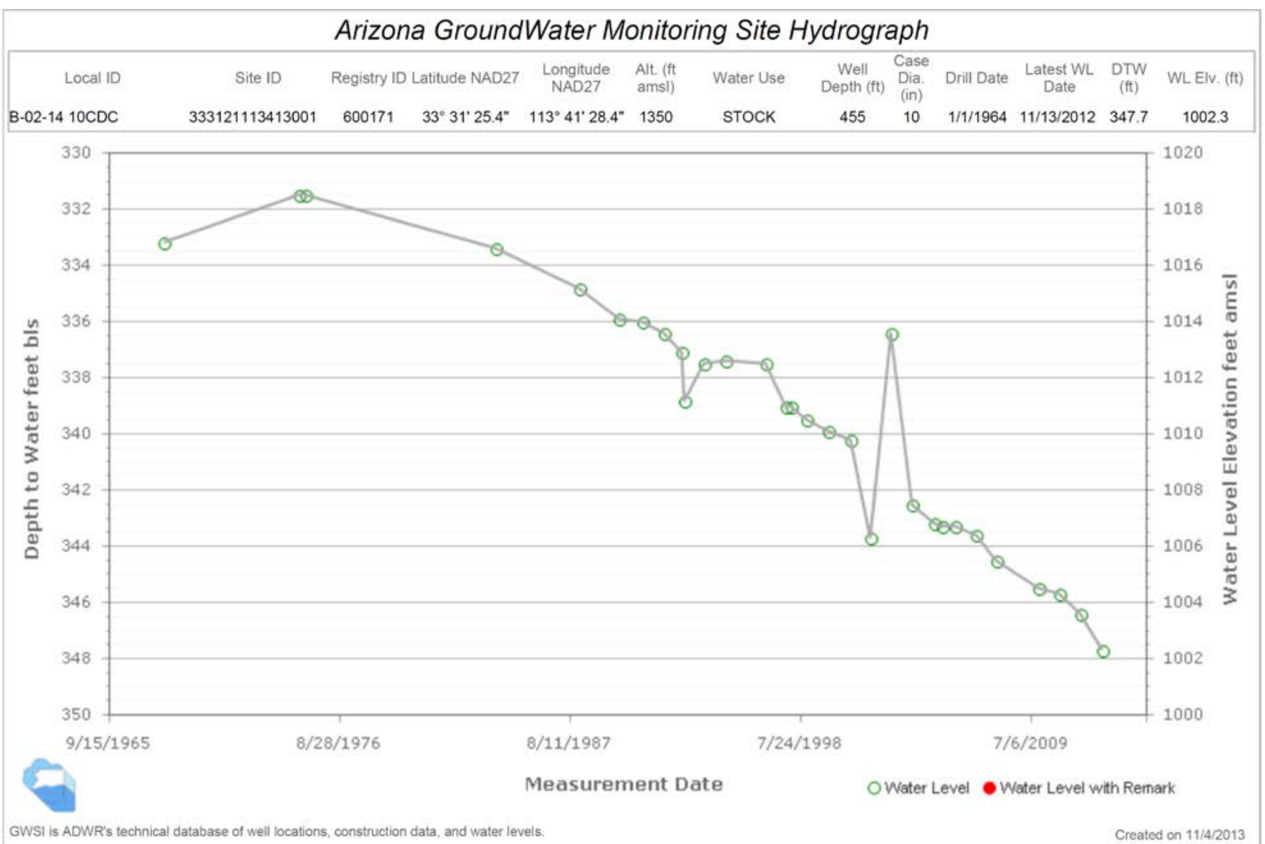


B-02-09 03BBB Harquahala INA about 10 miles east of Centennial.

Ranegras Plain Basin – West Basins Planning Area



B-05-15 35BDD2 – Ranegras Plain basin about 5 miles west of Vicksberg.

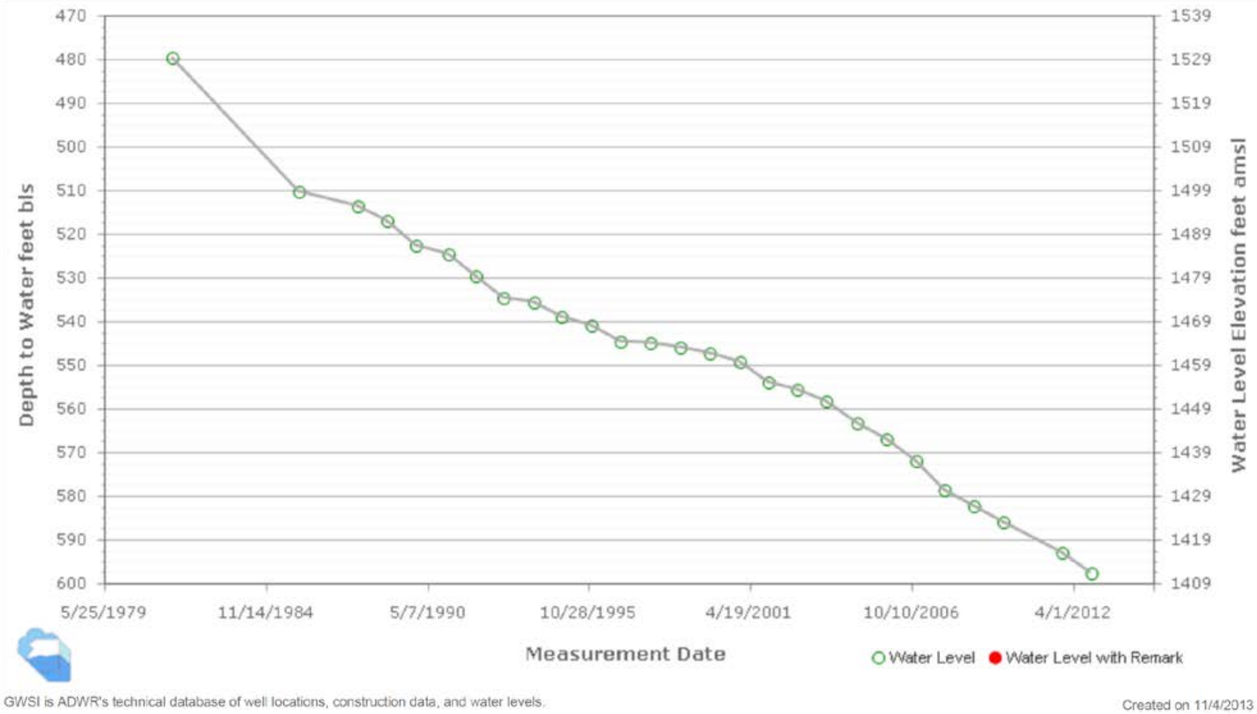


B-02-14 10CDC – Ranegras Plain basin south-central area.

McMullen Valley Basin – West Basins Planning Area

Arizona GroundWater Monitoring Site Hydrograph

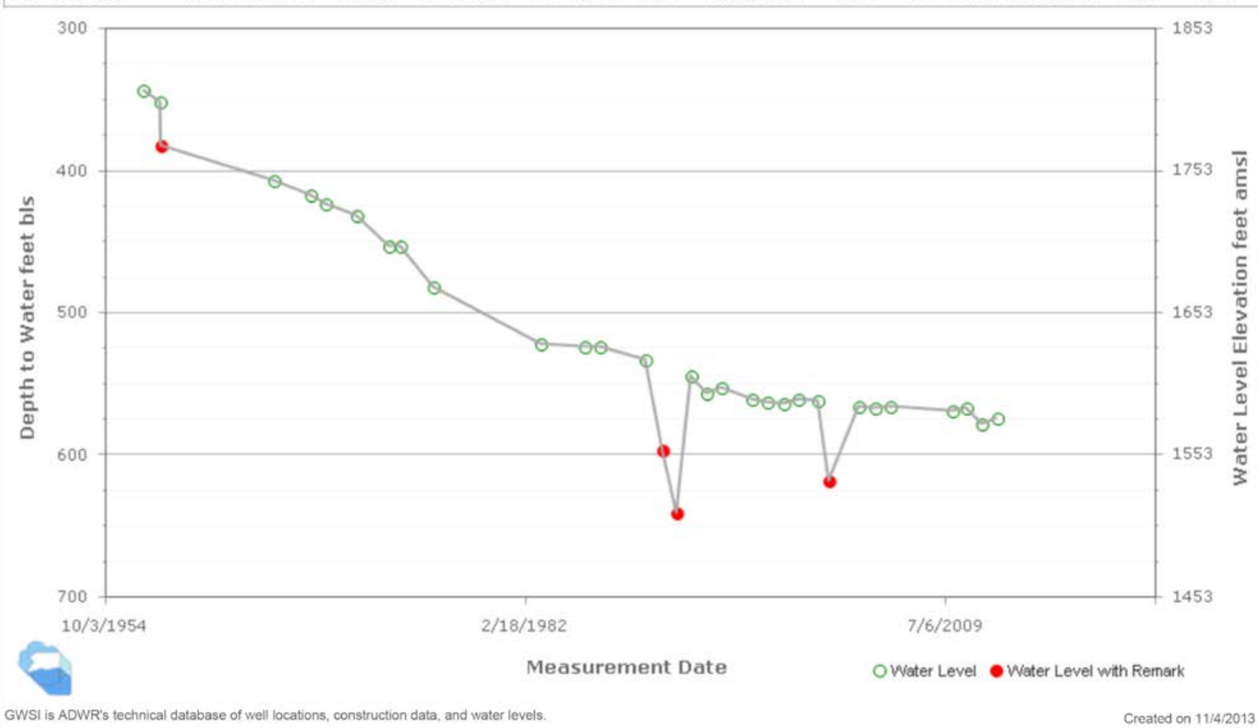
Local ID	Site ID	Registry ID	Latitude NAD27	Longitude NAD27	Alt. (ft amsl)	Water Use	Well Depth (ft)	Case Dia. (in)	Drill Date	Latest WL Date	DTW (ft)	WL Elv. (ft)
B-06-13 28DBD2	334955113365201	634103	33° 49' 55.1"	113° 36' 52.8"	2009	UNUSED	580	8	6/24/1980	10/30/2012	597.5	1411.5



B-06-13 28DBD2 – McMullen Valley basin about 4 miles west of Wenden.

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)
B-07-09 15CDD	335635113110601	604129	33° 56' 35.4"	113° 11' 5.8"	2153	IRRIGATION	1430	20	2/21/1957	11/6/2012	573.9	1579.1



B-07-09 15CDD – McMullen Valley basin NE McMullen Valley.

[WEST BORDERLANDS PLANNING AREA]

West Borderlands Planning Area

Background

The West Borderlands Planning Area is in the southernmost portion of the state along the Mexican border between the Tucson AMA and the Yuma area. The Planning Area consists of two groundwater basins, the San Simon Wash Basin in the east and the Western Mexican Drainage Basin in the west. The Planning Area lies within Pima County to the east and Yuma County to the west. Communities within the Planning Area include Sells, Pisinemo and Lukeville.

In the San Simon Wash Basin, 99 percent of the land is within the Tohono O'odham Indian Reservation (*see Figure P.A. 21-1*). Less than one percent is split between private, US Bureau of Land Management (BLM), State Trust Lands, and the National Park Service (NPS). Within the Western Mexican Drainage Basin 61 percent of the land is managed by the US Fish and Wildlife Service (FWS) as the Cabeza Prieta National Wildlife Refuge. The NPS manages 36 percent as the Organ Pipe National Monument. Approximately two percent of the land is within the Barry M. Goldwater Air Force Range. Less than one percent is split between the Tohono O'odham Indian Reservation, Stat Trust Lands, and private lands. All of the private land in the Western Mexican Drainage Basin is in and around Lukeville at the US/Mexico border crossing.

Water Supply Conditions

<u>Groundwater</u>

The West Borderlands Planning Area lies within 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.

Groundwater conditions in the Planning Area are variable. Groundwater is storage in the San Simon Wash Basin is estimated to be 6.7 MAF. Groundwater levels in the San Simon Wash Basin are generally rising at an average of 0.3 feet per year (*see Figure P.A. 21-2*). Groundwater in the Basin is primarily used for irrigation followed by municipal uses. Groundwater irrigation is concentrated in the Papago Farms area South of Pisinemo. Groundwater in storage in the Western Mexican Drainage Basin is estimated to be 4.1 MAF. Groundwater levels in the Basin are generally declining at an average rate of 0.8 feet per year. The majority of the groundwater use in the Basin is for domestic and municipal use.

<u>Surface Water</u>

There are no perennial or intermittent streams within the Planning Area (*see Figure P.A. 21-3*). The major drainage in the Planning Area is San Simon Wash which runs north to south through the central portion of the San Simon Wash Basin. The Tohono O'odham Indian Tribe operates a reservoir, Lake Menegers. With a maximum storage of 15,000 acre-feet the reservoir is used primarily to store water for irrigation.

<u>Reclaimed Water</u>

The communities in the Planning Area are small and widely scattered. As such, reclaimed water generation and water reuse is limited. There are two wastewater treatment plants in the San Simon

Wash Basin. The total reclaimed water production is less than 500 acre-feet per year. Disposal is through evaporation ponds. There is no known water reuse within the San Simon Wash Basin. There are no known waste water treatment facilities within the Western Mexican Drainage Basin and no known water reuse.

Water Demands

Table P.A. 21-1 illustrates the baseline and projected increase in water demands in the West Borderlands Planning Area. The majority of the growth is expected on tribal lands for municipal uses, but is anticipated to be limited.

Table P.A. 21-1. Projected Water Demands (in acre feet) – West Borderlands Planning Area

Sector	2010	2035	2060
Agriculture	500	500	500
Dairy	0	0	0
Feedlot	0	0	0
Municipal	1,024	1,495	1,881
Other Industrial	0	0	0
Mining	0		
High		0	0
Low		0	0
Power Plants	0		
High		0	0
Low		0	0
Rock Production	0		
High		127	161
Low		53	67
Turf	0		
High		0	0
Low		0	0
Total (High)	**1,524**	**2,122**	**2,542**
Total (Low)	**1,524**	**2,048**	**2,448**

Characteristics Affecting Projected Water Demands and Supply Availability

<u>Land Ownership</u>

Because the majority of the lands in this Planning Area are either Indian reservation or National Wildlife Refuge and National Monument, growth potential is very limited. Plans for future development on tribal areas are unknown.

Strategies for Meeting Future Water Demand

Groundwater supplies are expected to be available to meet the projected growth in this area.

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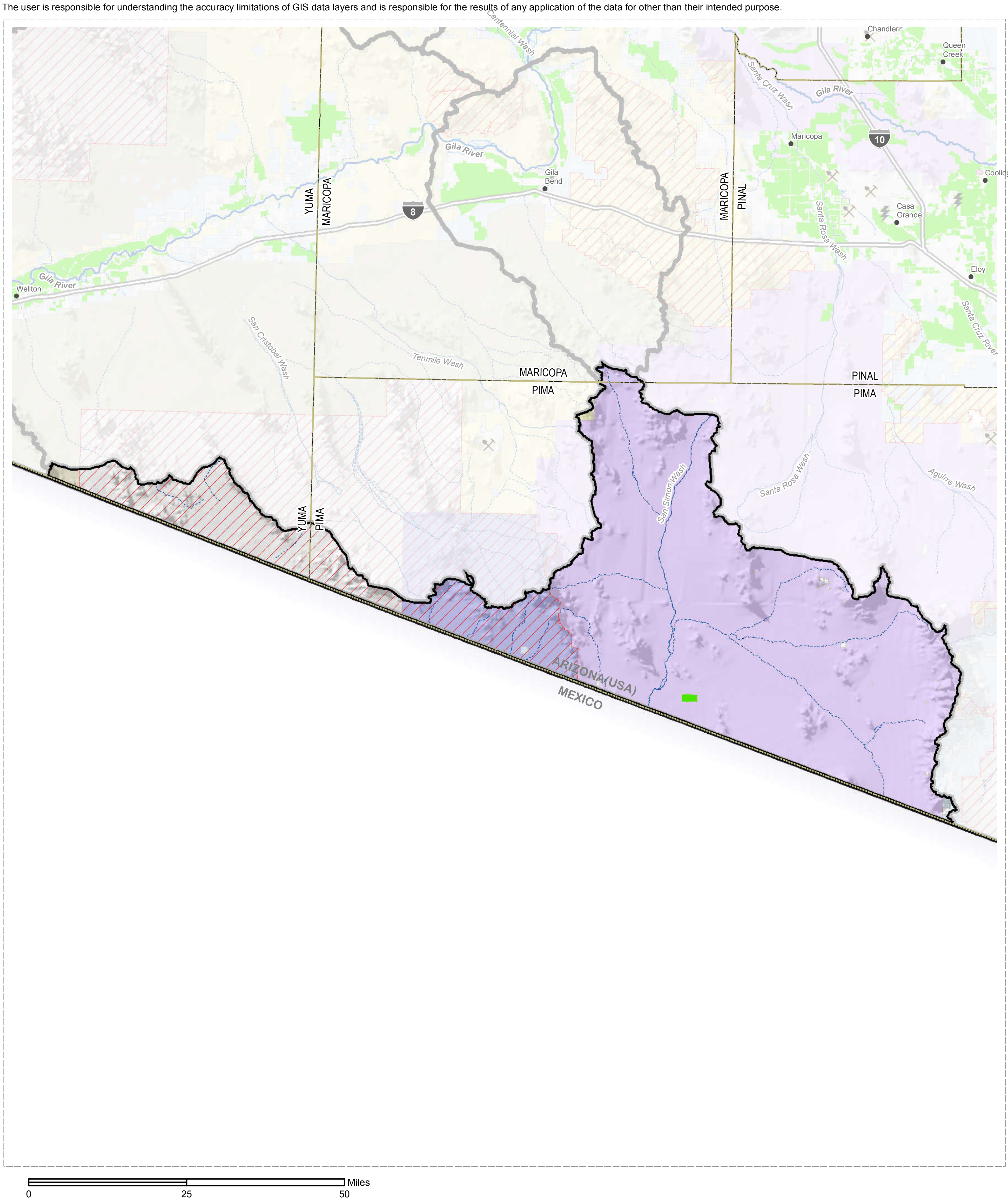

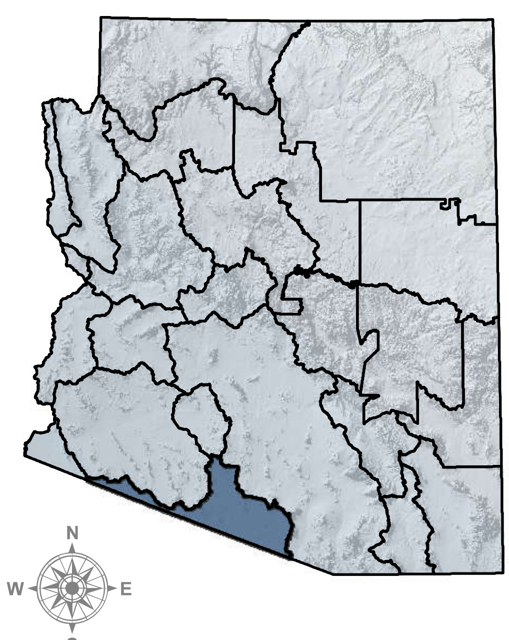

MAP LOCATION
(Planning Area Boundaries)

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.21-1

West Borderlands Land Ownership

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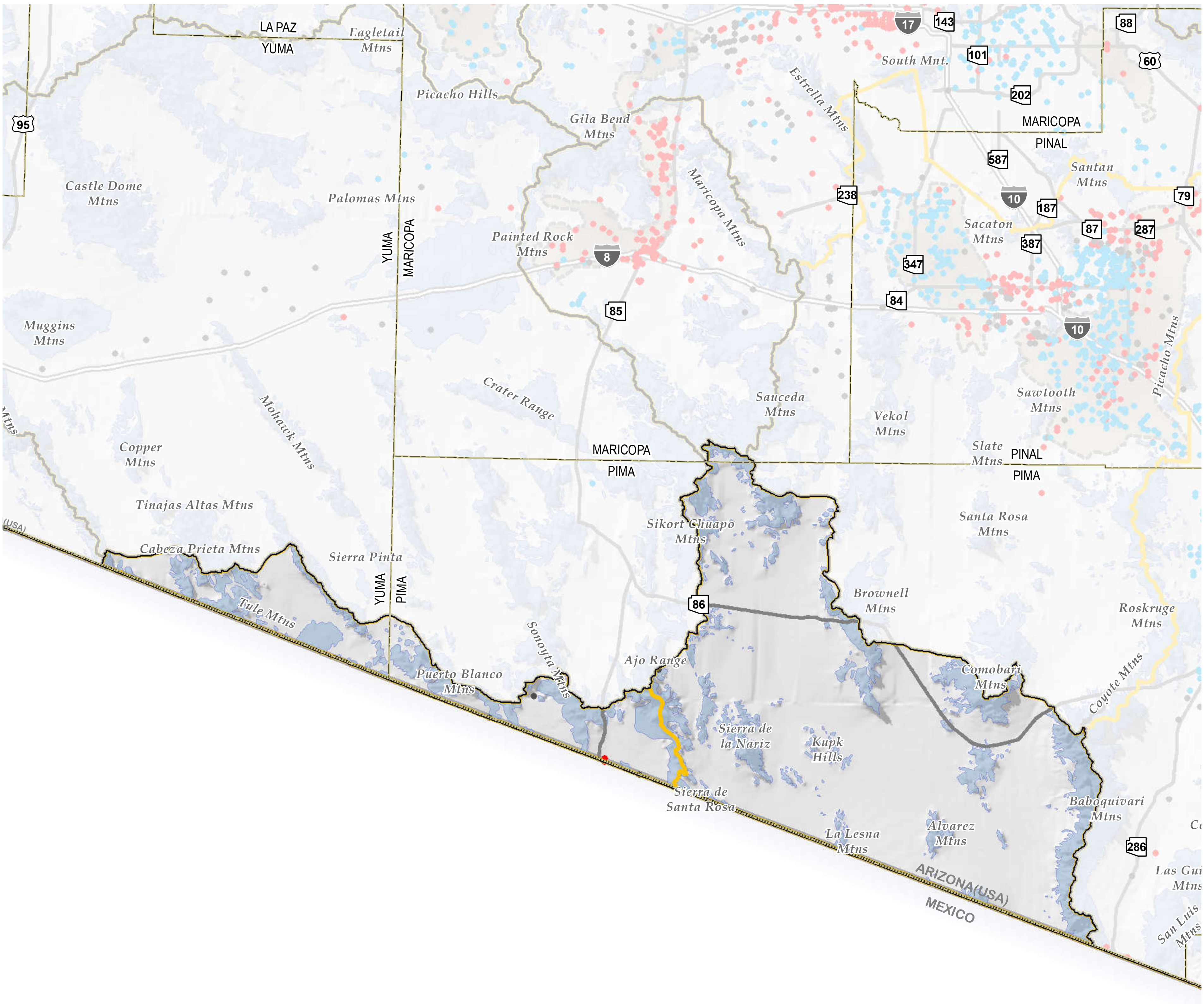
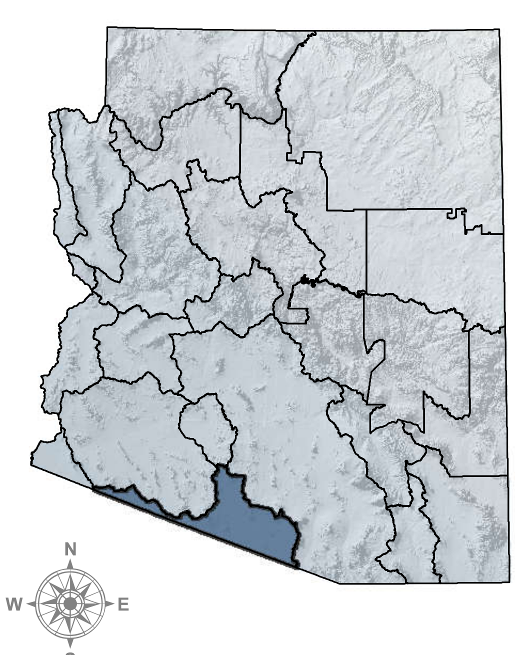




MAP LOCATION
(Planning Area Boundaries)

- 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)

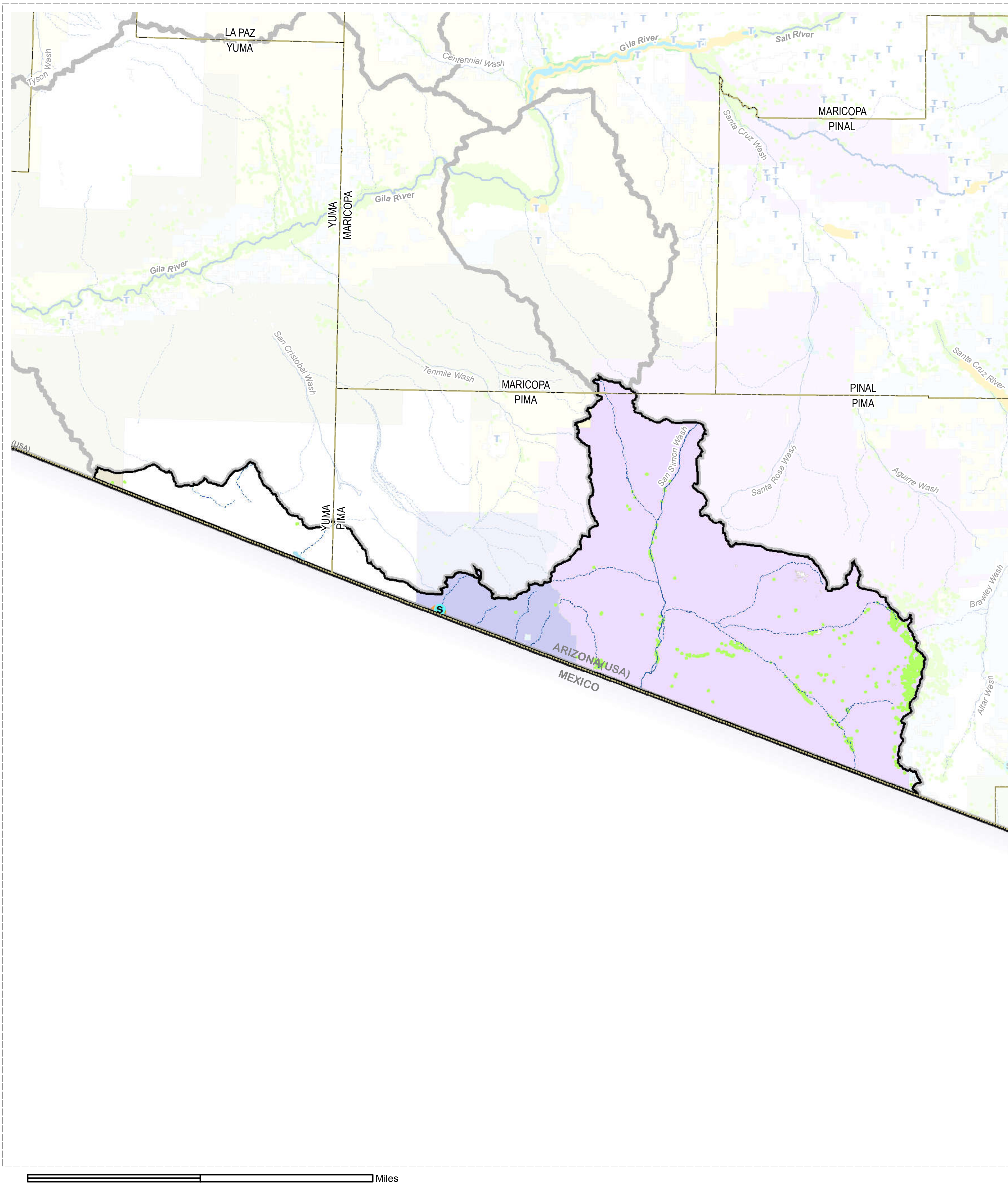
Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

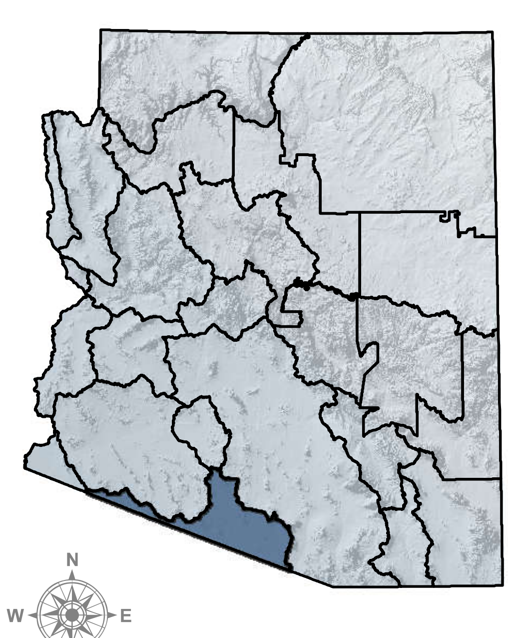
* Data provided by ADWR

Figure P.A.21-2

West Borderlands 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)

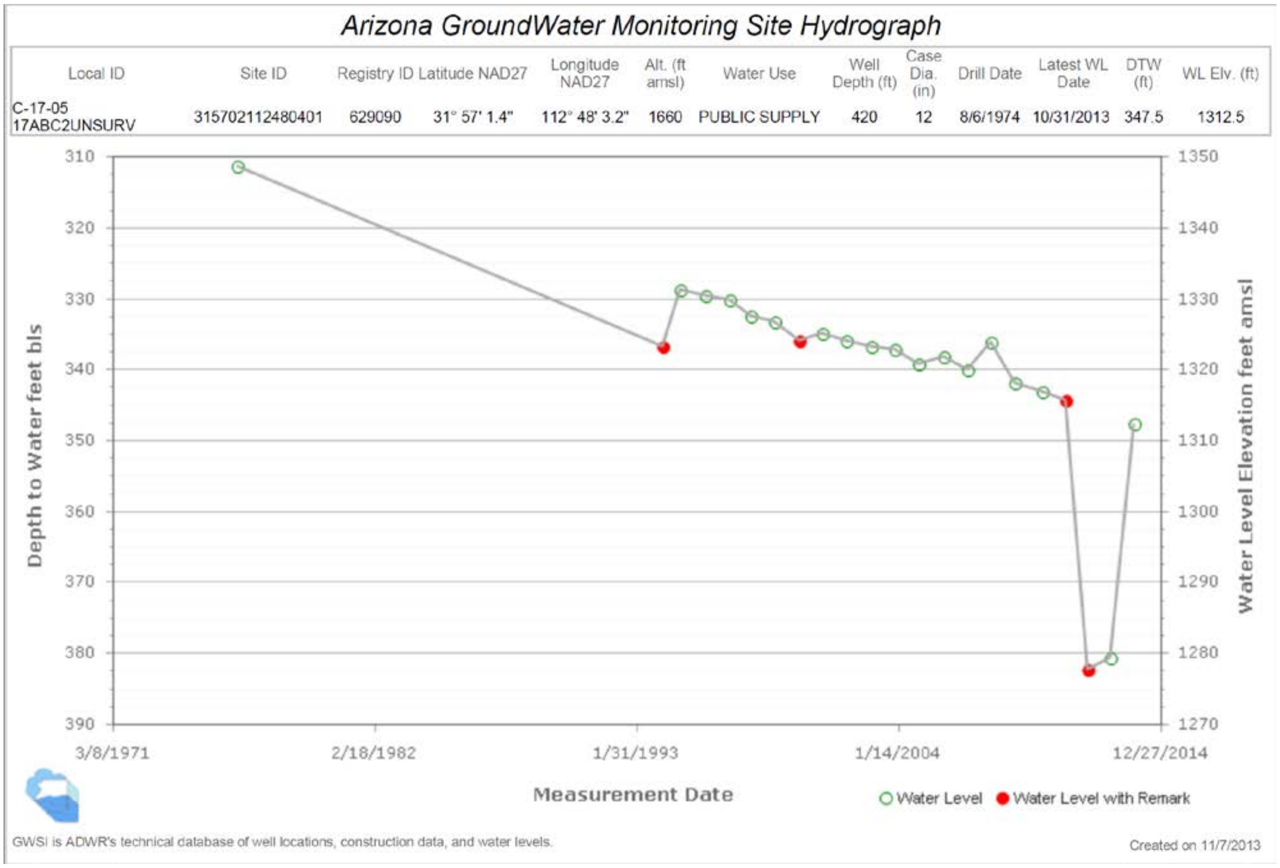
- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- Reservoir or Lake (NHD)
- Waste Water Treatment Plant (ADEQ)
- Major Spring (ADWR, Pima County)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ASLD)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- Instream Flow 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

ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.21-3

West Borderlands
Surface Water and Natural Features

Western Mexican Drainage-West Borderlands Planning Area



Western Mexican Drainage basin about 4 miles north of Lukeville. Monument Headquarters

[WESTERN PLATEAU PLANNING AREA]

Western Plateau Planning Area

Background

The Western Plateau Planning Area is located in the northwest portion of the State and is comprised of the Peach Springs Groundwater Basin in the west and portions of the Coconino Plateau Groundwater Basin in the east. The majority of the Planning Area lies within Coconino County, with portions of Yavapai County in the south and Mohave County in the west. Communities in the Planning Area include Grand Canyon West, Peach Springs, Truxton, Frazier Wells, and Audley in the Peach Springs Basin. The communities of Supai Village and Rose Well are in the Coconino Plateau Basin portion of the Planning Area.

A large portion (45 percent) of the land in this Planning Area is federally reserved for tribal communities concentrated in the northern boundary of the Planning Area along the Grand Canyon and Colorado River (*see Figure P.A. 22-1*). The largest reservation is the Hualapai Reservation, straddling the Peach Springs and Coconino Plateau basins. The Havasupai Reservation is in the Coconino Plateau Basin. Federal agencies including the National Park Service (NPS) and US Bureau of Land Management (BLM) own five percent each of the land in the Planning Area, which includes portions of the Grand Canyon National Park. Less than five percent is managed by the USDA Forest Service (Forest Service), the Kaibab National Forest, in the far eastern portion of the Planning Area. In the Peach Springs Basin, State Trust Land holdings are assembled in a checker board pattern with private lands in the eastern portion of the Basin, each holding 20 percent of the land within the Planning Area. In the Coconino Plateau Basin, there is a large concentration of State Trust Land holdings in the central part of the Basin, with a large concentration of private lands adjacent to the south, with a checkerboard pattern of private and State Trust lands along the southern boundary of the Planning Area.

Water Supply Conditions

<u>Groundwater</u>

The Western Plateau Planning Area is located in the Colorado Plateau Physiographic Province. The main productive aquifers in this province are large regional aquifers consisting of sandstone and limestone. Some formations produce relatively little, while some fracture zones are highly productive.

While some shallow perched aquifers are present in the Planning Area, the regional aquifers are deep and production can be highly variable depending upon location. The shallowest well of record in the Peach Springs Basin is near Truxton at 60 feet below land surface. Deep regional aquifers in the Peach Springs Basin are as deep as 1,341 feet below land surface. Groundwater in storage in the Peach Springs Basin is estimated to be 4.0 MAF. Groundwater levels in this portion of the Planning Area have been rising at 0.4 feet per year based on water level surveys conducted in the 1990s through the mid to late 2000s (*see Figure P.A. 22-2*).

In the Coconino Plateau Basin, shallow wells near Rose Well were measured at 25 feet below land surface. Production wells near Williams (just outside of the Planning Area to the south) are 2,700 feet in depth. Groundwater in storage in the Coconino Plateau Basin is estimated to be at least 3.0 MAF, although the only study available covered only a portion of the Basin. Groundwater levels in the Basin were reported to be declining at 0.5 feet per year from the 1990s through the mid to late 2000s.

Surface Water

Other than the Colorado River in the northernmost portion of the Planning Area, there are no perennial or intermittent streams in the Planning Area (*see Figure P.A. 22-3*). There is no reported surface water storage in the Peach Springs Basin, although there are five reservoirs in the Coconino Plateau Basin totaling 1,517 acre-feet in storage. The largest is on State Trust Lands with 967 acre-feet of storage.

Reclaimed Water

The lack of concentrated development limits the existence of centralized waste water collection and treatment systems. This limits the opportunities for reclaimed water use. Most users rely upon hauled water or exempt wells (those wells with a pump capacity of less than 35 gallons per minute) and septic systems for wastewater treatment and disposal. Two communities, Peach Springs and Supai Village, have small wastewater treatment systems generating less than 200 acre-feet per year of reclaimed water. Both systems rely upon evaporation and seepage ponds for disposal.

Ecological Resources

Portions of the Western Plateau Planning Area along the Colorado River have been designated as critical habitat under the Endangered Species Act (*see Figure P.A.* 22-3*)*. These areas are limited to federal and tribal lands.

Water Demands

Table P.A. 22-1, below, presents the baseline and projected water demands for the Western Plateau Planning Area. Municipal use is the largest water demand sector and it is projected to increase slightly throughout the planning period. Depending on the outcome of the outstanding claims of the Hualapai and Havasupai Indian Tribes, all other uses are relatively small and are not expected to increase at this time.

Characteristics Affecting Future Demands and Water Supply Availability

Unresolved Indian Water Rights Claims

The Hualapai and Havasupai Indian Tribes both have separate outstanding water rights claims, primarily to the Colorado River. Resolution of these claims, ideally through comprehensive water right settlements, will clarify the availability of water supplies for future growth in the Planning Area.

Land Ownership

Significant portions of this Planning Area are under federal ownership, limiting the potential for future development or raising questions regarding the availability of water supplies for growth on non-federal lands. This ownership is also often fragmented, with federal, State, and private land holdings assembled in a "checkerboard" fashion that further complicates the development and execution of comprehensive land management strategies.

Protected Species and Habitat

The presence of a listed species may be a critical consideration in water resource management and supply development in a particular area.

Table P.A. 22-1. Projected Water Demands (in acre feet) - Western Plateau Planning Area

Sector	2010	2035	2060
Agriculture	0	0	0
Dairy	0	0	0
Feedlot	0	0	0
Municipal	551	749	914
Other Industrial	0	0	0
Mining	0		
High		300	300
Low		300	300
Power Plants	0		
High		0	0
Low		0	0
Rock Production	1		
High		38	45
Low		16	19
Turf	0		
High		0	0
Low		0	0
Total (High)	**552**	**1,087**	**1,259**
Total (Low)	**552**	**1,065**	**1,233**

Strategies for Meeting Future Water Demands

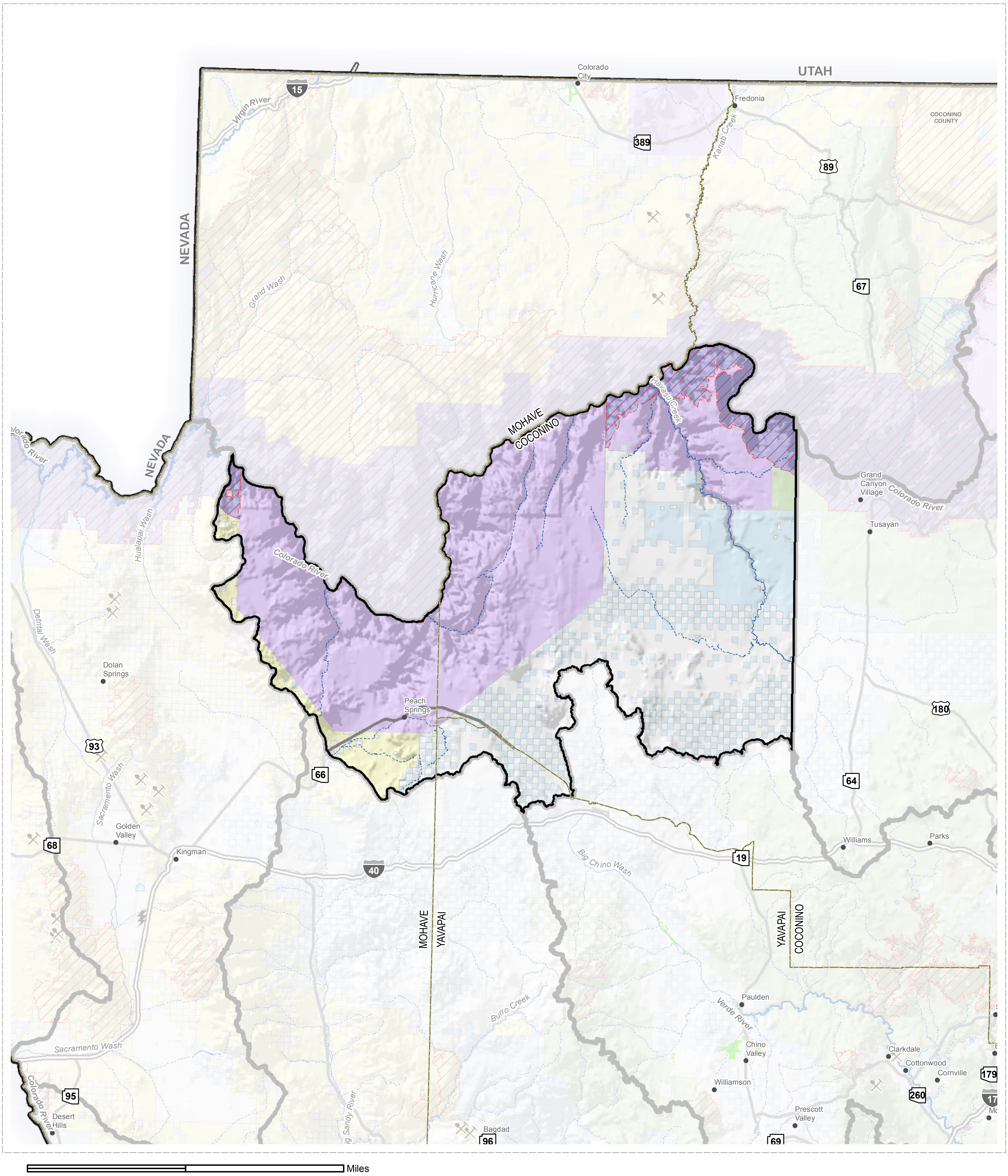
Resolution of Indian and Non-Indian Water Rights Claims

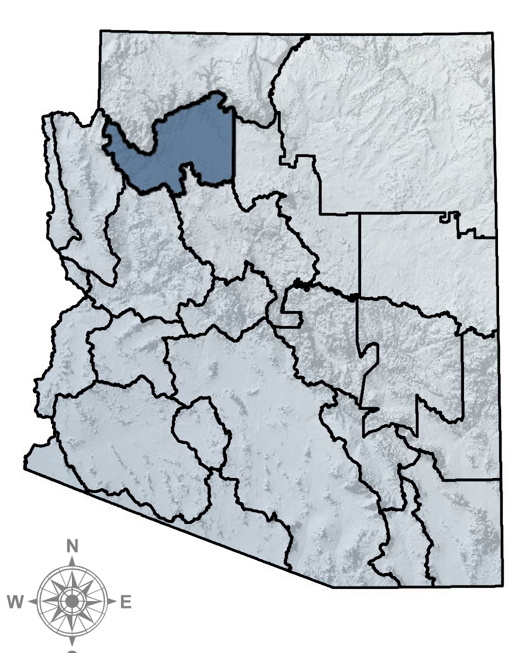
The Hualapai Tribe, the State of Arizona, and several non-Indian water users are currently engaged in settlement discussions, but details of those discussions are not available at this time. No formal discussions have begun on the Havasupai Tribe's claims, although the Tribe and the State of Arizona have requested that the federal government begin these discussions. Until these claims are quantified and settled, uncertainty regarding the extent and priority of water rights in this Planning Area will make it difficult to identify strategies for meeting the projected water demands.

Groundwater Modeling

ADWR believes that there are sufficient groundwater supplies to meet the projected demands for this area. Because projected water demand increases are still small for this area and the tribal claims have yet to be resolved, no strategies are being developed at this time. However, there is a need for increasing knowledge of the local groundwater system and developing a comprehensive hydrologic model and water budget to assess the availability and long-term sustainability of water supplies in this 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.





MAP LOCATION
(Planning Area Boundaries)

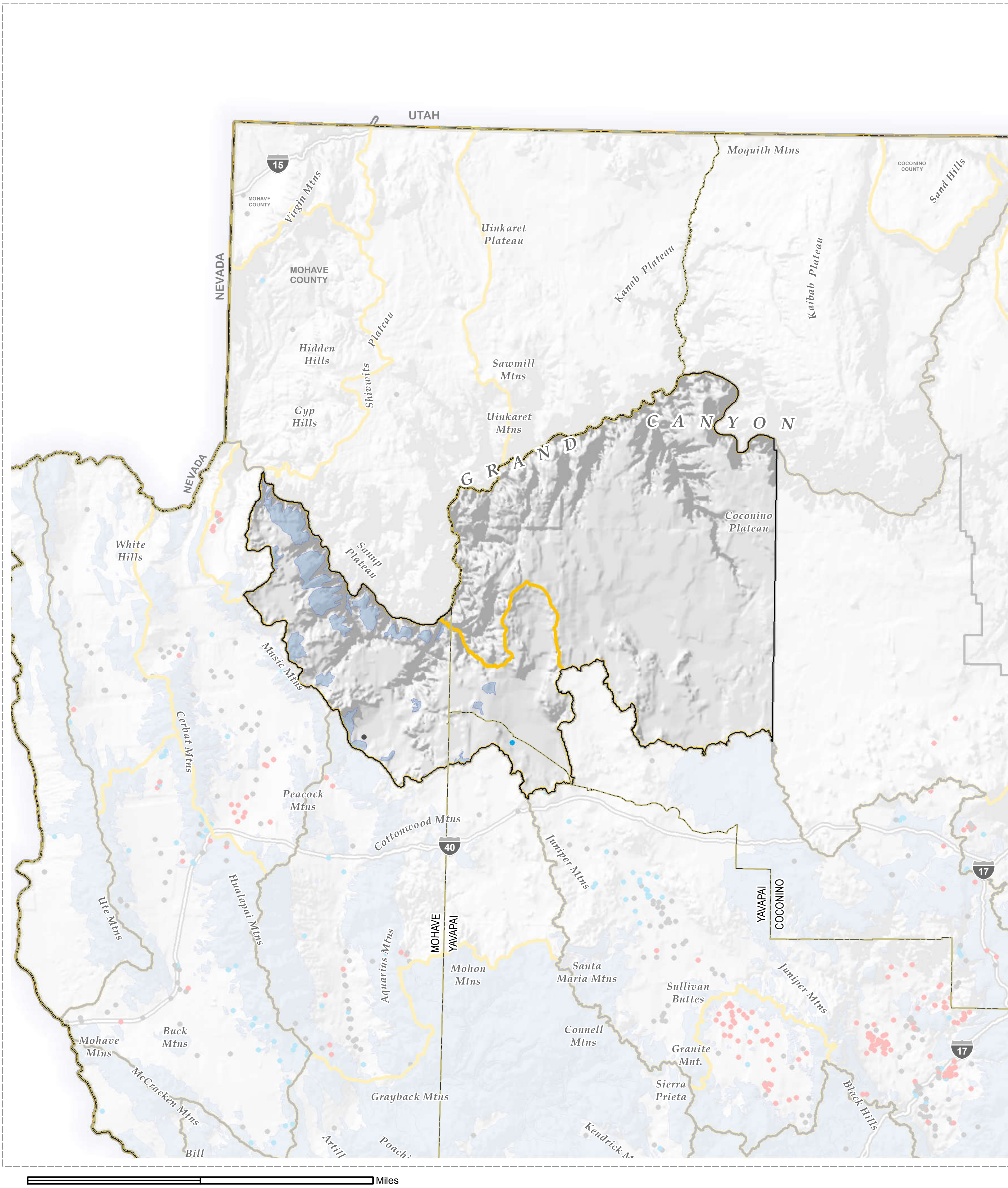
- Planning Area (ADWR)
- State (ALRIS)
- County (ALRIS)
- River or Stream (ASLD)
- Interstate (ADOT)
- Population Center (GNIS)
- Mine (ADMMR, ADWR)
- Hydroelectric Power Plant (ADEQ, ADWR)
- Thermoelectric Power Plant (ADEQ, ADWR)
- Agriculture (SWReGAP, 2004)
- Federal Conservation Land (USFS, BLM,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

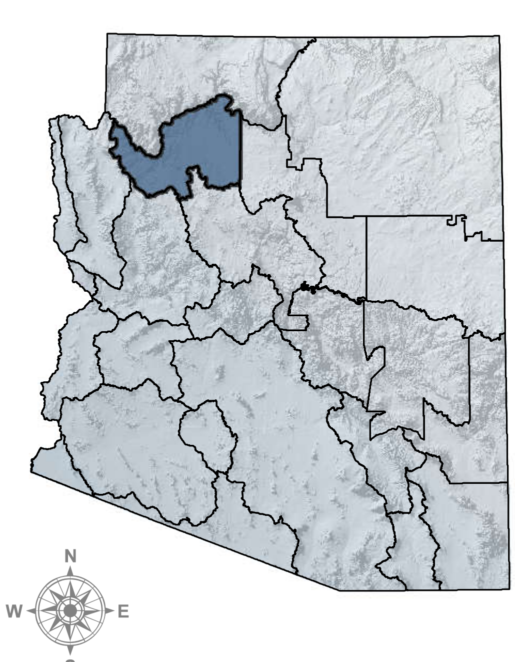
ARIZONA DEPARTMENT of WATER RESOURCES EST. 1980

Figure P.A.22-1

Western Plateau 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)

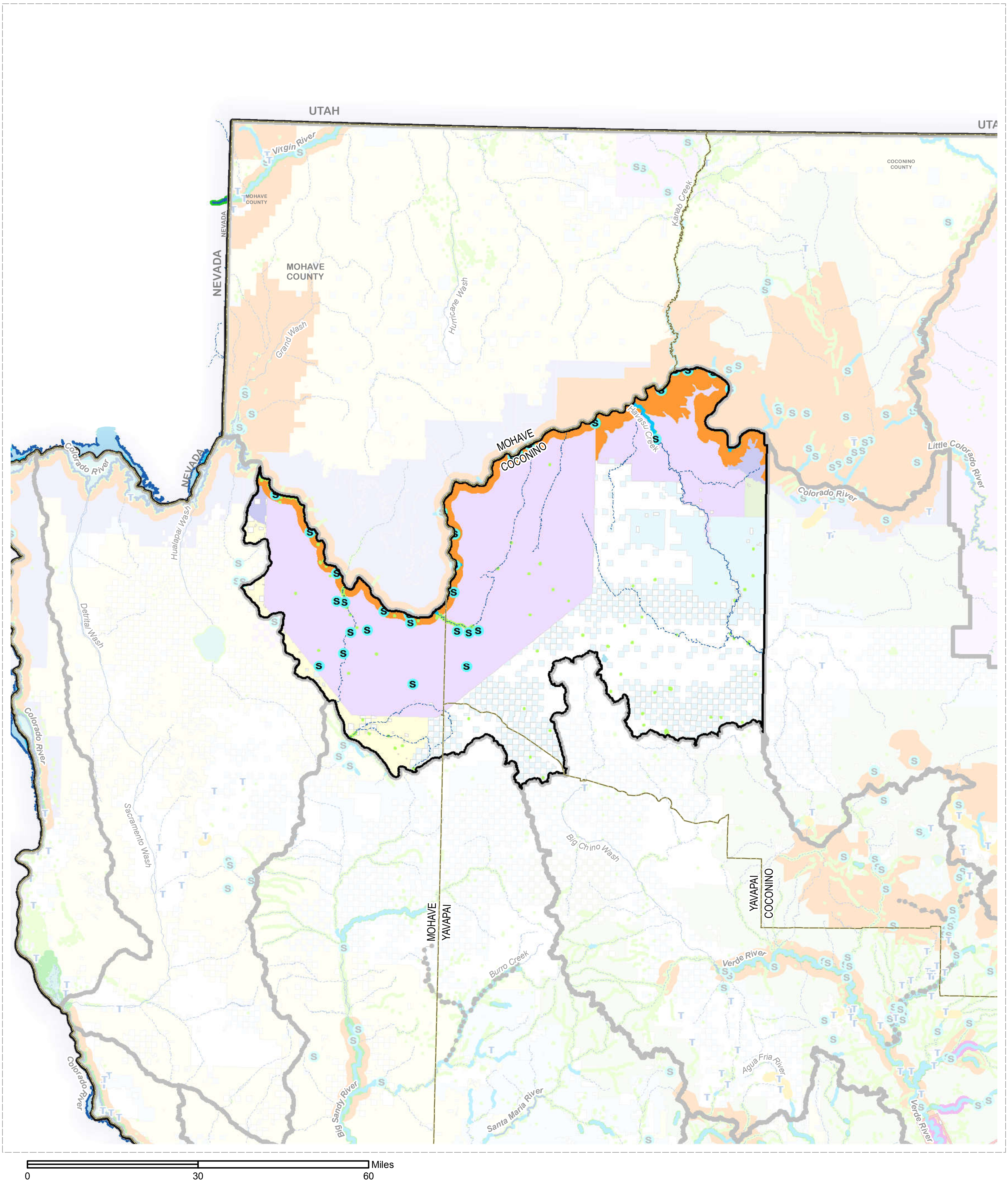
Recent Water Level Change * (1990's through 2000's)
- Minor WL Change +5' to -5'
- Negative
- Positive

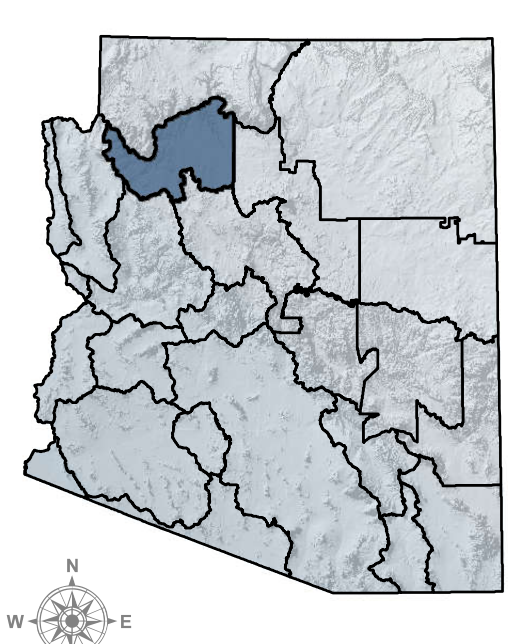
* Data provided by ADWR

Figure P.A.22-2

Western Plateau 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.





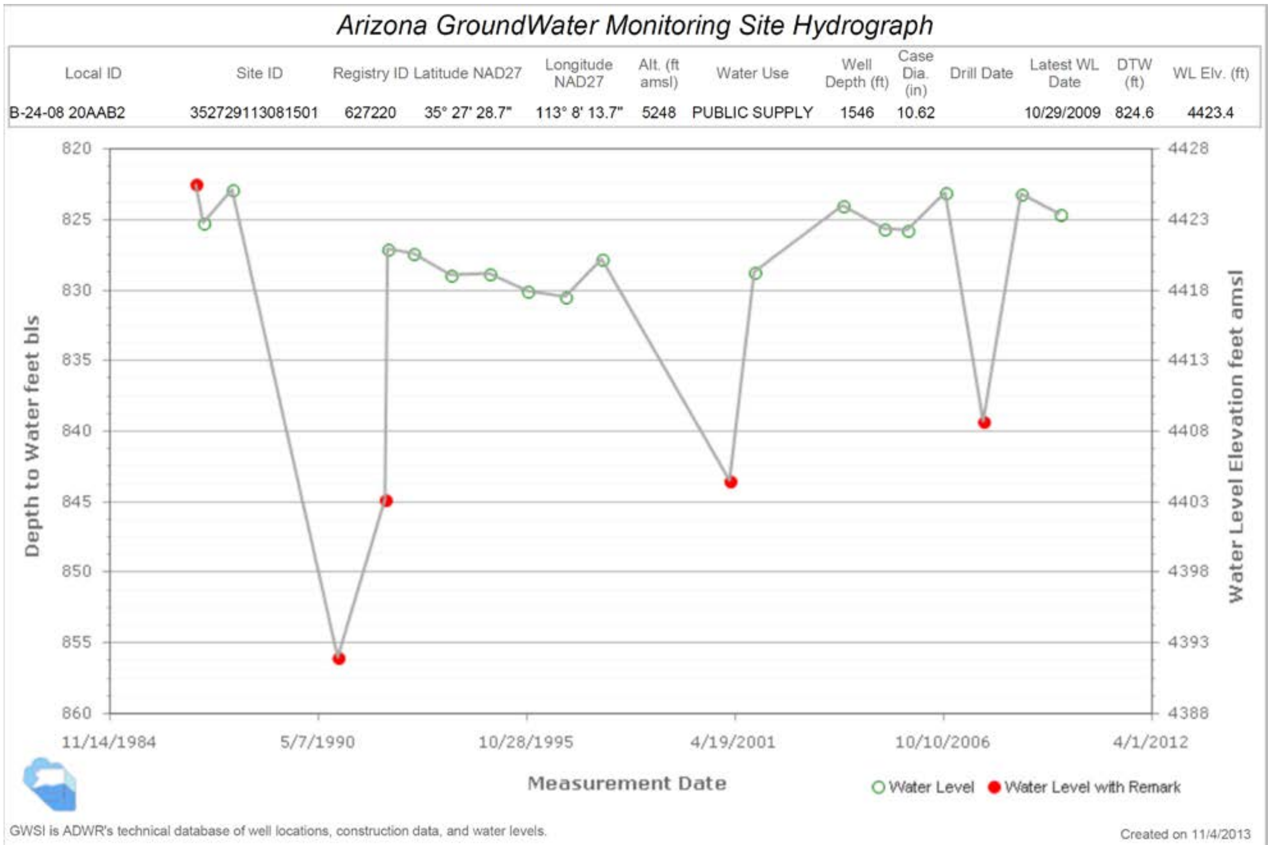
MAP LOCATION
(Planning Area Boundaries)

- 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

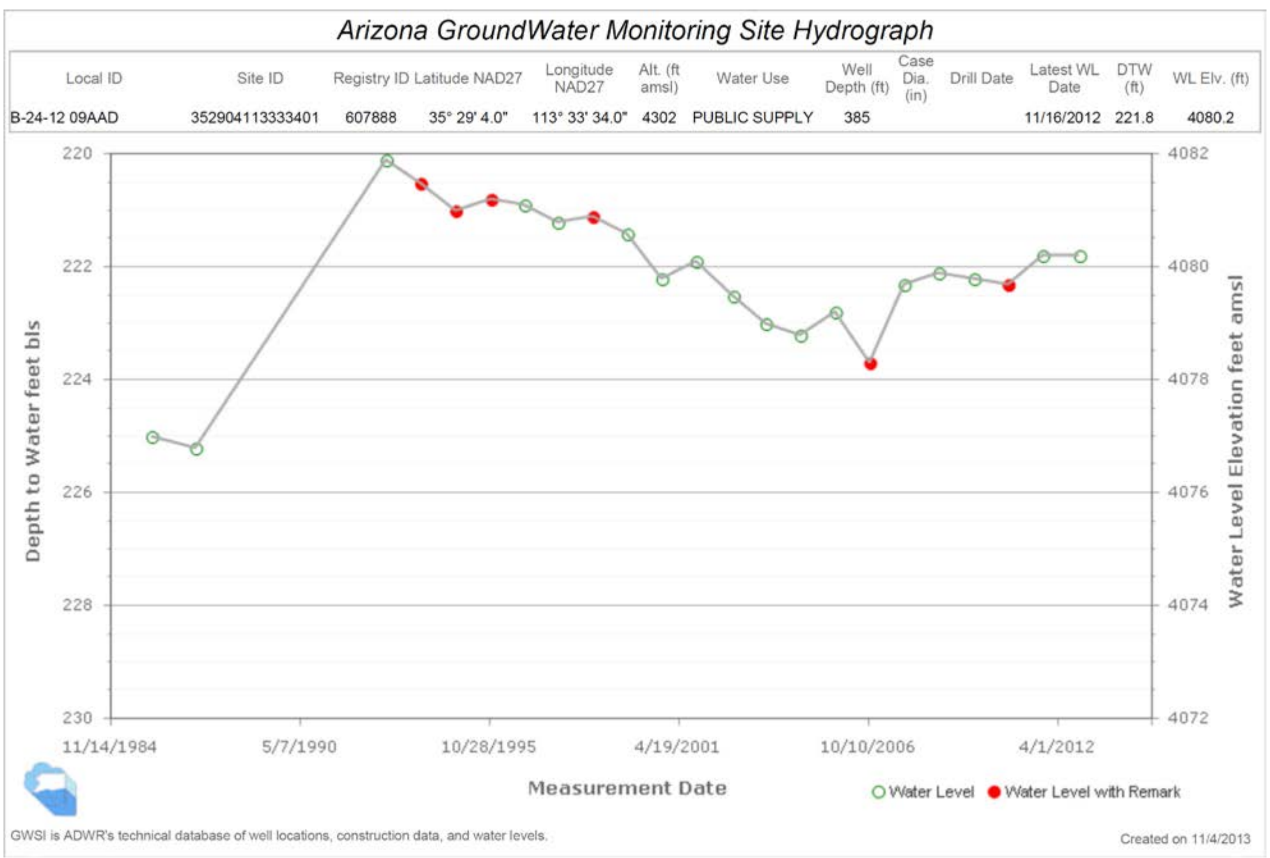
Figure P.A.22-3

Western Plateau
Surface Water and Natural Features

Peach Springs Basin – Western Plateau Planning Area



B-24-08 20AAB2 Peach Springs basin Aubrey Valley area.



B-24-12 09AAD Peach Springs basin near Truxton.

[SECTION 4: APPENDICES]

APPENDIX I - Timeline of Arizona Water Management History

1863 Arizona Territory is established
Arizona is declared a U.S. territory by President Lincoln on February 24, making it separate from the New Mexico Territory.

1864 Howell Code
The first Arizona Territorial Legislature adopts the Howell Code, which establishes the doctrine of prior appropriation for surface water – "First in Time, First in Right."

1877 Desert Land Act
Passed by Congress on March 3 to encourage and promote the economic development of the Western states by allowing individuals to apply for a desert-land entry to reclaim, irrigate and cultivate arid and semi-arid public lands. Lands granted through the Act do not convey any water rights, as the Act provides that water rights were to be acquired through state law.

1888 *Clough v. Wing*
The Arizona Territorial Supreme Court issues a decision recognizing the doctrine of prior appropriation as the means of allocating surface waters of the Territory, and stating that beneficial use is the limit of a water right.

1902 National Reclamation Act
This Act, signed by President Theodore Roosevelt, recognizes that a key component to Western growth and development is constructing a system of irrigation works for the storage, diversion and development of water. The Act provides funding for irrigation projects in the Western states and results in the creation of the U.S. Reclamation Service (later the Bureau of Reclamation). The Act provides that "the right of the use of water acquired under the provision of this Act shall be appurtenant to the land irrigated, and beneficial use shall be the basis, the measure, and the limit of the right."

1903 Salt River Valley Water User's Association in Incorporated
Salt River Project, based in Phoenix, was established as the nation's first multipurpose reclamation project authorized under the National Reclamation Act. Today, SRP is the nation's third-largest public power utility and one of Arizona's largest water suppliers.

1904 *Howard v. Perrin*
The Arizona Territorial Supreme Court ruling in this case (upheld in 1906 by the U.S. Supreme Court) recognizes a definite distinction, in character and ownership, between appropriable surface water and percolating groundwater. The court holds that percolating groundwater is the property of the overlying landowner and not subject to appropriation as surface water. The court further holds that subterranean streams flowing in natural channels between well-defined banks are subject to appropriation.

1906 *Gould v. Maricopa Canal Company*
The Arizona Territorial Supreme Court holds that the vested right to the use of water for irrigation is not with the canal company but with the users who put the water to beneficial use on land they own or possess. The court further holds that ownership of the means of diversion is not essential to perfect the right of appropriation.

1908 ***Winters v. United States***
The United States Supreme Court holds that an Indian tribe's water rights are established when the reservation is created, regardless of whether the tribe actually uses water on the reservation at that time. The Court holds that Congress, by creating the reservation, impliedly reserved all the waters of the river necessary for the purposes for which the reservation was created.

1910 **Arizona Constitution is adopted**
The Arizona Constitution is adopted by delegates to the Constitutional Convention. It becomes effective in 1912 following ratification by voters of the State and approval by Congress and President Taft. Article XVII, § 1 states: "The common law doctrine of riparian water rights shall not obtain or be of any force or effect in the State." Article XVII, § 2 states: "All existing rights to the use of any of the waters in the State for all useful or beneficial purposes are hereby recognized and confirmed."

1911 **Theodore Roosevelt Dam is completed**
This structure is the first multi-purpose project built by the Bureau of Reclamation. The dam is located 76 miles northeast of Phoenix at the confluence of the Salt River and Tonto Creek where it is operated and maintained by the Salt River Project.

1912 **Arizona Statehood**
Arizona is accepted for statehood by President Taft and becomes the 48th state on February 14, 1912.

1918 ***McKenzie v. Moore***
The Arizona Supreme Court holds that water from a spring that is not the source of a watercourse is not appropriable, but instead belongs to the owner of the land on which the spring is located, who may use its entire flow.

1919 **Public Water Code is adopted**
Enacted by the legislature on June 12, the Public Water Code establishes administrative procedures for obtaining a right to use appropriable water, including a permitting system. These procedures replace the prior practice of either merely putting the water to beneficial use or posting a notice at the point of diversion, recording a copy of the notice with the County Recorder, and then putting the water to beneficial use.

1922 **Colorado River Compact**
The Seven Basin States negotiate an interstate compact dividing the Colorado River Basin into an Upper and Lower River Basin and apportioning 7.5 MAF of Colorado River water per year to each basin. Arizona refuses to ratify the Compact (but signs it in 1944) because of concerns over how its tributary waters from the Salt and Gila Rivers will be counted in the apportionment. Article VII, inserted at the insistence of Herbert Hoover, the Colorado River Commission's federal chairman, states "Nothing in this compact shall be construed as affecting the obligations of the United States of America to Indian Tribes."

1926 ***Pima Farms Company v. Proctor***
The Arizona Supreme Court holds that a junior appropriator of water from an underground stream flowing within defined channels may be enjoined from lowering the water levels in the senior appropriator's wells because under the doctrine of prior appropriation, a junior appropriator may not render ineffective the prior appropriator's means of diversion.

1928 Boulder Canyon Project Act

Passed by Congress on December 21, 1928, this Act authorizes construction of the Hoover Dam on the condition that the Colorado River Compact is ratified. The Act provides a mechanism for approval of the Colorado River Compact without Arizona's approval and authorized the apportionment of the Lower Basin's 7.5 million acre-feet (MAF) among the states of California (4.4 MAF), Arizona (2.8 MAF) and Nevada (0.3 MAF). The Act also designates the Secretary of the Interior as the sole contracting authority for Colorado River water use in the Lower Basin.

1931 *Maricopa Co. Municipal Water Conservation District v. Southwest Cotton Co.*

The Arizona Supreme Court holds that water seeping through a streambed or from lands under or immediately adjacent to a stream (referred to as "subflow") is part of the surface stream and is therefore appropriable. The test of whether subsurface water is appropriable is whether drawing off of the subsurface water tends to diminish directly and appreciably the flow of the surface stream ("direct and appreciable test.")

1935 Completion of Hoover Dam

On September 30, 1935, President Franklin D. Roosevelt dedicates Hoover Dam on the Colorado River. The dam stores water for use by the Lower Division states, controls flooding and generates hydroelectricity. The reservoir created by the dam is Lake Mead.

1938 First Groundwater Study Group

Governor Stanford appoints a group to study groundwater in response to growing concerns over increased groundwater pumping. The efforts of this group lead to the legislature appropriating monies to the U.S. Geological Survey to study and report on groundwater conditions in the state.

1944 Mexican Water Treaty is signed

The United States and Mexico sign a treaty providing for an annual allocation of 1.5 MAF of Colorado River water to Mexico. The Treaty further provides for an increase in that volume, up to a total of 1.7 MAF, if a surplus exists, and for a reduction in that volume "in the event of extraordinary drought or serious accident to the irrigation system in the United States …."

Arizona approves the Colorado River Compact

Governor Osborn announces a policy shift in Arizona's position on matters relating to the Colorado River. As a result, Arizona approves the Colorado River Compact in hopes of getting approval for a reclamation project to deliver Colorado River water to central and southern Arizona (Central Arizona Project) and because of concerns over the recently-signed Mexican Water Treaty.

Arizona Colorado River Contract

Arizona contracts with the secretary of the Interior for delivery of 2.8 MAF of Colorado River water annually.

1945 Arizona's first Groundwater Code is adopted

Holding Arizona to its claim that construction of the Central Arizona Project would reduce groundwater use instead of allowing for more groundwater use by agricultural users, the Bureau of Reclamation warns that the Central Arizona Project will not be approved without restrictions on groundwater use. In response, the legislature enacts a Groundwater Code, but the Code only requires the registration of wells throughout the State.

1948 Critical Groundwater Code is adopted

Again, the federal government warns that the funding for the CAP will not be approved without a more meaningful Groundwater Code. The legislature responds by enacting the 1948 Code, which prohibits the drilling of new irrigation wells in ten designated Critical Groundwater Areas. However, the Code does nothing to regulate groundwater withdrawals from existing irrigation wells in those areas, thereby allowing groundwater pumping to continue at historic levels.

Upper Colorado River Basin Compact
The Upper Colorado River Basin States enter into an interstate compact apportioning the waters of the Upper Basin of the Colorado River between Arizona, Colorado, New Mexico, Utah and Wyoming. Arizona is included because Chinle Wash drains into the River above Lee Ferry. Arizona is apportioned 50,000 acre-feet per year of Upper Basin Colorado River water.

Arizona Interstate Stream Commission
The legislature establishes the Arizona Interstate Stream Commission to defend Arizona's rights to Colorado River water and to advance the authorization and construction of the Central Arizona Project.

1951 Arizona's Second Groundwater Study Commission is formed
In response to criticism that the 1948 Groundwater Code allows groundwater pumping to continue at historic levels within Critical Groundwater Areas, the second Groundwater Study Commission is formed to draft a new groundwater bill. The legislature fails to pass any of the Commission's recommendations and the Commission is ultimately abolished.

1952 *Bristor v. Cheatham I*
The Arizona Supreme Court holds that percolating groundwater is not owned by the owner of the overlying land but instead is subject to prior appropriation. This ruling reverses nearly 50 years of common law that had stated that percolating groundwater was not subject to prior appropriation.

1953 *Bristor v. Cheatham II*
The Arizona Supreme Court reverses its decision in *Bristor v. Cheatham I* (that groundwater is subject to the doctrine of prior appropriation) and instead adopts the American rule of reasonable use pertaining to groundwater. Under this rule, a landowner may withdraw groundwater for a reasonable and beneficial use on the land from which it is taken without liability for damages to surrounding landowners, but the withdrawal of groundwater for use away from the overlying land is subject to payment of damages to injured landowners.

1955 *Southwest Engineering Co. v. Ernst*
The Arizona Supreme Court upholds the provisions in the 1948 Groundwater Code restricting the drilling of new irrigation wells within Critical Groundwater Areas. The court rules that certain areas of the state may be managed differently, and that the additional restrictions placed on agricultural groundwater users by the 1948 Code are not in and of themselves unconstitutional.

1963 *Arizona v. California*
The United States Supreme Court upholds Congress' apportionment of the Lower Basin's share of mainstream waters of the Colorado River in the Boulder Canyon Project Act of 1928, with California receiving 4.4 MAF, Arizona 2.8 MAF and Nevada 0.3 MAF. In a major victory for Arizona, the Court holds that the waters apportioned to each state by the Act include only waters of the mainstream of the Colorado River, leaving to each state its own tributaries. The Court also holds that the Act gives the Secretary of the Interior broad discretion to determine how much water each state should receive during times of shortage, with some limitations. Finally, the Court holds that several Indian reservations near the Colorado River have reserved rights to water from the river in an amount sufficient to allow the irrigation

of all practicably irrigable acreage on the reservations and that other federal establishments, such as National Recreation Areas and National Forests, also have federal reserved water rights.

1966 Glen Canyon Dam is completed

Construction of Glen Canyon Dam on the Colorado River north of Page, Arizona is completed. The purpose of the dam is to regulate the flow of Colorado River water from the Upper Basin to the Lower Basin and to produce hydroelectricity. The reservoir created by the dam is Lake Powell.

1968 Colorado River Basin Project Act

Passed by Congress on September 30, 1968, this Act authorizes the construction of the Central Arizona Project. The Act contains a provision that safeguards California's 4.4 MAF entitlement, stating that in times of shortage this full amount will be delivered before any water is provided for the CAP. The stated legislative purpose of the Act calls for "furnishing irrigation water and municipal water supplies to the water-deficient areas of Arizona and western New Mexico …"

1969 ***Jarvis v. State Land Department I***

The Arizona Supreme Court affirms the superior court's issuance of an injunction prohibiting the City of Tucson from transporting groundwater to the City from wells in a Critical Groundwater Area outside the City. The court notes that the American rule of reasonable use provides that a person may not convey groundwater off the land if it will cause damage to other lands and further notes that this is a rule of property. The court finds that transporting groundwater away from a Critical Groundwater Area would necessarily cause damage to lands within the area and that an injunction is appropriate because damages would not adequately compensate the injured landowners.

National Environmental Policy Act

The purposes of this Act are to declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

1970 ***Jarvis v. State Land Department II***

Relying on a surface water statute that gives preference to domestic and municipal uses over agricultural uses, the Arizona Supreme Court states that it will modify the injunction issued in *Jarvis v. State Land Department I* to allow the City of Tucson to acquire cultivated lands within the Critical Groundwater Area outside the City, retire the lands from irrigation and transport to the City for municipal use an amount of groundwater equal to the "annual historical maximum use" on the lands. The court later holds that "annual historical maximum use" means the *average* of the annual maximum amount of groundwater *consumptively* used on the land for irrigation purposes.

1973 Construction of the CAP Canal begins

Designed to bring about 1.5 MAF of Colorado River water per year to Pima, Pinal and Maricopa counties. The CAP canal now carries water from Lake Havasu near Parker to the southern boundary of the San Xavier Indian Reservation southwest of Tucson. It is a 336-mile long system of aqueducts, tunnels, pumping plants and pipelines and is the largest single source of renewable water supplies in central Arizona.

Endangered Species Act

The purpose of the ESA is to protect and recover imperiled species and the ecosystems upon which they depend. It is administered by the U.S. Fish and Wildlife Service (FWS) and the Commerce Department's National Marine Fisheries Service (NMFS). The FWS has primary responsibility for terrestrial and freshwater organisms, while the responsibilities of NMFS are mainly marine wildlife such as whales and anadromons fish such as salmon. Under the ESA, species may be listed as either endangered or threatened. "Endangered" means a species is in danger of extinction throughout all or a significant portion of its range. "Threatened" means a species is likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened. For the purposes of the ESA, Congress defined species to include subspecies, varieties, and, for vertebrates, distinct population segments.

1974 Water Rights Registration Act

The Arizona legislature requires persons using, or claiming the right to use, surface water before June 12, 1919 to file a claim with the state. The Act provides that failure to file by a specified date will result in a waiver and relinquishment of any right, title or interest in the water. This Act triggers several water users throughout Arizona to request a determination of water rights in the Gila River and Little Colorado River watersheds. These actions eventually are combined into the Gila River Adjudication in the Maricopa County Superior Court and the Little Colorado River Adjudication in the Apache County Superior Court. The Act is later amended to require persons using, or claiming the right to use, surface water before March 7, 1995 to file a claim with the State.

1976 *Farmer's Investment Company (FICO) v. Bettwy*

The Arizona Supreme Court enjoins a mining company and the City of Tucson from transporting groundwater away from lands within a Critical Groundwater Area for use on lands outside the Critical Groundwater Area but within the same groundwater basin. The court holds that under the reasonable use doctrine, water may not be pumped from one parcel for use on another parcel if other lands will suffer injury or damage as a result, even though the two parcels overlie a common source of supply. The injunction is never enforced, however, as agricultural, mining and municipal interests soon begin negotiations on a legislative solution to groundwater transportation issues.

1977 Amendments to 1948 Groundwater Code

As a result of negotiations between agricultural, mining and municipal interests following the *FICO* decision, the legislature amends the 1948 Groundwater Code to allow all existing groundwater transportations to continue and to allow new or increased transportations under certain conditions. In most cases, groundwater transportation is subject to payment of damages to injured landowners, and injury is conclusively presumed if groundwater is transported way from a Critical Groundwater Area. Cities, towns, private water companies and irrigation districts are allowed to transport groundwater within their service areas without payment of damages. A 25-member Groundwater Study Commission is established and charged with developing a new Groundwater Code to address groundwater transportation and reduce groundwater overdraft occurring in parts of the state.

Stockpond Water Rights Registration Act

The legislature enacts legislation requiring an owner of a stockpond with a capacity of 15 acre-feet or less, that is used solely for livestock or wildlife, and that was constructed after June 12, 1919 and before August 27, 1977 to file a claim in order to obtain a valid water right with a priority date as of the date of construction. Failure to file a timely claim results in a priority date as of the date of the filing.

Federal Budget Cuts
President Carter announces that the Central Arizona Project is among several Federal projects whose funding will be cut, but later removes the CAP from this "hit list".

1979 **Groundwater Study Commission releases its <u>Draft Report of Tentative Recommendations</u>**
Secretary of the Interior Cecil Andrus warns that the Central Arizona Project will not be funded unless the State passes a Groundwater Code.

1980 **Groundwater Management Act**
Passed by the Arizona legislature on June 11, 1980 and signed into law by Governor Babbitt the next day, this Act implements the final recommendations of the Groundwater Study Commission. The Act **establishes the Arizona Department of Water Resources** to administer the provisions of the Act.

Secretary of the Interior Cecil Andrus informs Governor Babbitt that Arizona's enactment of the 1980 Groundwater Management Act will allow the Central Arizona Project to be funded.

<u>Town of Chino Valley v. City of Prescott</u>
The Arizona Supreme Court upholds the provisions of the 1980 Groundwater Management Act allowing groundwater to be transported within the sub-basin of an Active Management Area without payment of damages to injured landowners. The court rejects the plaintiffs' argument that landowners have a property right to the groundwater under their land that cannot be diminished without due process of law and without just compensation. The court states that "there is no right of ownership of groundwater in Arizona prior to its capture and withdrawal from the common supply and … the right of the owner of the overlying land is simply to the usufruct of the water." The court further holds that the legislature may enact laws regulating groundwater use under its police powers.

1982 ***<u>Cherry v. Steiner</u>***
The United States District Court holds that the provisions of the 1980 Groundwater Management Act restricting groundwater withdrawals from lands within Active Management Areas do not take property without due process of law. The court relies on the Arizona Supreme Court's holding in *Town of Chino Valley v. City of Prescott* that landowners have no property interest in the groundwater beneath their land prior to its capture and withdrawal. The court also upholds the legislature's designation of certain areas of the state as Active Management Areas.

1984 **First Management Plans are adopted**
The first of the five Management Plans called for by the Groundwater Management Act are adopted by ADWR for the Phoenix, Pinal, Prescott and Tucson AMAs.

1985 **The Central Arizona Project** begins deliveries of water to central Arizona.

1986 **The Lakes Bill**
The legislature enacts the Lakes Bill, which prohibits the construction of new bodies of water used primarily for landscape, scenic or recreational purposes and larger than 12,320 square feet within AMAs. There are several exceptions to the prohibition, including bodies of water filled entirely with effluent and bodies of water located in recreational facilities open to the public and owned or operated by a governmental entity.

Underground Water Storage Act
The legislature enacts laws allowing non-groundwater supplies to be stored in underground aquifers and recovered later through recovery wells. The water recovered may be used in the same manner in which it was permissible to use the water before it was stored.

Arizona Department of Environmental Quality is created
Established by the Arizona Environmental Quality Act in 1986 to administer all of Arizona's environmental protection programs, including a comprehensive groundwater protection program and the state's Water Quality Assurance Revolving Fund, to identify, assess and remediate contaminated sites with the potential to impact public health or groundwater. ADEQ supports a wide range of environmental programs that protect the quality of our air, water and land in Arizona. Also administers state environmental protection laws and a number of federally-delegated programs, such as the Clean Air Act program, the Safe Drinking Water Act program, and the National Pollutant Discharge Elimination System program.

1987 SRPMIC Water Rights Settlement Act
Settles the claims of the Salt River-Pima Maricopa Indian Community to groundwater, Salt River water and reclaimed water.

1989 Second Management Plans are adopted
ADWR adopts the second of the five Management Plans for the Phoenix, Pinal, Prescott and Tucson AMAs as called for by the Groundwater Management Act.

Arizona Public Service Company v. Long
The Arizona Supreme Court holds that effluent (treated municipal wastewater) is neither groundwater nor surface water and therefore is not subject to the groundwater or surface water laws. The court further holds that although effluent is neither groundwater nor surface water, it is water, and therefore must be put to a beneficial use. Additionally, the court notes that although the legislature has not regulated the use of effluent, it may do so in the future.

1990 Indirect Groundwater Storage
The legislature amends the Underground Water Storage laws to allow an entity to receive groundwater storage credits for delivering reclaimed water, CAP water or Colorado River water to a groundwater user who eliminates or reduces its use of groundwater.

1991 Groundwater Transportation Act
The legislature amends the groundwater transportation laws to prohibit the transportation of groundwater from areas outside of Active Management Areas to Active Management Areas, with several exceptions. The exceptions allow certain entities to transport groundwater from the McMullen Valley groundwater basin to the Phoenix AMA, from the Big Chino sub-basin of the Verde River groundwater basin to the Prescott AMA, and from the Butler Valley groundwater basin and the Harquahala INA to any initial AMA.

1992 Water Exchange Legislation
The Arizona legislature enacts legislation authorizing water exchanges. A person participating in a water exchange must have the right to use the water given in the exchange and may use the water received in the exchange only in the same manner in which the person has the right to use the water given in the exchange, but the person need not have a right to use the water received in the exchange. Water exchanges involving surface water, other than Colorado River water require a permit from ADWR. Most other water exchanges require the filing of a notice with the ADWR.

1992 Grand Canyon Protection Act

Passed by Congress, this Act requires the Secretary of Interior to operate Glen Canyon Dam in accordance with the additional criteria and operating plans *in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use,* subject to applicable provisions of the Law of the River.

1993 Restrictions on transporting groundwater outside of Active Management Areas

The legislature amends the groundwater transportation laws to prohibit most new transportations of groundwater between groundwater basins outside of Active Management Areas.

Central Arizona Groundwater Replenishment District

The legislature amends the laws governing the CAP to provide that the District shall serve as a groundwater replenishment entity for member lands and member service areas within the District (Maricopa, Pinal and Pima Counties). The CAGRD assists its members in obtaining determinations of assured water supply by agreeing to replenish groundwater used by a member in excess of the amount determined by ADWR to be consistent with the AMA's management goal.

Fort McDowell Indian Community Water Settlement

Settled the claims of the Fort McDowell Indian Community's claims to water supplies in the Verde River and groundwater and effluent

1994 Underground Water Storage, Savings and Replenishment Act

The legislature repeals previous enactments and consolidates all underground water storage programs into a unified program.

Water Protection Fund

The legislature establishes the Water Protection Fund. The fund is administered by a commission which issues grants from the fund to water users for implementing projects to protect Arizona's rivers and streams, including the use of excess CAP water for riparian enhancement.

1995 Assured and Adequate Water Supply Rules

ADWR adopts rules establishing criteria for demonstrating an assured or adequate water supply become effective. The rules require that an applicant for a certificate or designation of assured water supply in an AMA demonstrate that the use will be served primarily with renewable water supplies.

Yavapai-Prescott Indian Tribe Water Rights Settlement Agreement

Settles claims of the Yavapai-Prescott Indian Tribe to groundwater and surface water from Granite Creek and reclaimed water and allows for the transfer of the Tribe's and the City of Prescott's CAP water to the City of Scottsdale.

Santa Cruz Active Management Area is established

The Santa Cruz AMA is established from a portion of the Tucson Active Management Area to address unique water management goals.

1996 Arizona Water Banking Authority

The AWBA is established as a mechanism for Arizona to fully utilize its CAP allotment. The AWBA may annually purchase all or part of the state's unused CAP allotment and store it underground for times of

shortage. The legislation also allows the AWBA to store Colorado River water on behalf of agencies in Nevada and California.

1999 Third Management Plans are adopted

ADWR adopts the third of the five Management Plans for the Phoenix, Pinal, Prescott, Santa Cruz and Tucson AMAs as called for by the Groundwater Management Act.

Off stream Storage of Colorado River Water and Development and Release of Intentionally Created Unused Apportionment in the Lower Division States

The Secretary of the Interior adopts regulations providing for, which enables interstate water banking in the Lower Colorado River Basin.

Adjudication Court Decision: *In re the General Adjudication of all Rights to Use Water in the Gila River System and Source (Gila III)*

The Arizona Supreme Court holds that federal reserved water rights for federal reservations (Indian and non-Indian) include not only surface water but also groundwater to the extent that surface water supplies are inadequate to accomplish the purpose for which the reservation was created.

San Carlos Apache Tribe Water Rights Settlement Agreement

Settles the claims of the San Carlos Apache Tribe to the Salt River side of their reservation and includes groundwater, water from the Salt, Black, Gila and Sand Pedro Rivers, CAP water (that can be leased) and reclaimed water. The water right claims of the Tribe to the Gila River side of the reservation will be the subject of separate negotiations or litigation.

2000 Governor's Water Management Commission

Governor Jane Dee Hull announces the formation of the Governor's Water Management Commission.

Adjudication Court Decision: *In re the General Adjudication of all Rights to Use Water in the Gila River System and Source (Gila IV)*

The Arizona Supreme Court affirms the trial court's determination that the subflow zone within the San Pedro River watershed is the saturated floodplain Holocene alluvium. There is a rebuttable presumption that wells located within the subflow zone and wells whose cones of depression extend into the subflow zone are pumping appropriable subflow, and such wells are therefore subject to the jurisdiction of the adjudication court. ADWR will determine the extent of the saturated floodplain Holocene alluvium and conduct cone of depression tests.

2001 Colorado River Interim Surplus Guidelines

The United States Bureau of Reclamation adopts guidelines defining the conditions for declaration and implementation of surplus conditions in the Lower Basin of the Colorado River.

Agreement for Interstate Water Banking

The AWBA, the Southern Nevada Water Authority and the Colorado River Commission of Nevada reach an agreement allowing the storage of Colorado River water in Arizona for future uses in Nevada.

Adjudication Court Decision: *In re the General Adjudication of all Rights to Use Water in the Gila River System and Source (Gila V)*

The Arizona Supreme Court rejects the "practicably irrigable acreage" standard as the exclusive standard for quantifying federal reserved water rights for Indian reservations. Instead, the court holds that an

Indian reservation should be allocated the quantity of water necessary to achieve its purpose as a permanent homeland for the Indian tribe, which may include water for multiple present and future uses.

2003 Governor's Drought Task Force
Arizona adopts its first Operational Drought Preparedness Plan and comprehensive Statewide Water Conservation Plan. As a result of this effort legislation was adopted to require all Community Water Systems to annually report their water use and supply a Water Supply plan every five years to ADWR.

Zuni Indian Tribe Water Rights Settlement Agreement
Settles claims of the Zuni Tribe to surface water from the Little Colorado River and provides to the tribe additional groundwater and reclaimed water.

2004 Arizona Water Settlement Act
Through this Act, Congress approves an agreement between the United States and the State of Arizona for CAP repayment obligations. The Act also settles the water rights claims of the Gila River Indian Community and the claims of the Tohono O'odham Nation for its San Xavier reservation near Tucson, and reallocates 67,300 acre-feet of Non-Indian Agricultural priority CAP water to the Secretary of the Interior for use in future Indian water rights settlements in Arizona.

2005 Community Water System planning and reporting requirements
The Arizona legislature enacts legislation requiring community water systems (public water systems that provide water service to at least fifteen service connections or twenty-five year-round residents) to prepare a water supply plan, a drought preparedness plan and a water conservation plan every five years and submit the plans to ADWR. The legislation also requires community water systems to submit annual water use reports to ADWR.

2006 *Phelps Dodge v. Arizona Department of Water Resources*
The Arizona Court of Appeals holds that ADWR has authority to issue permits to appropriate water for instream flows, even though such an appropriation does not involve physical diversion of water.

Creation of Statewide Water Advisory Group
In 2006, ADWR in conjunction with rural legislative leadership and the Governor's office began a series of discussions with a group of representatives from state, county, city, tribal, private non-governmental organizations about the most immediate water resources problems facing the rural areas. The Advisory Group found an imbalance between growth and water supply planning in some rural areas of the state – varying considerably from county to county. After eight months of discussions and 14 public meetings throughout the state, ADWR introduced three bills for legislative action resulting from these discussions. A fourth bill was introduced by State Representative Jennifer Burns (R – Dist. 25). All of the bills passed into law in FY2007.

1) The first bill allows counties and cities to adopt requirements for demonstration of a 100-year adequate water supply for new development.
2) The second bill provide for a water resources revolving fund and grants to plan and build water projects.
3) The third bill prohibits the drilling of a well if it causes poor quality water to be drawn into another well.
4) The fourth bill provides for the formation of the Upper San Pedro Water District that is charged with conserving, reusing, recharging and augmenting the water supplies of the district to protect the flows of the San Pedro River and assist in meeting the water supply needs of Fort Huachuca and the surrounding communities (later defeated by vote within Cochise County)

2007 Mandatory Water Adequacy

The Arizona legislature enacts legislation authorizing counties and cities to adopt an ordinance requiring new subdivisions outside of AMAs to demonstrate a 100-year adequate water supply before obtaining plat approval or receiving a public report from the Arizona Department of Real Estate.

Seven-Basin States Agreement Concerning Colorado River Management and Operations

The Seven Colorado River Basin States join together to sign an agreement regarding Colorado River management for an interim period (until 2026). As part of the Seven States' Agreement, the States jointly submit a proposal for Colorado River operations, which is ultimately adopted by the Secretary of the Interior.

Record of Decision on Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead

The Bureau of Reclamation adopts guidelines that provide for coordinated management of Lake Mead and Lake Powell. Releases from Lake Powell are determined by conditions in both reservoirs. The Interim Guidelines incorporate, and in some cases modify, the Interim Surplus Guidelines, define shortage conditions in the Lower Basin, allow for the creation of Intentionally Created Surplus (ICS) through conservation and augmentation projects, and provide for delivery of ICS subject to forbearance by the Lower Basin Contractors. The Interim Guidelines will remain in effect until 2026.

2009 Governor's Blue Ribbon Panel on Water Sustainability

In 2009, as part of Governor Jan Brewer's commitment to collaboration on water resource issues, the Blue Ribbon Panel on Water Sustainability was tasked with initiating a statewide effort aimed at improving the long term sustainability of Arizona's water supplies and to provide advice to ADWR, ADEQ, and the ACC on the technical, legal, and policy aspects of promoting recycling of wastewater, gray water, industrial process water, and storm water.

2010 Minute 318

Agreement between the United States and Mexico as part of the continuing implementation of the 1944 Mexican Water Treaty related to the use of the Colorado River. Under Minute 318, Mexico will be able to temporarily defer delivery of a portion of its annual Colorado River water allotment while repairs are made to the irrigation system in the Mexicali Valley of Baja California as a result of an April 4, 2010 earthquake.

2011 Water Resources Development Commission Report

The WRDC, a study Commission authorized by the Arizona legislature in 2010, releases it report analyzing the projected water demands for the following 25, 50 and 100 years in comparison to the projected available water supplies in Arizona. The WRDC Report finds that there is a possible imbalance of approximately 3.2 MAF in Arizona in the year 2110.

2012 Arizona Celebrates its Centennial

Minute 319

Agreement between the United States and Mexico as part of the continuing implementation of the 1944 Mexican Water Treaty related to the use of the Colorado River. The Minute is a five-year cooperative agreement between Mexico and the United States (on behalf of the seven Colorado River Basin States - including Arizona) that provides a framework for: long-term planning and conservation activities;

protection of water levels in Lake Mead to reduce the potential for water shortage; and potential development of additional sources of water from joint United States-Mexico water development projects.

Colorado River Basin Water Supply and Demand Study Released
The US Bureau of Reclamation, in cooperation with the seven Colorado River Basin States issues a comprehensive assessment of water supplies and demands in the Colorado River basin through the year 2060. The Basin Study concludes that there is a median imbalance of approximately 3.2 MAF between existing supplies and projected demands for 2060.

2013 Bureau of Reclamation Announces Reductions in Water Releases from Glen Canyon Dam
In August of 2013, the U.S. Bureau of Reclamation released its monthly Operation Plan for Colorado River System Reservoirs 24-Month Study (Study), which projects that releases from Lake Powell into Lake Mead in water year 2014 (October 2014 through September 2015) will be reduced by 9% as compared to 2013 (7.48 million acre-feet versus 8.23 MAF). The study also indicates that releases will most likely be 7.48 MAF again in 2015. These back–to-back reductions could cause Lake Mead's elevation to fall below the 1075 foot elevation by the end of 2015, which would result in the U.S. Secretary of the Interior declaring a Lower Basin shortage for 2016. This would be the first time the Secretary has officially announce a shortage in the Lower Basin.

APPENDIX II – "Law of the River"

- **Colorado River Compact (1922)**
  - Divided River Between Upper Basin and Lower Basin States
    - Upper Basin States of Colorado, New Mexico, Utah, Wyoming and portion of Arizona
    - Lower Basin States of Arizona, California, and Nevada
  - Allocated 7.5 MAF to Upper Basin and 7.5MAF to Lower Basin

- **Boulder Canyon Project Act (1928)**
  - Authorized Federal Construction of:
    - Boulder (Hoover) Dam
    - Imperial Dam & Desilting Works
    - All-American Canal
  - Established Lower Basin Allocations
    - Arizona 2.8 MAF
    - Nevada 300 KAF
    - California 4.4 MAF

- **California Limitation Act (1929)**
  - Unlawful for California entities to use more than the Entitlement (4.4MAF)

- **California Seven Party Agreement (1931)**
  - Divided & Prioritized Colorado River Water Between Ag Users (3.85MAF) and Urban Users (500KAF)

- **Mexican Water Treaty (1944)**
  - Guaranteed 1.5 MAF to Mexico
  - During "Surplus" on the River provided an additional 200KAF to Mexico
  - Mexico to share proportionately any "shortages"

- **Upper Colorado River Basin Compact (1948)**
  - Divided Water Between Upper Basin States
    - Colorado 51.75%
    - New Mexico 11.25%
    - Utah 23%
    - Wyoming 14%
    - Arizona 50,000AF
  - Creation of the Upper Colorado River Commission

- **Colorado River Project Storage Act (1956)**
  - Authorized Construction of Glen Canyon Dam
    - Provides 1000 MW of hydroelectric generating capacity
    - 24 million AF Storage Reservoir
    - Provides the means for the Upper Basin States to meet their Compact obligation to the Lower Basin States
  - Also Authorized Construction of Flaming Gorge Dam, Navajo Dam, & the Aspinall Unit

- **AZ. v. CA. Decree (1964)**
  - Provided Arizona (and Nevada) with "rights" to in-State Streams & Rivers (Tributary Flow)
  - Confirmed the Lower Basin Entitlements

- Gave Secretary the responsibility of "Water Master" in the Lower Basin
- Allowed CA to continue to use "unused apportionment" – but gave no permanent "rights"
- Directed the Secretary to prepare an annual accounting of water use in Lower Basin
- Charged the Secretary with determining "surplus" and "shortage" conditions/operations
- Established "reserved rights" to approximately 900,000 AF to five Tribes located along River (included within the 7.5MAF allocation)

- **Colorado River Basin Project Act (1968)**
  - Authorized Construction of Central Arizona Project

- **Minute 242 - Mexican Treaty (1973)**
  - Requires U.S. to adopt measures to ensure that 1.36 million acre-feet of water delivered annually to Mexico upstream of Morelos Dam shall have an average salinity of no more than 115 (+/-30) parts per million over the annual average salinity of Colorado River water arriving at Imperial Dam.
  - Requires U.S. to deliver to Mexico, across the land boundary at San Luis, Arizona, and in the Limitrophe Section of the Colorado River downstream from Morelos Dam, approximately 140,000 acre-feet of water annually, with salinity substantially the same as that of water customarily delivered there.
  - Requires that the concrete-lined Main Outlet Drain Extension (MODE) be extended from Morelos Dam to the Cienega de Santa Clara in Mexico at United States expense.
- **Salinity Control Act (1974)**
  - Provided the means to comply with the obligations made by the U.S. to Mexico in Minute No. 242
  - Authorized Construction of the Yuma Desalinization Plant in Arizona
  - Authorized Construction of the Protective and Regulatory Pumping Unit – the 242 Well Field in Arizona

- **Arizona Water Banking Authority (1996)**
  - Established as a mechanism for Arizona to fully utilize its CAP allotment.
  - Storage of unused CAP water underground for times of shortage.

- **Off-stream Storage of Colorado River Water and Development and Release of Intentionally Created Unused Apportionment in the Lower Division States (1999)**
  - Enables interstate water banking in the Lower Colorado River Basin

- **Colorado River Interim Surplus Guidelines (2001)**
  - Defines conditions for declaration and implementation of surplus operations in the Lower Basin of the Colorado River.

- **Agreement for Interstate Water Banking (2001)**
  - The Arizona Water Banking Authority, the Southern Nevada Water Authority and the Colorado River Commission of Nevada reach an agreement allowing the storage of Colorado River water in Arizona for future uses in Nevada.

- **Record of Decision on Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (2007)**
  - Provide for coordinated management of Lake Mead and Lake Powell.
  - Define shortage conditions in the Lower Basin
  - Allow for the creation of Intentionally Created Surplus (ICS) in the Lower Basin through conservation and augmentation projects
  - Provide for delivery of ICS subject to forbearance by the Lower Basin Contractors.
  - ** The Interim Guidelines are only effect until 2026.**

- **Minute 318 - Mexican Treaty (2010)**
  - In response to Earthquake Damage in Mexicali Valley – allows Mexico to store water that cannot be delivered in Lake Mead until repairs are complete

- **Minute 319 - Mexican Treaty (2012)**
  - Allows Mexico to create Intentionally Created Mexican Allocation (similar to ICS in 2007 Guidelines)
  - Mexico agrees to take shortages at the same Lake Mead elevations as Lower Basin states
  - Provides for a base flow and pulse flow to study restoration of the Mexican Delta
  - **Only effective until 2017**

APPENDIX III – Arizona Stakeholder/Planning Efforts (2000-2010)

Water Resources Development Commission (2010)

In 2010, the Water Resources Development Commission was formed by HB 2661 for the purpose of assessing the current and future water needs of Arizona with greater focus on meeting the water needs in rural Arizona. The Director of the Department of Water Resources served as the Chairman of the Commission and was directed to select members to represent statewide water users and water use sectors to make up the Commission.

The WRDC was tasked to: (1) compile and consider the projected water needs of each county in Arizona in the next 25, 50 and 100 years; (2) identify and quantify the water supplies currently available in each county; (3) identify potential water supplies to meet additional demands in the same time frame, and the legal and technical issues associated with using them; (4) identify potential mechanisms for financing the acquisition, treatment and delivery of water supplies; and (5) make recommendations regarding further studies or necessary legislation required for implementation.

The Commission concluded that without proactive and localized water management strategies future water supply and demand imbalances may exist throughout the state, and, therefore, there is a need to acquire additional water supplies and develop infrastructure to access new and existing unused water supplies. The Commission recommended the formation of Regional Water Augmentation Authorities to assist communities in developing future water supplies and water infrastructure. Membership in the Regional Water Augmentation Authorities is proposed to be voluntary and may include Arizona cities, towns, private water utilities, other statutorily defined water providers, private entities, counties and State, Tribal and Federal entities. The Commission also identified current funding options available to the Regional Water Augmentation Authorities to meet the needs of their members.

Governor’s Blue Ribbon Panel on Water Sustainability (2009)

In 2009, as part of Governor Jan Brewer’s commitment to collaboration on water resource issues, the Blue Ribbon Panel on Water Sustainability (Panel) was tasked with initiating a statewide effort aimed at improving the long term sustainability of Arizona’s water supplies through increased conservation and recycling. The Director of the Arizona Department of Water Resources, Director of the Arizona Department of Environmental Quality and Chairman of the Arizona Corporation Commission made co-chaired the Panel.

The Panel was formed to identify and overcome obstacles to increased water sustainability. The Panel was challenged to provide advice to ADWR, ADEQ, and the ACC on the technical, legal, and policy aspects of promoting recycling of wastewater, gray water, industrial process water, and storm water. The Panel focused on wastewater reuse through detailed examinations of water quality, regulatory impediments, infrastructure requirements and public perception challenges that could limit the increased use of this important water supply. The Panel membership was composed of 40 members representing large and small cities, counties, agriculture, industry, Indian Tribes, environmental interests, Arizona universities, legislative leaders, and other leaders in Arizona water issues.

On November 30, 2010, the Final Report of the Governor’s Blue Ribbon Panel on Water Sustainability was released. The report contains 18 sets of recommendations to advance Arizona’s water sustainability future. Recommendations were organized into five categories: Education/Outreach, Standards, Information Development & Research Agenda, Regulatory Improvements, and Incentives.

Statewide Water Advisory Group (2006)

In 2006, the Statewide Water Advisory Group (SWAG) was formed to identify and discuss programs needed to continue developing a reliable water supply for the future. The purpose of SWAG purpose was to advise the

Arizona Department of Water Resources regarding programs for water resources development and management necessary to provide a sustainable water supply in all parts of Arizona and generate suggestions and activities for ultimate consideration by the Legislature. SWAG membership was made up of 50 citizens and city and county government, environmental, agricultural, and resource groups.

The following legislation was initiated out of the SWAG:

1) Authority for County Board of Supervisors or municipalities to adopt water adequacy provisions that require new subdivisions that are located outside of AMAs to have a 100-year water supply
2) The creation of the Water Supply Development Revolving Fund and the Water Supply Development Fund Committee;
3) Provided for an initiative to be brought to the votes in a portion of the Upper San Pedro Groundwater Basin to establish the Upper San Pedro Water District to develop local authorities on water related issues, as they currently exist or may evolve over time; and
4) The expansion of well impact rules to apply to all wells statewide.

Governor's Drought Task Force (2003)

In 2003, the Governor's Drought Task Force was established to address drought issues facing all Arizonans. This group was tasked with developing: a short-term drought plan to respond and mitigate water shortages; a long-term drought mitigation and coordination plan for the state and to address various specified areas of concern; and the development and implementation of a statewide water conservation strategy.

An Arizona Drought Preparedness Plan was created to assist State leaders, planners, and resource managers, in preparing for and responding to current and future drought conditions in Arizona. The Arizona Drought Preparedness Plan consists of two components: Background and Impact Assessment defines drought in Arizona, provides an historical context of drought, and catalogues the historical impacts and sources of drought vulnerability of water use sectors and water supplies; and an Operational Drought Plan that identifies regional vulnerability to drought impacts, identifies drought response options, defines drought mitigation strategies, outlines monitoring activities and programs to alert water users and resource managers of the onset of drought, and provides an implementation plan to respond to drought events.

Governor's Water Management Commission (2000)

In 2000, the Governor's Water Management Commission was established with the purpose of evaluating the goals outlined in the 1980 Groundwater Management Code to assure that they remain achievable; study ways to reduce the use of mined groundwater and increase the use of renewable supplies; and to make recommendations regarding changes to statutes or rules to ensure that Arizona's management practices will help to achieve a long-term, reliable water supply.

APPENDIX IV – Acronyms and Abbreviations

4FRI	Four Forest Restoration Initiative
A.R.S.	Arizona Revised Statutes
ACC	Arizona Corporation Commission
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AF	Acre-Feet
AFY	Acre-Feet per Year
AMA	Active Management Area
ASLD	Arizona State Land Department
AWBA	Arizona Water Banking Authority
AZGF	Arizona Game and Fish Department
Basin	Groundwater Basin
Basin States	Colorado River Basin States
Basin Study	Colorado River Basin Water Supply and Demand Study
BIA	U. S. Bureau of Indian Affairs
BLM	U.S Bureau of Land Management
CAGRD	Central Arizona Groundwater Replenishment District
CAP	Central Arizona Project
CFS	cubic feet per second
CSP	Concentrated Solar Power
CWA	Clean Water Act
DWID	Domestic Water Improvement District
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESRV	East Salt River Valley
FICO	Farmers Investment Company
FMC	Freeport McMoRan Copper and Gold, Inc.
Forest Service	U.S. Department of Agriculture Forest Service
FWS	U.S. Fish and Wildlife Service
GMA	Groundwater Management Act
gpm	Gallons per minute
GSF	Groundwater Savings Facility
GWSI	Groundwater Site Inventory Program
HCP	Habitat Conservation Plan
ID	Irrigation District
IDD	Irrigation and Drainage District
INA	Irrigation Non-Expansion Area
LCR MSCP	Lower Colorado River Multi-Species Conservation Program
M&I	Municipal and Industrial
MAF	Million Acre-Feet
MCWA	Mohave County Water Authority
MGD	Millions Gallons per Day
MVIDD	Mohave Valley Irrigation and Drainage District

MWh	Megawatt hour
NDWR	Navajo Department of Water Resources
NEPA	National Environmental Policy Act
NGS	Navajo Generating Station
NIA	Non-Indian Agricultural
NPL	National Priorities List
NRA	National Recreation Area
NWR	National Wildlife Refuge
P.L.	Public Law
PCE	Perchloroethylene
RCRA	Resource Recovery and Conservation Act
Reclamation	U.S. Bureau of Reclamation
S&T	Sever and Transfer
SAWRSA	Southern Arizona Water Rights Settlement Act
Settlements Act	Arizona Water Settlements Act
SGCTP	South Grand Canyon Treatment Plant
SNWA	Southern Nevada Water Authority
SPRNCA	San Pedro Riparian National Conservation Area
SRP	Salt River Project
TCE	Trichloroethylene
TDS	Total dissolved solids
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of Interior
USF	Underground Storage Facility
USGS	U.S. Geological Survey
WMIDD	Wellton-Mohawk Irrigation and Drainage District
WQARF	Water Quality Assurance Revolving Fund
WRDC	Water Resources Development Commission
WWTP	Waste Water Treatment Plant
YDP	Yuma Desalting Plant

APPENDIX V – Definitions and Key Terms

Acre-foot (AF): The volume of water needed to cover one acre of land, one foot deep; one acre-foot is 325,851 gallons or approximately enough water to provide for approximately two families of four living in a single-family home for one-year.

Active Management Area: A geographic area that has been designated pursuant to A.R.S.§ 45-411 as requiring active management of groundwater or, in the case of the Santa Cruz AMA, active management of any water, other than stored water, withdrawn from a well.

Agricultural water use: Water applied to two or more acres of land to produce plants or parts of plants for sale for human consumption or for use as feed for livestock, range livestock or poultry.

Alluvium: A deposit of earth, sand, and other transported matter left by water flowing over land not permanently submerged; chiefly applied to the deposits formed in river valleys and deltas.

Artificial recharge: Water recharged to the aquifer through recharge projects, which may be recovered annually or in the future based on accrued recharge credits.

Aqueduct: An artificial channel for conveying water.

Aquifer: A geologic formation that contains sufficient saturated materials to be capable of storing water and transmitting water in usable quantities to a well.

Augmentation: To supplement existing water supplies.

Baseflow: The part of a stream discharge that is not attributable to direct runoff from precipitation or melting snow. It is sustained by groundwater discharge and may be considered as normal day-to-day flow during most of the year.

Brackish Groundwater: Brackish water supplies are more highly saline than fresh water, but have lower salinity than seawater. Brackish groundwater is defined as having a total dissolved solids (TDS) concentration between 1,000 and 10,000 milligrams per liter (mg/L).

Colorado River Basin States (Basin States): In accordance with the Colorado River Compact of 1922, the Colorado River Basin is comprised of parts of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming, within and from which waters drain naturally into the Colorado River. These seven states are referred to as the Basin States.

Community Water System: A public water system, as defined in A.R.S. § 49-352(B), that serves at least fifteen service connections used by year-round residents of the area served by the system or that regularly serves at least twenty-five year-round residents of the area served by the system.

Desalination: The process of removing dissolved salts from water, thus producing fresh water from seawater or brackish water.

Drought: A sustained natural reduction in precipitation that results in negative impacts to the environment and human activity.

Earth fissure: Fractures or cracks that form in alluvial basins due to substantial groundwater overdrafts that produce local subsidence.

Evapotranspiration: Term describing the transport of water into the atmosphere from surfaces, including soil (soil evaporation), and from vegetation (transpiration).

Exempt well: Within an AMA, a well having a pump with a maximum pumping capacity of 35 gallons per minute or less, which is used to withdraw groundwater for non-irrigation purposes. This term is also used to describe any well outside an AMA having a pump with a maximum pumping capacity of 35 gallons per minute or less.

General Stream Adjudication: A judicial proceeding to determine or establish the extent and priority of water rights in the Gila and Little Colorado River Systems.

Groundwater: Water under the surface of the earth regardless of the geologic structure in which it is standing or moving. Groundwater does not include water flowing in underground streams with ascertainable beds and banks.

Groundwater Basin: An area which may be designated so as to enclose a relatively hydrologically distinct body or related bodies of groundwater, which shall be described horizontally by surface description.

Groundwater Savings Facility: A facility that meets the requirements of *A.R.S. §45-812.01* in an active management area or an irrigation non-expansion area at which groundwater withdrawals are eliminated or reduced by recipients who use in lieu water on a gallon-for-gallon substitute basis for groundwater that otherwise would have been pumped from within that active management area or irrigation non-expansion area.

Hydroelectricity: Electric current produced from water power.

Hydroelectric power: Electrical capacity produced by falling water.

Hydrograph: A graphic representation of the changes in the flow of water or the elevation of water levels over time.

Industrial water use: A non-irrigation use of water not supplied by a city, town or private water company, including animal industry use and expanded animal industry use.

Irrigation Non-Expansion Area (INA): A geographic area that has been designated pursuant to *A.R.S. § 45-431 or 45-432* as having insufficient groundwater to provide a reasonably safe supply for the irrigation of cultivated lands at the current rate of withdrawal. Within INA's, new agricultural use

occurring on land that was not irrigated in the five years preceding the designation of the INA is prohibited with a few exceptions for substitution or transfer of acres under specified circumstances.

Importation: To bring new water supplies from outside of Arizona.

Land subsidence: Land subsidence is the lowering of the elevation of the ground surface usually caused by the over-extraction of groundwater, oil, gas, or other material.

Lower Colorado River Basin States (Lower Basin): The states of Arizona, California, and Nevada make up the Lower Colorado River Basin.

Mainstem: The main course of a river or stream.

Municipal water use: All non-irrigation uses of water supplied by a city, town, private water company or irrigation district, except for uses of water, other than Colorado River water, released for beneficial use from storage, diversion or distribution facilities to avoid spilling that would otherwise occur due to uncontrolled surface water inflows that exceed facility capacity.

Overdraft: Occurs when more groundwater is being pumped than the amount of water naturally or artificial recharged to the aquifer.

Present Perfected Rights: A water right recognized by the U.S. Supreme Court Decree of 1964 in Arizona v. California which existed prior to June 15, 1929 (the effective date of the Boulder Canyon Project Act). The 1979 Supplemental Decree of the U.S. Supreme Court in Arizona v. California lists and quantifies these Present Perfected Rights.

Prior Appropriation: The surface water right doctrine applicable in those portions of Arizona not receiving Colorado River water. This doctrine is based on the tenet of "first in time, first in right" which means that the person who first puts the water to a beneficial use acquires a right that is superior to later appropriators of the water.

Rainwater harvesting: The collection of rainwater for future uses.

Reasonable and Beneficial Use: A legal doctrine that describes the limit and extent of water use.

Recharge: Water added to the aquifer through seepage and infiltration.

Reclaimed water: Water that has been collected in a sanitary sewer for subsequent treatment in a facility that is regulated as a sewage system, disposal plant or wastewater treatment facility. Such water remains effluent until it acquires the characteristics of groundwater or surface water.

Reservoir: An artificially created lake where water is collected and stored for future use.

Runoff: Water from rain or snow that flows over the surface of the ground into streams.

Safe-yield: A groundwater management goal which attempts to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial recharge in the active management area.

Surface water: The waters of all sources, flowing in streams, canyons, ravines or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwater, wastewater or surplus water, and of lakes, ponds and springs on the surface.

Transportation: The movement of groundwater from the point of withdrawal to the point of use.

Underground Storage Facility: means a constructed underground storage facility or a managed underground storage facility. “Constructed underground storage facility” means a facility that meets the requirements of section *A.R.S. § 45-811.01* and that is designed and constructed to store water underground pursuant to permits. “Managed underground storage facility” means a facility that meets the requirements of section *A.R.S. § 45-811.01* and that is designed and managed to utilize the natural channel of a stream to store water underground pursuant to permits through artificial and controlled releases of water other than surface water naturally present in the stream. Surface water flowing in its natural channel is not a managed underground storage facility.

Tributary: A river or stream flowing into a larger river or lake.

Upper Colorado River Basin States: The states of Colorado, New Mexico, Utah and Wyoming make up the Upper Colorado River Basin.

Water Storage: Adding water to an aquifer or saving water in an aquifer.

Weather modification: The application of scientific technology that can enhance a cloud's ability to produce precipitation.