Water Resources Development Commission

Final Report

Volume II

Committee Reports

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Water Resources Development Commission
Environmental Working Group
Arizona's Inventory of Water-Dependent Natural Resources

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SUMMARY OF FINDINGS

Overview

The Inventory of Arizona's Water-Dependent Natural Resources provides the Water Resources Development Commission (WRDC) with a significant new tool to evaluate the relationship between the state's waters and the environmental resources those waters support. Developed by the Environmental Working Group of the WRDC in 2011, the Inventory catalogs a wide-range of existing data and research on natural resources associated with rivers, streams, wetlands, lakes and springs throughout Arizona. It builds upon the Arizona Department of Water Resources' (ADWR) Arizona Water Atlas by focusing on the state's riparian and aquatic habitats, the fish, wildlife and natural communities these habitats support, and the conditions currently supporting these resources.

Organized by groundwater basin, the Inventory includes this Summary of Findings, a written overview of this effort along with recommendations based on these findings, and the following:

> Tables – tables for each of Arizona's 51 groundwater basins present information on the sub-basins, watersheds, counties, water features, riparian and aquatic-dependent wildlife, and flow volumes supporting these resources associated with each basin.
>
> Maps – groundwater basin and county maps visually represent the water-dependent natural resources characterized in the tables as well as other features.
>
> Basin Summaries – written summaries for each groundwater basin provide additional information in narrative form.
>
> Methodology – written explanation of the methodology and sources used to create the tables, maps, and summaries.
>
> References – a record of the studies and research used to complete this Inventory.

To best understand the water-dependent natural resource information included in this Inventory, the tables, maps, and summaries for each basin should be used conjunctively.

The Inventory of Arizona's Water-Dependent Natural Resources clearly documents the diversity of natural resources that exist in the State of Arizona. Arizona's water and environmental resources both enhance the economy and provide citizens a high quality of life. The inventory denotes some of the following findings about Arizona:

- Arizona's 51 groundwater basins are environmentally unique and diverse.
- More than 5,000 miles of perennial flow are estimated (ADEQ & USGS, 2007).
- Upwards of one million acres of riparian areas exist (AGFD, 1994).
- More than $1.7 billion is generated from wildlife-based recreation activities (Silberman, 2001; Southwick Associates, 2002 & 2003).
- Another $1.7 billion is produced from bird watching activities (Silberman, 2001; Southwick Associates, 2002 & 2003).
- 181 sensitive wildlife species tracked by the Arizona Heritage Data Management System (HDMS) are supported by water-dependent natural resources (AGFD, 2011).

The Inventory is a significant accomplishment that provides a better understanding of Arizona's water-dependent natural resources as we look at how to meet statewide water demands in the next 25, 50, and 100 years. The Inventory also demonstrates that additional data, quantification, and research are needed to ensure we continue to increase our understanding of water-dependent natural resources and anticipate and minimize risks to these resources as we move into the future.

Objective & Scope of the Inventory

The Environmental Working Group was formed under the work plan developed by ADWR for the WRDC. The Environmental Working Group was tasked to 1) identify current water-dependent natural resources; 2) identify conditions necessary to support them; and 3) prepare a summary of findings and recommendations including needed studies and research. Using available scientific data and methods to complete these objectives, the Environmental Working Group compiled an inventory that identifies the state's primary water-dependent natural resources and characterizes, where possible, the physical conditions of the water that supports those natural resources, which includes the state's rivers, lakes, streams, springs, wetlands, riparian and aquatic habitats, and the flora and animals, birds, fish and other wildlife.

More than 50 professionals from nearly 30 agencies, institutions, non-governmental organizations, tribes, and private sector firms stepped forward to participate in and contribute to the Environmental Working Group. Committee members reviewed and discussed over 100 studies and met at least 25 times to develop and prioritize tasks, gather data, prepare and compile the Inventory, and coordinate with other WRDC Committees.

An early decision of the Environmental Working Group was to assess only water currently in use by natural resources based on existing data. The Inventory is a catalog of current conditions; a snapshot in time. The work plan for the WRDC assigned the Environmental Working Group to determine if current and future water supplies are sufficient to meet current and additional demand. Compiling extensive amounts of research and data into one usable inventory that catalogs water-dependent natural resources was a significant challenge considering the time frame given to the Environmental Working Group. The Environmental Working Group did quantify current flow supporting water-dependent natural resources for 12 of the state's 51 basins for which data was available. Data was not available to identify current flow for the remainder of the basins with perennial flow as well as flow volumes needed to support water-dependent natural resources in the future. Developing the information necessary to satisfy these needs would be a lengthy scientific endeavor requiring additional information on perennial stream flow and an assessment of future cultural uses, effects of changing climate, and how these factors will affect riparian and aquatic habitats and the wildlife they support.

Content of the Inventory

The Environmental Working Group cataloged the diverse and unique water-dependent natural resources of Arizona by displaying the information as tables, maps and basin summaries. In addition, maps were created for each of Arizona's 15 counties to show this information at the county level. These materials identify groundwater sub-basins, watersheds, and counties associated with each groundwater basin.

A vast array of water-dependent natural resource data is clearly presented, including:

- The number and type of riparian, aquatic and/or marshland habitat dependent species (e.g. amphibians, birds, fish, etc.)
- Identification of species that are listed as endangered, threatened or candidate species under the Endangered Species Act
- Areas of Critical Habitat designated by the U.S. Fish and Wildlife Service under the Endangered Species Act

- Identification of major perennial streams and tributaries and their cumulative miles of flow
- Quantification of baseflow, evapotranspiration, and total flow supporting water-dependent natural resources for perennial streams in 12 groundwater basins where data was available
- Identification of perennial streams with flood flow components
- Streams classified as Outstanding Arizona Waters pursuant to A.A.C. §R18-11-112
- ADWR information related to instream flow water rights
- Important water resources within federal or state designated conservation and recreation lands such as national and state parks, wilderness areas, national conservation areas and others
- Important Bird Areas identified by the Arizona Audubon Society
- Identification of water courses that may be supported by effluent or other water discharges and the associated volumes
- Identification of Effluent-Dependent Waters pursuant to A.A.C. §R18-11-113
- The number, flow range and cumulative discharge volumes of major and minor springs
- The number of large and small reservoirs and the associated storage volumes
- The number of stockponds and wildlife catchments
- Water-based recreational values
- Federally designated Wild and Scenic Rivers pursuant to the Wild & Scenic Rivers Act

Information related to some categories of water-dependent natural resources as well as important information about legal and institutional characteristics of particular water resources was not included. For example, intermittent and ephemeral streams, which have ecological and hydrological significance (Levick et al., 2008) are not characterized or mapped here. Also, some water in a stream may be the subject of a water right under state or federal law. Some of these rights are well-settled and others have not been quantified and/or adjudicated. While this type of information has an important bearing on water resource planning, it was beyond the scope and capacity of the Working Group to catalog this information.

Quantifying Water Flow for Water-Dependent Natural Resources

While each table contains a significant amount of information, the Environmental Working Group wanted to be able to show the quantifiable current water flow supporting water-dependent natural resources. After evaluating available data and consulting with members of the scientific community (see Methodology Section), the Working Group concluded that it was feasible to develop a set of quantitative estimates of flow volumes for a subset of the state's rivers, which includes 12 of Arizona’s 51 groundwater basins (Agua Fria, Aravaipa Canyon, Bill Williams, Cienega Creek, Lower San Pedro, Safford, Salt River, Santa Cruz AMA, Tonto Creek, Tucson AMA, Upper San Pedro, and the Verde River). The tables for the other groundwater basins do not include estimated flow volumes because the comprehensive data and research to access and then quantify a specific water flow is lacking.

The Environmental Working Group recognized there are different methods and data available for estimating flow volumes and that results may vary depending upon which methods and data are used. Rather than select one technique and rely on one set of estimates, two sets of estimates were developed. This approach provides some advantages. First, given the goal was to develop a first approximation rather than a precise set of flow estimates, a range of flow estimates for watersheds is more appropriate. Second, generating a range of estimates enables the members of the WRDC, Environmental Working Group, and scientific community to better understand sources of variation in the different methods and data, which will lead to future refinements in methodologies and the overall certainty of results. To develop a general estimate of current flow volumes supporting water-dependent natural resources, the Working Group started by identifying the components of flow that support these resources. Based on studies of water budgets and discussions with experts in hydrology, two components were identified:

Baseflow is the part of stream flow originating from groundwater discharge and that sustains year-round flow.

Evapotranspiration (ET) refers to the combined amount of water evaporated from riparian soil, open water surfaces, and transpired by riparian vegetation.

The Environmental Working Group did not include two other components, groundwater underflow and flood flow, in the calculations. Ideally, each of these components would be used to calculate water flow estimates but available data were limited. For example, estimates of groundwater underflow, which is subsurface water that flows out of a basin into the next down-gradient basin, are derived through modeling rather than direct measurement. Similarly, flood flows are difficult to incorporate into a quantitative flow estimate. A practical method for integrating these parameters into a quantitative flow estimate was unavailable, and therefore, they were omitted from the estimate.

The omission of the groundwater underflow and the flood flow does not minimize their significant role in the formation and functioning of riparian and aquatic ecosystems. Flood flows, including snowmelt runoff, play a vital role in the transport of sediment, recharge of floodplain and alluvium, recruitment and dispersal of riparian plant species and, among other things, trigger breeding in some aquatic species. In addition to the annual total volume of flood flows, factors such as flood frequency, timing, and duration are also important components that affect a groundwater basin.

Therefore, in the 12 groundwater basins where it was feasible, the Environmental Working Group estimated the flow volume as a sum of the baseflow and riparian evapotranspiration. As stated in the recommendations, it would be useful to have more complete information about the other 39 groundwater basins. The baseflow and ET estimates developed by the Environmental Working Group provides a first approximation of the flow volumes currently supporting water-dependent natural resources, such as aquatic and riparian habitat for fish and wildlife. Presented in the same units of measure as the information developed by the Supply and Demand Working Group, the flow estimates for the 12 basins provide an important baseline that can be used to assess opportunities to maintain or enhance these resources as well as potential impacts to natural resources from future water developments.

Arizona & Water-Dependent Natural Resources

The tables, maps, and summaries for the 51 groundwater basins comprising this Inventory demonstrate the uniqueness and diversity of the state's natural resources. These natural resources are integral to Arizona's overall environment and character as well as to the state's economy. Water in the environment serves important and obvious functions such as drinking water for terrestrial species, water for plants, and aquatic habitat for fish and other species. It supports riparian vegetation that provides cover, food, shade, and sites for wildlife nesting and foraging. Flows of water in the environment also serve plants and animals in less obvious ways such as modulating temperatures, triggering reproduction or other life-cycle changes, contributing to nutrient and waste cycles, and maintaining the form and function of river channels in a manner that affects the functioning of the larger ecosystem. Indeed, freshwater ecosystems are complex systems in which flowing water is a central component (Annear et al., 2002; Nadeau & Megdal, 2011; Silk & Ciruna, 2004).

On the whole, riparian areas are among the most biologically diverse, abundant, and productive in North America and are especially important in semi-arid areas (Briggs, 1996). Sensitive wildlife species occurrences are tracked by Arizona Game and Fish Department through the Heritage Data Management System (HDMS). According to HDMS, 78 obligate aquatic species (those that can only live in water) including 35 native fish have been documented. Additionally, HDMS tracks 68 riparian species (those that can only live in riparian areas), which include birds, mammals, reptiles, amphibians, and invertebrates. There are also 20 species of insects and 62 plant species dependent on aquatic and riparian systems. Most wildlife relies on water in the environment (Poff et al., 1997). Eighty percent of all vertebrates spend some portion of their life cycle in riparian areas, and the majority of Arizona's threatened and endangered vertebrates depend on riparian habitat (Zaimes, 2007). The connectivity of these habitats is important as well; streams and riparian areas serve as corridors for wildlife movement and as key flyways for migratory birds (Kirkpatrick & Conway, 2007).

Ecosystems throughout Arizona depend not only on the existence of a certain quantity of water but also on the magnitude, frequency, duration, timing, and rate of flow. Each is important and may affect such factors as water quality, energy sources, physical habitat, and biotic interactions. Changes in any of these aspects of a flow can affect the ecological integrity of a water dependent area (Nadeau & Megdal, 2011). Location of a particular flow also matters. Water for natural resources needs to be understood within the context of occurring along a particular segment of stream as well as in relation to a larger system.

The health of Arizona's waters can be affected by actions taken throughout a watershed. For example, higher elevation forested watersheds provide much of the surface water and groundwater recharge in the state. It has been estimated that forested watersheds of Arizona contribute nearly 90% of the total streamflow in the state (Ffolliott & Thorud, 1975) and serve as important recharge areas for large regional aquifers (Pool, Blasch, Callegary, Leake, & Graser, 2011). Changes to land and watershed management may change the timing and rates of recharge to these aquifers (National Research Council [NRC], 2008).

The contributions that water in the environment makes to human life are ubiquitous that they may be overlooked amid the complexities of ecosystem and human social activity. Finding a consistent and appropriate way to assess their value may provide valuable information to decision makers in natural resource management. The concept of "ecosystem services" was developed as a framework to assess these values. Water-dependent natural resources throughout Arizona provide important ecosystem services that may include clean water (by supporting water quality), clean air, flood control and erosion control (by supporting healthy riparian areas), a variety of recreational opportunities, and sustainable water supplies (by contributing to groundwater recharge).

The 51 tables and maps of the groundwater basins demonstrate the importance of water to sustain the natural resources of Arizona. These natural resources are not only important to plants and animals. Rivers, springs, and other water resources are also culturally important to local communities, including Arizona's Native American tribes, and sustain places and provide materials that are culturally important to tribes and other communities. Water in rivers, lakes and streams is also important to Arizonans and those who visit Arizona who care about natural beauty, outdoor recreation, open space, and wilderness values, or just that such water dependent natural resources continue to exist for their children or grandchildren to experience. (Southwick Associates, 2002) "Water in the desert" is a quintessential characteristic of the Arizona landscape and an important part of the state's heritage.

Economics of Water-Dependent Natural Resources

Arizona's water-dependent natural resources offer notable economic opportunities because they attract large numbers of tourists, anglers, hunters, and other outdoor recreationists, while enhancing local property values and business revenues. Fishing, hunting and wildlife watching recreation activities alone generate billions of dollars in retail sales each year.

Economic studies for the state of Arizona, conducted by Southwick Associates Inc. (2003) and Arizona State University (Silberman, 2001), identified the economic benefits from hunting, fishing and wildlife watching.

The studies show these wildlife-based recreation activities generated a total economic impact of $2.8 billion in 2001, which includes retail sales and their overall ripple effect through the economy. The table below illustrates the total expenditures from retail sales alone for wildlife-based recreation activities in 2001.

County	2001 Hunting/Fishing Total (Millions)*	2001 Non-Consumptive Total (Millions)*	Totals (Millions)
Apache	$62.8	$24.8	**$87.6**
Cochise	$12.7	$13.7	**$26.4**
Coconino	$101.2	$46.6	**$147.8**
Gila	$39.4	$11.5	**$50.9**
Graham	$7.3	$7.0	**$14.3**
Greenlee	$2.5	NA	**$2.5**
La Paz	$17.8	$1.8	**$19.6**
Maricopa	$409.1	$368.3	**$777.4**
Mohave	$79.9	$30.9	**$110.8**
Navaho	$33.3	$24.4	**$57.7**
Pima	$84.5	$173.5	**$258.0**
Pinal	$20.0	$50.8	**$70.8**
Santa Cruz	$13.9	$11.9	**$25.8**
Yavapai	$40.0	$38.9	**$78.9**
Yuma	$34.2	$12.3	**$46.5**
Statewide	**$959**	**$816**	**$1.7 Billion**

Figure 1. Wildlife-Based Recreation Retail Sales in 2001

For a more localized example, in the San Pedro Riparian National Conservation Area the natural landscape attracts enough visitors to bring in $17.0 to $28.3 million to the local economy (Orr & Colby, 2002).

Southeastern Arizona was identified as the number one birding site in a study evaluating birding economics and demographics in the United States (Kerlinger, 1993). Of the U.S. total birdwatching economic output ($84 billion), over $1.5 billion may be attributed to Arizona in 2001. According to the U.S. Fish and Wildlife Service (2003), approximately 22% of Arizona residents participate in bird watching activities. With the national bird watching population estimated at 50 million people, there is clearly a large pool of U.S. citizens who could be and have been enticed to visit Arizona for birding. This means the Arizona birding industry may have the potential to expand, attract more visitors, and become an even greater economic benefit to the state (Orr & Colby, 2002).

Another water-related component to Arizona's economic success is the value added by riparian areas, wetlands, and natural waterways near private property. This added value has been explored by researchers in the Santa Cruz River Basin more than any other area in the state. Studies conducted in Tucson and the surrounding metropolitan areas all agreed that "homebuyers…place considerable value on those sections of the riparian corridor that support …riparian species" (Bark-Hodgins, Osgood, Colby, Katz, & Stromberg, 2009). Specifically, Bourne (2007) showed that homes closer to riparian areas carry a "premium" that can increase the home's value by 5.8%. Colby and Wishart (2002) support this estimate of additive home value and also state that vacant land may carry an increase of 10-27% depending on its proximity to riparian areas. Finally, another study showed that an increase in general "greenness" contributes to increased property values (Bark-Hodgins, Osgood, & Colby, 2006).

In summary, wildlife related recreation, outdoor recreation activities, and close proximity to riparian areas all produce notable economic benefits for individuals and businesses across Arizona. Many watchable wildlife dollars are often spent at retailers, manufacturers, and support services in rural or lightly populated areas and constitute a larger contribution to those economies than for more urban and highly populated areas. Thus, the economic contributions of water-dependent outdoor recreation activities are particularly important to Arizona's rural economic base.

Potential Risks to Water-Dependent Natural Resources

The Environmental Working Group did not attempt to assess potential risks to the state's water-dependent natural resources, trends affecting these resources, or the level of legal or other protection afforded to water supporting these resources. Risks to particular resources may exist; human activities and natural events have caused substantial alterations to riparian areas (Zaimes, 2007). The risk to a particular resource will depend on a variety of circumstances that deserve consideration in the future.

RECOMMENDATIONS

This Inventory is a unique accomplishment in cataloging a wide range of research and data into one place, thus providing a snapshot of Arizona's water-dependent natural resources that we enjoy. From the various work involved in compiling this Inventory, the Environmental Working Group proposes the following recommendations:

1. The Working Group recommends that the Inventory be a standalone document that could be used to inform local, regional and statewide decision makers and water resource planners when it comes to issues involving Arizona's water-dependent natural resources.
2. The Inventory demonstrates that additional data and research is needed. Additional knowledge of the condition and trend of resources that depend on water, particularly those that comprise the riparian and aquatic communities, are needed to guide future land and water resource planning. Various data and research projects can be identified but the following are four key examples of such further data and research:
    a. A comprehensive, spatially-explicit inventory of the state's riparian habitat is needed to better plan for the management of the riparian resource.
    b. A complete and current field assessment of the extent of perennial and intermittent surface water would enable a better understanding of how to manage surface water in the future.
    c. Water planning efforts have benefitted from development of detailed modeling data on the relationship between groundwater and surface water. Additional work is needed to characterize this connection in other basins to aid communities in efforts to manage water sustainably for both people and the environment.
    d. The Inventory was able to quantify the current flow supporting water-dependent natural resources in portions of 12 of the 51 groundwater basins. Additional work is needed to identify and quantify such flow in all of Arizona's groundwater basins.
3. Evaluation of future water supply options should include consideration of the potential impacts on and risks to water-dependent natural resources.

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TABLE 1. WATER-DEPENDENT NATURAL RESOURCE INDEX

Water-Dependent Natural Resource Index for the Water Resource Development Commission

BASINS	Perennial Water (Instate)	Basin Includes Colorado River	Major Springs	Waters in Federal / State Conservation Lands	Current GW-SW Connection*	Effluent Dependent Stream Reach	ESA Critical Habitat Designated	ESA Species Observed	Instream Flow Certificate	Audubon Important Bird Area	Water Based Recreation Opportunity	ADEQ Outstanding Arizona Water	Federal Wild and Scenic Designation
AGUA FRIA	▧		■	■	■		■	■	■	■	■		
ARAVAIPA CANYON	▧		■	■	■		■	■	■	■	■	■	
BIG SANDY	■		■		■		■	■			■		
BILL WILLIAMS	▧	■	■	■	■		■	■	■	■	■	■	
BONITA CREEK	■		■	■	■			■			■	■	
BUTLER VALLEY													
CIENEGA CREEK	▧		■	■	■	■	■	■	■	■	■	■	
COCONINO PLATEAU	■	■	■	■	■	■	■	■		■	■		
DETRITAL VALLEY		■		■			■				■		
DONNELLY WASH	■				■		■	■			■		
DOUGLAS				■				■	■		■		
DRIPPING SPRINGS WASH	■		■	■	■		■	■	■		■		
DUNCAN VALLEY	■		■	■	■		■	■			■		
GILA BEND						■		■			■		
GRAND WASH		■	■	■			■	■			■		
HARQUAHALA INA													
HUALAPAI VALLEY		■	■	■			■	■			■		
KANAB PLATEAU	■	■	■	■	■	■	■	■		■	■		
LAKE HAVASU		■		■			■	■			■		
LAKE MOHAVE		■	■	■			■	■			■		
LITTLE COLORADO RIVER PLATEAU	■		■	■	■	■	■	■		■	■	■	
LOWER GILA		■		■			■	■		■	■		
LOWER SAN PEDRO	▧		■	■	■	■	■	■	■	■	■	■	
MCMULLEN VALLEY													
MEADVIEW		■	■	■			■	■			■		
MORENCI	■		■	■	■		■	■		■	■	■	
PARIA	■	■		■	■					■	■		
PARKER		■		■			■	■			■		
PEACH SPRINGS		■	■	■	■		■	■			■		
PHOENIX AMA	■		■	■	■	■		■	■	■	■		
PINAL AMA						■		■			■		
PRESCOTT AMA	■		■	■	■	■	■	■		■	■		
RANEGRAS PLAIN													
SACRAMENTO VALLEY		■	■	■			■	■			■		
SAFFORD	▧		■	■	■	■	■	■		■	■	■	
SALT RIVER	▧		■	■	■	■	■	■	■	■	■	■	
SAN BERNARDINO VALLEY	■			■	■		■	■			■		
SAN RAFAEL	■			■	■		■	■		■	■		
SAN SIMON WASH								■			■		
SANTA CRUZ AMA	▧		■	■	■	■	■	■		■	■		
SHIVWITS PLATEAU		■	■	■			■	■			■		
TIGER WASH													
TONTO CREEK	▧		■	■	■		■	■	■	■	■		
TUCSON AMA	▧		■	■	■	■	■	■		■	■		
UPPER HASSAYAMPA	■				■		■	■	■		■		
UPPER SAN PEDRO	▧		■	■	■	■	■	■	■	■	■		
VERDE RIVER	▧		■	■	■	■	■	■	■	■	■	■	■
VIRGIN RIVER	■		■	■	■		■	■			■		
WESTERN MEXICAN DRAINAGE			■	■			■	■					
WILLCOX	■		■	■	■		■	■		■	■		
YUMA		■			■			■		■	■		

▧ Hatched cells represent perennial streams within groundwater basins where current flow volumes that support water-dependent natural resources have been estimated.

This table depicts major water-dependent natural resources cataloged by the Environmental Workgroup of the WRDC. It is not meant to be a comprehensive assessment of *all* important water-dependent natural resources, and some potentially important features are not represented here. Rather, this information is meant to be used as a starting point for identifying important water-dependent natural resources in Arizona's counties and groundwater basins. For a more detailed description of known resources in each groundwater basin, please review the Maps, Basin Descriptions and Environmental Conditions Table. For a description of the

*Brown DE, Carmony NB, Turner RM. 1981. Drainage map of Arizona showing perennial streams and some important wetlands. Arizona Game and Fish Department, Phoenix.

*Anning, D.W. and Konieczki, A.D. 2005. Classification of hydrogeologic areas and hydrogeologic flow systems in the Basin and Range Physiographic Province, Southwestern United States. USGS Professional Paper 1702. 37 pp.

BASIN SUMMARIES

AGUA FRIA

The Agua Fria Basin located predominantly in Yavapai County is characterized by mid-elevation mountain ranges and high mesa semi-desert grasslands. The Agua Fria River flows intermittently from east of Prescott to the Gila River west of Phoenix. Vegetation types include Arizona upland Sonoran desertscrub, semidesert grassland, interior chaparral, montane conifer forests and Great Basin conifer woodland. Riparian vegetation is found along the Agua Fria River including mixed broadleaf and Cottonwood/Willow assemblages.

Important Riparian, Aquatic, and Wetland Resources

The Agua Fria River and its tributaries support the riparian system, and drain into Lake Pleasant—a popular recreation area for boating and fishing. The river cuts through Agua Fria National Monument and is fed along the way by several major and minor tributaries including, Big Bug, Ash, Sycamore, and Yellow Jacket Creeks. These ribbons of valuable riparian forests contribute to an outstanding biological resource. Riparian vegetation is primarily mixed broadleaf and cottonwood-willow systems. Common species include: Fremont Cottonwood, various willow such as Narrowleaf, Goodding, and Bebb, Arizona Sycamore, Velvet and Green Ashes, Arizona Alder, Arizona Walnut, and Box Elder.

Many important aquatic and riparian wildlife species occur within the riparian forests and along the shores of Lake Pleasant. Lowland Leopard Frog, Arizona Toad, Peregrine Falcon, Bald Eagle, Belted Kingfisher, Yellow-billed Cuckoo, and Zone-tailed Hawk have all been observed. The endangered Desert Pupfish and Gila Topminnow were historically found within the stream system and were recently reintroduced to isolated springs in the Agua Fria Basin. Other aquatic and wetland species include Longfin Dace, Speckled Dace, and Great Blue Heron. Mule Deer, Javelina, Mountain Lion and Black Bear also visit the canyons and riparian areas. Other State Wildlife Species of concern observed in the basin include the Belted Kingfisher, Common Black-Hawk and Western Red Bat.

Important Conservation Lands

- The Agua Fria National Monument, BLM
- Riparian Corridors within the Agua Fria National Monument, BLM have been identified by the Arizona Audubon Society as Important Bird Areas. Over 28 species of birds have been observed including, Common Black-Hawk, Golden Eagle, Yellow-billed Cuckoo, Lucy’s Warbler, Bell’s Vireo, and Gray Vireo.
- Agua Fria Wildlife Preserve at Lake Pleasant Regional Park is also identified as a birding area by the Maricopa Audubon Society, Maricopa County, BOR
- Castle Creek Wilderness, USFS
- Hells Canyon Wilderness, BLM
- Cedar Bench Wilderness, USFS
- Pine Mountain Wilderness, USFS
- Horseshoe Ranch Wildlife Area was recently acquired by the AGFD in 2011.

Federally Protected Species and Critical Habitats

Critical habitat is designated for the Gila Chub and Mexican Spotted Owl.

Federally protected species observed in the basin include:

- Endangered- Gila Chub, Desert Pupfish, Gila Topminnow, and Southwestern Willow Flycatcher
- Threatened- Mexican Spotted Owl and the Bald Eagle
- Candidate- Western Yellow-billed Cuckoo (Western U.S. DPS), Roundtail Chub, and Northern Mexican Gartersnake

The Endangered Gila Trout was recently introduced to Grapevine Creek in the Big Bug Creek watershed.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 520,744 Angler Use Days were documented in the Agua Fria Basin, equating to over $81 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/CentralHighlands/documents/Volume_5_AGF_final.pdf

ARAVAIPA CANYON

The Aravaipa Canyon Basin is located in Graham and Pinal Counties. The basin is characterized by medium-elevation mountain ranges, canyons and valleys. Aravaipa Creek emerges from the Pinaleno, Santa Teresa, and Galiuro Mountains at an elevation of about 3,000 feet. It then flows westward and enters a narrow canyon with pronounced gradient.

Vegetation within the basin is primarily Semidesert Grassland with smaller areas of Great Basin Conifer Woodland, madrean Evergreen Woodland, Interior Chaparral and Arizona Uplands Sonoran Desertscrub. Riparian vegetation includes Cottonwood/Willow, Mesquite and mixed broadleaf.

Important Riparian, Aquatic, and Wetland Resources

Aravaipa Creek's 18-mile-long perennial reach supports the best remaining assemblage of native desert fish in Arizona including, the Roundtail Chub, Speckled Dace, Desert Sucker, Sonoran Sucker, and the Federally listed (threatened) Loach Minnow and Spikedace. Reptiles and amphibians include the Canyon Tree Frog, Lowland Leopard Frog, Red-spotted Toad, Black-necked Gartersnake, and a variety of rattlesnakes. Water resources in the basin provide habitat that was suitable for the reintroduction of Federally endangered Gila Topminnow and Desert Pupfish.

Aravaipa is famed as a birder's paradise, with nearly every type of desert songbird and more than 150 species documented in the wilderness. Birds of prey include Peregrine Falcon, Common Black-Hawk, Zone-tailed Hawk, and Elf Owl. Migratory songbirds include Vermilion Flycatcher, Black Phoebe, Canyon and Rock Wrens, White-throated Swift, Yellow Warbler, and Bell's Vireo. Healthy populations of Desert Bighorn Sheep roam the area, along with 44 other mammals such as Black Bears, Bobcats, Coyotes, and Mountain Lions. Aravaipa Creek also provides important habitat for at least nine species of bats. Other State Wildlife Species of concern observed in the basin include the Northern Gray Hawk, Western Red Bat and Western Yellow Bat.

Flows in the upper reaches of Aravaipa Creek are intermittent. Within The Nature Conservancy Preserve and Aravaipa Canyon Wilderness the flow becomes perennial, fed by springs, seeps, and tributary streams. The Nature Conservancy and the BLM have instream-flow rights that are used to maintain base flows for conservation purposes.

Important Conservation Lands

- Aravaipa Canyon Wilderness, BLM
- Aravaipa Canyon Preserve, The Nature Conservancy
- Aravaipa Canyon State Conservation Wildlife Area, AGFD
- Aravaipa Native Fish Barriers, installed by CAP, to protect and conserve native fish in the canyon; at the confluence of Aravaipa Canyon and the San Pedro River in the Lower San Pedro Basin.
- Aravaipa Creek is designated an Outstanding Arizona Water, ADEQ
- Aravaipa Creek, State Watchable Wildlife Area
- Aravaipa Creek has been identified by Arizona Audubon Society as an Important Bird Area
- Galiuro Wilderness, USFS
- Santa Teresa Wilderness, USFS

The Nature Conservancy has established an active management program to ensure the long-term protection of the stream system and its mixed broadleaf riparian forest composed of cottonwood, willow, walnut, alder, and sycamore trees. This program includes fish monitoring, controlled burning, and removal of non-native species. Their goals also include restoration of grasslands in the upper watershed. BLM management of the wilderness area supports most of these same conservation goals**.**

Federally Protected Species and Critical Habitats

Critical Habitat is designated for the Mexican Spotted Owl in higher elevations of the basin and for Spikedace and Loach Minnow in Aravaipa Creek.

Candidate Roundtail Chub are present in the creek along with Threatened Loach Minnow and Spikedace. Endangered Gila Topminnow and Desert Pupfish have been reintroduced into tributary and spring habitats in the groundwater basin. Candidate Yellow-billed Cuckoo has also been observed in the canyon. Other federally protected species observed in the basin include the Threatened Chiricahua Leopard Frog and Mexican Spotted Owl.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_ARA_final.pdf

BIG SANDY

Big Sandy Basin within Mohave and Yavapai Counties is characterized by large valleys and mid-elevation mountain ranges and plateaus. Vegetation types include Arizona upland Sonoran desertscrub, plains and Great Basin and semidesert grasslands, interior chaparral, Rocky Mountain and madrean montane forest and Great Basin conifer woodland.

Important Riparian, Aquatic, and Wetland Resources

Knight Creek and Trout Creek drain the northern part of the basin, converging 15 miles north of Wikieup to form the Big Sandy River. The Big Sandy River floodplain, upstream from Wikieup, supports dense riparian vegetation including, cottonwood-willow, mesquite and tamarisk. Sections of Trout Creek support mesquite, cottonwood-willow and mixed broadleaf communities. The Big Sandy River flows approximately ten miles southward, exiting the groundwater basin, eventually converging with the Santa Maria River just above Alamo Lake in the Bill Williams Basin. Meadow Lake is the perennial headwaters of Fort Rock Creek, a tributary of Trout Creek.

Native fish species documented in this basin include Desert Sucker, Longfin Dace, Roundtail Chub, Sonora Sucker, and Speckled Dace. Other species associated with riparian habitats include Lowland and Northern Leopard Frog, Common Black-Hawk, Zone-tailed Hawk, and the federally listed Southwestern Willow Flycatcher, Yellow-billed Cuckoo, and Yuma Clapper Rail.

Important Conservation Lands

- Wabayuma Peak Wilderness, BLM
- Juniper Mesa Wilderness, BLM
- Hualapai Mountain County Park

Hualapai Mountain County Park supports great wildlife viewing opportunities. The habitat is mainly pinion pine forest with many natural springs. It supports bear, elk, Mule Deer, Mountain Lion, Javelina and several other species. Higher elevations are home to Mule Deer, elk, Mountain Lions, foxes and a wide variety of birds.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for the Southwestern Willow Flycatcher.

Federally listed species occurring within the basin include, the Listed Endangered Southwestern Willow Flycatcher, Yuma Clapper Rail and Hualapai Mexican Vole. Other federally protected species in the basin include the Listed Threatened Mexican Spotted Owl, and Candidate Yellow-billed Cuckoo and Roundtail Chub.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_BIS_final.pdf

BILL WILLIAMS

The Bill Williams Basin, within Mohave, La Paz and Yavapai counties, is characterized by hilly terrain in much of the basin and by several major river drainages. The basin ranges from high elevation forested mountains along the western margin of the central highlands province, to low lying, rugged desert mountains and intervening alluvial valleys in the basin and range province. There is also a range of vegetation types including Arizona upland and Lower Colorado River Sonoran desertscrub, Mohave desertscrub, semidesert grassland, interior chaparral, Great Basin conifer woodland and montane conifer forest. Riparian vegetation is found along streams including cottonwood/willow, mesquite and tamarisk along Bill Williams, Big Sandy and Santa Maria Rivers and mesquite, cottonwood/willow and mixed broadleaf along sections of Burro Creek.

The Bill Williams River originates at the confluence of the Big Sandy and the Santa Maria rivers and is impounded by Alamo Dam that forms Alamo Lake. Prior to the construction of Alamo Dam, the river's flow was perennial. Today, much of the drainage flows only during rainstorms. During times of heavy runoff releases from Alamo Dam may reach as much as 7,000 cubic feet per second (CFS), they are generally less than 40 CFS. These water releases are regulated by the U.S. Army Corps of Engineers, in cooperation with the U.S. Fish & Wildlife Service.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Bill Williams Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Bill Williams River (BWR) ecosystem contains lush riparian vegetation that grows in many locations within its valley, a striking contrast to the adjacent, sparsely vegetated uplands. The BWR supports the largest stand of cottonwood-willow forest remaining along the Lower Colorado River. Riparian vegetation along the BWR is dominated by several woody species common to low elevation southwestern riparian ecosystems, including Fremont Cottonwood, Goodding Willow, Tamarisk, Seep Willow, and mesquite. Herbaceous vegetation tends to be quite sparse, except adjacent to areas where water and light availability are high. The herbaceous flora comprises the greatest plant diversity along the river. Riparian forests along the BWR provide habitat that is valuable to a great diversity of animal species.

Riparian vegetation is found along other streams and rivers in this basin including Big Sandy River, Santa Maria River, Burro Creek, Boulder Creek, Bridle Creek, Date Creek, Francis Creek, Mountain Spring Wash, Sycamore and Wilder Creek.

Vegetation patterns are also influenced by local geomorphology, flood flows and the availability of groundwater. There is a mix of canyon and valley reaches along the BWR. The canyon reaches tend to have narrower floodplains, less complex arrangements of channels, and shallower groundwater tables. The valley reaches may have multiple channels, a broader floodplain, and lower groundwater tables—especially at the upstream end.

More than 300 bird species have been sighted along the BWR, including resident, wintering, and summer breeding and migratory taxa. The BWR attracts bird watchers from around the world and has been designated an Important Bird Area by the Audubon Society and a Globally Important Bird Area by the American Bird Conservancy.

The Sonoran Yellow Warbler, Bell's Vireo, Summer Tanager, Yellow-breasted Chat, Bald Eagle, Peregrine Falcon, Gambel's Quail and Mourning Dove are found along the BWR as well Mule Deer, Desert Bighorn Sheep, and Javelina. Beaver are prevalent and have built dozens of dams along the river in between floods, influencing the river geomorphology, surface and groundwater dynamics, riparian vegetation and the animals using these habitats. At least 14 bat species occur along the BWR, many of which specialize in consuming the night-flying, nocturnal insects of the riparian zones. Mammalian predators within the BWR include Mountain Lions, Bobcats, Ringtail Cats and Grey and Kit Foxes.

Waterfowl and shorebirds frequent the Alamo Wildlife Area and Alamo Lake, including breeding populations of American White Pelican and Western Grebe. Bald Eagles nest in the wildlife area, as does the Southwestern Willow Flycatcher, Yellow-billed Cuckoo, Black-chinned Hummingbird, Gila and Ladder-backed Woodpeckers, Vermilion, Ash-throated and Brown-crested Flycatchers, Bell's Vireo, Crissal Thrasher, Phainopepla, Lucy's and Yellow Warblers, Yellow-breasted Chat, summer Tanager, Blue Grosbeak, Abert's Towhee, Bullock's Oriole, and Lesser Goldfinch. Common reptiles and amphibians that may be encountered by visitors include Common Kingsnake, Long-nosed Snake, Sonoran Mud Turtle, Desert Spiny and Ornate tree Lizards, and Red-spotted and Great Plains Toads. Other State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, California Black Rail, Clark's Grebe, Common Black-Hawk, Western Red Bat and Western Yellow Bat.

Important Conservation Lands

- Bill Williams River National Wildlife Refuge, USFWS, also a recognized Arizona Audubon Important Bird Area and a Watchable Wildlife Viewing Area
- Aubrey Peak Wilderness, BLM
- Arrastra Mountains Wilderness, BLM
- Granite Mountain Wilderness,
- Rawhide Mountains Wilderness, BLM
- Swansea Wilderness Area, BLM
- Harcuvar Mountains Wilderness, BLM
- Upper Burro Creek Wilderness, BLM
- Tres Alamos Wilderness, BLM
- Aubrey Peak Wilderness, BLM
- Alamo Lake Wildlife Area, AGFD – Arizona Audubon Important Bird Area
- Alamo Lake State Park, AZ State Parks
- Francis Creek, Burro Creek and People's Canyon Creek are designed as Outstanding Arizona Waters, ADEQ

Flow releases from Alamo Dam are being adjusted to meet a variety of natural resource objectives, including the enhancement of cottonwood-willow riparian areas and flood control. There is also an evaluation of management efforts that encourages making necessary adjustments to better achieve a sound balance between various management objectives above and below Alamo Dam.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Endangered Southwestern Willow Flycatcher along the Big Sandy

River and for Mexican Spotted Owl in the upland. Critical Habitat is also designated for the Endangered Bonytail Chub at the confluence of the BWR and the Colorado River. Gila Topminnow and Desert Pupfish have been reintroduced in small populations within tributary springs and wetlands.

Other federally listed species include the Endangered Yuma Clapper Rail, Southwestern Willow Flycatcher, Bonytail, Desert Pupfish, Gila Topminnow, and Razorback Sucker. Candidate Roundtail Chub and Yellow-billed Cuckoo have also been observed. The Mexican Spotted Owl is listed as threatened, as is the desert population of the Bald Eagle under the Endangered Species Act. The BWR and Alamo Lake provide habitat and food sources for these birds of prey.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 167,458 Angler Use Days were documented in the Bill Williams Basin, equating to over $26 million in economic revenue generated by angler activity within the basin.

Web Sources

http://billwilliamsriver.org/default.htm

http://www.wildlifeviewingareas.com/wv-app/ParkDetail.aspx?ParkID=82

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_BWM_final.pdf

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Shafroth & Beauchamp. (2006). Streamflow-Biota Relations: Riparian Vegetation. In P. Shafroth, & V. Beauchamp, (eds.), *Defining Ecosystem Flow Requirements for the Bill Williams River, Arizona* (pp. 31-40). Reston, Virginia: U.S. Geological Survey.

BONITA CREEK

Bonita Creek Basin is located in Graham County and is characterized by medium-high elevation plains and mountain ranges. The vast majority of lands within the basin are located on the San Carlos Indian Reservation. Vegetation is primarily Plains and Great Basin grassland with smaller areas of Great Basin conifer forest, interior chaparral, Chihuahuan desertscrub, semidesert grassland and Arizona uplands Sonoran desertscrub. Riparian vegetation includes mixed broadleaf, strand and mesquite on Bonita Creek.

Important Riparian, Aquatic, and Wetland Resources

A 14 mile perennial stretch of Bonita Creek flows roughly from the northwest to the southeast in a tight steep-walled canyon with scattered stands of large Cottonwood, Sycamore, Walnut, Ash and Mesquite trees. In this stretch of Bonita Creek over 140 species of birds have been recorded, including the Common Black Hawk, Zone-tailed Hawk, and Yellow-billed Cuckoo. More than 70 species nest along the creek. Bonita Creek is also a haven for native fish and frogs. Black bears and javelina are commonly seen. Bonita Creek is popular for bird watching, hiking, and picnicking, and lined with large Cottonwoods, Sycamores, and Willows.

Other State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog and American Peregrine Falcon.

Important Conservation Lands

- Bonita Creek identified as an Outstanding Arizona Water, ADEQ
- Gila Box Riparian National Conservation Area, BLM
- Fishhooks Wilderness, USFS

Federally Protected Species and Critical Habitats

There is no designated critical habitat in this basin.

Federally protected species observed in the basin include the Listed Endangered Gila Chub and the Listed Threatened Chiricahua Leopard Frog. Candidate Yellow-billed Cuckoo and Northern Mexican Gartersnake have also been observed. Bonita Creek is a candidate for native fish reintroductions as well as a proposed fish barrier to prevent non-native fish from the Gila River to move into Bonita Creek. Sensitive species in Bonita Creek consist of Longfin Dace and Speckled Dace, Sonora Sucker as well as the Lowland Leopard Frog.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_BON_final.pdf

http://visitgrahamcounty.com/birdbrochure2

BUTLER VALLEY

The Butler Valley Basin is located in the eastern part of La Paz County. The basin is characterized by a valley bordered by two mountain ranges; Harcuvar and Buckskin Mountains. Vegetation types include Lower Colorado River and Arizona uplands Sonoran desertscrub and a small amount of interior chaparral on the eastern basin boundary.

Important Riparian, Aquatic, and Wetland Resources

There are no perennial streams and no identified springs in the Butler Valley Basin. Cunningham Wash runs northeast to southwest in the northern portion of the basin. Although no observations of wildlife species of concern have been documented within this basin, Cunningham Wash may offer important habitat and movement corridors for reptiles, birds, and mammals.

Important Conservation Lands

- Rawhide Mountains Wilderness, BLM
- Harcuvar Mountains Wilderness, BLM

Federally Protected Species and Critical Habitats

There is no designated critical habitat in this basin.

No additional species of concern have been observed in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_BUT_final.pdf

CIENEGA CREEK

Cienega Creek Basin is located in Pima, Santa Cruz and Cochise counties and is characterized by a series of mid- to high-elevation mountain ranges, grasslands and woodlands. Vegetation includes Plains and Great Basin and semidesert grasslands, Chihuahuan desertscrub, madrean evergreen woodland and small portion of Rocky Mountain and montane madrean conifer forest. Riparian vegetation includes mixed broadleaf and strand on Red Rock Canyon and mixed broadleaf, mesquite and strand on Sonoita and Cienega Creeks.

Cienega Creek originates in the Canelo Hills and continues roughly 50 miles toward the northwest where it becomes Pantano Wash. From its origin in the Canelo Hills, Cienega Creek flows northwesterly through the upper Cienega basin, a wide alluvial valley separating the Northern Santa Rita and Empire Mountains to the west and Whetstone Mountains to the east. Cienega Creek continues northward through the lower alluvial basin until it bends west/northwest in the vicinity of Anderson and Wakefield Canyons. After crossing I-10, Cienega Creek again becomes perennial. In these stretches groundwater is forced upward through faults in the bedrock from aquifers near the surface.

Important Riparian, Aquatic, and Wetland Resources

The Cienega Creek Basin contains approximately 46 miles of perennial flow in Cienega Creek, Mattie Canyon, Alum Gulch, Harshaw Creek, Redrock Canyon Creek, and Sonoita Creek lined with a mature cottonwood-willow gallery. Cienega Creek flows through some of the last remaining oak grasslands in southeastern Arizona.

Cienega Creek supports outstanding examples of cottonwood-willow gallery forest and mesquite bosque. The rare marshland and perennial aquatic habitat provides a home for a wide variety of amphibians, birds, invertebrates, and riparian plants. Amphibian species include Chiricahua Leopard Frog, Lowland Leopard Frog, Tarahumara Frog, and Western Barking Frog. Diverse migratory and native birds rely on the riparian vegetation around Cienega Creek, including, Elegant Trogon, Mexican Spotted Owl, Southwestern Willow Flycatcher, Yellow-billed Cuckoo, American Peregrine Falcon, and Tropical Kingbird. Cienega Creek is one of the few remaining streams in southern Arizona that has not been invaded by non-native fish. The Las Cienegas National Conservation Area supports the largest natural population of the federally endangered Gila Topminnow in the United States, as well as a healthy population of endangered Gila Chub and the Longfin Dace. Some of the last remaining known communities of the endangered Huachuca Water Umbel can be found in Cienega Creek. Other State Wildlife Species of Concern observed in the basin include; Black-bellied Whistling Duck, Common Black-Hawk, Northern Buff-breasted Flycatcher, Northern Gray Hawk, Thick-billed Kingbird, Violet-crowned Hummingbird, and the Western Red Bat.

Important Conservation Lands

Much of upper Cienega Creek flows through the Las Cienegas Natural Conservation Area (NCA), managed by the BLM. In 1986, the Pima County Board of Supervisors established the Cienega Creek Natural Preserve, which protects over 12 miles of the lower creek. The creek’s flow is perennial through roughly half of this preserve.

- Las Cienegas National Conservation Area, BLM
- Cienega Creek Natural Preserve, Pima County
- Patagonia-Sonoita Creek Preserve, TNC, also a recognized Arizona Audubon Important Bird Area
- Santa Cruz River and Tributaries, Arizona Audubon Important Bird Areas

- Rincon Mountain Wilderness, USFS
- Mount Wrightson Wilderness, USFS
- Saguaro National Monument, NPS
- Cienega Creek identified as an Outstanding Arizona Water, ADEQ

Fish monitoring, grazing management and other conservation management activities on the Las Cienegas NCA are directed toward ensuring the long-term protection of the cienega system and associated riparian forest. Instream flow permits in the Cienega Creek Preserve, along with ongoing monitoring and restoration activities are also intended to protect one of the last remaining reaches of perennial flow.

Pima County monitors groundwater levels in the Preserve on a quarterly basis. Between 2002 and 2005, lower than average rainfall dropped water levels in most of the Preserve's monitoring wells by 10 to 20 feet. Groundwater levels throughout the Preserve rose during the fall of 2006, but remain at or below levels measured in 2000. In general, stream lengths have been decreasing over the last five years, with a drop of approximately 3.7 miles since the spring of 2002.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Mexican Spotted Owl, Gila Chub, and Huachuca Water Umbel.

The Mexican Gartersnake, identified as a Candidate for listing, has declined throughout its range in the United States, but retains a strong population in Cienega Creek. The federally Threatened Chiricahua Leopard Frog occurs only in the upper reaches of the creek. Other federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher, Gila Chub and Gila Topminnow. Threatened Mexican Spotted Owl and Yellow-billed Cuckoo and Huachuca Springsnail have also been observed.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_CCK_final.pdf

COCONINO PLATEAU

The Coconino Plateau Basin is located in Coconino County and a small portion of Mohave County. The basin is characterized by rolling high plateaus, deeply-incised canyons, and rounded volcanic mountains. Vegetation types include Mohave and Great Basin desertscrub, Plains and Great Basin grasslands, Great Basin conifer woodland and Rocky Mountain and madrean montane conifer forest. There are small areas of subalpine conifer forest and alpine tundra in the San Francisco Mountains in the southeast corner of the basin.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Coconino Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The most significant aquatic and riparian resources in the basin are the Colorado River through the Grand Canyon, the lower Little Colorado River, Havasu Creek and the lakes around Williams.

A large part of the groundwater moves northward and is discharged from springs along the Little Colorado and Colorado Rivers and Havasu Creek. The largest of these springs includes Blue Springs on the Little Colorado River where perennial flow begins in the stream, and Havasu Springs on Havasu Creek which begins the perennial flow of Havasu Creek. The two springs discharge more than 100,000 gallons per minute and 29,000 gallons per minute, respectively. Havasu Falls is located on the Havasupai Indian Reservation in Grand Canyon and stands 120 feet high. Havasu Springs have a high mineral content and calcium carbonate which precipitates to form the cascading falls, pools and natural travertine dams.

The basin is also home to numerous constructed reservoirs that provide water for the communities around Williams, as well as for recreational opportunity. They include Dogtown, City, Santa Fe, Cataract and Kaibab reservoirs in the headwaters of Cataract Canyon near Williams.

State Wildlife Species of Concern observed in the basin include; Northern Leopard Frog, American Peregrine Falcon, Golden Eagle, Bald Eagle, Osprey, Navajo Mexican Vole, and Western Red Bat.

Important Conservation Lands

- Kendrick Mountain Wilderness, USFS
- Kachina Peaks Wilderness, USFS
- Grand Canyon National Park, NPS
- Grand Canyon National Game Preserve, NPS
- Arizona Audubon Important Bird Areas - Marble Canyon, Grand Canyon (Lipan & Yaki Points)

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Humpback Chub, (translocations have occurred), Mexican Spotted Owl, San Francisco Peaks Groundsel, and Razorback Sucker.

Federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher, Humpback Chub, Kanab Ambersnail, and Hualapai Mexican Vole. The Listed Threatened Mexican Spotted Owl has also been observed.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 62,866 Angler Use Days were documented in the Coconino Basin, equating to over $9 million in economic revenue generated by angler activity within the basin.

This basin contains portions of AGFD Game management Units 7W, 7E, 9 and 10. Combined, these Game Management Units provide hunting opportunities for mule deer, whitetail deer, elk, pronghorn antelope, mountain lion, turkey, bighorn sheep and black bear. All big game species rely on surface water for maintaining healthy and abundant populations.

Web Sources

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DETRITAL VALLEY

The Detrital Valley Basin, located in Mohave County, is characterized by a wide north-south trending valley and mountains on the east and west basin margins. Lake Mead forms the northern boundary of the basin. Vegetation is almost exclusively Mohave desertscrub with small areas of semidesert grassland, interior chaparral, Great Basin conifer woodland and montane conifer forest.

Important Riparian, Aquatic, and Wetland Resources

Ephemeral Detrital Wash, the basin's main hydrological feature, runs north-south through the basin, emptying into Lake Mead at the basin's lowest elevation (1,100 feet) at Bonelli Bay.

The Detrital Valley Basin has no additional major lakes or reservoirs and no perennial or intermittent streams or rivers. Streamflow in the Detrital Valley Basin is essentially ephemeral, generated by precipitation in the surrounding mountains. Surface flow rarely reaches the central parts of the valley because of evapotranspiration and infiltration on alluvial fans—areas which provide most of the groundwater recharge.

The American Peregrine Falcon is a State Wildlife Species of Concern observed in the basin. Other species observed include Western Red-tailed Skink and Kingman Springsnail.

Important Conservation Lands

- The Mt. Wilson Wilderness Area, BLM
- Mt. Tipton Wilderness Area, BLM
- Lake Mead National Recreation Area, NPS

Detrital Valley's northern boundary follows the shore of Lake Mead. The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Razorback Sucker along the Colorado River in the northern portion of the basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_DET_final.pdf

DONNELLY WASH

The Donnelly Wash Basin is located in the eastern part of Pinal County. A segment of the Gila River flows east to west through the upper half of the basin, entering just west of Kelvin, through Cochran and exiting the basin at Price. The Gila River is regulated through this portion of the Donnelly Wash Basin. A portion of Box Canyon has perennial flow. The basin is characterized by low elevation hills, washes and canyons. Vegetation is primarily Arizona Sonoran desert scrub with a smaller area of semi-desert grassland.

Important Riparian, Aquatic, and Wetland Resources

State Wildlife Species of Concern observed in the basin include the American Peregrine Falcon, Lowland Leopard Frog and Common Black-Hawk. Other native aquatic species observed include Desert Sucker, Longfin Dace, and Sonora Sucker.

Important Conservation Lands

- White Canyon Wilderness, BLM.

White Canyon Wilderness includes the southeast portion of the Mineral Mountains. The canyon itself is narrow with walls rising as much as 800 feet almost straight up. Throughout the area are numerous side canyons. The canyon is reported to have perennial flow. Mountain lion and black bear have been observed.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Southwestern Willow Flycatcher and Spikedace.

Federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher, Threatened Spikedace, and Candidate Yellow-billed Cuckoo.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DON_final.pdf

http://www.blm.gov/az/st/en/prog/blm_special_areas/wildareas/whitecanyon.html

http://www.sangres.com/arizona/blm/whitecanyon.htm

DOUGLAS

The Douglas Basin, located in Cochise County, is geographically influenced by the surrounding mountain ranges that include the Swisshelm, Pedrogosa, Perilla, Mule and Dragoon Mountain ranges. The basin is characterized by a large valley, grasslands and desertscrub vegetation. Vegetation is primarily semi-desert grassland with smaller areas of Chihuahuan desertscrub. Riparian vegetation includes cottonwood and willow along Leslie Creek.

Important Riparian, Aquatic, and Wetland Resources

Vegetation and wildlife in the Douglas Basin varies greatly because of the diversity of the landscape. An area of the Coronado National Forest contained in the Basin is the Douglas Ranger District which is primarily used for grazing, timber, and recreational activities. The Douglas Basin is also notable for the wildlife in the Whitewater Draw Wildlife Area and Leslie Canyon NWR. Whitewater Draw and agricultural lands in the area provide habitat and forage for large numbers of Sandhill Cranes and other migratory birds that winter in the area. Other animals commonly observed and range from bats to mountain lions and the Mojave green rattlesnake to the Sonoran box turtle. The Violet-crowned Hummingbird is a State Wildlife Species of Concern observed in the basin.

Watercourses are generally ephemeral in the basin; Whitewater Draw is the largest drainage and flows south into Mexico. Leslie Creek in Leslie Canyon NWR is the only perennial connection in the Basin and in managed by USFWS to protect the endangered Yaqui topminnow and Yaqui chub.

Important Conservation Lands

- Whitewater Draw Wildlife Area, AGFD
- Leslie Canyon National Wildlife Refuge, USFWS

Federally Protected Species and Critical Habitats

There is no designated critical habitat in this basin.

Federally protected species observed in this basin include the Endangered Yaqui-Chub, Yaqui Topminnow, and Huachuca Water-umbel. Threatened Chiricahua Leopard Frog has also been observed in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.adwr.state.az.us/azdwr/StatewidePlanning/WaterAtlas/SEArizona/Hydrology/DouglasBasin.htm

http://www.fs.fed.us/r3/coronado/forest/conditions/conditions.shtml

http://www.blm.gov/az/st/en/prog/blm_special_areas/ncarea/sprnca.html

http://www.fws.gov/refuges/profiles/index.cfm?id=22524

http://www.adwr.state.az.us/azdwr/StatewidePlanning/WaterAtlas/SEArizona/Hydrology/DouglasBasin.htm

http://www.fws.gov/refuges/profiles/index.cfm?id=22524

http://www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs_PDFs_for_web/Southeastern_Arizona_Planning_Area/Douglas_Basin.pdf

http://www.azgfd.gov/outdoor_recreation/wildlife_area_whitewater.shtml

http://www.azheritagewaters.nau.edu/loc_yaqui_river.html

http://www.adwr.state.az.us/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DOU_final.pdf

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http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DOU_final.pdf

DRIPPING SPRINGS WASH

The Dripping Springs Wash Basin, located in Pinal, Gila and Graham counties is characterized by a mid-elevation mountain range and Arizona uplands Sonoran desertscrub, interior chaparral, semidesert grassland and madrean evergreen woodland vegetation. Riparian vegetation includes strand and mesquite on the Gila River and cottonwood, willow, strand and mixed broadleaf on Mescal Creek.

Important Riparian, Aquatic, and Wetland Resources

The Gila River is regulated through the Dripping Springs Wash Basin and considered perennial for three miles. The Gila River creates the boundary between Pinal and Gila counties. The basin is named for Dripping Springs Wash northwest of the community of Christmas, a tributary of the Gila River which has perennial flows for three miles through the basin until its confluence with the Gila. Other noted tributaries are Deer Creek and Ash Creek running roughly parallel to one another southeast of Christmas, and Mescal Creek. Mescal Creek has one mile of perennial flow in the basin.

A noted feature located just outside the Basin is Coolidge Dam on the Gila River, just upstream and out of the basin. Coolidge Dam forms San Carlos Reservoir on the Gila and is located in the Safford Basin.

State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, American Peregrine Falcon, Common Black-Hawk and Osprey.

Important Conservation Lands

- Needles Eye Wilderness Area, BLM

The Mescal Mountains cut across the middle of Needles Eye Wilderness, their southwestern flank forming a spectacular striped slope of Paleozoic limestone that rises more than 2,500 feet high. The Gila River flows across the wilderness and forms its southern border. The river threads through a section of steep-walled canyon so narrow it's earned the name Needle's Eye. Several small slickrock side canyons wind down to the Gila, bisecting the area. The narrow river channel is dense with riparian growth.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Southwestern Willow Flycatcher, Mexican Spotted Owl, and Razorback Chub.

Federally protected species of concern observed in the basin include the Endangered Southwestern Willow Flycatcher and Gila Topminnow. The Bald Eagle is also listed as Threatened.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DSW_final.pdf

http://www.wilderness.net/index.cfm?fuse=NWPS&sec=wildView&WID=403

http://www.blm.gov/az/st/en/prog/blm_special_areas/wildareas/needles.html

http://en.wikipedia.org/wiki/Area_of_Critical_Environmental_Concern

http://www.fs.fed.us/psw/programs/rna/

http://www.blm.gov/pgdata/etc/medialib/blm/az/pdfs/nepa/library/resource_management/safford.Par.29271.File.dat/appendices.pdf

http://www.fws.gov/southwest/es/arizona/Documents/Redbook/Southwestern%20Willow%20Flycatcher%20RB.pdf

http://www.fws.gov/southwest/es/Arizona/Documents/CountyLists/Gila.pdf

http://www.fws.gov/southwest/es/Arizona/Documents/CountyLists/Pinal.pdf

http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2004_register&docid=fr31au04-14

DUNCAN VALLEY

Duncan Valley Basin, located predominantly in Greenlee County and a small section of Cochise County is characterized by mid-elevation mountain ranges and Chihuahuan desertscrub, semidesert grassland and madrean evergreen woodland vegetation. Riparian vegetation includes mesquite and tamarisk on the Gila River.

Important Riparian, Aquatic, and Wetland Resources

The Gila River flows north from New Mexico in the vicinity of Duncan and exits the basin west of Guthrie for over 20 miles. These areas support native fish including Desert Sucker, Longfin Dace, Sonora Sucker and Razorback Sucker.

The 23,000-acre Gila Box Riparian National Conservation Area (NCA) falls partially within the Duncan Valley Basin. The NCA has four perennial waterways - the Gila and San Francisco Rivers and Bonita and Eagle Creeks. The Gila River canyon section, known as the Gila Box, is composed of patchy mesquite woodlands, mature cottonwoods, sandy beaches, and buff-colored cliffs. Several raptors can be found in the NCA including, Zone-tailed Hawks and Common Blackhawks. The perennial creek and riparian vegetation make this a cool year-round desert oasis.

Duncan Valley Basin also contains the following perennial waters: Cold Creek, Linden Creek, Apache Creek and Bitter Creek, all of which are located northeast of Duncan, Arizona.

Lowland Leopard Frog and Common Black-Hawk are both State Wildlife Species of Concern observed in the basin

Important Conservation Lands

- Gila Box Riparian National Conservation Area, BLM
- Peloncillo Mountains Wilderness, BLM

A portion of the Gila Box Riparian national Conservation Area, one of only two Riparian national Conservation Areas in the nation, is located in the Duncan Valley Basin. It was established in 1990 to conserve, protect and enhance the riparian and associated values of the area. While it contains four perennial waters, only the Gila River flows in the Duncan Valley Basin.

Desert Bighorn Sheep have been reintroduced into the Peloncillo Mountains Wilderness. Deer and Peregrine Falcon also inhabit that canyons and uplands. Vegetation ranges from desert shrub grasslands in the surrounding flatlands to oak juniper woodlands in the higher reaches. One of the more scenic parts of the Wilderness is Little Doubtful Canyon with an extensive forest of Emory and Arizona white oak along the bottom.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Endangered Southwestern Willow Flycatcher and Razorback Sucker.

Economic Values

See Report Discussion.

Web Sources

http://www.blm.gov/az/st/en/prog/blm_special_areas/ncarea/gbox.html

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_DUN_final.pdf

http://www.sangres.com/arizona/blm/peloncillomountains.htm

http://www.blm.gov/az/st/en/prog/blm_special_areas/wildareas/peloncillo.html

http://www.aziba.org/az_ibas.htm

http://wildlifeviewingareas.com/default.asp

http://www.azheritagewaters.nau.edu/designated_w.html

http://www.blm.gov/az/st/en/prog/blm_special_areas.html

http://www.blm.gov/az/st/en/prog/blm_special_areas/ncarea/gbox.html

http://www.fs.fed.us/recreation/map/state_list.shtml#Arizona

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/documents/Volume_3_final.pdf

http://www.azgfd.gov/w_c/edits/hdms_status_definitions.shtml

http://www.azgfd.gov/w_c/edits/species_concern.shtml

http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E054

GILA BEND

The Gila Bend Basin in Maricopa County is characterized by washes and a series of small mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub. The principal geographic feature of the basin is the Gila River which runs east to west through the basin. Painted Rock Dam and Reservoir are located in the basin. The dam impounds flood flows from the Gila River.

Important Riparian, Aquatic, and Wetland Resource

Within the Gila Bend Basin, most of the Gila River is ephemeral and flows only in response to precipitation events or water releases from upstream dams. Historically, the river would flow in the spring due to winter rains and melting snow, and in summer following monsoon rains. Today, these flows are controlled by dams.

Important Conservation Land

- 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
- Painted Rock Wildlife Area, AGFD

Depending on the quantity of water in Painted Rock Reservoir after floods, many birds may be present. An exceptionally large, shallow lake can be created by flood flows which serves as a temporary habitat.

The Sonoran Desert National Monument was created in 2001; its purpose is to protect the historic sites, Indian relics, native habitats, vegetation and wildlife. Within the National Monument are the North and South Maricopa Mountains Wilderness areas. These wilderness areas are characterized by two major vegetation communities: Paloverde-Mixed Cacti, which includes the dense "forests" of Saguaro Cactus, Paloverde, and Ironwood Trees that represent the classic popular image of the Sonoran Desert, and the Creosote-Bursage community that covers low elevation valley floors in seemingly unbroken expanses.

Woolsey Peak Wilderness is located in the Gila Bend Basin on the north side of the Gila River. Desert Mesquite, Paloverde, and Ironwood grow in the washes throughout this rugged and expansive desert wilderness. Desert Bighorn Sheep, Mule Deer, Bobcats, Mountain Lions, hawks, and owls might be found in the more remote areas of this wilderness.

A Portion of the Gila Bend Basin is federally owned and managed by the US military as the Barry Goldwater Air Force Range. There are five species of concern on the Goldwater Range, three of which are listed as threatened or endangered under the Endangered Species Act. These include the Sonoran Pronghorn Antelope, Lesser Long-nosed Bat, and the Peirson's Milkvetch. The Cactus Ferruginous Pygmy Owl was once listed as endangered but was delisted in 2006. It is not known if these species are found on that portion of the range located within the Gila Bend Basin.

There is a small portion of Maricopa County's Buckeye Hills Regional Park located in the north portion of the Gila River Basin. The primary use of this park is for recreation, although a portion of it overlooks the Robins Butte Wildlife Area along the Gila River outside the basin boundary.

Federally Protected Species and Critical Habitats

There are no critical habitats designated in the Gila Bend Basin.

The endangered Southwestern Willow Flycatcher and the Yuma Clapper Rail have been observed in this basin.

According to the 2001 report “Biological Resources of the Sonoran Desert National Monument, Arizona,” special status species known to be present in the Sonoran Desert National Monument include the Desert Tortoise, Swainson’s Thrush, the Lesser Long-nosed Bat, the Sonoran Pronghorn, and the Acuña Cactus.

Economic Values

See Report Discussion.

Web Sources

http://www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs_PDUSFS_for_web/Lower_Colorado_River_Planning_Area/Lower_Gila_River_Watershed.pdf

http://www.arizonensis.org/sonoran/places/paintedrock.html

http://en.wikipedia.org/wiki/Painted_Rock_Dam

http://www.wilderness.net/index.cfm?fuse=NWPS&sec=wildView&WID=564 (South Maricopa);

http://www.wilderness.net/index.cfm?fuse=NWPS&sec=wildView&WID=421 (North Maricopa).

http://www.wilderness.net/index.cfm?fuse=NWPS&sec=wildView&WID=659

http://en.wikipedia.org/wiki/Barry_M._Goldwater_Air_Force_Range

http://www.ecr.gov/pdf/bgrange.pdf http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_GIL_final.pdf

http://aznps.com/Floras/sdnm.pdf

GRAND WASH

The Grand Wash Basin, within Mohave County, is part of the Arizona Strip and is located on the western edge of the Colorado Plateau region in the northwest portion of the state. It is a remote, undeveloped area, characterized by cliffs and washes. The terrain is highly faulted with colorful sedimentary and volcanic rock formations. There are incised canyons and high desert plateaus, which offer breathtaking scenery. Vegetation is primarily Mohave desertscrub and Great Basin conifer woodland with small areas of Great Basin desertscrub, interior chaparral and Plains and Great Basin grassland.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Grand Wash Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Colorado River is the only perennial stream in the basin. There are several springs, with Tassi Spring discharging up to 75 gallons per minute and smaller springs discharging at a much lower rate of 2 gallons per minute.

The wildlife in the Grand Wash Basin is diverse. Big game species include bobcat, Desert Bighorn Sheep, and Desert Mule Deer. This area is also inhabited by Gila Monsters, Arizona Toad, Baja California Tree Frog, and Relict Leopard Frog. Bird species include American Peregrine Falcon, Black-Crowned Night-Heron, and Yellow-billed Cuckoo. During the summer, Neotropical song bird species visit the area. Dove and Gamble Quail can be found year round.

Important Conservation Lands

The majority of the land in the Grand Wash Basin is within the BLM Grand Canyon-Parashant National Monument. Other conservation lands include Grand Canyon National Park, NPS; Grand Wash Cliffs Wilderness, Paiute Wilderness, and Mt. Logan Wilderness, BLM.

Federally Protected Species and Critical Habitats

The Grand Wash Basin has designated a critical habitat for Mohave Desert Tortoise and Razorback Suckers. Other federally protected species known to occur in the basin include California Condor, and the Grand Wash Springsnail. Candidate Relict Leopard Frog and Yellow-billed Cuckoo have also been observed.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_GWA_final.pdf

Additional References

Kearsley, M. & Ayers, T. (2009). Riparian vegetation responses: snatching defeat from the jaws of victory and vice versa. In R. Webb, J. Schmidt, R. Valdez, (eds.), *The Controlled Flood in Grand Canyon* (pp. 309-327). Washington, D.C.: American Geophysical Union.

Ralston, B. (2010). *Riparian vegetation response to the March 2008 short-duration high-flow experiment-Implications of timing and frequency of flood disturbance on nonnative plant established along the Colorado River below Glen Canyon Dam.* Reston, Virginia: U.S. Geological Survey.

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HARQUAHALA INA

The Harquahala Basin is located in Maricopa and La Paz Counties. The basin is characterized by a plain bordered by mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub and a small amount of interior chaparral on the northern basin boundary.

Important Riparian, Aquatic, and Wetland Resources

There are no perennial waters or major springs within the Harquahala Basin. Centennial Wash, a large ephemeral wash, runs through the center of the basin.

Wildlife species observed in the Harquahala INA Basin include Lowland Leopard Frog and Western Red-tailed Skink.

Important Conservation Lands

- Big Horn Mountains Wilderness, BLM
- Eagletail Mountains Wilderness, BLM
- Harquahala Mountains Wilderness, BLM
- Hummingbird Springs Wilderness, BLM

Federally Protected Species and Critical Habitats

Harquahala Basin contains no designated critical habitat and no documented occurrences of federally listed species.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_HAR_final.pdf

HUALAPAI VALLEY

Hualapai Valley Basin, located in Mohave County is characterized by a wide north-south trending valley, mountains along the west basin margins and cliffs and plateau on the eastern basin boundary. Vegetation types include Mohave desertscrub, semi-desert grassland, interior chaparral, conifer woodlands and conifer forest. There are no riparian areas within this basin.

Important Riparian, Aquatic, and Wetland Resources

The Colorado River is the only perennial river in the basin. There are three identified major springs. The southern portion of the basin is drained by an ephemeral watercourse, Truxton Wash, which drains north, and after heavy precipitation flows into the normally dry Red Lake Playa, underneath which exists a large salt body. The other major ephemeral watercourse, Hualapai Wash, runs north from Red Lake Playa after heavy precipitation and flows into Lake Mead. The Colorado River, impounded in Lake Mead, forms the northern boundary of the basin.

American Peregrine Falcon and the Bald Eagle are both State Wildlife Species of Concern observed in the basin

Important Conservation Lands

- Lake Mead National Recreation Area, NPS
- Mt. Tipton Wilderness, BLM

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Endangered Razorback Sucker. Hualapai Mexican Vole, listed as Endangered, has also been observed in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_HUA_final.pdf

www.azdeq.gov/environ/water/assessment/download/hualapai_fact.pdf

www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs

http://www.adwr.state.az.us/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/default.htm

http://criticalhabitat.fws.gov/crithab/

KANAB PLATEAU

The Kanab Plateau Basin, located in Mohave and Coconino Counties, is characterized by plateaus and canyons. Vegetation types include Mohave and Great Basin desertscrub, Plains and Great Basin grassland, Great Basin conifer woodland, Great Basin subalpine conifer forest and Rocky Mountain and madrean montane conifer forest. There are small areas of subalpine grassland on the Kaibab Plateau south of Jacob Lake.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Kanab Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Kanab Plateau is the largest tributary canyon system leading into the Grand Canyon and contains Kanab Creek, the Paria River and North Canyon Creek. Scattered riparian areas contain cottonwoods and single-leaf ash. These areas provide winter range for Mule Deer and the introduced Chukar Partridge. Kanab Creek contains several native fish such as the Bluehead Sucker, Humpback Chub and Speckled Dace. The Paria River contains the Flannelmouth Sucker and Speckled Dace. The North Canyon area provides habitat for reintroduced Apache Trout, one of two native species of trout, as well as providing habitat for turkeys, the Kaibab Squirrel, and the introduced bison.

State Wildlife Species of Concern observed in the basin include the Northern Leopard Frog, American Peregrine Falcon, and Western Red Bat.

Important Conservation Lands

- Grand Canyon-Parashant National Monument, BLM
- Vermilion Cliffs National Monument, BLM
- Vermilion Cliffs Wilderness, BLM
- Cottonwood Point Wilderness, BLM
- Paria Canyon Wilderness, BLM
- Kanab Creek Wilderness, BLM
- Mount Logan Wilderness, BLM
- Mount Trumbull Wilderness, BLM
- Saddle Mountain Wilderness, BLM
- Glen Canyon National Recreation Area, NPS
- House Rock Wildlife Area, AGFD
- Ryan Cabin Site State Conservation Land, AGFD
- Grand Canyon National Game Preserve, NPS
- Arizona Audubon Important Bird Areas; Marble Canyon, Grand Canyon Lipan and Yaki Points.

Federally Protected Species and Critical Habitat

Critical Habitat is designated for Threatened Mexican Spotted Owl, Endangered Razorback Sucker, and Endangered Humpback Chub.

Other Endangered species found in the basin include the California Condor, Kanab Amber Snail, and Southwestern Willow Flycatcher. The Kanab Amber Snail is critically endangered and can be found in marshes of seeps and springs at the base of sandstone cliffs. Also observed in the area are the Threatened Bald Eagle and Apache Trout.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 127 Angler Use Days were documented in the Kanab Plateau Basin, equating to over $19,000 in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_KAN_final.pdf

Additional References

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LAKE HAVASU

The Lake Havasu Basin, located in Mohave County, is characterized by a valley adjacent to the Colorado River and Lake Havasu, which form the western boundary of the basin, and by lower elevation mountains along the north and eastern basin boundary. Vegetation types include lower Colorado River and Arizona upland Sonoran desertscrub and Mohave desertscrub. Riparian vegetation includes tamarisk and marsh along sections of the Colorado River.

Important Riparian, Aquatic, and Wetland Resources

The majority of perennial water in the basin is the 38 mile shoreline along the lake. There are no known springs in the basin. Havasu Wildlife Refuge offers marsh and upland farm field habitats for waterfowl, migrating songbirds, shorebirds, and other wildlife. Clark’s Grebe and American Peregrine Falcon are State Wildlife Species of Concern observed in the basin.

Important Conservation Lands

- Havasu National Wildlife Refuge, USFWS
- Havasu Refuge Wilderness, BLM
- Cattail Cove, Arizona State Park
- Lake Havasu State Park, Arizona State Park

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP’s purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

As part of the MSCP, land and water agreements with USFWS wildlife refuges were formed to implement conservation actions on those refuges. Havasu National Wildlife Refuge is one of three refuges that have a land and water agreement in place. The land and water agreements allow the MSCP to use refuge lands and a portion of that refuge’s Colorado River surface water allocations (the refuges do not have groundwater rights; any wells are considered to be pumping Colorado River water from the alluvium) to develop conservation areas. The MSCP pays for the development and maintenance activities of the conservation areas, as well as any monitoring associated with the projects. The partnership with the MSCP allows the refuges to gain improved wildlife habitats on their lands supporting the mission of the refuge without having to pay for the development of that habitat.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Bonytail Chub.

Twenty-six threatened, endangered, or rare species are covered by the Lower Colorado River Multi-species Conservation Plan including the endangered Razorback Sucker, Bonytail Chub, Humpback Chub, Southwestern Willow flycatcher, Yuma \Clapper Rail, Desert Pupfish, and the Desert Tortoise. The Plan includes the Colorado River located along the western boundary of the basin.

Species observed in the basin include the Endangered Southwestern Willow Flycatcher, Yuma Clapper Rail, Bonytail Chub and Desert Pupfish.

Economic Values

The economy of the basin is heavily dependent on water based recreation centered on Lake Havasu and the Colorado River, while the Havasu National Wildlife Refuge offers important wildlife and bird watching opportunities.

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 248,620 Angler Use Days were documented in the Lake Havasu Basin, equating to over $38 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_LKH_final.pdf

LAKE MOHAVE

Lake Mohave Basin, located in Mohave County is characterized by a broad valley along the Colorado River in the southern part of the basin and by mountains in the northern part of the basin. The Colorado River, Lake Mohave and Lake Mead define the western and northern basin boundary. Vegetation is primarily Mohave desertscrub with a small area of lower Colorado River Sonoran desertscrub and tamarisk and marsh vegetation along sections of the Colorado River.

Important Riparian, Aquatic, and Wetland Resources

The basin's main hydrological feature is the Colorado River and impounded Lake Mead at the northern tip, Lake Mohave along the western edge of the basin and Topock Marsh at the southern tip of the basin. This feature forms 122 miles of the basins western edge. Stream flow outside of the Colorado River in the Lake Mohave groundwater basin is essentially ephemeral, generated by precipitation in the surrounding mountains. Seasonal precipitation and surface flow provide most of the groundwater recharge in the basin.

The American Peregrine Falcon and Clark's Grebe are listed as State Wildlife birds of concern observed in the basin.

Important Conservation Lands

- Mount Nutt Wilderness, BLM
- Mount Wilson Wilderness, BLM
- Warm Springs Wilderness, BLM
- Lake Mead National Recreation Area, NPS
- Havasu National Wildlife Refuge, USFWS
- Colorado River Nature Center Wildlife Area, AGFD
- Topock Marsh State Conservation Land, AGFD

Several wilderness areas most notably support populations of Desert Bighorn Sheep. The U.S. Fish and Wildlife Service manage the Havasu National Wildlife Refuge at the southern edge of the basin. From Desert Bighorn Sheep to the Endangered Southwestern Willow Flycatcher and Yuma Clapper Rail, birds and other animals at Havasu National Wildlife Refuge rely on the waters of the Lower Colorado River. The refuge protects 30 river miles - 300 miles of shoreline - from Needles, California, to Lake Havasu City, Arizona. One of the last remaining natural stretches of the lower Colorado River flows through the 20-mile-long Topock Gorge.

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

As part of the MSCP, land and water agreements with USFWS wildlife refuges were formed to implement conservation actions on those refuges. Havasu National Wildlife Refuge is one of three refuges that have a land and water agreement in place. The land and water agreements allow the MSCP to use refuge lands and a portion of that refuge's Colorado River surface water allocations (the refuges do not have groundwater rights; any wells are considered to be pumping Colorado River water from the alluvium) to develop conservation areas. The MSCP pays for the development and maintenance activities of the conservation areas, as well as any monitoring associated with the projects. The partnership with the MSCP allows the refuges to gain improved wildlife habitats on their lands supporting the mission of the refuge without having to pay for the development of that habitat.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Razorback Sucker, Bonytail Chub, Mexican Spotted Owl, and Little Colorado Spinedace.

Federally listed species that are dependent on riparian or other water related habitats occur within the basin including the Threatened Bald Eagle and Candidate Relict Leopard Frog and Yellow-billed Cuckoo have been observed in the basin.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 110,714 Angler Use Days were documented in the Lake Mohave Basin, equating to over $17 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_MHV_final.pdf

LITTLE COLORADO RIVER PLATEAU

The Little Colorado River Plateau Basin, located in Coconino, Navajo and Apache Counties is characterized by relatively high elevation, semi-arid mesas and several high elevation mountain ranges. Elevations generally increase from north to south. Vegetation types are primarily Great Basin conifer woodland, plains and Great Basin grasslands and Great Basin desertscrub. At higher elevations vegetation types include subalpine grassland, Rocky Mountain subalpine conifer forest and Rocky Mountain and madrean montane conifer forests. Riparian vegetation is found along streams including: conifer oak, wet meadow, mixed broadleaf, and Russian olive along Tsalie Creek, Kinlechee Creek and Canyon de Chelly; tamarisk on Chinle Creek and Silver Creek; and mixed broadleaf, wet meadow and conifer oak on the Little Colorado River east of Springerville.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Little Colorado River Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

Common riparian native trees and shrubs, depending on location and elevation, include Narrowleaf Cottonwood, Box Elder, Aspen, New Mexico Locust, and Willows. At higher elevations, streams pass through the upland montane forests of mixed-conifer and ponderosa pine communities. The riparian zones themselves are usually narrow, often following relatively steep stream channels in restricted valleys. This basin also counts a number of high elevation wetlands and cienegas that host cattail, Bulrush, sedges, waterweed, Spike rushes, Quaking Aspen, and Colorado Blue Spruce.

Principal waterfowl species that utilize the high mountain wetlands include Mallard, Pintail, Cinnamon Teal, Ruddy Duck, and Redhead. Taller emergent plants such as bulrush provide nesting sites for American Bittern, Yellow and Red-headed Blackbirds, and Marsh Wren. Birds of prey include the Peregrine Falcon, Zone-tailed Hawk, Osprey, and the Bald Eagle. Migratory songbirds include Vermilion Flycatcher, Black Phoebe, Canyon and Rock Wrens, White-throated Swift, Yellow Warbler, and Bell's Vireo. Birds identified as State Wildlife Species of Concern are; Belted Kingfisher, Black-billed Magpie, Bobolink, and Veery.

The Little Colorado River Basin contains much of the remaining native fish habitat for species such as the Apache Trout, Little Colorado Spinedace, Desert Sucker, Little Colorado Sucker and the Roundtail Chub. Reptiles and amphibians include the Arizona Toad, Northern Leopard Frog, Mogollon Rim Treefrog Narrow-headed Gartersnake, and a variety of rattlesnakes. Other mammals observed as State Wildlife Species of concern are the American Water Shrew and Navajo Mexican Vole.

Important Conservation Lands

- Allen Severson Memorial Wildlife Area, AGFD
- Bear Springs, AGFD
- Becker Lake Wildlife Area, AGFD
- Chevelon Canyon Ranch Wildlife Area, AGFD
- Concho Lake, AGFD
- Jacques Marsh Wildlife Area, AGFD
- Lamar Haines Wildlife Area, AGFD

- Lee Valley Lake, AGFD
- Nelson Reservoir, AGFD
- Raymond Ranch, AGFD
- Rainbow Lake Lands, AGFD
- Silver Springs Hatchery, AGFD
- Sipe White Mountain Wildlife Area, AGFD
- Wenima Wildlife Area, AGFD
- White Mountains Grasslands Wildlife Area, AGFD
- Fool Hollow Lake Recreation Area, Arizona State Park
- Homolovi Ruins State Park, Arizona State Park
- Lyman lake State Park, Arizona State Park
- Riordan Mansion State Historic Park, Arizona State Park
- Little Colorado River East Fork, Phelps Cabin Research Natural Area, USFS
- Escudilla Wilderness, USFS
- Mount Baldy Wilderness, USFS
- Kachina Peaks Wilderness, USFS
- Mount Baldy Wilderness, USFS
- Petrified Forest Wilderness, USFS
- Strawberry Crater Wilderness, USFS
- Canyon De Chelly National Monument, NPS
- Lee Valley Creek and Little Colorado River West Fork are designated as Outstanding Arizona Waters, ADEQ
- Arizona Audubon Important Bird Areas; Marble Canyon, Upper Little Colorado River Watershed, Mogollon Rim Snowmelt Draws, Anderson Mesa

Federally Protected Species and Critical Habitats

Critical habitat has been designated for Mexican Spotted Owl, Little Colorado Spinedace, Navajo Sedge, San Francisco Peaks Groundsel, and the Southwestern Willow Flycatcher.

Native fish reintroductions have occurred in several streams. The basin contains 30 miles of occupied native habitat, montane aquatic systems, for the federally threatened Apache Trout, all in streams reclaimed for recovery of Apache trout, including Little Colorado River West Fork, Little Colorado River East fork, Little Colorado River South Fork, Lee Valley Creek, Coyote Creek, Mamie Creek, and Mineral Creek. The basin also contains all populations and habitat for the federally threatened Little Colorado Spinedace, which is endemic to the basin.

Federally protected species observed in the basin also include:

- Listed Endangered- Southwestern Willow Flycatcher
- Listed Threatened- Chiricahua Leopard Frog, Mexican Spotted Owl, and Little Colorado Spinedace
- Candidate- Yellow-billed Cuckoo, Roundtail Chub, Zuni Bluehead Sucker, New Mexico meadow jumping mouse, and Northern Mexican Gartersnake.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 863,297 Angler Use Days were documented in the Little Colorado River Plateau Groundwater Basin, equating to over $134 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/EasternPlateau/documents/Volume_2_final_LCR.pdf

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LOWER GILA

The Lower Gila Basin is located in Yuma, Pima, La Paz and Maricopa Counties and is characterized by plains and valleys surrounded by low elevation mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands sonorant desertscrub. Riparian vegetation includes tamarisk along the Colorado River and Gila River.

The principal geographic feature of the basin is the Gila River which runs east to west through the entire basin, exiting on the west boundary of the basin before it reaches its confluence with the Colorado River. A short stretch (11 miles) of the Colorado River forms the western boundary of the basin in the vicinity of Fishers Landing. Beyond the river floodplains and valleys, the basin is surrounded by small mountain ranges.

Important Riparian, Aquatic, and Wetland Resources

Within the Lower Gila Basin, most of the Gila River is ephemeral and flows only in response to precipitation events or water releases from upstream dams. Historically, the river would flow in the spring due to winter rains and melting snow, and in summer following monsoon rains. Today, these flows are controlled by dams. Painted Rock Dam was constructed in 1959 at the eastern edge of the basin to control infrequent flood flows. A small lake occasionally forms at the base of Painted Rock Dam, but is frequently dry.

Along the Colorado River, flows are constant. The Colorado is highly regulated by upstream dams, although floods occasionally occur. When the Imperial Dam was completed in 1935, Martinez Lake was formed as part of the Imperial Reservoir.

The Wellton-Mohawk Irrigation District returns surplus irrigation water to the Gila River channel near Dome, Arizona. This influx of water supports flow from Dome a short distance to the boundary of the basin and then to the confluence with the Colorado River.

There are several State Wildlife Species of Concern observed in this basin including, Lowland Leopard Frog, California Black Rail, Peregrine Falcon, Bald Eagle, Great Egret, Least Bittern, Snowy Egret, and Western Yellow Bat.

Important Conservation Lands

- Arizona Audubon Important Bird Areas; Imperial Reservoir, Lower Gila River, Quigley Wildlife Area, Sonoran Desert Borderlands
- Quigley Wildlife Area, AGFD
- Texas Hill Lands State Conservation, AGFD
- Kofa National Wildlife Refuge, USFWS
- Cabeza Prieta National Wildlife Refuge, USFWS
- Imperial Reservoir National Wildlife Refuge, USFWS
- Organ Pipe Cactus National Monument, NPS
- Eagletail Mountains Wilderness, BLM
- Muggins Mountains Wilderness, BLM

- Signal Mountain Wilderness, BLM
- Woolsey Peak Wilderness, BLM
- Organ Pipe Wilderness, NPS

The Quigley Wildlife Area encloses a remnant slough of the Gila River. The area provides magnificent views across the Gila River floodplain to the Castle Dome, Palomas and other mountain ranges. Several rare and endangered species including the Yuma Clapper Rail and Southwestern Willow Flycatcher are recorded here as well as large concentrations of wintering waterfowl and shorebirds can be seen, along with significant numbers of neotropical migrants. Visitors may see mourning and White-winged Doves, Snow Geese, and Osprey. The Arizona Game and Fish Department reports that the marsh habitat at Quigley has in the past supported at least 4-6 pairs of the endangered Yuma Clapper Rail, and that “appropriate habitat” exists at Quigley for the endangered Southwestern Willow Flycatcher (although nesting has not been documented).

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP’s purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

As part of the MSCP, land and water agreements with USFWS wildlife refuges were formed to implement conservation actions on those refuges. Imperial National Wildlife Refuge is one of three refuges that have a land and water agreement in place. Imperial National Wildlife Refuge protects wildlife habitat along 30 miles of the lower Colorado River in Arizona and California, including the last un-channelized section before the river enters Mexico. The land and water agreements allow the MSCP to use refuge lands and a portion of that refuge’s Colorado River surface water allocations (the refuges do not have groundwater rights; any wells are considered to be pumping Colorado River water from the alluvium) to develop conservation areas. The MSCP pays for the development and maintenance activities of the conservation areas, as well as any monitoring associated with the projects. The partnership with the MSCP allows the refuges to gain improved wildlife habitats on their lands supporting the mission of the refuge without having to pay for the development of that habitat.

The Kofa National Wildlife Refuge provides essential habitat for Desert Bighorn Sheep, the California Fan Palm, and other wildlife and plants. By enlarging natural water holes, shading them to reduce evaporation, and blasting artificial basins in areas previously without a water supply, refuge managers have greatly increased the availability and reliability of water for Desert Bighorn Sheep and other wildlife. The Refuge also supports a number of amphibians and reptiles, including the desert tortoise. Other species include the Rosy Boa, Coachwhip, Gophersnake, Western Shovel-nosed Snake, Common Kingsnake, five species of rattlesnakes, Western Banded Gecko, Zebra-tailed Lizard, Eastern Collared Lizard, Desert Horned Lizard, Common Chuckwalla, Desert Iguana, Desert Spiny Lizard, Sonoran Desert Toad, and the Red-spotted Toad. Birds include Red-tailed Hawk, Golden Eagle, Ash-throated Flycatcher, Loggerhead Shrike, Cactus and Canyon Wrens, Phainopepla, Scott’s Oriole, and Curve-billed Thrasher. Isolated nesting populations of Blue-gray Gnatcatcher, Canyon Towhee, and Black-chinned and Rufous-crowned Sparrows can be found.

Parts of the Basin are within the Sonoran Desert Borderlands are listed as Important Bird Area (IBA), a program administered Arizona Audubon primarily because of the Lower Colorado Desert Microphyll Woodland Major Wash Complex habitat. This largely intact, undeveloped, and un-fragmented IBA encompasses Organ Pipe Cactus National Monument (in its entirety), Cabeza Prieta National Wildlife Refuge (in its entirety), and the Barry Goldwater Range East and West Units (pending military acceptance).

The Cabeza Prieta National Wildlife Refuge is the third largest refuge in the nation and nearly all is a designated wilderness. Common vegetation includes Creosote bush flats, bursage on the bajadas, Mesquite, Paloverde, Ironwood, and an abundance of cacti, including Ocotillo, Cholla, and Saguaro. Also present are the endangered Sonoran Pronghorn and Lesser Long-nosed Bats, as well as desert bighorns, lizards, rattlesnakes, Desert Tortoises, Elf Owls, and Gila Woodpecker. Refuge staff brings water to artificial catchments and guzzlers throughout Cabeza Prieta NWR for wildlife. The refuge also takes the lead role in Sonoran pronghorn recovery. This endangered species with international significance ranges across the Sonoran desert in small, scattered bands.

Parts of the Barry Goldwater Air Force Range are located in the Basin and used for pilots to practice basic air-to-surface weapons deployment. There are five species of concern on the Goldwater Range, three of which are listed as threatened or endangered under the Endangered Species Act. These include the Sonoran Pronghorn Antelope, Lesser Long-nosed Bat, and the Peirson’s Milkvetch.

The Organ Pipe Cactus National Monument, an International Biosphere Reserve, exhibits an extraordinary collection of plants and animals of the Sonoran Desert. Twenty-six species of cactus are found, as well as numerous species of birds, mammals, reptiles and fish. Every summer Organ Pipe Cactus NM hosts a “maternal” colony of 20,000 endangered Lesser Long-nosed Bats.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Razorback Sucker.

Federally protected species observed in this basin include the Endangered Southwestern Willow Flycatcher, Yuma Clapper Rail, Desert Pupfish, Sonoran Pronghorn Antelope, and Razorback Sucker. The Candidate-Yellow-billed Cuckoo is also found here.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 45,970 Angler Use Days were documented in the Lower Gila Basin, equating to over $7 million in economic revenue generated by angler activity within the basin.

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LOWER SAN PEDRO

The Lower San Pedro Basin is split between Cochise, Pima, Graham, Pinal and Gila Counties. The Basin is characterized by high-elevation mountain ranges and washes. Vegetation is primarily Arizona uplands Sonoran desertscrub and semidesert grassland with smaller areas of Chihuahuan desertscrub, madrean evergreen woodland, Rocky Mountain and montane conifer forest and interior chaparral. Riparian vegetation includes strand and mesquite on the San Pedro River and Aravaipa Creek.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the San Pedro River watershed. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

This basin contains a portion of the San Pedro River – one of the last remaining free flowing desert rivers in the world. The Lower San Pedro Basin contains approximately 75 miles of perennial flows in Aravaipa Creek, Bass Canyon, Buehman Canyon, Copper Creek, Devils Canyon, Mill Creek, Mineral Creek, Hot Springs Canyon, Redfield Canyon Creek, and Swamp Springs Canyon Creek. Some reaches of the Lower San Pedro River itself are also perennial.

The Lower San Pedro Basin supports high quality cottonwood-willow riparian gallery forest and adjacent mesquite bosque. The basin provides a lush wildlife movement corridor between the Santa Catalina and Galiuro Mountains.

The middle and lower portions of the San Pedro River have been designated by Arizona Audubon as a Priority Important Bird Area (IBA) due to the large number of birds of concern that rely on the riparian habitat of the basin. The Southwestern Willow Flycatcher, Gray Hawk, Thick-billed Kingbird, Yellow-billed Cuckoo, Northern Beardless-Tyrannulet, and Tropical Kingbird can all be found here. The Lower San Pedro and its tributaries also provide habitat for Chiricahua Leopard Frog, Lowland Leopard Frog, Gila Chub, Spikedace, Loach Minnow, Sonoran Sucker, and is one of the last remaining known locations of the Huachuca Water Umbel. Additional State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Peregrine Falcon, Black-bellied Whistling Duck, Common Black-Hawk, Mississippi Kite, Northern Buff-breasted Flycatcher, and Western Red Bat.

Important Conservation Lands

- Swamp Springs/Hot Springs Watershed Area of Critical Environmental Concern, BLM
- Redfield Canyon Wilderness Area, BLM
- Rincon Mountain Wilderness Area, USFS
- Galiuro Wilderness Area, USFS
- Oracle State Park, Arizona State Park
- Saguaro National Park, NPS
- Audubon Arizona Important Bird Area; Lower San Pedro River
- Middle/Lower San Pedro River, Pima County Preserves

- 3 Links Farm, BOR Conservation Easement and The Nature Conservancy Preserve
- Buehman Canyon Preserve/Conservation Easements, The Nature Conservancy
- Muleshoe Ranch Preserve, The Nature Conservancy
- Lower San Pedro River Preserve, The Nature Conservancy
- Buehman Canyon is identified as an Outstanding Arizona Water, ADEQ

The Nature Conservancy is conducting restoration activities to re-vegetate old pasture lands with native vegetation. Their activities have reduced water consumption along the main stem Lower San Pedro. The conservation easements ensure the permanent protection of some of the most important sections of the basin.

Federally Protected Species and Critical Habitats

Critical Habitat is designated for Mexican Spotted Owl, Southwestern Willow Flycatcher, Razorback Sucker, Gila Chub, Spikedace, and Loach Minnow.

Federally protected species observed in the basin also include:

- Listed Endangered- Southwestern Willow Flycatcher, Gila Chub, and Huachuca Water Umbel
- Listed Threatened- Chiricahua Leopard Frog, Bald Eagle, Mexican Spotted Owl, Loach Minnow, and Spikedace
- Candidate- Yellow-billed Cuckoo and Roundtail Chub

Economic Values

Studies have been conducted that describe the economic contribution of riparian bird habitat, and surveys conducted to identify economic value of wildlife watching in the San Pedro River (Pima County, 2009; Leenhouts et al., 2006).

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Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Vol_3_LSP_final.pdf

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MCMULLEN VALLEY

The McMullen Valley Basin is located in La Paz, Yavapai and Maricopa Counties. The basin is characterized by two valleys; the McMullen Valley and the Aguila Valley, which are bordered by the Harcuvar mountain range to the north and the Harquahala mountain range to the south. Vegetation types include Lower Colorado River Valley and Arizona uplands, Sonoran desertscrub with small amounts of interior chaparral and semidesert grassland.

Important Riparian, Aquatic, and Wetland Resources

The main riparian feature is the Centennial Wash which runs east to west through the basin. Centennial Wash is a large, normally dry ephemeral stream which runs through the town of Wenden. It has been known to collect such large amounts of rainfall funneled from surrounding mountains that it overflows and causes serious flooding and the impact of the flow regime is an issue of concern for the local community. Local flows along Centennial Wash have resulted in heavy vegetation growth of Ironwood, Mesquite, and Paloverde trees which serves as habitat for many bird and animal species. Quail are common in the Centennial Wash area between Salome and Aguila. Lowland Leopard Frogs are listed as State Wildlife Species of Concern in the basin. White-tailed Kite and Western Red-tailed Skink have also been observed in the basin.

Important Conservation Lands

- Harquahala Mountains Wilderness, BLM
- Harcuvar Mountains Wilderness, BLM

Harquahala means “running water high up” in the language of one early native tribe. The Harquahala Mountains Wilderness was so named for its numerous perennial seeps and springs that support rare habitat with exceptional diversity among Sonoran Desert mountains. Rare cacti are found in relict “islands” of chaparral and desert grasslands as well as the endangered Desert Tortoise, the largest Mule Deer herd in western Arizona, a sizable raptor population, and one of the few increasing Desert Bighorn Sheep herds.

The Harcuvar Mountains Wilderness includes plant and animal communities and diverse landforms, including a 3,500-acre “island” of interior chaparral habitat that supports a few species of wildlife cut off from their parent populations: Rosy Boas, Gilbert’s Skinks, and Desert Night Lizards. Desert Bighorn Sheep, Mountain Lions, Desert Tortoises, Golden Eagles, and several species of hawks are also found in the basin.

Federally Protected Species and Critical Habitats

No Critical Habitat Designated.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_MMU_final.pdf

MEADVIEW

Meadview Basin is located in Mohave County and is characterized by a south to north trending wash, a mesa in the western portion of the basin, cliffs along the eastern basin boundary and Lake Mead on the north. Vegetation includes Mohave desertscrub and Great Basin conifer woodland.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Meadview Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The only perennial flow in the basin is about 7 miles of the Colorado River, essentially Lake Mead. There are numerous springs of varying discharge located primarily in the southern part of the basin.

The American Peregrine Falcon is a State Wildlife Species of Concern observed in the basin. A native fish, Speckled Dace is also known to occur in the basin.

Important Conservation Lands

- Lake Mead National Recreation Area, NPS
- Grand Canyon National Park, NPS

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Razorback Sucker.

Federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher and Razorback sucker and the Candidate Relict Leopard Frog.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_MEA_final.pdf

Additional References

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Valdez, R., Shannon, J., & Blinn. D. (1999). Biological implications of the 1996 Controlled Flood. In R. Webb, J. Schmidt, R. Valdez, (eds.), *The Controlled Flood in Grand Canyon* (pp. 343-350). Washington, D.C.: American Geophysical Union.

MORENCI

The Morenci Basin is located mostly in Greenlee County, Graham County and the southern part of Apache County. The basin is characterized by high-elevation mountain ranges and a diversity of biotic communities including Rocky Mountain and montane conifer forest, Great Basin conifer, madrean evergreen woodland, plains and Great Basin grassland, interior chaparral, Chihuahuan desertscrub and semidesert grassland vegetation.

Important Riparian, Aquatic, and Wetland Resources

Riparian vegetation ranges from wet meadow and mountain scrub on the San Francisco River near Alpine at the higher elevations to mixed broadleaf and cottonwood/willow on the Campbell Blue Creek; cottonwood/willow, mixed broadleaf and mesquite on the Blue River; mixed broadleaf on Cienega and Willow Creeks; and at the lower elevations, mesquite and mixed broadleaf on Eagle Creek and the San Francisco River near Clifton.

Perennial streams are located throughout the basin including San Francisco River, Blue River, Grant Creek, Strayhorse Creek, KP Creek, Willow Creek, Cienega Creek and Eagle Creek. The San Francisco River is declared an Impaired Water by ADEQ for sediment, while KP Creek has been designated an Outstanding Arizona Water by ADEQ.

There are over 450 miles of streams; five species of trout can be found in these waters. Luna Lake State Wildlife Area is home to a variety of wildlife, including the Bald Eagle and migrating waterfowl, as well as a managed sportfishery.

The forested area is home to most big game animals such as antelope, elk, deer, bighorn sheep and turkey. Black Bear, Mountain Lion and Mexican Gray Wolf are even spotted on occasion. There is a large variety of songbirds, waterfowl, small mammals, fish, amphibians and reptiles.

State Wildlife Species of Concern observed in the basin include Peregrine Falcon, Bald Eagle, Lowland Leopard Frog, and Narrow-headed Gartersnake.

Important Conservation Lands

- Escudilla Wilderness, USFS
- Blue Range Primitive Area, USFS
- Gila Box Riparian National Conservation Area (at the southernmost portion), BLM
- Luna Lake State Conservation Land, AGFD
- Arizona Audubon Important Bird Area; Blue River Complex
- KP Creek is identified as an Outstanding Arizona Water, ADEQ
- US Fish and Wildlife Service, the Mexican Wolf Recovery Program
- US Department of the Interior, proposed Native Fish Restoration Project, Lower Blue River

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Mexican Spotted Owl, Razorback Sucker, Gila Chub and Loach Minnow. Apache and Gila Trout have been the focus of conservation efforts in this basin.

Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher, Gila Chub, and Razorback Sucker
- Listed Threatened- Chiricahua Leopard Frog, Mexican Spotted Owl, Apache Trout, Gila Trout, Loach Minnow, and Spikedace
- Candidate- Yellow-billed Cuckoo, Roundtail Chub, New Mexico meadow jumping mouse, and Northern Mexican Gartersnake

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 27,335 Angler Use Days were documented in the Morenci Basin, equating to over $4 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Vol_3_MOR_final.pdf

Bureau of Land Management (BLM)

United States Forest Service (USFS, Prescott Forest)

United States Fish and Wildlife Service (USFWS)

Arizona Game and Fish Department (AGFD)

Arizona Department of Water Resources (ADWR)

Wildlife Linkages (NAU)

PARIA

The Paria Basin in northern Coconino County is characterized by a plateau and canyons. Vegetation types include Great Basin desertscrub and Great Basin conifer woodland.

Important Riparian, Aquatic, and Wetland Resources

The Paria River originates in southern Utah, draining high plateaus. Near the Arizona border the river enters a narrow canyon of towering sandstone walls streaked with desert varnish, winding past amphitheater formations, natural arches, wooded terraces and hanging gardens. Emerging from the Vermilion Cliffs, the Paria River meets the Colorado River at Lees Ferry.

Although a fairly small perennial stream, the Paria River is capable of generating massive flash floods that deliver huge sediment loads into Grand Canyon. In September 1998, a flood of 6,500 cubic feet per second (cfs) delivered about 800,000 tons of sand to the Colorado River.

The vegetation of the lower Paria River consists of sparse desert riparian grass, forbs and shrubs, dominated by fescue and arrowweed, with relatively low plant cover and diversity. Extensive stands of non-native tamarisk have replaced much of the native vegetation. The only other trees along the Paria River are Fremont cottonwood, and those are sparse with low recruitment. Some evidence suggests that more extensive stands of cottonwood previously occupied the area, but were removed for fuel and construction by early settlers.

Bald Eagles, Golden Eagles, Red-tailed Hawk, Great Horned Owl, Cooper’s Hawk, and Peregrine Falcon utilize the riparian habitat along the river, as do flycatchers, swallows, swifts, wrens, hummingbirds, and herons. Bobcats, foxes, Mountain Lions, porcupines, beavers, and Coyotes are found throughout the rugged terrain in the Paria Basin.

Prior to construction of Glen Canyon Dam, the Paria River provided important habitat for several species of fish, now federally endangered. Humpback Chub, Razorback Sucker and possibly, Bonytail Chub spawned in the mouth of the Paria River. Colorado Pikeminnow, another endangered fish, spent time in the mouth of the river as they migrated through Grand Canyon. Formerly a top predator in the Colorado River basin, this large fish would sometimes grow to nearly six feet long and weigh up to 80 pounds.

Important Conservation Lands

- Paria Canyon-Vermilion Cliffs Wilderness Areas, BLM
- Vermilion Cliffs National Monument, BLM
- Arizona Audubon Important Bird Area; Marble Canyon
- Glen Canyon National Recreation Area, NPS

Federally Protected Species and Critical Habitats

Critical Habitat has not been designated in the Paria Basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_PAR_final.pdf

PARKER

The Parker Basin is located in La Paz and Yuma Counties. This basin is characterized by plains and valleys and low elevation mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona Uplands Sonoran desertscrub. Riparian vegetation includes tamarisk, marsh and mesquite along the Colorado River.

Important Riparian, Aquatic, and Wetland Resources

The Parker Basin is characterized by an extremely arid environment with an average annual precipitation of 4.5 inches. The Colorado River is the basin's main hydrological feature and runs north-south along the western edge of the basin for about 144 miles; Twelve Mile Slough is the only other identified perennial water outside the river channel. The basin begins at Parker Dam and the western edge runs along the Colorado River to the Imperial National Wildlife Refuge.

Numerous backwaters along the Colorado River provide the majority of aquatic features and wildlife habitat. Much of the western basin contains abundant farmland. The central and eastern portion of the basin is made up of low lying mountain ranges. There are about a dozen small springs in the basin.

Several State Wildlife Species of Concern have been observed in the basin including, the Bald Eagle, California Black Rail, Great Egret, Least Bittern, and Western Yellow Bat. Other wading birds observed in the basin include Great Egret, California Black Rail, Great Blue Heron, Least Bittern, marsh Wren and White-faced Ibis. The Western Yellow Bat has also been observed.

Important Conservation Lands

- Buckskin Mountain State Park, Arizona State Park
- East Cactus Plain Wilderness, BLM
- Cactus Plain Wilderness Study Area, BLM
- Gibraltar Wilderness, BLM
- New Water Mountains Wilderness, BLM
- Trigo Mountains Wilderness, BLM
- Cibola National Wildlife Refuge, USFWS
- Imperial Reservoir National Wildlife Refuge, USFWS
- Kofa National Wildlife Refuge, USFWS

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

As part of the MSCP, land and water agreements with USFWS wildlife refuges were formed to implement conservation actions on those refuges. Cibola and Imperial National Wildlife Refuges are two of three refuges that have a land and water agreement in place. The land and water agreements allow the MSCP to use refuge lands and a portion of that refuge's Colorado River surface water allocations (the refuges do not have groundwater rights; any wells are considered to be pumping Colorado River water from the alluvium) to develop conservation areas. The MSCP pays for the development and maintenance activities of the conservation areas, as well as any monitoring associated with the projects. The partnership with the MSCP allows the refuges to gain improved wildlife habitats on their lands supporting the mission of the refuge without having to pay for the development of that habitat.

Federally Protected Species and Critical Habitats

The Parker Basin contains about 12,000 acres of federal critical habitat for the Endangered Razorback Sucker along 144 miles of the Colorado River. Aquatic and riparian habitats associated with the Colorado River provide suitable habitat for numerous other federally listed or sensitive species.

Federally protected species observed in the basin include the Endangered Southwestern Willow Flycatcher, Yuma Clapper Rail, Bonytail Chub, and Razorback Sucker. Candidate Yellow-billed Cuckoo has also been observed.

Economic Values

The Parker Strip, below Parker Dam is a heavily utilized waterway for watercraft recreation, fishing and other outdoor and wildlife related recreational activities, especially at the Imperial National Wildlife Refuge. There is one area stocked by the AGFD for fishing, located at La Paz County Park. The lagoon and one off-channel pond are used for fishing clinics each year. The Colorado River and associated backwaters and ponds are also used for waterfowl hunting and fishing activities.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_PKB_final.pdf

PEACH SPRINGS

Peach Springs Basin is located at the intersection of Mohave, Yavapai, and Coconino Counties. The basin is characterized by a relatively high elevation plateau area, steep canyons and relatively small valleys. The Colorado River defines the northwestern basin boundary. Vegetation types include Great Basin conifer woodland, plains and Great Basin grassland, Great Basin and Mohave desertscrub and a small area of mountain conifer forest.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Shivwits Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

Native species observed in the basin include the Arizona toad, Northern Leopard Frog, American Peregrine Falcon, Southwestern Willow Flycatcher, Yellow-billed Cuckoo, Flannelmouth Sucker, Speckled Dace, and Hualapai Mexican Vole. The Northern Leopard Frog and Peregrine Falcon are both State Species of Concern observed in the basin.

Perennial waters include the Colorado River and a short segment of Diamond Creek. There are also a number of major and minor springs.

Important Conservation Lands

- Grand Canyon National Park, NPS

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for the Razorback Sucker.

Federally protected species observed in the basin include the Endangered Hualapai Mexican Vole and Southwestern Willow Flycatcher and Candidate Yellow-billed Cuckoo.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_PSC_final.pdf

http://www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs_PDFs_for_web/Upper_Colorado_River_Planning_Area/Peach_Springs_Basin.pdf

Additional References

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PHOENIX AMA

The Phoenix Active Management Area (AMA) located predominantly in Maricopa County and in Pinal and Yavapai counties. It is one of five AMA's created by the Arizona Groundwater Code. The AMA includes all of the urban Phoenix metro area and many undeveloped areas. It stretches out to include Anthem, to Sacaton, and east/west from Superior to Tonopah.

The basin is characterized by valleys surrounded by mid-elevation mountain ranges. Vegetation types are predominantly Lower Colorado River Valley and Arizona Uplands Sonoran desertscrub with a small area of southwestern interior chaparral in the northeastern portion of the AMA. Riparian vegetation, primarily tamarisk, is found extensively along the Gila River below the 91st Avenue Wastewater Treatment Plant.

Important Riparian, Aquatic, and Wetland Resources

Major surface water sources include the Salt, Verde, Aqua Fria, and Hassayampa Rivers, all of which drain into the Gila River. The Colorado River provides an additional surface water source to the Phoenix AMA and is delivered via the Central Arizona Project (CAP).

The Salt and Verde Rivers are the major water sources for the Phoenix AMA, and these rivers sustain riparian habitat, primarily outside the developed metro area. There are also important riparian areas along the Gila River. While the CAP contributes significant water supplies for Phoenix metro cities, it has little impact on wildlife or riparian vegetation. It is fenced to keep all but the smallest animals out and is subject to routine vegetation control.

Arnett Creek, Camp Creek, New River, Queen Creek, Seven Springs Wash, and Skunk Creek have perennial reaches within the AMA. The Agua Fria River is also intermittent with perennial stretches. A small portion of perennial flow along the Hassayampa River is also found in the Phoenix AMA. These perennial reaches are typically lined with cottonwood and willow trees, and rushes and sedges in the wetter areas. There are also sycamore, mesquite and invasive tamarisk trees. Riparian areas, even those within developed landscapes are important habitats for many fish, birds, and other wildlife.

In addition, there are also extensive riparian areas and wetlands on the west side of Phoenix where the Salt, Gila, and Agua Fria rivers converge with treated effluent water released from the 91st Avenue Wastewater Treatment Plant. In this vicinity, the Arizona Game and Fish Department manages the Base and Meridian, Robbins Butte and Arlington Wildlife Areas and the City of Phoenix manages the Tres Rios wetlands.

The mesquite bosques and reedy marshes of the Tres Rios area are of particular importance to birds. Plentiful food and nesting resources attract hundreds of species of breeding and migratory birds. Some species, White-winged and Mourning Doves in particular, arrive in flocks that number in the thousands. Robbins Butte Wildlife Area is home to more than 115 species of winter-resident birds and is the center of the National Audubon Society's annual Gila River Christmas Bird Count. Many raptors, including the White-tailed Kite and Bald Eagle, are included in this list. Arizona Audubon has identified several Important Bird Areas in this basin including Boyce Thompson Arboretum, Arnett-Queen Creeks, Salt-Verde and Salt-Gila ecosystems and the Gilbert Riparian Preserve.

Wetlands along the Gila River and throughout the Tres Rios area are home to a diverse group of reptiles, a minimum of 19 species, as well as deer, Ring-tail Cats, and other mammals. Northern Leopard Frog, Western Yellow-billed Cuckoo, and the Sonoran Desert Tortoise are also a few of species identified as Wildlife of Special Concern by the Arizona Game and Fish Department that occur in the basin. Seven species of native fish live within the AMA, including Roundtail Chub, Speckled Dace, Desert Sucker, Sonoran Sucker, Loach

Minnow, Gila Topminnow, and Desert Pupfish.

Other basin species include Lowland Leopard Frog and Narrow Headed Gartersnake, Peregrine Falcon, Black-bellied Whistling-Duck, Common Black-Hawk, Least Bittern, Mississippi Kite, Osprey, Western Red and Yellow Bat, and Arizona Skink.

Important Conservation Lands

The Phoenix AMA, although significantly urban and developed, includes several BLM or Forest Service wilderness areas in the surrounding upland and desert landscape.

- Sonoran Desert National Monument, BLM
- Big Horn Mountain Wilderness, BLM
- Hell's Canyon Wilderness, BLM
- Hummingbird Springs Wilderness, BLM
- Sierra Estrella Wilderness, BLM
- Signal Mountain Wilderness, BLM
- South Maricopa Mountain Wilderness, BLM
- North Maricopa Mountains Wilderness, BLM
- White Canyon Wilderness, BLM
- Woolsey Peak Wilderness, BLM
- Superstition Wilderness, USFS
- Arlington Wildlife Area, AGFD
- Base and Meridian Wildlife Area, AGFD
- Powers Butte Wildlife Area, AGFD
- Robbins Butte Wildlife Area, AGFD
- Gila River State Conservation Lands, AGFD
- Hohokam Pima National Monument, NPS
- Arizona Audubon Important Bird Areas; Boyce Thompson Arboretum, Arnett-Queen Creeks, Salt and Verde Ecosystem, Salt and Lower Gila Ecosystem, Gilbert Riparian Preserve
- Boyce Thompson Arboretum State Park, Arizona State Park
- Lost Dutchman State Park, Arizona State Park

In Phoenix, the U.S. Army Corps of Engineers and the city government plan to expand the Tres Rios demonstration wetlands along a 7-mile stretch of the Salt and Gila Rivers. Originally built by Reclamation, the demonstration wetlands treats thousands of gallons of wastewater and provides habitat to a wide variety of waterfowl and aquatic life, and supports cottonwoods, seep willows and dense stands of cattail. Tres Rios also serves as a laboratory for biologists and hydrologists looking to better understand the interface between urban settlement and native ecosystems.

Federally Protected Species and Critical Habitats

No Critical Habitat has been designated within the Phoenix AMA Basin.

The Yuma Clapper Rail, Lesser Long-nosed Bat, Gila Topminnow, Desert Pupfish, Southwestern Willow Flycatcher, and Sonoran Pronghorn Antelope are classified as endangered and may be found within the AMA. The Sonoran Desert bald Eagle also nests within the AMA and is classified as threatened. The Yellow-billed Cuckoo, Roundtail Chub, and Desert Tortoise are classified as candidates for the Federal endangered species list.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 38,664 Angler Use Days were documented in the Phoenix AMA Basin, equating to over $6 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/ActiveManagementAreas/documents/Volume_8_PHX_final.pdf

PINAL AMA

The Pinal Active Management Area (AMA) is located in Pinal, Maricopa and Pima Counties, and is the second largest of the five AMAs designated by the 1980 Arizona Groundwater Management Act. It is characterized by broad, alluvial Sonoran desert valleys and mid-elevation north to northwest trending fault-block mountains. The Gila River flows east to west in the northern part of the basin while the Santa Cruz River enters the basin from the southeast, flowing toward the northwest. Neither of these rivers have perennial flows in the basin. Elevations range from about 1,000 feet where the Gila River and Santa Cruz River exit the basin in the northwest to over 6,800 feet at Kitt Peak at the southern basin boundary. Vegetation types are predominantly Lower Colorado River Valley and Arizona Uplands Sonoran desertscrub with a small area of semidesert grassland in the western portion of the AMA.

Important Riparian, Aquatic, and Wetland Resources

There are three large reservoirs in the Pinal AMA Basin: Saint Clair, Reach 11 Detention Dike 3, and Picacho Reservoir. Picacho Reservoir is located 11 miles south of Coolidge. Over the years, siltation and vegetation have reduced the capacity and surface area, so that much of the reservoir is a shallow marsh with extensive stands of cattails and rushes. Water level is highly variable, and the lake is completely dry in some years.

Water is diverted from the Gila River at Ashurst-Hayden Diversion Dam twelve miles east of Florence for the San Carlos Irrigation Project (SCIP). This dam serves as a diversion dam only and is not a storage or flood control facility.

There are several State Wildlife Species of Concern observed in this basin including, Lowland Burrowing Treefrog, Western Barking Frog, Western Narrow-mouthed Toad, Great Egret, Least Bittern, and Western Yellow Bat. Other native species observed in the basin include Sonora Sucker, Longfin Dace, Arizona Mud Turtle, Sonoran Green Toad, Great Blue Heron, Great Egret, and Least Bittern.

Important Conservation Lands

- Ironwood Forest National Monument, BLM
- Sonoran Desert National Monuments, BLM
- Coyote Mountains Wilderness, BLM
- Sierra Estrella Wilderness, BLM
- South Maricopa Mountains Wilderness, BLM
- Tabletop Wilderness, BLM
- Casa Grande National Monument, NPS
- McFarland/Picacho Reservoir State Conservation Land, AGFD
- Santa Rosa Wash Cooperative Agreement State Conservation Land, AGFD
- McFarland State Historic Park, Arizona State Park
- Picacho Peak State Park, Arizona State Park

Coyote Mountains Wilderness is a detached mountain adjacent to the Baboquivari Mountain Range. The vegetation includes paloverde, saguaro, chaparral, and oak woodlands. Wildlife includes mountain lion, javelina and bobcat.

Sierra Estrella Wilderness contains an elevation range that supports diverse plant communities: saguaro, cholla, ocotillo, paloverde, and elephant bush lower down, shrub live oak and junipers higher up. A remnant herd of Desert Bighorn Sheep, Gila Monster, Giant Spotted Whiptail Lizard, Desert Tortoise, Mountain Lion, Mule Deer, Coyote, Javelina, Golden Eagle, Prairie Falcon, and Cooper's Hawk are found.

The South Maricopa Mountains Wilderness is characterized by two major vegetation communities -- Paloverde-Mixed Cacti, which includes the dense "forests" of saguaro cactus, paloverde, and ironwood trees, and the Creosote-Bursage community that covers low elevation valley floors. In 2001 the South Maricopa Mountains Wilderness was incorporated into the Sonoran Desert National Monument.

The Table Top Wilderness is dominated by Table Top Mountain (4,373-feet in elevation), which abruptly rises above the nearly level Vekol Valley. The wilderness is characterized by two major vegetation communities -- Paloverde-Mixed Cacti, and the Creosote-Bursage community that covers low elevation valley floors. At the summit of Table Top Mountain is a small, 40-acre area of Sonoran Desert Grassland. In 2001 the Table Top Wilderness was incorporated into the Sonoran Desert National Monument.

The Sonoran Desert National Monument contains more than 487,000 acres of Sonoran Desert landscape including extensive saguaro cactus forest. A small portion of the Monument is located within the Pinal AMA Basin. The Sonoran Desert is the most biologically diverse of the North American deserts. The monument contains three distinct mountain ranges, the Maricopa, Sand Tank and Table Top Mountains, as well as the Booth and White Hills, all separated by wide valleys. The portion of the monument within the Pinal AMA basin is home to the congressionally designated Table Top wilderness area, as well as many significant archaeological and historic sites, and remnants of several important historic trails.

The Ironwood Forest National Monument is partially located in the Pinal AMA Basin. A significant concentration of Ironwood is found in the monument, along with two federally recognized endangered animal and plant species. An array of flora is present in the Ironwood Forest National Monument. The higher elevations contain Pinyon-juniper woodland plant community while the lower elevations are in the Sonoran Desert ecoregion. One of the notable trees native here is the Elephant tree, Bursera microphylla. Small populations of the endangered Nichols Turk's Head Cactus, although not found among Ironwood trees, occur in localized limestone-rich areas within the Monument.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for the Southwestern Willow Flycatcher and Spikedace along the Gila River, which minimally intersects the eastern edge of the Pinal AMA Basin.

Federally protected species observed in the basin include the Endangered Yuma Clapper Rail and Desert Pupfish and Candidate Yellow-billed Cuckoo.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 1,702 Angler Use Days were documented in the Pinal AMA Basin, equating to over $265,000 in economic revenue generated by angler activity within the basin.

Web Sources

http://en.wikipedia.org/wiki/Area_of_Critical_Environmental_Concern http://www.pr.state.az.us/ohv/downloads/OHV_Sonoran_Desert_NM.pdf

http://www.blm.gov/pgdata/etc/medialib/blm/az/pdfs/planning/ironwood/deis.Par.77638.File.pdf/Appendix_H.pdf

http://www.blm.gov/pgdata/etc/medialib/blm/az/pdfs/planning/ironwood.Par.75215.File.dat/DRMP_DEIS.pdf

http://protectedplanet.net/sites/Ironwood_Forest_National_Monument_Blm

http://en.wikipedia.org/wiki/Barry_M._Goldwater_Air_Force_Range

http://www.ecr.gov/pdf/bgrange.pdf

http://www.nps.gov/cagr/index.htm

http://www.fws.gov/southwest/es/arizona/Documents/Redbook/Southwestern%20Willow%20Flycatcher%20RB.pdf

http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2005_register&docid=fr19oc05-12

http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2007_register&docid=fr21mr07-12

http://www.fws.gov/southwest/es/Arizona/Documents/CountyLists/Pinal.pdf

PRESCOTT AMA

The Prescott Active Management Area (AMA) located in Yavapai County is characterized by rolling hills and broad valleys. It was designated as an AMA by the 1980 Arizona Groundwater Management Act, the smallest of five such areas established. Vegetation types include plains and Great Basin grassland, southwestern interior chaparral, Great Basin conifer woodland and petran montane conifer forest.

Important Riparian, Aquatic, and Wetland Resources

The basin has some significant surface water resources, including the headwaters of the Agua Fria River. The Agua Fria is the longest perennial stream in the basin, and flows perennially for 3.6 miles before it exits the basin south of Dewey-Humboldt. Granite Creek, which also has its headwaters in the basin, flows south to north with 0.90 miles listed as perennial. Flows from Granite Creek, Willow Creek, and Del Rio Springs in the basin contribute significantly to the flow of the Verde River whose headwaters is located just outside the boundary of the basin at Sullivan Lake. Much of the Verde's base flow is dependent on these creeks and springs, fed by interconnected aquifers in the basin.

Watson and Willow Lakes are listed as Important Bird Areas (IBA), a program administered Arizona Audubon. The Granite Dells/upland habitat is a provisionally listed IBA. The Watson and Willow Lakes areas were designated an IBA including: Wood Duck, Lucy's Warbler, and Sonoran Yellow Warbler (breeding); and Bald Eagle and Belted Kingfisher (wintering). From 2005 to 2010 bird surveys here identified nearly 180 separate species.

Watson and Willow Lakes are contained in Watson Lake Park and Heritage Park, City of Prescott facilities that are listed as Wildlife Viewing areas by Watchable Wildlife, Inc. A variety of birds, especially migratory and wintering waterfowl, can be seen along the lake and in the cottonwood gallery forest, which is home to an active Great Blue Heron Rookery and many pairs of Wood Ducks. Bald Eagles and Osprey seasonally appear. Mule Deer, Javelina, and Pronghorn can also be found here. A variety of reptiles and amphibians inhabit the lake and its shores, including, Clark's Spiny Lizard, Plateau Lizard, Eastern Collared Lizard, Terrestrial Gartersnake, Woodhouse's Toad, and Red-spotted Toad. Other species observed include Peregrine Falcon, Belted Kingfisher, and Arizona Skink.

Important Conservation Lands

- Upper Verde, Granite Creek Wildlife Area, AGFD
- Arizona Audubon Important Bird Area; Watson/Willow Ecosystems
- Woodchute Wilderness, USFS

Portions of the Prescott National Forest are contained along the eastern and southern boundaries of the Prescott AMA basin. At the lowest elevation, the primary vegetation is of the Sonoran Desert type. As the elevation rises, chaparral becomes common, followed by piñon pine and juniper. Above that, Ponderosa pine dominates the landscape.

A portion of the Woodchute National Wilderness Area extends into the Prescott AMA basin. The high elevation of this area provides for growth of Ponderosa pine forests. With the dramatic elevation changes from the bottom to the top of this wilderness, wildlife populations are diverse and include Black Bear, Elk, Mule and Whitetail Deer, Mountain Lions, Golden and Bald Eagles.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated within the Prescott AMA for Mexican Spotted Owl.

Federally protected species observed in the basin include:

- Listed Endangered- Razorback Sucker and Hualapai Mexican Vole
- Listed Threatened- Sonoran Desert Bald Eagle and Mexican Spotted Owl
- Candidate- Yellow-billed Cuckoo and Northern Mexican Gartersnake.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 39,660 Angler Use Days were documented in the Prescott AMA Basin, equating to over $6 million in economic revenue generated by angler activity within the basin.

RANEGRAS PLAIN

The Ranegras Plain Basin is in La Paz County and a small part of Yuma County in southwestern Arizona. The basin is characterized by a plain bordered by mountain ranges. The center of the basin is bordered by the Plomosa, New Water and Little Horn Mountains in the west and the Granite Wash and Little Harquahala Mountains in the east. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub.

Important Riparian, Aquatic, and Wetland Resources

Ranegras Plain Basin contains no large or small reservoirs, perennial or intermittent streams, or major or minor springs, and contains just 16 registered stock ponds. Bouse Wash is large dry wash that drains to the Colorado River through the northern portion of the groundwater basin. Average annual rainfall is as high as 14 inches along the eastern basin boundary north of Vicksburg to a low 4 inches in the north central portion of the basin.

Important Conservation Lands

- Eagletail Mountains Wilderness, BLM
- New Water Mountains Wilderness Area, BLM
- Kofa National Wildlife Refuge, USFWS

The New Water Mountains Wilderness area contains important desert bighorn sheep habitat, including the New Water and Dripping Springs lambing areas.

Federally Protected Species and Critical Habitats

Ranegras Plain Basin contains no designated critical habitat and no documented occurrences of federally listed species.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_RAN_final.pdf

SACRAMENTO VALLEY

The Sacramento Valley Basin in Mohave County is characterized by broad valleys and mountains along the eastern and western basin boundaries. The basin trends in a north-south direction and is bounded on the west by the Black Mountains, on the southwest by the Mohave Mountains, and on the east by the Cerbat and Hualapai Mountains. Sacramento Wash, a major ephemeral wash, drains into the Colorado River.

A small segment of the Colorado River defines the westernmost basin boundary. Vegetation is primarily semidesert grassland with smaller areas Arizona upland and lower Colorado River Sonoran desertscrub, semidesert grassland, Great Basin conifer woodland, interior chaparral and montane conifer forest. A small riparian area consisting of marsh and mesquite occurs along the Colorado River.

Important Riparian, Aquatic, and Wetland Resources

There is one perennial stream, the Colorado River, located along the northeastern basin boundary, spanning almost five miles.

The Clark's Grebe is a State Wildlife Species of Concern observed in this basin. Other native species observed include Flannelmouth Sucker, Baja California Treefrog, Marsh Wren, Zone-tailed Hawk, Kingman Springsnail, and Western Red-tailed Skink.

Important Conservation Lands

- Aubrey Peak Wilderness, BLM
- Mount Nutt Wilderness, BLM
- Warm Springs Wilderness, BLM
- Wabayuma Peak Wilderness, BLM
- Havasu National Wildlife Refuge, USFWS

Several areas in this basin have been identified by the BLM as special management lands for Desert Tortoise and Bighorn Sheep.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Bonytail Chub.

The Southwestern Willow Flycatcher, Yuma Clapper Rail and Hualapai Mexican Vole are all endangered federally protected species observed in the basin. The Candidate Yellow-billed Cuckoo is also found there.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/UpperColoradoRiver/documents/Volume_4_SAC_final.pdf

SAFFORD

The Safford Basin is within Gila, Graham, Greenlee, Pinal and Cochise Counties. The basin is characterized by valleys, high-elevation mountain ranges and a variety of vegetation types including Arizona uplands, Sonoran and Chihuahuan desertscrub, semidesert grassland, Rocky Mountain and montane conifer forest, Great Basin conifer woodland, madrean evergreen woodland and a small portion of Rocky Mountain subalpine forest atop Mt. Graham. Riparian vegetation includes mesquite and tamarisk on the Gila River; conifer oak, mixed broadleaf and mesquite on Ash Creek; conifer oak and mesquite on Fry Canyon; and conifer oak and mixed broadleaf on Deadman Canyon and Cave Creek and its tributaries.

Important Riparian, Aquatic and Wetland Resources

Riparian areas include the Gila River, Cave and Turkey Creeks, and San Carlos River. Native Apache Trout have been reintroduced to Cave Creek and Gould's Turkey has been reintroduced into several of the mountain and riparian habitats.

The 23,000-acre Gila Box Riparian National Conservation Area (NCA) falls primarily within the Safford Basin. The NCA has four perennial waterways - the Gila and San Francisco Rivers and Bonita and Eagle Creeks. The Gila River canyon section, known as the Gila Box, is composed of patchy mesquite woodlands, mature cottonwoods, sandy beaches, and grand buff-colored cliffs. Several raptors can be found in the NCA including, Zone-tailed Hawks and Common Blackhawks. The perennial creek and riparian vegetation make this a cool year-round desert oasis.

There are several State Wildlife Species of Concern observed in this basin; Lowland Leopard Frog, Peregrine Falcon, Northern Buff-breasted Flycatcher, Sonora Sucker, Speckled Dace, Arizona Shrew, Western Red Bat, and Western Yellow Bat. Other native species observed in the basin include Yellow Mud Turtle, Arizona Toad, Plains Spadefoot, Western Green Toad, Zone-tailed Hawk, Desert Sucker, Longfin Dace, Sonora Sucker, and Speckled Dace.

Important Conservation Lands

- Gila Box Riparian National Conservation Area, BLM
- Arizona Audubon Important Bird Area; Chiricahua Mountains
- Chiricahua Wilderness Area, USFS
- Fishhooks Wilderness Area, USFS
- Dos Cabezas Mountains, USFS
- North Santa Teresa Wilderness, USFS
- Peloncillo Mountains, USFS
- Mt. Graham Wilderness Study Area, USFS
- Santa Teresa Wilderness, USFS
- Chiricahua National Monument, NPS
- Clarence May Memorial State Conservation Land, AGFD

- Cluff Ranch Wildlife Area, AGFD
- Roper Lake, AGFD
- Roper Lake State Park, Arizona State Park
- Manhattan Claims State Conservation Land, AGFD
- Cave Creek and Cave Creek South Fork are identified as Outstanding Arizona Waters, ADEQ

The Chiricahua wilderness is a unique intersection between the Chihuahuan and Sonoran Deserts, and the Rocky Mountains and Mexico's Sierra Madres, covering the upper slopes and inner canyons of the largest mountain range in the 'Sky Island' region. There are over 70 species of mammals, 46 species of reptiles, 8 amphibians, and over 170 species of birds documented in the Chiricahuas. The varied habitats and southern location bring a variety of Mexican bird species across the border, such as the Elegant Trogon, Whiskered Screech-owl, Arizona Woodpecker, and the Magnificent Hummingbird. In all, 13 hummingbird species are known to occur here. Common birds in the area include Mexican Jay, Black-headed Grosbeak, Acorn Woodpecker, Yellow-eyed Junco, Painted Redstart, Grace's Warbler, and Spotted Towhee.

Federally Protected Species and Critical Habitat

Critical Habitat has been designated for Mexican Spotted Owl, Mt. Graham Red Squirrel, Southwestern Willow Flycatcher, Razorback Sucker, and Loach Minnow.

Federally protected species observed in the basin include:

- Listed Endangered- Gila Topminnow, Gila Chub, Desert Pupfish, Southwestern Willow Flycatcher,
- Listed Threatened- Loach Minnow, Mexican Spotted Owl, Sonoran Bald Eagle, Chiricahua Leopard Frog
- Candidate- Headwater Chub, Northern Mexican Gartersnake, Yellow-billed Cuckoo,

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 9,597 Angler Use Days were documented in the Safford Basin, equating to over $1 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_SAF_final.pdf

SALT RIVER

The Salt River Basin intersects Navajo, Gila, Maricopa, Pinal, Greenlee, Graham, and Apache Counties. This basin is characterized by mid- to high-elevation mountain ranges, plateaus and canyons. Vegetation types include: Arizona upland Sonoran desertscrub; semidesert, plains and Great Basin and subalpine grasslands; interior chaparral; madrean evergreen woodland; Great Basin conifer woodland; and montane and Rocky Mountain subalpine conifer forests. Riparian vegetation includes Mesquite, mixed broadleaf and Tamarisk along the Salt River and mixed broadleaf along the Black River. Over half of this basin is managed by Native American tribes, principally the Fort Apache and San Carlos Indian reservations.

Important Riparian, Aquatic, and Wetland Resources

The Salt River, a popular whitewater rafting destination, runs east to west through the southern part of the basin from the confluence of the White and Black Rivers. There are numerous perennial streams located throughout the basin, particularly in the high elevation eastern portion, and include the Salt River, Black River, East Fork Black River, West Fork Black River, White River, East Fork White River, North Fork White River, Big Bonito Creek, Carrizo Creek, Cibecue Creek, Canyon Creek and Cherry Creek. Perennial waters also flow through many of the wilderness areas within the basin; Bear Wallow Creek, Campaign, Pinto and Tortilla Creeks, Cherry and Coon Creeks, Devils Chasm Creek, and Rock Creek.

Bear Wallow Creek flows year-round through the wilderness area, shaded by green riparian hardwoods. The creek provides a habitat for the threatened Apache Trout.

Theodore Roosevelt Lake is located in the western portion of the basin and Apache Lake, Canyon Lake and Saguaro Lake are in the vicinity of Tortilla Flat. Hawley Lake, Sunrise Lake, Crescent Lake and Big Lake are found in the high-elevation northeastern portion of the basin. The most common use of the large reservoirs is recreation; boating, fishing, camping, and other water sports.

Portions of perennial flow in Pinal Creek are supported by effluent discharge.

State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Northern Leopard Frog, Western Barking Frog, Peregrine Falcon, Belted Kingfisher, Common Black-Hawk, Northern Gray Hawk, Osprey, American Water Shrew, Western Red Bat, and Narrow-headed Gartersnake. Other native species observed Mogollon Rim Treefrog, Zone-tailed Hawk, Sonora Sucker, Speckled Dace, and Arizona Montane Vole.

Important Conservation Lands

- Roosevelt Lake Wildlife Area, AGFD
- Three Bar Wildlife Area, AGFD
- Black River and Cunningham State Conservation Lands, AGFD
- Arizona Audubon Important Bird Area; Upper Little Colorado River Watershed, Mogollon Rim Snowmelt Draws, Blue River Complex
- Bear Wallow Wilderness Area, USFS
- Four Peaks Wilderness Area, USFS
- Salome Wilderness Area, USFS

- Salt River Canyon Wilderness Area, USFS
- Sierra Ancha Wilderness Area, USFS
- Superstition Wilderness Area, USFS
- Tonto National Monument, NPS
- Bear Wallow Creek, Bear Wallow Creek North Fork, and Bear Wallow Creek South Fork are identified as Outstanding Arizona Waters, ADEQ
- Hay Creek, Snake Creek, and Stinky Creek are identified as Outstanding Arizona Waters, ADEQ

Federally Protected Species and Critical Habitats

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. It is officially designated as Arizona's state fish, and was historically found only in the headwaters of the White, Black and Little Colorado Rivers. Once nearing extinction, the Apache trout had been reduced to 13 relict populations, all located in headwater streams that flow into the White and Black rivers within the Salt River basin. A recovery program has restored Apache trout to much of their historic range in the White Mountains on the Fort Apache Indian Reservation (FAIR) and Apache-Sitgreaves National Forest (ASNF). Apache Trout offer anglers a unique fishing opportunity, providing a recreational and economic asset to the state. Apache Trout are stocked in several waters in eastern Arizona including the East Fork of the Black River, lower West Fork of the Black, the Little Colorado River in Greer, the West Fork of the LCR, and upper Silver Creek. The state also stocks some lakes, of which Lee Valley Lake is most notable.

Recovery actions for Apache Trout include stream restoration, fencing, stabilizing stream banks, managing erosion, fish barrier construction, and establishing new populations. New populations that have been or are in the process of being restored in the Salt River basin include:

- Bear Wallow Creek, including North and South Forks (ASNF)
- Conklin Creek (ASNF)
- Fish Creek, including Double Cienega and Corduroy creeks and Ackre Lake (ASNF)
- Hayground Creek (ASNF)
- Home Creek (ASNF)
- Stinky Creek (ASNF)
- West Fork Black River, including Thompson and Burro creeks (ASNF and FAIR)
- Wildcat Creek (ASNF)
- Paradise Creek (FAIR)
- Squaw Creek (FAIR)
- Wohlenberg Draw (FAIR)

Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher, Yuma Clapper Rail, Desert Pupfish, Gila Topminnow, and Razorback Sucker

- Listed Threatened- Chiricahua Leopard Frog, Sonoran Desert Bald Eagle, Mexican Spotted Owl, Apache Trout, and Loach Minnow,

- Candidate- Yellow-billed Cuckoo, Roundtail Chub, Three Forks Springsnail, New Mexico meadow jumping mouse, and Northern Mexican Gartersnake

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 1,259,065 Angler Use Days were documented in the Salt River Basin, equating to over $196 million in economic revenue generated by angler activity within the basin. Additionally, while no calculated economic value could be identified, the Salt River Canyon provides one of only a few opportunities for white water rafting, kayaking and canoeing available in Arizona. Reservoirs in this groundwater basin provide some of the best watercraft recreation related opportunities, as well (Roosevelt, Apache, Canyon and Saguaro lakes). Water resources, primarily springs, and small streams, provide needed watering sites for an abundance of back-country wilderness experiences for back-packers and horseback riders. The water resources of the basin also provide needed water for abundant big and small game species that provide recreation opportunity for, and economic benefit from, thousands of hunters each year.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/CentralHighlands/documents/volume_5_SRB_final.pdf

SAN BERNARDINO VALLEY

San Bernardino Valley is in the extreme southeast part of the state in Cochise County. This basin is characterized by a valley flanked by two mountain ranges; Peloncillo Mountains to the east and Pedregosa Mountains on the northwest basin boundary. Vegetation is primarily semidesert grassland with smaller areas of madrean evergreen woodland and Chihuahuan desertscrub. Riparian vegetation includes Mesquite and Cottonwood and Willow along Black Draw.

Important Riparian, Aquatic, and Wetland Resources

More than 280 species of birds are drawn to the aquatic habitats in the San Bernardino Valley. The San Bernardino Cienega was historically the most extensive wetland in the region, forming an important migratory link between Mexico and North America.

The San Bernardino Valley is dissected by ephemeral streams that flow only during rain events. However, in the central valley just north of the International Boundary, discharge from artesian wells and springs flow into Black Draw, a perennial stream on the San Bernardino National Wildlife Refuge and the largest drainage in the valley.

The wetlands and riparian habitats support a wide diversity of birds including ducks, woodpeckers, cranes, hummingbirds, and raptors. Coyote, bobcat and the occasional mountain lion inhabit the refuge along with Mule Deer, Whitetail Deer, Badger, and Javelina.

The basin is located in the northernmost part of the Yaqui River drainage that extends far into Mexico. Eight species of fish are native to the Yaqui River drainage, including federally endangered Yaqui Chub and Yaqui Topminnow. Yaqui Catfish and Yaqui Beautiful Shiner, both threatened species, were once extirpated in the United States but were successfully reintroduced from Mexican populations. Other fish, native to the drainage, are the Mexican Stoneroller, Longfin Dace, Roundtail Chub, and Yaqui Sucker.

State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Thick-billed Kingbird, Tropical Kingbird, Violet-crowned Hummingbird, Mexican Stoneroller, and Western and Yellow Bat.

Important Conservation Lands

- San Bernardino National Wildlife Refuge, USFWS
- San Bernardino Wilderness Area, USFS

Extensive watershed renovations on lower Whitewater Draw and upper Black Draw within the San Bernardino National Wildlife Refuge are resulting in a rising water table and the recovery of riparian vegetation. The refuge is internationally significant, playing a critical role in supporting populations of native fish by restoring and maintaining aquatic and riparian habitat in the United States and Mexico.

Federally Protected Species and Critical Habitats

Critical habitat has been designated for Beautiful Shiner, Yaqui Catfish, and Yaqui Chub.

Federally protected species observed in the basin include:

- Listed Endangered- Yaqui Chub, Yaqui Topminnow, and Huachuca Water Umbel
- Listed Threatened- Chiricahua Leopard Frog, Beautiful Shiner, and Yaqui Catfish

- Candidate- Yellow-billed Cuckoo, San Bernardino Springsnail, and Northern Mexican Gartersnake

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_SBV_final.pdf

http://www.azheritagewaters.nau.edu/loc_yaqui_river.html

SAN RAFAEL

The San Rafael Basin is bisected by Cochise and Santa Cruz Counties. The sparsely populated basin is characterized by a high-elevation mountain range, the Huachuca Mountains, and a valley and Great Basin grassland and madrean evergreen woodland vegetation. Riparian vegetation includes Cottonwood and Willow and strand along the Santa Cruz River.

Important Riparian, Aquatic, and Wetland Resources

The San Rafael Basin contains the headwaters of the Santa Cruz River. There are over 10 miles of perennial flow in the basin along the Santa Cruz River and Ramsey Canyon. The Upper Santa Cruz River flows through rolling oak grassland hills and supports cottonwood-willow gallery forests.

The San Rafael Valley is one of the best remaining examples in Arizona of intact native grasslands. The native grasslands and riparian areas support a wide range of important species. The endangered Huachuca Water Umbel grows in the river area and Chiricahua Leopard Frog, Lowland Leopard Frog, Western Barking Frog, and Sonora Tiger Salamander also depend on the riparian area. Surface flows support Gila Chub, Gila Longfin Dace, Gila Topminnow, Desert Sucker and Sonora Sucker. Mexican Spotted Owl, Yellow-billed Cuckoo, Elegant Trogon, Bald Eagle, Zone Tailed Hawk, and Northern Buff-breasted Flycatcher can also be found in the basin.

Important Conservation Lands

- San Rafael Ranch State Natural Area, Arizona State Park
- Miller Peak Wilderness Area, USFS
- Coronado National Monument, NPS
- Bog Hole Wildlife Area, AGFD
- Arizona Audubon Important Bird Area; Huachuca Mountains

Arizona State Parks acquired the San Rafael State Natural Area from The Nature Conservancy and it remains under a conservation easement along with 17,000 acres of deed-lands. The State Natural Area is managed to preserve the native grasslands as well as the historic San Rafael Ranch buildings.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Mexican Spotted Owl and Huachuca Water Umbel.

Federally protected species observed in the basin include:

- Listed Endangered- Sonora Tiger Salamander, Gila Chub, Gila Topminnow, Madrean Ladies'-tresses
- Listed Threatened- Chiricahua Leopard Frog and Mexican Spotted Owl
- Candidate- Arizona Tree Frog, Yellow-billed Cuckoo, Huachuca Springsnail, and Northern Mexican Gartersnake

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_SRF_final.pdf

SAN SIMON WASH

The San Simon Wash Basin in Pima County is characterized by plains and valleys bordered by mountain ranges including the Baboquivari Mountains on the southeastern basin boundary. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub, semidesert grassland and madrean evergreen woodland along the eastern basin boundary.

Important Riparian, Aquatic, and Wetland Resources

There are no perennial or intermittent streams in the basin. San Simon Wash is the major basin drainage, flowing ephemerally into Mexico. There is one large reservoir in the southeastern corner of the basin, a dozen small reservoirs and a number of small springs.

State Wildlife Species of Concern observed in the basin include; Lowland Burrowing Treefrog, Western Narrow-mouthed Toad. Other native species observed in the basin include Sonoran Green Toad and Arizona Mud Turtle.

Important Conservation Lands

Approximately 99 percent of lands within the San Simon Wash Basin are Tohono O'odham lands. Very small portions of other conservation lands intersect this basin, including:

- Organ Pipe Cactus National Monument and Wilderness, NPS
- Baboquivari Peak Wilderness, USFS
- Buenos Aires National Wildlife Refuge, USFWS

Federally Protected Species and Critical Habitats

No Critical Habitat has been designated within the basin.

Federally protected species observed in the basin include Candidate species Yellow-billed Cuckoo and Northern Mexican Gartersnake

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_SSW_final.pdf

SANTA CRUZ AMA

The Santa Cruz Active Management Area (AMA) in Pima County and Santa Cruz counties is characterized by mid to high elevation mountains surrounding the Santa Cruz River Valley. Vegetation types include southwestern grassland, madrean evergreen woodland and riparian species, principally found along the Santa Cruz River and Sonoita Creek.

From its headwaters in the San Rafael Valley, the river flows southward approximately 9 miles and enters Mexico. During its 35 mile course through Mexico, the river continues its southward flow for a short distance and then bends northward and enters Arizona five miles east of Nogales. Within the United States, the Santa Cruz River continues northward for 65 miles from Nogales to Tucson, where it continues beyond to the confluence of the Gila River.

Important Riparian, Aquatic, and Wetland Resources

The Santa Cruz Valley contains several stretches of natural river flow, important riparian and grassland habitats, unfragmented wildlife migration corridors, and diverse plant and animal communities, including numerous endangered species. Wastewater is discharged from Nogales and Rio Rico into the river drainage of the Santa Cruz supporting the riparian habitats. The river is perennial through much of the upper valley in the San Rafael Valley and Sonora, supporting many native and migratory species. The ephemeral reaches support woody riparian vegetation of mostly cottonwood and willow; density and diversity increase as the river progresses southward toward the perennial section.

A large number of bird species inhabit the Santa Cruz Valley, and waterfowl migrate through in the spring and fall. The Northern Goshawk, a rare woodland raptor, occasionally hunts for birds and rodents in the foothills.

Sonoita Creek provides a unique array of species from endangered fish to butterflies and birds. The lush riparian area provides habitat for over 200 species of birds including Gray Hawks which nest in the large Fremont Cottonwoods, Zone-tailed Hawks, Common Black Hawks, Thick-bill Kingbirds and Northern Beardless Tyrannulets can also be found along Sonoita Creek.

The TNC Sonoita Creek Preserve protects a Fremont Cottonwood, Goodding Willow riparian forest. Arizona Black Walnut, Velvet Nesquite, Velvet Ash, Netleaf Hackberry, and various willows are also found in slightly different habitats throughout the preserve.

Cienega wetlands, a once common feature of the Sonoita Creek floodplain are now rare in Arizona. A significant number of rare and sensitive plant species are found in the Sonoita Creek watershed including, Huachuca Water Umbel, Santa Cruz Striped Agave, and the Santa Cruz Beehive Cactus.

State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Western Barking Frog, Western Narrow-mouthed Toad, Peregrine Falcon, Bald Eagle, Black-bellied Whistling-Duck, Elegant Trogon, Osprey, Tropical Kingbird, Violet-crowned Hummingbird, Gila Topminnow, and Brown Vinesnake.

Important Conservation Lands

- Sonoita Creek State Natural Area, Arizona State Park
- Patagonia Lake State Park, Arizona State Park
- Sonoita Creek Preserve, The Nature Conservancy
- Coal Mine Spring Wildlife Area, AGFD

- Arizona Audubon Important Bird Area; Sonoita Creek State Natural Area, Patagonia Lake State Park, Santa Rita Mountains
- Mt. Wrightson Wilderness, USFS
- Pajarito Wilderness, USFS
- Tumacacori National Monument, NPS

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for Mexican Spotted Owl. The Santa Cruz Valley harbors two federally endangered plants, Huachuca Water Umbel and Madrean Ladies'-tresses, as well as the rare Wilcox Fishhook Cactus. The endangered Gila Topminnow, thought once to be one of the most common fish in southern Arizona and the Gila Chub, a federal candidate species, survive in the perennial segments of the Santa Cruz river, as do several sensitive species of frogs and reptiles.

Other federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher
- Listed Threatened- Mexican Spotted Owl and Chiricahua Leopard Frog
- Candidate- Northern Mexican Gartersnake and Yellow-billed Cuckoo

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 88,811 Angler Use Days were documented in the Santa Cruz AMA Basin, equating to over $17 million in economic revenue generated by angler activity within the basin.

Additional studies have been conducted that describe the economic value of quality riparian habitat in close proximity to home developments, increasing real estate values (Bark et al., 2009; Bourne, 2007; Bark-Hodgins et al., 2006; Colby & Wishart, 2002).

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SHIVWITS PLATEAU

Shivwits Plateau Basin in Mohave County is characterized by plateaus, canyons and cliffs. Vegetation is primarily Great Basin conifer woodland, Great Basin and Mohave desertscrub and Plains and Great Basin grassland with small areas of Rocky Mountain and madrean montane forest and interior chaparral.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Shivwits Plateau Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

Water resources in the Shivwits Plateau Basin consist of three perennial streams: Boulder Wash; Colorado River, Spring Canyon and Diamond Creek. There are as many as 56 springs. Spring Canyon is the major spring and has a discharge rate of 331 gallons per minute.

With an elevation of 4000 to 6000 feet, and the highest point reaching 7072 feet at Mount Dellenbaugh, the vegetation in the Shivwits Plateau Basin is diverse. In the higher elevations Rocky Mountain and madrean montane conifer forest can be found along with juniper trees. The lower elevations consist of giant Mojave Yucca, Great Basin conifer woodland, Great Basin and Mohave Desert scrub, Great Plains and Great Basin grassland, and small areas of interior chaparral. Shrubs at the lower elevation include sagebrush and blackbrush. Mountain Star-lily and Red Alum Root are a few of the flowering plants that grow in the basin. Perennial grasses in the Shivwits Plateau region include Bottlebrush Squirreltail, and Blue Grama.

Wildlife that inhabits the Shivwits Plateau Basin includes Desert Mule Deer, Desert Bighorn Sheep, Kaibab Squirrel, and Mountain Lion. Birds of prey include American Peregrine Falcon, Turkey Vulture, and Red-tailed Hawk. Some of the types of fish that can be found in this area include Flannelmouth Sucker, Humpback Chub, and Speckled Dace. Other species observed in the basin include the Great Basin Spadefoot Toad, Western Mastiff Bat, and Wild Turkey.

Important Conservation Lands

Land in the Shivwits Plateau Basin is primarily owned by the Bureau of Land Management and the National Park Service.

- Grand Canyon-Parashant National Monument, BLM
- Grand Canyon National Park, NPS
- Mount Logan Wilderness, BLM
- Grand Wash Cliffs Wilderness, BLM

Federally Protected Species and Critical Habitats

Critical Habitat has been designated along the Colorado River for endangered Razorback Sucker.

There are several other endangered species known to occur in the Shivwits Plateau Basin. These include the California Condor, Mexican Spotted Owl, and Southwestern Willow Flycatcher. The Humpback Chub is another federally protected species found in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_SHV_final.pdf

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TIGER WASH

Tiger Wash Basin, located in Maricopa County is characterized by a valley bordered by mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub and a small amount of southwestern interior chaparral near the northwestern basin boundary.

Important Riparian, Aquatic, and Wetland Resources

Tiger Wash contains no perennial waters or major springs. Tiger Wash, an ephemeral drainage is in the center of the basin.

Important Conservation Lands

- Harquahala Mountains Wilderness, BLM
- Hummingbird Springs Wilderness, BLM

Federally Protected Species and Critical Habitats

Tiger Wash Basin contains no designated critical habitat and no documented occurrences of federally listed species.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_TIG_final.pdf

TONTO CREEK

Tonto Creek in Gila and Coconino counties is characterized by mid-elevation mountain ranges. Vegetation types include Arizona uplands Sonoran desertscrub, semidesert grassland, interior chaparral, Great Basin conifer and madrean evergreen woodlands and montane conifer forests. Riparian vegetation is found along streams including mixed broadleaf, tamarisk and mesquite along Tonto Creek.

The basin is bound on the north by the Mogollon Rim, on the east by the Sierra Ancha Mountains, and on the west by the Mazatzal Mountains. Elevations range from 7,800 feet above mean sea level in the Mazatzal Mountains to 2,200 feet above mean sea level at Roosevelt Lake where Tonto Creek terminates.

Important Riparian, Aquatic, and Wetland Resources

The unique geographic character of the Mogollon Rim provides a wide diversity of vegetation types and ecosystems. The Tonto Creek Basin contains diverse vegetation types such as the Madrean evergreen woodland, which occurs in small areas in the eastern part of the Tonto Creek at elevations of about 5,000 to 6,000 feet. Semidesert grasslands occur in valleys between the desert and woodlands or chaparral at elevations between 3,500 and 5,000 feet and are found south of Payson in the Tonto Creek Basin. Arizona upland Sonoran desertscrub covers parts of the basin below about 3,500 feet.

Along the riparian areas in the basin there is a combination of mixed broadleaf, Cottonwood and Willow, strand and Mesquite vegetation. Canyon habitat consists of Cottonwood, Willow, Arizona Walnut, Sycamore, and Maple. Perennial streams in this basin include Tonto Creek, Haigler Creek, Spring Creek, Dell Shay Creek, Houston Creek, Christopher Creek, Greenback Creek, Gordon Canyon Creek, Marsh Creek, Rye Creek, Lambing Creek, Horton Creek, East Fork Horton Creek and Dick Williams Creek—equaling approximately 129 stream miles. Because of the high elevations and associated higher rainfall and snowfall, this area is included in the state's most important water producing watersheds, the Salt and Verde Rivers. These watersheds contain the greatest concentration of perennial streams found in the state, which in turn support extensive riparian habitat.

A wide range of riparian-dependent birds occur in the basin including, Heron, Belted Kingfisher, Osprey and American Dipper. Riparian breeding birds include Common Black-Hawk, Peregrine Falcon, Rufous, Black-chinned, and Broad-tailed Hummingbird, Black Phoebe, Warbling Vireo, American Robin, Bridled Titmouse, Virginia's and MacGillivray's Warblers, Black-headed Grosbeak, and occasionally Indigo Bunting. Merriam's Turkey, Band-tailed Pigeon, Acorn Woodpecker, Nuthatches, Towhees, and a variety of other woodland birds. The Tonto Creek fish hatchery raises Arizona's state fish, the Apache Trout, as well as Rainbow, Brook and Cutthroat Trout. White-tailed Deer, Elk, Black Bear, Abert's Squirrel, Arizona Gray Squirrel, Rock Squirrel, and Mantled Ground Squirrel are also found in the area. Reptiles and amphibians inhabiting the hatchery grounds and Tonto Creek include Mexican Gartersnake, Terrestrial Gartersnake, Sonoran Mountain Kingsnake, Arizona Black-tailed Rattlesnake, Clark's Spiny Lizard, Madrean Alligator Lizard, Greater Short-horned Lizard, Plateau Lizard, Many-lined Skink, Canyon and Arizona Treefrog, Lowland Leopard Frog, and Arizona Toad. Other native fish observed in the basin include Desert Sucker, Longfin Dace, Sonora Sucker, and Speckled Dace.

Important Conservation Lands

- Mazatzal Wilderness, USFS
- Hellsgate Wilderness, USFS

- Salome Wilderness, USFS
- Arizona Audubon Important Bird Area; Mogollon Snowmelt Draws
- Tonto Creek Fish Hatchery, AGFD - Management goals of the hatchery are to provide for the continued operation of fish culture activities, to protect and enhance the wildlife habitat of the property, and to provide public outdoor recreation opportunities like wildlife watching and educational interpretation.

Federally Protected Species and Critical Habitats

Critical Habitat is designated for the Mexican Spotted Owl and for Southwestern Willow Flycatcher along the Tonto Creek as it flows into Roosevelt Lake. Critical habitat is also being proposed by the Fish and Wildlife Service for spikedace in this basin.

Other Federally protected species that are known to occur in the basin are the threatened Bald Eagle, and the endangered Lesser Long-nosed Bat, Arizona Hedgehog cactus, Chiricahua Leopard Frog, and Yuma Clapper Rail.

Other federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher, Gila Topminnow
- Listed Threatened- Bald Eagle , Mexican Spotted Owl
- Candidate- Northern Mexican Gartersnake, Yellow-billed Cuckoo, Headwater Chub

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 12,928 Angler Use Days were documented in the Tonto Basin, equating to over $2 million in economic revenue generated by angler activity within the basin. Water resources, primarily springs, and small streams, provide needed watering sites for an abundance of back-country wilderness experiences for back-packers and horseback riders. The water resources of the basin also provide needed water for abundant big and small game species that provide recreation opportunity for and economic benefit from, thousands of hunters each year.

Web Sources

http://www.wildlifeviewingareas.com/wv-app/ParkDetail.aspx?ParkID=82

http://www.azgfd.gov/outdoor_recreation/wildlife_area_tonto_creek.shtml

http://www.americansouthwest.net/arizona/tonto_creek/canyon.html

http://www.adwr.state.az.us/azdwr/StatewidePlanning/RuralPrograms/OutsideAMAs_PDUSFS_for_web/CentralHighlands/tonto_creek.pdf

http://www.adwr.state.az.us/azdwr/StatewidePlanning/WaterAtlas/CentralHighlands/Streams/TontoCreek.htm

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/CentralHighlands/documents/Volume_5_TON_final.pdf

TUCSON AMA

The Tucson Active Management Area (AMA) in Pima, Santa Cruz and Pinal counties is characterized by mid to high elevation mountains and broad alluvial basins. The Tucson AMA includes the Tucson municipal area and encompasses the Avra and Altar Valleys. Vegetation types include Lower Colorado River and Sonoran upland desertscrub, southwestern grassland, interior chaparral, madrean evergreen woodland and small areas of petran montane conifer forest. Riparian vegetation is found along some watercourses, notably Sabino, Cienega and Romero Creeks, along effluent dependent reaches of the Santa Cruz River and at Arivaca Cienega.

Important Riparian, Aquatic, and Wetland Resources

The Tucson AMA contains over 40 miles of perennial flow along Arivaca Creek, Cienega Creek, Madera Canyon Creek, Romero Canyon Creek, Sabino Creek, Santa Cruz River, Sycamore Canyon, Sutherland Wash and an unnamed tributary to Madera Canyon.

The Tucson AMA supports a wide diversity of Sonoran Desert and Sky Island habitats. Aquatic species such as the Chiricahua Leopard Frog, Western Narrow-mouthed Toad, Desert Pupfish, Gila Chub, Gila Topminnow, Arizona Mud Turtle, Huachuca Water Umbel, and Arizona Giant Sedge can be found in the Tucson AMA. The Santa Cruz River and other riparian habitats provide a critical winter stopover for migratory and native birds such as the Black-bellied Whistling-Duck, Great Blue Heron, Mexican Spotted Owl, Osprey, Southwestern Willow Flycatcher, Yellow-billed Cuckoo, and Tropical Kingbird. Western Yellow Bat, Arizona Shrew, Huachuca Water Umbel, Goodding Onion, Fallen Ladies'-tresses and Northern Mexican Gartersnakes, among many others, can also be found in the Tucson AMA.

Other State Wildlife Species of Concern observed in the basin include; Lowland Leopard Frog, Western Barking Frog, Peregrine Falcon, Elegant Trogon, Northern Buff-breasted Flycatcher, Northern Gray Hawk, Thick-billed Kingbird, Violet-crowned Hummingbird, Arizona Shrew, and Brown Vinesnake.

Important Conservation Lands

- Buenos Aires National Wildlife Refuge, USFWS
- Pusch Ridge Wilderness Area, USFS
- Pajarita Wilderness Area, USFS
- Mount Wrightson Wilderness Area, USFS
- Rincon Mountain Wilderness Area, USFS
- Arizona Audubon Important Bird Area; Sabino and Bear Creeks, Sycamore Canyon, Pajarita Mountains, Santa Rita Mountains, Arivaca Cienega, Arivaca Creek, California Gulch
- Saguaro National Park, NPS
- Saguaro Wilderness Area, NPS
- Tucson Mountain State Conservation Land, AGFD
- Arivaca Lake, AGFD
- Coyote Mountain Wilderness Area, BLM

- Baboquivari Creek Wilderness Area, BLM
- Ironwood Forest National Monument, BLM
- Altar Valley Ranch, Pima County Preserve
- Canoa Ranch, Pima County Preserve
- Tucson Mountain Park, Pima County
- Tortolita Mountain Park, Marana/Pima County
- Pima County Sonoran Desert Habitat Conservation Plan, Pima County
- Arthur Pack Regional Park, Pima County
- Catalina State Park, Arizona State Park

The Pima County Multi-Species Conservation Plan (MSCP) was created to comply with the “take” provisions of the Endangered Species Act (ESA). Incidental take of a listed species, as the result of carrying out an otherwise lawful activity, is not allowed without a permit from the USFWS. The permit will provide mitigation to impacts on 49 species and approximately 36,000 acres. For the 36,000 impacted acres, Pima County proposes to acquire and protect about 125,000 acres of land by the end of the permit period. By 2009, the county had acquired over 71,000 acres of fee lands and was managing over 130,000 acres of State Trust Lands.

The Pima County MSCP is part of a larger planning effort known as the Sonoran Desert Conservation Plan (SDCP), which covers 5.9 million acres in Pima County and is focused on six elements: habitat, corridors, cultural resources, mountain parks, ranch conservation and riparian protection. The SDCP planning process began in 1998 as a way to create a science-based conservation plan, update the county’s comprehensive land use plan, and comply with the ESA. The plan directs growth to areas with the least natural, historic, and cultural resource values as well as sets aside sensitive habitat through land acquisitions.

Federally Protected Species and Critical Habitats

Critical Habitat designated for Mexican Spotted Owl, Gila Chub, and Sonora Chub.

Federally protected species observed in the basin include:

- Listed Endangered- Huachuca Water-umbel, Southwestern Willow Flycatcher, Desert Pupfish, Gila Chub, and Gila Topminnow
- Listed Threatened- Mexican Spotted Owl, Chiricahua Leopard Frog, and Sonora Chub
- Candidate- Northern Mexican Gartersnake and Yellow-billed Cuckoo

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 29,208 Angler Use Days were documented in the Tucson AMA Basin, equating to over $4 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/azdwr/StatewidePlanning/WaterAtlas/ActiveManagementAreas/documents/Volume_8_TUC_final.pdf

UPPER HASSAYAMPA

The Upper Hassayampa basin is located in Yavapai and Maricopa counties, south of Skull Valley located on the northerly limit of the basin. The southerly limit is in northern Maricopa County and just south of Wickenburg. The basin is characterized by mid-elevation mountains and valleys. Vegetation types include Arizona upland Sonoran and Mohave desertscrub, semidesert grassland, interior chaparral and small areas of montane conifer forest. Riparian vegetation including Mesquite and Cottonwood and Willow is found along the perennial portions of Hassayampa River.

Important Riparian, Aquatic, and Wetland Resources

The Hassayampa River is the primary surface drainage through the basin. It runs north to south through the center and is fed by drainage from the Bradshaw, Weaver and Date Creek Mountains. French Gulch, Ash Creek, Weaver Creek, Minnehaha Creek, Lion Creek, Martinez Wash and Antelope Creek also supply surface runoff into the Hassayampa River.

Much of the southern portion of this 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. State Wildlife Species of Concern observed in the basin include the Common Black-Hawk, Peregrine Falcon, Snowy Egret, and Western Yellow Bat. Other native species known to occur in the basin include Arizona Toad, Zone-tailed Hawk, Desert Sucker, Longfin Dace, and Western Red-tailed Skink.

Important Conservation Lands

- Hassayampa River Canyon Wilderness, BLM
- TNC Hassayampa River Preserve

Hassayampa River Canyon Wilderness includes several miles of free-flowing Hassayampa River and its associated riparian habitat. Mexican Garter Snake, Desert Tortoise, Desert Sucker and Longfin Dace are special status species known to occur or potentially occur within this wilderness. The side canyons and the uplands support Chaparral, Paloverde and Saguaro Plant Communities.

Federally Protected Species and Critical Habitats

Critical Habitat has been designated for the Mexican Spotted Owl.

Other Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher, Desert Pupfish, Gila Topminnow
- Listed Threatened- Mexican Spotted Owl
- Candidate- Yellow-billed Cuckoo

Economic Values

See Report Discussion.

Web Sources

Bureau of Land Management (BLM)

United States Forest Service (USUSFS, Prescott Forest)

United States Fish and Wildlife Service (USFWS)

Arizona Game and Fish Department (AGFD)

Arizona Department of Water Resources (ADWR)

Wildlife Linkages (NAU)

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/CentralHighlands/documents/Volume_5_UHA_final.pdf

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/arizona/placesweprotect/hassayampa-river-preserve.xml

UPPER SAN PEDRO

The Upper San Pedro Basin located in Cochise, Santa Cruz and Pima counties is characterized by a large valley flanked by a series of mountain ranges. Vegetation is primarily semidesert grassland and Chihuahuan desertscrub with smaller areas of madrean evergreen woodland, plains and Great Basin desertscrub and Rocky Mountain and montane conifer forest. Riparian vegetation includes Cottonwood, Willow, Mesquite and Tamarisk along the San Pedro River and conifer oak and mixed broadleaf along Gardner, Ramsey and Miller Canyons.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the San Pedro River watershed. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Upper San Pedro Basin contains a portion of the San Pedro River – one of the last remaining free flowing desert rivers in the world. The Upper San Pedro Basin contains over 100 miles of perennial flows through much of the San Pedro Riparian National Conservation Area (SPRNCA), the Babocomari River, Bass Canyon, Carr Canyon, Double R Canyon Creek, Miller Canyon, Ramsey Canyon, Garden Canyon Creek, and Turkey Creek.

The SPRNCA provides habitat for over 375 species of birds including, Elegant Trogon, Great Blue Heron, Green Kingfisher, Mexican Duck, Mexican Spotted Owl, Southwestern Willow Flycatcher, Tropical Kingbird, Yellow-billed Cuckoo, Zone-tailed Hawk, and Violet-crowned Hummingbird. Amphibians such as Arizona Treefrog, Chiricahua Leopard Frog, Western Barking Frog, Western Green Toad, and Lowland Leopard Frog also depend on the riparian corridors. Many important native fish occur including Gila Chub, Speckled Dace, Gila Longfin Dace, Desert Pupfish, Gila Topminnow, and Sonoran Sucker. The Huachuca Water Umbel, Madrean Ladies'-tresses, Thurber's Bog Orchid and many other unique plants thrive in this riparian area, adjacent mesquite bosque, and dense Sacaton grasslands.

Other State Wildlife Species of Concern observed in the basin include; Peregrine Falcon, Black-bellied Whistling-Duck, Common Black-Hawk, Mississippi Kite, Northern Buff-breasted Flycatcher, Northern Gray Hawk, Arizona Shrew, Western Red Bat and Western Yellow Bat.

Important Conservation Lands

- San Pedro Riparian National Conservation Area, BLM
- TNC Conservation Easements – Upper San Pedro River
- Miller Peak Wilderness, USFS
- Coronado National Memorial, NPS
- Ramsey Canyon Preserve, The Nature Conservancy
- Appleton-Whittell Audubon Research Ranch
- Arizona Audubon Important Bird Area; Huachuca Mountains, San Pedro Riparian National Conservation Area, Audubon Research Ranch
- Kartchner Caverns, Arizona State Park

The BLM SPRNCA contains nearly 57,000 acres of protected land in Cochise County. The Nature Conservancy and Arizona Land and Water Trust also protect large acreages under conservation easement along the Babocomari River. The BLM continues to manage the SPRNCA for scientific study and is involved in ongoing restoration efforts to the river and watershed.

Federally Protected Species and Critical Habitats

Critical Habitat designated for Mexican Spotted Owl, Huachuca Water Umbel, and Gila Chub.

Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher**,** Desert Pupfish, Gila Topminnow, Gila Chub, Sonora Tiger Salamander, Huachuca Water-umbel, and Madrean Ladies'-tresses
- Listed Threatened**-** Mexican Spotted Owl and Chiricahua Leopard Frog
- Candidate- Arizona Treefrog, Yellow-billed Cuckoo, Huachuca Springsnail, and Northern Mexican Gartersnake

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 28,584 Angler Use Days were documented in the Upper San Pedro Basin, equating to over $4 million in economic revenue generated by angler activity within the basin.

Additional studies have been conducted that describe the economic contribution of visitors to natural areas, the value of streamflow and riparian bird habitat, and surveys conducted to identify economic value of wildlife watching in the San Pedro River (Pima County 2009, Leenhouts et al. 2006, and Orr and Colby 2002).

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http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/SEArizona/documents/Volume_3_USP_final.pdf

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Brand, L., Cerasale, D., Rich, T. (2009). Breeding and Migratory Birds: Patterns and Processes. In Stromberg, J. & Tellman, B., *Ecology and Conservation of the San Pedro River* (pp. 153-174). Tucson, Arizona: The University of Arizona Press.

Stromberg, J., Lite, S., & Beauchamp, V. (2003). Managing stream flow regimes for riparian ecosystem restoration. *2003 Tamarisk Symposium* Grand Junction, Colorado.

VERDE RIVER

The Verde River Basin is within Yavapai, Maricopa, Gila and Coconino Counties. It is characterized by mid-elevation mountain ranges and valleys with high elevation areas along its north central boundary. Vegetation types include Arizona upland Sonoran desertscrub, semidesert and plains and Great Basin grasslands, interior chaparral, Great Basin conifer woodland, montane conifer forests and a very small area of Rocky Mountain subalpine conifer forest in the vicinity of Humphreys Peak. Riparian vegetation is found along streams including mixed broadleaf and mesquite along the Verde River and mixed broadleaf along other streams such as West Clear Creek, Wet Beaver Creek and Oak Creek.

Flood flow plays a vital role in the function of river systems and its importance has been studied and described within the Verde River Basin. Studies indicate that flood intensity and frequency affect productivity of aquatic, riparian and flood plain vegetation and habitats (see Additional References).

Important Riparian, Aquatic, and Wetland Resources

The Verde River Basin contains the Verde River, one of Arizona's largest perennial waters. The 170-mile long Verde River drains much of central and northern Arizona, generally flowing south to its confluence with the Salt River. Perennial flow on the Verde River originates from springs located just below Sullivan Lake Dam, an artificial reservoir at the confluence of Little Chino Creek, and the Big Chino and Williamson Valley Washes. From below Sullivan Lake, the Verde flows freely for 125 miles before reaching Horseshoe Reservoir. Perennial tributaries, including Oak Creek, Wet Beaver Creek, and West Clear Creek, as well as ephemeral washes, supply base flow to the Verde River.

The Verde River and associated riparian vegetation provide high-quality wildlife and fish habitat. Until the 1890s, the riparian zone was over a mile wide in places, creating a series of marshes and sloughs that provided habitat for a variety of plants and animals. Common riparian vegetation consists of strand, mixed broadleaf and cottonwood willow communities, wet meadows and emerging marshlands. Important species include Cattail, Bulrush, Freemont Cottonwood, Gooding Willow, Arizona Sycamore, and Arizona Alder.

The ecologically important Verde River provides extensive woody riparian and wetland vegetation, and contains critical habitat for a diversity of native aquatic and riparian-dependent species. Thirty-one native and sport fisheries occur in the Verde River. Many aquatic, terrestrial, arboreal and aerial animal species depend directly or indirectly upon the river and its tributaries. Included within the Verde River's flora and fauna are plants and animals listed as threatened or endangered by Arizona or the federal government.

The Verde River riparian zone is a critical flyway for migratory birds and supports a high density of breeding birds; over 200 resident and neo-tropical migratory bird species have been recorded. Species such as the federally endangered Southwestern Willow Flycatcher and the Yellow-billed Cuckoo depend on the river's woody riparian forests of cottonwood, willow and ash. Other species include the Peregrine Falcon, Desert Bald Eagle, Summer Tanager, Osprey, Vermillion Flycatcher, Blue-throated Hummingbirds, and Great Blue Herons. The Verde River supports the largest number of Bald Eagle nesting sites of any river in the state.

Native fish populations in the upper Verde River are among the most diverse in Arizona. Historically the Verde River supported sixteen native fish species; only ten remain including the federally endangered Razorback Sucker and Colorado Pikeminnow, as well as the threatened Spikedace and Gila Chub. Additionally, the Verde River is one of three Arizonan rivers that sustain populations of River Otter.

Other State Wildlife Species of Concern observed in the Verde Basin include the following: Lowland Leopard Frog, Northern Leopard Frog, Peregrine Falcon, Common Black-Hawk, Bobolink, Belted Kingfisher, Navajo

Mexican Vole, Western Red Bat, and Narrow-headed Gartersnake.

Page Springs State Fish Hatchery is located along the banks of Oak Creek and is the state's largest coldwater fish hatchery, producing nearly 700,000 trout annually. Located nearby is Bubbling Ponds Fish Hatchery which produces not only sportfish, but also native fish species (razorback suckers and Colorado pikeminnow) used for native fish conservation and recovery efforts. The Audubon Society designated the riparian habitat near the hatcheries and along Oak Creek as an Important Bird Area. The Page springsnail is found only at the Page Springs spring complex, from which several main springs and other minor springs arise.

The West Fork of Oak Creek, a tributary of Oak Creek, is another perennial stream in the Verde Basin that provides fish and wildlife habitat. Oak Creek Canyon and its perennial streams are a popular destination, second only to the Grand Canyon.

Wet Beaver Creek is a perennial stream with one major tributary, Dry Beaver Creek. Wet Beaver Creek flows through secluded canyons and the Wet Beaver Wilderness Area before flowing through Montezuma Well and Montezuma Castle, eventually reaching the Verde River near Camp Verde. Wet Beaver Creek provides habitat for stocked trout as well as dense riparian vegetation for numerous species of songbirds. The perennial waters in the Wet Beaver Wilderness attract large numbers of wildlife, including elk, deer, bear, mountain lion, and a variety of smaller mammals, reptiles, and birds.

West Clear Creek is another important perennial stream with headwaters originating from Willow and Clover Creeks. West Clear Creek flows through the 13,600 acre West Clear Creek Wilderness Area and provides extensive riparian habitat along canyon bottoms. Dominant vegetation includes cottonwood, sycamore, and alder along with some ash, willow, walnut and wild grape along the riparian zone. The creek attracts anglers with its stocked populations of trout and smallmouth bass.

Fossil Creek is a unique warm-water perennial stream that supports one of the most diverse riparian areas in Arizona. Fossil Creek flows from a complex of springs that supply a constant 20,000 gallons per minute of 72 degree Fahrenheit water. Over thirty species of trees and shrubs and over a hundred species of birds have been observed along Fossil Creek's riparian area. In 2004, federal and state agencies completed an extensive restoration of Fossil Creek to remove invasive fish species and have since successfully reintroduced native fish species. In March 2009 Fossil Creek became the second Arizona stream to receive federal designation as a Wild and Scenic River.

Important Conservation Lands

- Apache Creek Wilderness, USFS
- Arizona Audubon Important Bird Area; Lower Oak Creek, Tuzigoot NPS
- Cedarbench Wilderness, USFS
- Dead Horse Ranch State Park, Arizona State Park
- East Verde River Wild and Scenic River, USFS
- Fossil Creek Wild and Scenic River: In 2009 Congress designated a portion of Fossil Creek as a federal Wild and Scenic River. Fossil Creek is a major tributary of the Verde River with outstanding and remarkable scenic, fish and wildlife, historic and cultural values. Fossil Creek flows through two congressionally designated wilderness areas (Fossil Springs and Mazatzal Wilderness Areas) and underwent an extensive successful multi-agency restoration in 2005, USFS

- Fossil Creek Wilderness, USFS
- Fossil Springs Wilderness, USFS
- Four Peaks Wilderness, USFS
- Gap Creek Wild and Scenic River, USFS
- Gibson Wildlife Area, AGFD
- Granite Mountain Wilderness, USFS
- Houston Creek Wild and Scenic River, USFS
- Juniper Mesa Wilderness, USFS
- Mazatzal Wilderness, USFS
- Munds Mountain Wilderness, USFS
- Oak Creek and West Fork Oak Creek are identified as Outstanding Arizona Waters, ADEQ
- Page Springs Hatchery, AGFD
- Pine Mountain Wilderness, USFS
- Red Rock Secret Mountain Wilderness, USFS
- Red Rock State Park, Arizona State Park
- Slide Rock State Park, Arizona State Park
- Sunflower Flat State Conservation Land, AGFD
- Sycamore Canyon Wilderness, USFS
- Montezuma Castle, NPS
- Tavasci Marsh, NPS: Situated in the backwaters of the upper Verde River, Tavasci Marsh is one of the largest marshes in Arizona. Designated an Important Bird Area by the National Audubon Society, the marsh supports one of the most diverse bird gatherings in Arizona. Cattails and other wetland vegetation provide nesting and habitat for hundreds of bird species including the notable Red-winged Blackbird and the threatened Bell's Vireo. Herons, egrets, finches, wrens and flycatchers flourish in the dense marsh vegetation. Frogs and turtles are abundant in the marsh. River Otter and beaver are also present; beaver activity supplemented restoration efforts.
- Tonto Natural Bridge State Park, Arizona State Park
- Tuzigoot National Monument, NPS
- Upper Verde River Wildlife Area (796 acres), AGFD: A 796-acre property located along the Upper Verde River and lower Granite Creek managed for riparian habitat and to maintain native fish diversity.
- Verde River Greenway State Natural Area, Arizona State Parks: Designated in 1987, this six mile, 700-acre stretch of Verde River was identified by state officials as a critical natural resource that needed

protection and management. This reach, located between Clarkdale and the Bridgeport State Route 89A Bridge, is part of the Arizona State Parks system.

- Verde Wild and Scenic River: In 1984, Congress designated a forty mile stretch of the Verde River as a Wild and Scenic River for its outstanding remarkable scenic, fish and wildlife, historic and cultural values. The Wild and Scenic Verde River flows through the Mazatzal Wilderness Area.
- West Clear Creek Wilderness, USFS
- Wet Beaver Creek Wilderness, USFS
- Woodchute Wilderness, USFS

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Mexican Spotted Owl, San Francisco Peaks Groundsel, Gila Chub, Razorback Sucker, Southwestern Willow Flycatcher, and Spikedace.

Federally protected species observed in the basin include:

- Listed Endangered- Southwestern Willow Flycatcher**,** Gila Topminnow, Gila Chub, Yuma clapper Rail, Colorado Pikeminnow, Razorback Sucker, and Hualapai Mexican Vole
- Listed Threatened**-** Mexican Spotted Owl, Chiricahua Leopard Frog, Bald Eagle, Apache Trout, and Spikedace
- Candidate- Yellow-billed Cuckoo, Page Springsnail, Northern Mexican Gartersnake, Headwater Chub, and Roundtail Chub,

Renovation (chemical treatment) of Stillman Lake in the Upper Verde River was undertaken to remove non-native aquatic predators and prepare the habitat for reintroduction of Razorback Suckers. Candidate Roundtail Chub have already been reintroduced into Stillman Lake.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 388,652 Angler Use Days were documented in the Verde River Basin, equating to over $60 million in economic revenue generated by angler activity within the basin.

An additional study was conducted in the Verde River Basin that reports on the social valuation of the Verde River (West et al. 2009).

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VIRGIN RIVER

The Virgin River Basin in Mohave County is characterized by the Virgin Mountains on the south, the Virgin and Beaver Dam Mountains on the east, the Utah state line on the north, and the Nevada state line on the west. The primary surface hydrologic features are the Virgin River, which flows from the northeast corner to the Arizona-Nevada state line on the west and the Beaver Dam Wash. Vegetation is primarily Mohave desertscrub with smaller areas of Great Basin desertscrub, Great Basin conifer woodland, interior chaparral and a small area of Rocky Mountain and madrean montane conifer forest. Riparian vegetation along the Virgin River is predominantly tamarisk.

The Virgin River flows through Arizona from the Utah border downstream over 30 miles to the Nevada border. After a winding route through the Beaver Dam Mountains the river enters the Virgin River Gorge. The river emerges abruptly from the gorge and flows into the broad Virgin River Valley. A few miles farther downstream it is joined by the short perennial reach of Beaver Dam Wash just before it passes Littlefield, a small town, but the largest in the basin. The river flows another dozen miles through Mohave desertscrub and riparian vegetation dominated by salt cedar to the Nevada border, the lowest point in the basin (1600 feet).

Important Riparian, Aquatic, and Wetland Resources

The Virgin River and the short reach of Beaver Dam Wash flowing into the Virgin from the north just above Littlefield are the only significant surface water resources in the basin. The mean annual flow of the Virgin River at Littlefield is about 175,000 acre-feet. The highest flow recorded at Littlefield was nearly 600,000 acre-feet in 2005. Most of the annual flow comes as spring snow melt runoff and contributions from the springs in the gorge.

The canyon riparian areas are relatively narrow from the Utah border through the gorge, but widen after the river emerges from the gorge. The vegetation includes Willow and riparian brush, but for its entire length in Arizona, riparian areas are completely dominated by Tamarisk. Although the diversity of the riparian habitat is limited, the endangered Southwestern Willow Flycatcher and other species occupy this habitat.

The Virgin River and Beaver Dam Wash supports several native fish species, including two federally listed endangered species, the Woundfin and the Virgin River Chub. The Virgin River is also habitat for additional state Wildlife Species of Concern including Flannelmouth Sucker, the Virgin Spinedace, and the Speckled Dace. Lowland Leopard Frog, Peregrine Falcon, Common Black-Hawk and Virgin Spinedace are all State Wildlife Species of Concern observed in this basin.

Important Conservation Lands

The Bureau of Land Management manages nearly 92 percent of the land in basin. The remaining acreage is divided between state trust land and private ownership. BLM-managed land includes two wilderness areas, The Beaver Dam Mountain Wilderness on the north side of the Virgin River Gorge, and the Piute Wilderness on the south side of the gorge. BLM also manages three "Areas of Critical Environmental Concern in the basin:" the Beaver Dam Slope, the Virgin River Corridor, and the Virgin Slope. These are areas where special management is needed to protect important historical, cultural, scenic, and natural areas, or to identify areas hazardous to human life and property.

Federally Protected Species and Critical Habitats

The entire length of the Virgin River, including within Arizona, has been designated as Critical Habitat for two federally listed endangered species, the Woundfin and the Virgin River Chub. Sections of Virgin River riparian areas, mostly above the Virgin River Gorge, have also been designated as Critical Habitat for the federally listed Southwestern Willow Flycatcher. Substantial areas of the Virgin River Basin below the gorge have also been designated critical habitat for the Mohave Desert Tortoise.

Federally protected species found in the basin include the Endangered Southwestern Willow Flycatcher, Virgin River Chub, and Woundfin. Candidate Yellow-billed Cuckoo is also found here.

Economic Values

Although data on economic contribution of water-dependent activities is not available for the Virgin River, some recreational activity does occur. A recreation area is maintained by BLM on the river above the gorge. Also, some rafting does occur during spring high flows.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/WesternPlateau/documents/Volume_6_VRG_final.pdf

WESTERN MEXICAN DRAINAGE

The Western Mexican Drainage Basin is split by Yuma and Pima Counties. It is characterized by desert valleys and low elevation mountain ranges. Vegetation types include Lower Colorado River Valley and Arizona uplands Sonoran desertscrub.

Important Riparian, Aquatic, and Wetland Resources

Located along the southwest border with Mexico, there are no perennial flows in the Western Mexican Drainage Basin. There is one major spring, the Quitobaquito, and not more than half a dozen total springs. Most of the basin is within the Cabeza Prieta National Wildlife Refuge and the Organ Pipe Cactus National Monument. The Quitobaquito springs supports a population of the Quitobaquito Pupfish, while the refuge is home to the Sonoran pronghorn, both of which are endangered species. In both cases, there are numerous species of birds and wildlife that are associated with both of these areas.

Other State Wildlife Species of Concern observed in the basin include the Western Narrow-mouthed Toad and Tropical Kingbird.

Important Conservation Lands

- Cabeza Prieta National Wildlife Refuge, USFWS
- Organ Pipe Cactus National Monument, NPS

Federally Protected Species and Critical Habitats

Critical habitat has been designated for the Quitobaquito Pupfish.

The Endangered Yuma Clapper Rail and Quitobaquito Pupfish, and Candidate Sonoyta Mud Turtle are federally protected species observed in this basin.

Economic Values

See Report Discussion.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_WMD_final.pdf

WILLCOX

The Willcox Basin located in Cochise and Graham Counties is characterized by a series of medium-high to high-elevation mountain ranges. Vegetation is primarily semidesert grassland with smaller areas madrean evergreen woodland and Rocky Mountain and montane conifer forest. Riparian vegetation includes conifer oak and mixed broadleaf on Turkey Creek and conifer oak on Rucker Canyon.

Important Riparian, Aquatic, and Wetland Resources

Willcox Playa is a sparsely vegetated desert grassland, strongly dominated by alkalai Sacaton and Saltgrass, with some cover of Little Bluestem and other grasses. Shrub cover increases towards the periphery, with saltbushes, mesquites and non-native tamarisk. Scattered Fremont cottonwood and Goodding's willow grow in or along the network of ditches that have been built to drain sections of the playa over the past century. The playa also supports a population of a rare plant species, the Chiricahua Mountain tansy-aster. Willcox Playa is best known to the public for its wintering population of Sandhill Cranes that migrate to the playa in large numbers, particularly in wet winters. It is not unusual to see several thousand cranes in winter at the power plant ponds viewing area on the southwest side of the playa, or at the Arizona Game and Fish Department's 600-acre Wildlife Area on the southeast side. The cranes feed and court, migrating after February to their summer breeding grounds in the northern Great Plains.

Willcox Playa also supports other large water birds, including White-faced Ibis, as well as many raptors, including several wintering hawks. Red-tailed Hawks, Northern Harriers, Harris's Hawks, Prairie Falcons, Bald and Golden Eagles, Caracaras, Great Horned Owls, and Burrowing Owls all utilize the habitat. The shrubs and trees on the periphery of the playa support migrating Northern Flickers, White-necked Ravens, and many songbird species. Sometimes more than 10,000 birds will congregate at the playa.

An array of other vertebrates also lives on and around Willcox Playa including several distinctive amphibian and reptile species, including Chiricahua and Plains Leopard Frogs as well as Texas Horned Lizards. Mammals include Desert Cottontails, Black-tailed Jackrabbits, Kangaroo Rats, other desert herbivorous rodents, and Collared Peccaries.

Less well known is the extraordinary diversity of tiger beetles found at Willcox Playa, one of the highest concentrations in a single small area in the United States. Several endemic species exist there, including the Willcox Nevada tiger beetle and the Sulphur Springs Williston's tiger beetle.

The Willcox Basin is a closed basin that drains into Willcox Playa. The Willcox Basin contains over 30 miles of perennial flows through Big Bend Creek, Big Creek, Grant Creek, Leslie Creek, Post Creek, Rucker Canyon, Soldier Creek, Turkey Creek, and Ward Canyon.

The Willcox Basin, especially the western slopes of the Chiricahuas, contains a broad diversity of wildlife. American Avocet, American Peregrine Falcon, Black-necked Stilt, Elegant Trogon, Mexican Spotted Owl, White-faced Ibis, Yellow-billed Cuckoo and Zone-tailed Hawk all occur in the Basin. The Basin's streams provide aquatic habitat for Apache Trout, Mexican Stoneroller, Yaqui Chub, Yaqui Longfin Dace, Chiricahua Leopard Frog, Plains Leopard Frog and Western Green Toad. Arizona Shrew, Cockrum's Desert Shrew, White-bellied Long-tailed Vole and Western Red Bat all live in this diverse region along with a diversity of plant species that mingle on this intersection between the Sonoran Desert and Chihuahuan Desert. Other State Wildlife Species of Concern include the Bald Eagle, Gray Catbird, Northern Buff-breasted Flycatcher, and Violet-crowned Hummingbird.

Important Conservation Lands

- Chiricahua National Monument, NPS
- Mt. Graham Wilderness Study Area, USFS
- Chiricahua Wilderness, USFS
- Dos Cabezas Mountains Wilderness, USFS
- Chiricahua National Monument, NPS
- Arizona Audubon Important Bird Area; Willcox Playa, Chiricahua Mountains
- Willcox Playa Wildlife Area, AGFD
- Leslie Canyon National Wildlife Refuge, USFWS
- Galiuro Wilderness Area, USFS

The Willcox Playa IBA and Wildlife Area are managed to optimize waterfowl habitat for migratory birds that winter at the playa.

Willcox Playa is managed for multiple purposes. The Arizona Game and Fish Department Wildlife Area is managed to support wildlife habitat in perpetuity, and to maintain opportunities for public hunting and other forms of wildlife-oriented recreation.

Federally Protected Species and Critical Habitats

Critical Habitat designated for Mexican Spotted Owl and Mt Graham Red Squirrel.

Federally protected species observed in this basin include the Endangered Yaqui Chub, Threatened Apache Trout, Mexican Spotted Owl and Chiricahua Leopard Frog, and Candidate Yellow-billed Cuckoo.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 9,712 Angler Use Days were documented in the Willcox Basin, equating to over $1 million in economic revenue generated by angler activity within the basin.

Web Sources

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http://www.azheritagewaters.nau.edu/loc_wilcox_playa.html

YUMA

The Yuma basin in Yuma County is characterized by desert valleys and mountain ranges. Vegetation type is Lower Colorado River Valley Sonoran desertscrub. The Gila and Colorado River confluence is located in this basin.

Important Riparian, Aquatic, and Wetland Resources

The Colorado River is the major source and drain for the region. The Gila River joins the Colorado within the basin, but it is regulated and managed upstream such that there is no downstream flow, except during flood events. However, the many agricultural returns to the river channel maintain abundant surface flow and a diverse riparian gallery along the lower Gila valley. There are no additional perennial streams in the area. Colorado River flow into the basin is determined by outflow from Imperial Dam. Colorado River outflow from the basin into Mexico is defined by treaty and strictly managed.

Game fish species in the Colorado River are Channel Catfish, Flathead Catfish, Largemouth Bass, Smallmouth Bass, Striped Bass, Rainbow Trout, Carp, Crappie, Bluegill, Sunfish, and Tilapia. Fortuna Pond, constructed within the lower Gila River floodplain also provides angler opportunities for similar species.

Mittry Lake, north of Yuma, is operated jointly by BOR, BLM, and Arizona Game and Fish Department. Mittry Lake has about 600 acres of open water surface, significant marshlands with cattails and bulrushes, and is part of a 2,400 acre wildlife habitat. The primary purpose of Mittry Lake is for hunting and fishing. The most common fish caught in Mittry Lake are Largemouth Bass, crappie, Channel and Flathead Catfish, tilapia, Bluegills, and carp. There are also bullfrogs, Bullhead Catfish, Redear and Green Sunfish. Hunting is for waterfowl, dove, quail, and rabbit.

The larger mammals in the area are Javelina, Coyotes, Bobcat, and Mule Deer. There are Desert Bighorn Sheep in limited locations. There is a large, diverse bird population along the river and at Mittry Lake, including the Cattle-Egret.

The Great Blue Heron, Least Bittern, California Black Rail, Great Egret, Snowy Egret, Western Yellow Bat, and Lowland Leopard Frog are species of concern to the state of Arizona.

Important Conservation Lands

- Mittry Lake Wildlife Area, AGFD
- Audubon Important Bird Area; Lower Colorado River Gadsen Riparian Area, Mittry Lake Wildlife Area

Constructed wetlands in the Yuma Basin provide habitat for many rare and endangered birds along the Colorado River.

The Lower Colorado River Multi-Species Conservation Program (MSCP) is a coordinated, comprehensive, long-term multi-agency effort to conserve and work towards the recovery of endangered species, and protect and maintain wildlife habitat on the Lower Colorado River. The MSCP's purposes are to protect the lower Colorado River environment while ensuring the certainty of existing river water and power operations, address the needs of threatened and endangered wildlife under the Endangered Species Act, and reduce the likelihood of listing additional species along the lower Colorado River.

Federally Protected Species and Critical Habitats

There are no critical habitat areas within the basin.

Endangered birds known to occur in the basin are the Yuma Clapper Rail, and Southwestern Willow Flycatcher. The Yellow-billed Cuckoo is classified as a candidate on the federal list.

Economic Values

The economics of outdoor recreation is significant in Arizona, especially when associated with water bodies, streams, and other riparian and aquatic habitats. In 2001, a total of 83,999 Angler Use Days were documented in the Yuma Basin, equating to over $13 million in economic revenue generated by angler activity within the basin.

Web Sources

http://www.azwater.gov/AzDWR/StatewidePlanning/WaterAtlas/LowerColoradoRiver/documents/Volume_7_YUM_final.pdf

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METHODS AND RESOURCES

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INTRODUCTION AND PURPOSE

The Environmental Working Group was formed under the work plan of the Water Resource Development Commission (WRDC). The Environmental Working Group was tasked to 1) identify current water-dependent natural resources; 2) identify conditions necessary to support these resources; and 3) prepare a summary of findings and make recommendations regarding the need for further research and studies.

Available scientific data was used to identify the state's primary water-dependent natural resources. The physical conditions currently supporting these natural resources were also identified and characterized, where possible. This information presents clear evidence about the diversity and unique conditions provided by the state's rivers, lakes, streams, springs, wetlands, and riparian and aquatic habitats, but also that the existing information is incomplete and more research is needed.

A summary of the Environmental Working Group's findings, entitled *Arizona's Inventory of Water-Dependent Natural Resources*, includes a compilation of natural-resource data. This data is presented in a variety of formats including narrative summaries, data tables and maps for each groundwater basin and county. This document provides a description of the data sources and methodologies used to develop *Arizona's Inventory of Water-Dependent Natural Resources*.

Note on Mapping Efforts: To maintain clarity at the given scale and preserve the purpose of the maps, symbols representing certain features were slightly exaggerated. These features include critical habitat for fish and other species constrained to river and stream courses, surface water filings in-stream, riparian habitat and effluent dependent streams.

Amplification of features is an accepted part of the cartographic process, and enhancement of the symbols was not meant to exaggerate their meaning, but only to improve legibility and accommodate the associated symbology.

HYDROLOGIC COMPONENTS

Groundwater basins (ADWR, 1984a)

Water-dependent natural resources are identified for each of Arizona's 51 groundwater basins. According to ARS 45-402(13) "Groundwater basin" means an area which, as nearly as known facts permit as determined by the director pursuant to this chapter, 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. ADWR Groundwater Basins include the five Active Management Areas (AMAs).

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Summaries, Tables & Maps

Groundwater sub-basins (ADWR, 1984b)

According to ARS 45-402(34) "Subbasin" means an area which, as nearly as known facts permit as determined by the director pursuant to this chapter, may be designated so as to enclose a relatively hydrologically distinct body of groundwater within a groundwater basin, which shall be described horizontally by surface description.

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Tables

Watersheds (ADWR, 1982; USGS, 2008))

A watershed is an elevation or a divide separating a catchment area, or drainage basin, of one river system or group of river systems from another system or group of systems. The term is synonymous with drainage basin (8-digit HUC (hydrologic unit code) level).

Data available from the USGS (2008) and ADWR (1982) were used to identify watersheds in relation to each groundwater basin.

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Tables

Springs (ADWR, 2008; 2009-2010; & 2010a)

Basin tables list the number of major (discharge ≥10 gpm) and minor (discharge <10 gpm) springs, the annual range of spring discharge in gallons per minute, and the combined spring discharge rate in acre-feet per year. The combined annual discharge rate was calculated using data from the Arizona Water Atlas Volumes 2-8 (ADWR, 2009-2010), which lists discharge rates for each major and minor spring. This calculation assumes that the spring discharge at the time of measurement is constant throughout the year.

Original data sources include the USGS, universities, and other government agencies including the USFS, NPS and BLM. These datasets were compiled into a database by ADWR (ADWR, 2008). A detailed description of the methods used to compile information on springs is provided in the Arizona Water Atlas, Volume 1 (ADWR, 2010a).

Major and minor springs are also identified in the basin and county maps. Two GIS layers were used to represent these springs. The statewide springs dataset provided by ADWR was supplemented by the Pima County springs dataset (ADWR, 2009-2010). Major and minor springs were identified by filtering an attribute field containing gallons per minute information. Springs from both layers were symbolized identically.

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Tables & Maps

Streams (ALRIS, 1993)

Streams classified as major, minor were identified using the ALRIS stream dataset by filtering the attribute field for cartographic order (CO). Major streams have a cartographic order of 1 through 3, while minor streams are limited to a cartographic order 4. Cartographic orders 1 through 3 include Arizona's major rivers, the main stem of each drainage basin and all Reach File 1 streams. Minor stream orders include all Reach File 2 streams and streams with names.

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Maps

Perennial Streams (Anning & Parker, 2009; ADEQ, 2010)

Perennial stream reaches are identified in the basin tables and maps. The perennial stream reach length within each basin was calculated and the information is presented in the basin tables.

Several datasets depicting perennial flow were initially evaluated by the Environmental Workgroup. ADEQ (2010) appeared to be most complete and up-to-date. However, there are some limitations with the dataset that users of this information should be aware of. In certain cases the dataset may not depict ALL perennial stream reaches in Arizona, and because of the changing nature of the environment, users should re-evaluate areas of interest to identify where perennial waters exist. In addition, the length of the perennial stream reach may differ from other datasets.

Limitations of the ADEQ dataset are identified by Anning and Parker (2009). They explain that, "In general, a significant objective of developing regional-scale models is to apply them and obtain predictions throughout the study area. A clear limitation to the models developed in this study is the requirement of having discharge measurements to obtain hydrologic regime predictions."

According to Arizona Game and Fish Department staff, based on relational analysis of the ADEQ dataset and statewide fish records, "When I map 33,382 fish collection records within the state, 22,696 of them fall within 100 m of the Perennial ADEQ layers. That means that 10,686 fish records are found in systems other than perennial streams classified by that ADEQ layer. Many of those are likely reservoir collections, isolated sites etc. When I remove from that about 10,000 sites that have "spring, lake, tank, pond, reservoir, drain or canal" in the 'sitename' of the fish record, there are about 4,722 fish records left that fall on sites that were not identified as perennial by the ADEQ layer. That's not too bad." (AZGFD, pers. comm.)

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Summaries, Tables & Maps

Perennial stream reaches and springs located in federal/state designated conservation areas (Anning & Parker, 2009; ADEQ, 2010; ADWR, 2008, 2009-2010, & 2010a)

Information pertaining to perennial stream reaches and springs located within federal and state conservation lands is presented in the basin summaries, tables and maps. The Environmental Workgroup decided to enumerate perennial stream reaches and springs located within federal and state conservation lands because they represent a subset of waters that had additional conservation values due to their inclusion on lands with specific conservation measures.

Working with data sets from multiple agencies presented problems for GIS analysis. Because of overlapping jurisdictions (see Figure 1), there was the potential for double counting perennial waters. To avoid duplicate counts and accurately identify what perennial waters exist within conservation lands, it was necessary to first build a composite layer of like boundaries before performing any GIS analysis (see Figure 2). Separate composite layers were made for federal and state designated conservation lands.

The process was as follows:

1) Merge all like lands (ex. state managed conservation land) into one feature

2) Dissolve internal boundaries

3) Clip the perennial stream reaches to the boundaries of protected areas

4) Query for perennial stream name and number of stream miles

These same composite layers were later used to identify major springs located in federal or state designated conservation lands.

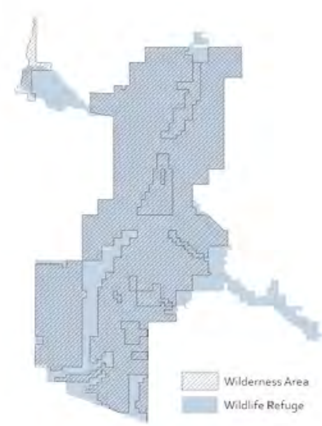

Figure 1: Overlapping jurisdictions

Figure 2: Composite of overlapping jurisdictions

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Summaries, Tables & Maps

Stream gages (ADWR, 2007; Fisk et al., 2006; Marshall et al., 2010)

A stream gage or *streamgage* is a device used to measure specific characteristics of a stream. These characteristics typically include the stream's surface elevation ("stage") and/or volumetric discharge (flow).

Stream gages are an invaluable tool used to assess the condition of Arizona's rivers and streams. These devices are installed, maintained and monitored by many government and private agencies for the benefit of water management decisions, recreation activities, and wastewater treatment plant operations. Stream gage networks are also used to monitor and protect populated areas from potential natural disasters such as flood flows and drought conditions. As part of Arizona's Flood Warning System, federal, state and local agencies cooperatively maintain and monitor stream gage data across the state (available at http://data.afws.org).

As part of the National Streamflow Information Program (NSIP), real-time streamgage data collected by numerous entities is made available via the USGS National Water Information System (available at http://waterdata.usgs.gov/az/nwis/rt). According to the USGS, for the purposes of the NSIP, (unless otherwise stated) a *"streamgage"* is an active, continuously functioning measuring device in the field for which a mean daily streamflow is computed or estimated and quality assured for at least 355 days of a water year or a complete set of unit values are computed or estimated and quality assured for at least 355 days of a water year.

The Environmental Working Group identified and presented stream gage locations on each of the basin maps (where applicable). A subset of stream gages were also identified on the basin maps (in yellow) within certain basins where streamflow measurements were evaluated to calculate baseflow volumes (Marshall et al., 2010). Baseflow estimates were enumerated for 12 groundwater basins, and included in the basin tables (Section 6 of this document describes the methodology for enumerating baseflow).

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Tables & Maps

Stockponds (ADWR, 2009-2010; 2010a)

The total number of registered stockponds is listed in each of the basin tables. Information available from ADWR's registry of surface water rights and adjudication claims was used to identify stockponds with a capacity of 15 acre-feet or less as presented in, and obtained from, the Arizona Water Atlas Volumes 2-8 (ADWR, 2009 & 2010). A detailed description of the methods used to compile information on stockponds is provided in the Arizona Water Atlas, Volume 1 (ADWR, 2010a).

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Tables

Reservoirs (ADWR, 2009-2010)

Information on surface-water reservoirs is presented in the basin tables and maps. Reservoirs include natural water bodies such as dry and intermittent lakes and man-made reservoirs.

Basin tables display the total number of large and small reservoirs in the basin and their combined maximum storage capacity or surface acres. Large reservoirs are water bodies with a maximum storage capacity of 500 acre-feet or greater or a maximum surface area of 50 acres or greater. Small reservoirs are water bodies with a capacity of greater than 15 acre-feet but less than 500 acre-feet or a maximum surface area of between 5 and 50 acres. The combined annual large and small reservoir capacity was calculated using data from the Arizona Water Atlas Volumes 2-8 (ADWR, 2009 & 2010), which provides information for each large reservoir and an aggregate total for small reservoirs. A detailed description of the methods used to compile information on reservoirs is provided in the Arizona Water Atlas, Volume 1 (ADWR, 2010).

Large and small reservoirs are displayed on the county and basin maps using unique symbology for each. The volume and capacity values used to classify a reservoir as large or small are the same as those used in the basin tables.

Four distinct GIS layers were used to display reservoirs on the maps. Within Active Management Areas (AMA), reservoir data layers available from the USGS (USGS_Reservoirs) and the National Inventory of Dams (NID_Reservoirs) were used. Large reservoirs in the USGS layer were defined as values >50 in the "ACRES" attribute field; likewise, small reservoirs were defined as values <50. In the NID layer, large reservoirs were defined as values >500 (acre-feet) and small reservoirs were defined as values < 500 (acre-feet) in the "Max_storag" attribute field.

To display reservoirs located outside of an AMA, data from the Arizona Water Atlas (2009-2010) was used (ADWR_Reservoirs, and smallReservoirs). To avoid any potential overlaps with the layers used for the AMAs, the attributes of both GIS layers were filtered using the following criteria: NOT "BASIN_NAME" LIKE '%AMA'. Small and large reservoirs were defined in the ADWR_Reservoirs layer using the "WaterAtlas" field. The smallReservoirs layer only includes small reservoirs, so no additional filters were needed.

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Tables & Maps

Effluent-Dependent Waters (A.A.C., 2008; ADWR, 2009-2010 & 2010a; NEMO, 2009)

Effluent-Dependent Waters (EDW), as classified by ADEQ pursuant to A.A.C. R18-11-113, are identified in the basin tables and maps. In general, Effluent-Dependent Waters are characterized as streams or stream reaches that are naturally ephemeral, but have surface flow in response to the discharge of treated wastewater.

A compilation of two datasets (ADWR, 2009-2010 & 2010a; & NEMO, 2009) were used to identify and illustrate EDW. Using GIS software, the two datasets were merged and manually edited to create a new unique feature that is used within the Environmental Working Group's report. Within each groundwater basin, the EDW stream segments were identified and their reach lengths were calculated for inclusion in the basin tables.

Presented In:

Tables & Maps

VEGETATION/RIPARIAN

Arizona Riparian Inventory and Mapping Project (AGFD, 1994; Valencia et al., 1993)

This dataset was developed at the Arizona Game & Fish Department (AGFD) in 1993 – 1994 and discussed by Valencia, et al. (1993). It identifies riparian vegetation associated with perennial waters mapped in response to the requirements of the Waters - Riparian Protection Program (Laws 1992, CH. 298). The AGFD created maps using two major sources of imagery - Landsat Thematic Mapper digital satellite data and Multiple Resolution Aerial Videography. Riparian imagery was ground-truthed in the field. The dataset was distributed in June 1994.

Limitations: While working with the AGFD 1993-94 data, limitations were encountered. First, the dataset is fairly dated. Second, the dataset includes several non-riparian classes and several others for which we don't have data on evapotranspiration. Non-riparian classes were removed from the dataset for the Environmental Working Group's mapping purposes and for estimating ET rates. Lastly, the *1993-94* dataset was not a comprehensive statewide approach, and several areas of the state were not mapped.

Habitats excluded and rationale:

- *Areas not Ground Verified* (not able to verify if vegetation was present; total acres = 428)
- *Conifer Oak* (not a riparian habitat type)
- *Mountain Scrub* (not a riparian habitat type)
- *Mesquite* (excluded from this dataset but is captured by the SW ReGAP/SWAP dataset, which covers a larger area and thus will capture more of the mesquite habitat type throughout the state; total unique acres not captured by SW ReGAP/SWAP = 849)
- *Marsh* (ET values for emergent wetland habitat types not available; total acres = 51)
- *Wet Meadow* (ET values for emergent wetland habitat types not available; total acres = 771)
- *Flood Scoured* (flood scoured habitats are areas of bare sand that are likely spots for future riparian recruitment; total acres = 7,000). Including these areas would likely have overestimated riparian acreage.

To augment the 1993-94 dataset, the Environmental Workgroup also utilized a Riparian Habitat Model (Lowry et al., 2007), developed by the Arizona Game and Fish Department, to identify additional areas of the state with potential riparian habitats.

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Maps

Arizona Game and Fish Department State Wildlife Action Plan (SWAP) Riparian Model (Lowry et al., 2007; Valencia et al., 1993)

At the time this model was developed, two sources of riparian data were available for Arizona: the Southwest Regional Gap Analysis Project (SWReGAP) landcover database (Lowry et al., 2007) and the Arizona Game and Fish Department's (Department) Riparian Inventory (Valencia et al., 1993). Both were reviewed for accuracy by an internal team familiar with riparian areas throughout the state. The SWReGAP landcover layer was found to under represent riparian in much of the state while misclassifying large areas of mesquite woodlands as riparian. These misclassified pixels were re-assigned to mesquite forest in the original data. The 1993 Department's Riparian Inventory was discovered to be out-of-date and incomplete since riparian vegetation was only mapped along perennial drainages and not intermediate ones.

In an attempt to fill in the blanks left by those datasets, the Department modeled the potential riparian vegetation along lakes and perennial and intermittent streams by calculating cost weighted distance from each stream and lake using slope as the cost surface, essentially mapping the flood plain around each stream and lake. The resulting output was constrained by an upper cost limit and by distance from the stream or lake. The model was combined with the Department's riparian inventory and the SWReGAP riparian categories to create a comprehensive map of potential riparian vegetation. Known areas of development, agriculture or dewatering were erased from the model. In recognizing the importance of riparian vegetation in Arizona, the Department chose methodology that may over represent the presence of riparian habitat in Arizona as opposed to methodology that under represents riparian habitat.

<u>Presented In:</u>

Maps

WILDLIFE

Catchments (Wildlife Waters) (AGFD, 2010)

The number of catchments identified within each basin is presented in the tables.

A **wildlife water catchment** is a watering device for wildlife. It collects precipitation, holds the water in a covered tank to minimize evaporation and maintain adequate water quality, and dispenses water into a basin or reservoir from which animals can drink. Catchments are manufactured in several styles, including inverted umbrella and apron. They often are used in remote wilderness locations.

To provide water to wild animals fencing is usually built to surround the catchment. Catchments are a wildlife management tool, and are widely used in the southwest United States, where periodic droughts may cause population crashes in game animals unless water supplies are provided.

Spatial data for wildlife water catchments/resources within Arizona Game & Fish Department Wildlife Water Development Database to which AZGFD holds responsibility. Data does not include Forest Service or BLM owned/operated/managed water catchments.

Presented In:

Tables

USFWS Designated ESA Critical Habitat Areas by Species (USFWS, 2011b)

The Endangered Species Act of 1973 allows the U.S. Fish and Wildlife Service and National Marine Fisheries Service to designate specific areas as protected "critical habitat" zones.

The provision of the law in Section 4 that establishes critical habitat is a regulatory link between habitat protection and recovery goals, requiring the identification and protection of all lands, water and air necessary to recover endangered species. Critical habitats are areas considered essential for the conservation of a listed species.

The GIS files and their associated coordinates are not the legal source for determining the critical habitat boundaries. The user is referred to the critical habitat textual description in the appropriate final rule for the species as published in the Federal Register.

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Summaries, Tables & Maps

Arizona Game and Fish Department State Wildlife Action Plan (AGFD, 2011b)

The Arizona Game and Fish Department (AGFD) modeled species distributions for their 2011 revision of the Statewide Wildlife Action Plan (SWAP). Not all species in Arizona were modeled; modeling efforts were limited to those species identified in the SWAP as having the greatest conservation need. Data sources included the following: Arizona Breeding Bird Atlas (ABBA) (Corman & Wise-Gervais, 2005), Southwest Regional GAP (SWReGAP) Land Cover Dataset (Lowry et al., 2007), SWReGAP Animal Habitat Models (Boykin et al., 2007), and the Lower Colorado River Basin (LCRB) Aquatic Gap Analysis project (Whittier et al., 2010e.

Species Distribution Models

The AGFD developed species distribution models for the species of greatest conservation need as identified in the Arizona SWAP. These species distribution models represent the historic, present, and potential distribution for an individual species. A specific set of parameters was used for each species distribution model, including vegetation, elevation and slope associations, and known occurrences.

Several base data layers were used for a majority of the predictive distribution models, including:

- SWReGAP landcover to map vegetation associations for individual species.
- Digital elevation model (DEM) to map elevational and slope associations for individual species.
- 10-digit HUC (watershed) boundaries and species occurrence data were used to identify watersheds associations for individual SGCN species.

After the SGCN species distribution models were created, the parameters that went into each model were entered into the database. This created a straightforward way to access the model parameters via queries and tables. The species distribution parameters database is fully linked to the SWAP database, so future updates to the SWAP database (e.g., taxonomic or legal status changes) will be reflected in the species parameters database.

Methods for species distribution models were generally consistent within higher taxonomic levels (e.g., invertebrates, amphibians, birds, etc.), but occasionally species specific parameters were employed (see discussions below). However, all of the data sources discussed above were used in compiling the distribution models for the SGCN, and were further refined through expert opinion and through validation with the HDMS element occurrence data (if those data were available). For most species, validation with HDMS data has not yet occurred. We are continuing to refine models as time permits.

Regardless of methods, there are assumptions inherent in all of the models:

1. Most of the models are built using SWReGAP Landcover as a base layer and have a base pixel size of 30 m. However, the models, as is the Landcover database, are meant to be used for landscape level analysis at a scale of 1,000 ha or greater (Boykin et al., 2007).

2. Each model represents a *predicted* range distribution for a species. Species are expected to occur within that range, but are not assumed to be present at every point within the geographic range. Also, the models do not provide information on species abundance or on habitat quality within the predicted range.

The SGCN species distribution models were reviewed by AGFD biologists before they became finalized. The SGCN species distribution models were created using the best available data at the time, and will be updated as data become available in the future.

Presented In:

Summaries, Tables & Maps

SWAP Data Sources

Arizona Breeding Bird Atlas: First statewide survey of Arizona birds containing a wealth of information regarding the actual locations and habitat preferences of over 370 species of birds. The survey was based on the U.S. Geological Survey's (USGS) 7.5 minute topographic maps. Each quad was divided into six blocks and a block from each quad was randomly selected for sampling. Each block was visited several times during the breeding season to detect each bird species and confirm breeding of as many species as possible. In addition, field personnel noted other environmental information such as vegetation types and elevational ranges in which each species was detected (Corman & Wise-Gervais, 2005).

Southwest Regional GAP (SWReGAP): The U.S. Geological Survey mapped landcover and terrestrial vertebrate species using 1999-2001 satellite imagery (Prior-MaGee et al., 2007). The landcover map served as a proxy for vegetation in the species distribution models.

The SWReGAP developed 819 terrestrial vertebrate models based on environmental parameters that define Wildlife Habitat Relationships (WHRs). Vegetation alliances were the primary parameter for modeling wildlife habitats followed by elevation and distance to water. WHRs were restricted to 8-digit Hydrological Unit Codes (HUCs) that the species had historically occurred in. A full description of the modeling process can be found in chapter 3 of the Southwest Regional Gap Analysis Final Report (Boykin et al., 2007).

Lower Colorado River Basin Aquatic GAP Analysis: Identified areas with native aquatic fauna diversity to support development of future conservation strategies for the Lower Colorado River Basin (Whittier et al., 2010e. Project collected fish observation data from federal and state agencies, universities, online fish databases and museums.

Riparian

Existing SWReGAP riparian was supplemented with modeled riparian (see SWAP Riparian Model discussion in previous section) and coded to “AZ05 – Riparian.” In addition, the development team felt that xeric riparian, an important vegetation type for many species, was seriously under represented. We addressed that problem with a very simple modeling exercise in which named washes were extracted from the Arizona State Lands Department’s Arizona streams dataset (ALRIS, 1993). The washes were assumed buffered by 60 meters below 4,000 feet elevation and by 30 meters at higher elevations. The 4,000 foot elevational limit corresponds roughly to the elevational ranges of Fremont cottonwood (lower elevations) and sycamore (higher elevations).

Invertebrates

Invertebrate species models were created using several approaches. Aspect, slope, elevational and vegetation associations for individual species were identified by AGFD biologists. Aspect, slope, and elevational associations were extracted from a 30 meter Digital Elevation Model. Vegetation associations were extracted from SWReGAP vegetation layer. Occurrence data from the HDMS were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer down to only those watersheds in which the individual species occurs. The aspect, slope, and elevational association layers were then used to further restrict the updated vegetation association layer.

In some cases, the watershed distributions identified by HDMS occurrence data were used to locate water springs located within the selected watersheds. When the water springs were used in the invertebrate species distribution models, a spatial buffer was used around each spring to ensure that the springs are present in the final version of each distribution model.

Fish

Three hydrological data layers were used to create the fish distribution models. Two hydrologic data layers with stream features created by AGFD were used to extract intermittent and perennial stream features. A hydrologic data layer with lake features created by the Arizona Department of Environmental Quality (ADEQ) was used to query a subset of lakes.

AGFD staff used LCRB Aquatic GAP Analysis Project to identify 10-digit level watersheds. The identified watershed range was used to restrict hydrological features to only those watersheds in which the individual fish species was known to occur. The hydrological features were merged together to create a final distribution model for each SGCN fish species.

Amphibians

The amphibian distribution models were created using several approaches. Elevation and vegetation associations for individual species were identified by AGFD staff. Those associations were extracted from a DEM of Arizona and the SWReGAP vegetation layer. Occurrence data from the primary literature, the Riparian Herpetofauna Database, HDMS and other AGFD sources (e.g., internal reports) were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer to only those watersheds in which the individual species was known to occur. Then the elevation association layer was used to further restrict the updated vegetation association layer. This method created predictive species distribution models that assumed that if a species was known to occur in a portion of a watershed within a specific elevational range and within specific vegetation types, then it should occur in other areas of the watershed that have the associated vegetation types and fall within that elevational range.

In some cases species distributions were inferred from distribution maps in field guides e.g., Brennan & Holycross, 2007) or species accounts in the Catalogue of American Amphibians and Reptiles (published by the Society for the Study of Amphibians and Reptiles). This information was coupled with staff knowledge and literature reviews of habitat types and elevational ranges. Additional species distribution models created by the SWReGAP project were used for the SWAP. When Arizona-specific species information was available, such as elevational range, vegetation associations, and occurrence information, the SWReGAP species distribution models were modified to incorporate those data.

Reptiles

The reptile distribution models were created using a similar approach as for amphibians. Elevation and vegetation associations for individual species were identified by AGFD staff and selected from a DEM of Arizona and SWReGAP vegetation layer. Occurrence data from the primary literature, the Riparian Herpetofauna Database, Desert Tortoise Database, HDMS and other AGFD sources (e.g., internal reports) were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer to only those watersheds in which the individual species was known to occur. The elevation association layer was used to further restrict the updated vegetation association layer. This method created predictive species distribution models that assumed that if a species was known to occur in a portion of a watershed within a specific elevational range and within specific vegetation types, then it should occur in other areas of the watershed that have the similar vegetation types and elevational ranges.

In some cases species distributions were inferred from distribution maps in field guides (e.g., Brennan & Holycross, 2007) or species accounts in the Catalogue of American Amphibians and Reptiles (published by the Society for the Study of Amphibians and Reptiles). This information was coupled with staff knowledge and literature reviews of habitat types and elevational ranges. Species distribution models created by the SWReGAP project were used to map a few reptile species distributions for the SWAP. When Arizona-specific species information was available, such as elevational range, vegetation associations, and occurrence information, the SWReGAP species distribution models were modified to incorporate those data.

Birds

The bird distribution models were created using similar methods as the reptiles and amphibians. Elevational and vegetation associations for individual species were identified by AGFD staff, and extracted from DEM and SWReGAP vegetation layers. Occurrence data from the Arizona Breeding Bird Atlas were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer down to only those watersheds in which the individual species was known to occur, and then the elevational association layer was used to further restrict the updated vegetation association layer. This method created predictive species distribution models that assumed that if a species was known to occur in a portion of a watershed within a specific elevational range and within specific vegetation types, then it should occur in other areas of the watershed that have the associated vegetation types and fall within that elevational range.

Mammals

The mammal distribution models were created using a combination of new models and SWReGAP mammal distributions. Elevational and vegetation associations for individual species were identified by AGFD staff and those associations were extracted from DEM and SWReGAP vegetation layers. Occurrence data from a variety of sources, including the HDMS, were used to identify watersheds in which each species occurs at the HUC 10-digit level. The identified watershed range was used to restrict the vegetation association layer down to only those watersheds in which the individual species occurs, and then the elevational association layer was used to further restrict the updated vegetation association layer. This method created predictive species distribution models that assumed that if a species was known to occur in a portion of a watershed within a specific elevational range and within specific vegetation types, then it should occur in other areas of the watershed that have similar vegetation types and elevational ranges.

In some cases species distributions models created for the SWReGAP project were used as the species distribution models for the SWAP. If Arizona specific species information was available the SWReGAP species distribution models were modified to incorporate the refined data such as elevational range, vegetation associations, and occurrence information.

SWAP Species data were filtered to represent aquatic, marshland and riparian species. Data subsets were then queried by groundwater basin, and presented in the Basin Table as a numeric summary of Birds, Amphibians, Fish, Invertebrates or Mammals. It is also noted of those enumerated how many are listed under the Endangered Species Act.

Limitations: SWAP Species Models are based on habitat characteristics and other features associated with each species. In many instances the models also utilize species occurrence data. However, some models may overestimate the potential occurrence of particular species.

Presented In:

Summaries, Tables & Maps

Arizona Game and Fish Department, Heritage Data Management System (AGFD, 2011a)

Arizona’s Heritage Data Management System (HDMS), housed in the Arizona Game and Fish Department, is part of an international network of natural heritage programs and conservation data centers operating in all 50 American states, Canada, Latin America and the Caribbean. The HDMS collects and manages detailed local information on plants, animals, and ecosystems and is the leading source of information about rare and endangered species in the State of Arizona.

HDMS data is compiled from many sources and carefully documented. Information included in the HDMS comes from published and unpublished reports, data collected by cooperating agencies, museum and herbarium collections, the scientific and academic communities, and many other sources. The Arizona Heritage Data Management System (HDMS) tracks species that are federally listed as threatened or endangered under the Endangered Species Act of 1973 (ESA), or are candidate species for listing under ESA. The HDMS also tracks some species that have been identified as sensitive species by other agencies, notably the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS). The BLM has a Bureau Sensitive Species list to focus management on species that may be declining or for which habitat may be limited or susceptible to alteration. The USFS's Threatened, Endangered and Sensitive (TES) Species list identifies species that need special management attention and habitat restoration. The HDMS also tracks species included on the Navajo Nation endangered species list managed by the Navajo Natural Heritage Program.

Not all species have been systematically surveyed throughout the state, meaning that some species may not be accounted for in all basins. In general, sensitive species tracked by the HDMS are declining due to habitat losses and modifications, competition with other species and weather-related drought. Additional species get added to the HDMS tracking system when they become federally listed or are identified as candidate species for federal listing. The Arizona Game and Fish has also identified Wildlife of Special Concern; these data are also included in the HDMS.

All natural heritage programs and conservation data centers use standardized methods for gathering, managing, and analyzing biological and ecological data. These methods focus on documenting location and condition of species and ecosystems, with particular focus on those that are of greatest conservation concern. HDMS also contains information on conservation status, taxonomy, distribution, life history, and habitat requirements of the species and associated ecological communities.

Species summaries for the WRDC report were generated using the HDMS Geographic Information System (GIS) dataset. This dataset depicted element occurrences, a spatial representation of a species or ecological community at a specific location. An element occurrence generally delineates a species population or ecological community stand, and represents the geo-referenced biological feature that is of conservation or management interest. Element occurrences are documented by voucher specimens (where appropriate) or other forms of observations. A single element occurrence may be documented by multiple specimens or observations taken from different parts of the same population, or from the same population over multiple years.

HDMS data are used to promote sound environmental planning and conservation measures concerning the plants, animals, and communities that compose Arizona's diverse natural heritage. Users of HDMS information include cooperating agencies, naturalists, educators, researchers, resource managers, consultants, planners, policy makers, developers, environmentalists, and the general public.

HDMS species data were provided by AGFD. The database was queried to provide a subset of information relating only to aquatic, marshland, and riparian species. The data subset was then filtered by groundwater basin to identify which species have been observed and documented in each groundwater basin.

These data are described in the narrative Basin Summaries. It is also noted in the Basin Summaries which species are listed under the Endangered Species Act.

Limitations: Not all species have been systematically surveyed throughout the state, meaning that some species may not be accounted for in all basins.

Presented In:

Summaries, Tables & Maps

Economics of Fishing (AGFD, 2001; Silberman, 2001)

Data were provided by AGFD from 2001 evaluating Angler Use Days at water bodies throughout Arizona. The value of an Angler Use Day in 2001 is calculated using economic data on fishing in a study prepared by Jonathan Silberman, PhD, ASU School of Management.

Using information presented by Silberman (2001): Table 4: Total Fishing Expenditure ($831,493,493) divided by Table 3: Total Angler days (5,302,707) = $156 per Angler Use Day in 2001.

These data are described in the narrative Basin Summaries.

Limitations: Not all water bodies have been systematically surveyed throughout the state, meaning that some economic impacts from fishing opportunities have not been estimated.

Presented In:

Summaries

ADMINISTRATIVE DESIGNATIONS AND BOUNDARIES

Cities (ALRIS, 2006)

Major Arizona cities are presented in the maps.

This dataset represents point locations of cities and towns in Arizona. As described by the ASLD, the data contains point locations for incorporated cities; Census designated places and populated places. Several data sets were used as inputs to construct this data set. A subset of the Geographic Names Information System (GNIS) national dataset for the state of Arizona was used for the base location of most of the points. Polygon files of the Census Designated places (CDP), from the U.S. Census Bureau and an incorporated city boundary database developed and maintained by the Arizona State Land Department were also used for reference during development. Every incorporated city is represented by a point, originally derived from GNIS. Some of these points were moved based on local knowledge of the GIS Analyst constructing the data set. Some of the CDP points were also moved and while most CDP's of the Census Bureau have one point location in this data set, some inconsistencies were allowed in order to facilitate the use of the data for mapping purposes.

During development, an additional attribute field was added to provide additional functionality to the users of this data. This field, named 'DEF_CAT', implies definition category, and will allow users to easily view, and create custom layers or datasets from this file. For example, new layers may created to include only incorporated cities (DEF_CAT = Incorporated), Census designated places (DEF_CAT = Incorporated OR DEF_CAT = CDP), or all cities that are neither CDP's or incorporated (DEF_CAT= Other).

<u>Presented In:</u>

Maps

Counties (ALRIS, 1988)

This dataset consists of the county boundaries in Arizona. As described by the ASLD,

the data was created to serve as base information for use in GIS systems for a variety of planning and analysis purposes.

<u>Presented In:</u>

Tables & Maps

<u>Presented In:</u>

Summaries, Tables & Maps

State Managed Conservation Lands (AGFD, 2011c & 2011d; & ASP, 2010)

The state managed conservation lands data sets were provided by the AGFD and ASP; boundaries include Arizona state parks, historic parks and natural areas, AGFD deeded lands (ranches, wildlife areas, nesting areas etc), and AGFD designated wildlife areas.

<u>Presented In:</u>

Summaries, Tables & Maps

Federally Protected Lands (ALRIS, 1990 & 2011; BLM, 1992, 1999, & 2001; UMT, 2010; USFS, 2004; & USFWS, 2011a)

Federally protected lands data sets are from BLM, UMT, USFS, USFWS and ALRIS. Boundaries include USFWS national wildlife refuges, BLM conservation areas, national monuments and wilderness areas, USFS wilderness areas, national parks, and national recreation areas.

Presented In:

Summaries, Tables & Maps

Wild and Scenic Rivers (National Wild and Scenic Rivers System Act of 1968; AGFD, 2011e; USFS, 2007; & WSRC, 2009)

The National Wild and Scenic Rivers System was created by Congress in 1968 (Public Law 90-542; 16 U.S.C. 1271 et seq.) to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. There are three designations under the Act: 1) Wild Rivers or sections of rivers are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted; 2) Scenic Rivers or sections of rivers are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads; and 3) Recreational Rivers or sections of rivers are readily accessible by road or railroad, may have some development along their shorelines, and may have undergone some impoundment or diversion in the past.

As described by the AGFD (2011e), modifications were made to the USFS Wild and Scenic Rivers dataset (2007) and the Wild & Scenic River Council's dataset (2009):

> Data was downloaded from Wild and Scenic Rivers website (http://www.rivers.gov/index.html). Data for Fossil Creek were selected from the dataset and buffered 1/4 mile since a Comprehensive River Management Plan (CRMP) has not been developed for Fossil Creek. Per USFS-Region 2 office, 1/4 mile is the interim Wild and Scenic corridor before a CRMP is approved. Data was merged with the approved Verde River Wild and Scenic data downloaded from the Tonto NF GIS data download site.

Presented In:

Summaries, Tables & Maps

Outstanding Arizona Waters (A.A.C., 2008; & ADEQ, 2009)

Outstanding Arizona Waters, as classified by ADEQ, are identified in the basin tables and maps. The term "outstanding Arizona waters" (OAW) was formerly known as "unique waters"; these terms are considered to be synonymous. R18-11-101(28) "Outstanding Arizona water (OAW)" means a surface water that is classified as an outstanding state resource water by the Director of ADEQ under R18-11-112.

Unique waters are designated only by administrative rulemaking. Members of the public may nominate surface waters for unique waters classification or the DEQ may initiate the rulemaking. The director of the DEQ may classify a surface water as a unique water by making a finding that a surface water is an "outstanding state resource water" because it meets decision criteria set out at R18-11-112(D). In general, a surface water has to be perennial, in a free-flowing condition, have water quality that meets or is better than applicable water quality standards, and meet one or both of the following: 1) The surface water is of "exceptional recreational or ecological significance," or 2) threatened or endangered (T&E) species are known to be associated with the water body and maintenance and protection of existing water quality is essential to the maintenance of the threatened or endangered species or the surface water provides critical habitat.

Presented In:

Summaries, Tables & Maps

Instream Flow (ADWR, 2010b)

An instream flow water right is a non-diversionary appropriation of surface water for recreation and wildlife use. An application to appropriate public water for instream flow purposes must be submitted to the Arizona Department of Resources, which makes the determination of whether to approve or reject the application. If a permit is approved, the Department issues a Certificate of Water Right. All permits and certificates are for specific uses at specific places. The Department maintains a database that tracks the status of instream flow applications.

Presented In:

Tables & Maps

National Hydrography Dataset (USGS, 2008)

The basin tables and maps utilized data available in the National Hydrography Dataset for water features and geographic boundaries in Arizona. These features include watersheds as defined by the 8-digit hydrologic unit codes, surface water bodies and streams.

The NHD is a national framework for assigning reach addresses to water-related entities, such as industrial discharges, drinking water supplies, fish habitat areas, wild and scenic rivers. Reach addresses establish the locations of these entities relative to one another within the NHD surface water drainage network, much like addresses on streets. Once linked to the NHD by their reach addresses, the upstream/downstream relationships of these water-related entities (and any associated information about them) can be analyzed using software tools ranging from spreadsheets to geographic information systems (GIS). GIS can also be used to combine NHD-based network analysis with other data layers, such as soils, land use and population, to help understand and display their respective effects upon one another. Furthermore, because the NHD provides a nationally consistent framework for addressing and analysis, water-related information linked to reach addresses by one organization (national, state, local) can be shared with other organizations and easily integrated into many different types of applications to the benefit of all.

The National Hydrography Dataset (NHD) is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system. NHD data was originally developed at 1:100,000-scale and exists at that scale for the whole country. This high-resolution NHD, generally developed at 1:24,000/1:12,000 scale, adds detail to the original 1:100,000-scale NHD. (Data for Alaska, Puerto Rico and the Virgin Islands was developed at high-resolution, not 1:100,000 scale.) Local resolution NHD is being developed where partners and data exist. The NHD contains reach codes for networked features, flow direction, names, and centerline representations for areal water bodies. Reaches are also defined on water bodies and the approximate shorelines of the Great Lakes, the Atlantic and Pacific Oceans and the Gulf of Mexico. The NHD also incorporates the National Spatial Data Infrastructure framework criteria established by the Federal Geographic Data Committee.

Presented In:

Summaries, Tables & Maps

WATER-DEPENDENT NATURAL RESOURCE INDEX

Groundwater/Surface Water Connections

Basin	Sub-basin	Current GW/SW Connection? (h=historic connection; may not currently exist)	Description of GW/SW Connection
Agua Fria	None	YES	Agua Fria basin contains perennial reach on Horseshoe Ranch and other locations; BLM National Monument
Aravaipa Canyon	None	YES	Aravaipa basin contains perennial Aravaipa Creek, on TNC and BLM managed property.
Big Sandy	Fort Rock	YES	Fort Rock subbasin contains the upper perennial reach of Big Sandy River.
	Wikieup	YES	Wikieup subbasin contains a perennial reach of the Big Sandy River; managed by the BLM, I believe it has an ISF permit.
Bill Williams	Burro Creek	YES	Burro Creek subbasin contains perennial reaches of Burro Creek.
	Alamo Reservoir	YES	Alamo Reservoir subbasin contains perennial reaches of lower Burro Creek, Santa Maria River, and Big Sandy River.
	Clara Peak	YES(h)	Clara Peak subbsin contains flowing reachs of Bill Williams River downstream from Alamo dam (gaining reaches?)
	Skull Valley	YES	Skull Valley subbasin contains a perennial reach of Kirkland Creek.
	Santa Maria	YES	Santa Maria subbasin contains perennial reaches of: Kirkland Creek; Peoples Creek; Date Creek; Santa Maria River; Sycamore Creek; Smith Canyon; Cottonwood Canyon
Bonita Creek	None	YES	Bonita Creek basin contains the lower perenial reach of Bonita Creek; City of Safford infiltration gallery captures much of the perennial flow.
Butler Valley	None	NO	Bulter Valley contains ephemeral washes (Cunningham Wash)
Cienega Creek	None	YES	Cienega Creek basin contains perennial reaches of Cienega Creek (BLM NCA) and Sonoita Creek
Coconino Plateau	None	YES	Coconino Plateau basin contains perennial Blue Spring and the South Rim springs.
Detrital Valley	None	NO	Detrital Valley contains ephemeral washes (tributary to the Colorado River)
Donnelly Wash	None	YES(h)	Donnelly Wash contains a regulated reach of the Gila River between Florence and Colidge Dam
Douglas	Douglas	----	----
	Douglas INA	NO (h)	Douglas INA - Brown, Camory, and Turner (BCT) document an historically perennial reach on Whitewater Draw just north of the International border.
Dripping Springs Wash	None	YES(?)	Dripping Springs Wash subbasin contains a regulated reach of the Gila River and a perennial(?) reach of Ash Creek
Duncan Valley	None	YES	Duncan Valley basin contains a perennial reach and a formerly perennial reach of the Gila River - sw diversions and gw pumping in the Duncan-Virden area have depleted streamflow.
Gila Bend	None	NO (h)	Gila Bend basin contains a formerly perennial reach of the Gila River
Grand Wash	None	NO	Grand Wash basin contains ephemeral washes
Harquahala	None	NO	Harquahala basin contains ephemeral washes (Centential Wash)
Hualapai Valley	None	NO	Hualapai Valley basin contains ephemeral washes
Kanab Plateau	None	YES	Kanab Plateau basin contains N. Rim perennial creeks: Kanab, Crystal, Tapeats, Deer, Bright Angel, Clear, Vishnu, N. Canyon, Nankoweap
Lake Havasu	None	NO	Lake Havasu basin contains ephemeral washes
Lake Mohave	None	NO	Lake Mohave basin contains ephemeral washes (tributary to the Colorado River)
Little Colorado River Plateau	C-aquifer	YES	Little Colorado River Plateau C-aqufer discharges to springs and perennial reaches along Little Colorado River
	D-aquifer	YES(?)	Perennial reaches(?)
	N-aquifer	YES(?)	Perennial reaches(?)
	Joseph City INA	YES	Joseph City INA contains a perennial reach of the Little Colorado River
Lower Gila	Childs Valley	NO (h)	Childs Valley subbasin contains a formerly perennial reach of the Gila River
	Dendora Valley	NO (h)	Dendora Valley subbasin contains a formerly perennial reach of the Gila River
	Wellton-Mohawk	NO (h)	Wellton-Mohawk subbasin contains a formerly perennial reach of the Gila River
Lower San Pedro	Camp Grant Wash	YES	Camp Grant Wash subbasin contains a perennial reach of Camp Grant Wash (BCT); spans the downstream boundary of this subbasin
	Mammoth	YES	Mammoth subbasin contains perennial reaches of the Lower San Pedro River
McMullen Valley	None	NO	McMullen Valley basin contains ephemeral reaches
Meadview	None	NO	Meadview basin contains ephemeral washes
Morenci	None	YES	Morenci Basin contains San Francisco and Blue rivers and Eagle Creek, perennial with perennial tributaries. Snow-melt and rainfall driven flow, but summer flow likely gw discharge.
Paria	None	YES	Paria River is perennial

Anning, D.W. and Konieczki, A.D. 2005. Classification of hydrogeologic areas and hydrogeologic flow systems in the Basin and Range Physiographic Province, Southwestern United States. USGS Professional Paper 1702. 37 pp.

Groundwater/Surface Water Connections (continued)

Basin	Sub-basin	Current GW/SW Connection? (h=historic connection; may not currently exist)	Description of GW/SW Connection
Parker	Cibola Valley	NO	Parker basin contains ephemeral washes (CRIR and Cibola tributary to Colorado River)
	Colorado River Indian Reservation	NO	
	La Posa Plains	NO	
Peach Springs	None	YES	Peach Spring basin contains a short perennial reach in Spencer Canyon and part of N. boundary of basin is coincident with the perennial reach of Diamond Creek
Phoenix	Carefree	YES	Cave Creek subasin contains a perennial reach of Cave Creek
	East Salt River	?	East Salt River subbasin contains a short perennial reach on Queen Creek
	Fountain Hills	YES	Fountain Hills subbasin contains a perennial reach of Camp Creek and a regulated reach of lower Verde River
	Hassayampa	YES	Hassayampa subbasin contains part of the lower perennial reach Hassayampa River
	Lake Pleasant	YES	Lake Pleasant subbasin contains a perennial reach of New River
	Rainbow Valley	NO	Rainbow Valley contains ephemeral washes
	West Salt River	YES	West Salt River Valley contains formerly perennial Gila River, now effluent dominated
Pinal	Aguirre Valley	NO	Aquirre Valley subbasin contains ephemeral washes
	Eloy	NO(h)	Eloy subbasin contains a formerly perennial (now regulated) reach of the Gila River
	Maricopa-Stanfield	NO	Maricopa-Stanfield subbasin contains ephemeral washes
	Santa Rosa	NO	Santa Rosa subbasin contains ephemeral washes
	Vekol Valley	NO	Vekol Valley subbasin contains ephemeral washes
Prescott	Little Chino	YES	Little Chino subbasin contains Del Rio Spring and the Upper Verde River
	Upper Agua Fria	YES	Upper Agua Fria subbasin contains a perennial reach of Agua Fria River adjacent to Young Farm
Ranegras Plain	None	NO	Ranegras Plain basin contains ephemeral washes
Sacramento Valley	None	NO	Sacramento Valley basin contains ephemeral washes (tributary to the Colorado River)
Safford	Gila Valley	YES	Gila Valley subbasin contains perennial and formerly perennial reaches of the Gila River
	San Carlos Valley	YES	San Carlos Valley subbasin contains the perennial San Carlos River and formerly perennial and regulated reaches of the Gila River
	San Simon Valley	NO	San Simon Valley subbasin contains ephemeral washes (perennial water only at high elevations)
Salt River	Black River		A groundwater/ surface water connection is exhibited for some of the perennial streams that carry C-aquifer baseflow that originate along the southern flank of the Mogollon Rim. Otherwise, for most other portions of the SR basin, the streams carry runoff over consolidated sedimentary rocks, and/or igneous and metamorrphic rock formations that probably have minimal connections to groundwater. Per Frank Corkhill, ADWR.
	Salt River Canyon		
	Salt River Lakes		
	White River		
San Bernardino Valley	None	YES	San Bernadino Valley basin contains a perennial reach of Black Draw and the San Bernadino National Wildlife Refuge
San Rafael	None	YES	San Rafael Valley contains perennial reaches of the Santa Cruz River
San Simon Wash	None	NO	San Simon Wash basin contains ephemeral washes
Santa Cruz	None	YES	Santa Cruz AMA basin contains perennial reaches of Potero Creek, Sonoita Creek, Peck Canyon, and Santa Cruz River (effluent dominated)
Shivwits Plateau	None	NO	Shivwits Plateau basin contains ephemeral washes; southern boundary coincides with the Colorado River in the western Grand Canyon
Tiger Wash	None	NO	Tiger Wash basin contains ephemeral washes
Tonto Creek	None	YES	Tonto Creek basin contains perennial Tonto Creek and numerous other perennial creeks
Tucson	Avra Valley	YES	Avra Valley subbasin contains Arivaca Creek and Sycamore Canyon; otherwise, ephemeral washes
	Upper Santa Cruz	YES	Upper Santa Cruz subbasin contains Cienega Creek and formerly perennial reaches of the Santa Cruz River; plus mountain creeks such as Sabino Creek
Upper Hassayampa	None	YES	Upper Hassayampa basin contains perennial reaches of the Hassayampa River (downstream from Wickenburg at TNC preserve; upstream from Wickenburg at the Box; and upstream at Wagner) and Minnehaha Creek.
Upper San Pedro	Allen Flat	YES	Allen Flat subbasin contains Bass Canyon Creek and Double R Canyon Creek on Muleshoe preserve; otherwise ephemeral washes
	Sierra Vista	YES	Sierra Vista subbasin contains perennial reaches of the San Pedro and Babocomari rivers, O'Donnel Canyon Creek, Turkey Creek, and Brown Canyon Creek
Verde River	Big Chino	YES	Big Chino subbasin contains perennial reaches of the Verde Rivera and Williamson Valley wash
	Verde Canyon	YES	Verde Canyon contains perennial reaches of the Verde River and tributaries (East Verde River, Fossil Creek; Deadman Creek, Lime Creek, and others)
	Verde Valley	YES	Verde Valley subbasin contains perennial reaches of the Verde River and tributaries (Sycamore Creek; Oak Creek; Beaver Creek; West Clear Creek
Virgin River	None	YES	Virgin River basin contains perennial reaches of the Virgin River
Western Mexican Drainage	None	NO	Western Mexican Drainage contains ephemeral washes
Willcox	None	NO	Willcox basin contains perennial water only at higher mountain elevations; otherwise ephemeral washes
Yuma	None	YES	Yuma basin contains formerly perennial reaches of the Gila River and reaches of the Colorado River

Anning, D.W. and Konieczki, A.D. 2005. Classification of hydrogeologic areas and hydrogeologic flow systems in the Basin and Range Physiographic Province, Southwestern United States. USGS Professional Paper 1702. 37 pp.

SUMMARY OF METHODS USED TO DEVELOP FIRST APPROXIMATION ESTIMATES OF FLOW VOLUMES CURRENTLY SUPPORTING WATER-DEPENDENT NATURAL RESOURCES

By Rob Marshall, The Nature Conservancy

Primary Differences in the Datasets Used to Estimate Current Flows Supporting Water-Dependent Natural Resources

The Commission developed two sets of estimates of current flows. The two estimates both use the same formula for estimating flow volumes [flow volume = *(baseflow + groundwater underflow + (riparian acres x ac-ft of evapotranspiration)*] and the same data for estimating baseflow. The primary difference between the two is in the data used to estimate riparian acreage and evapotranspiration.

<u>Riparian Estimates</u>

The USGS data used for the first set of estimates (estimate 1) derived values for riparian acreage from remotely-sensed imagery. The imagery was used to calculate riparian acreage along a 100 m buffer centered on river drainages. Sampling vegetation laterally 50 m on either side of the river channel likely underestimates riparian acreage in some areas and overestimates in others. For example, riparian habitat found in valley bottoms may extend several hundred meters laterally from the river channel. Conversely, within steeper parts of watersheds the method likely captures non-riparian vegetation types. So in flat valley bottoms the method may underestimate riparian habitat extent, while in steeper areas it may overestimate.

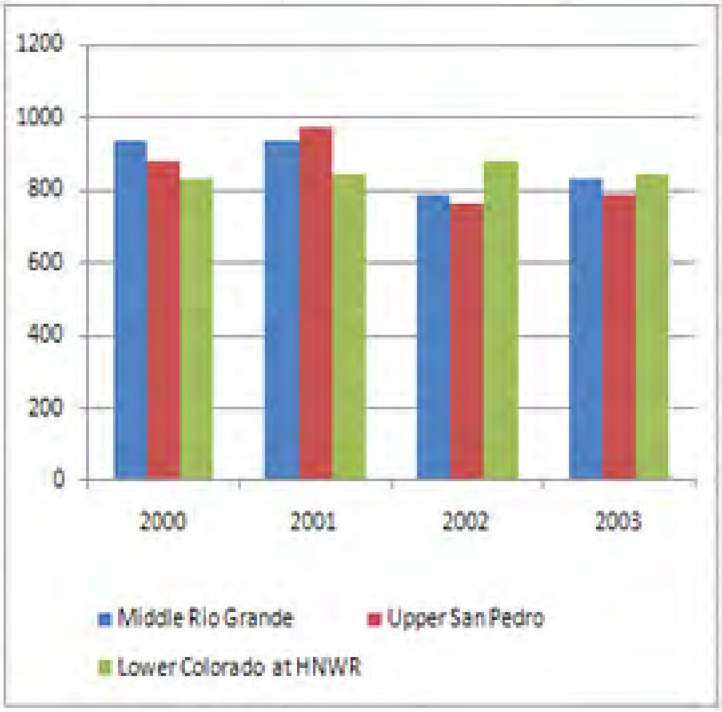
For the Committee's second set of riparian habitat estimates (estimate 2) two data sources were used. The first was a study conducted in 1993 by the Arizona Game and Fish Department that used a combination of aerial photography, aerial videography and ground verification. That study was limited to the larger perennial river basins and to the wider, valley-bottom sections of those watersheds. As a result, a substantial portion of the state's riparian habitat was not surveyed. To include areas not surveyed by the AGFD 1993 study, the Committee also used a dataset produced by USGS called the Southwest ReGAP project. The SW ReGAP was completed using remotely-sensed imagery (although a different type of imagery than what Tillman and others used for estimate 1 described above). To improve the accuracy of the SW ReGAP product, the Arizona Game and Fish Department modified the dataset for use in their State Wildlife Action Plan. Those modifications are described in detail further down on this page.

<u>Evapotranspiration Estimates</u>

Evapotranspiration for the first set of estimates was based on reflectance values from the same remotely-sensed imagery that Tillman and others used to estimate riparian acreage. Different vegetation types have different signatures on remotely-sensed imagery that show up as differences in the amount and bandwidth of the light reflected off of vegetation. The different reflectance values were correlated with field data on evapotranspiration, which enabled USGS to estimate evapotranspiration directly from the imagery across a large portion of Arizona (all areas south of the Colorado Plateau/Mogollon Rim).

The Committee's second set of estimates for evapotranspiration relied on empirical data developed by USGS (Nagler et al., 2005). The data in the graphic box below are from Table 4 in Nagler et al. (2005). The data show the results of field studies that measured evapotranspiration for stretches of three rivers in the Southwest: Rio Grande, Upper San Pedro, and Lower Colorado River. The values are in mm/year. The graph and table demonstrate that rates across the three study areas show little variation. Based on the close correspondence across these study basins, the Committee selected the mean value (859 mm/yr converted to English units = 2.828 ft/yr) to use for the Committee's second set of estimate for evapotranspiration.

	Middle Rio Grande	Upper San Pedro	Lower Colorado at HNWR	
2000	937	881	832	
2001	934	973	846	
2002	791	763	881	
2003	832	790	844	
Mean (SEM)	874 (74)	852 (95)	851 (21)	Mean = 859



The Committee's review of the overall flow estimates derived using these datasets revealed a counter-intuitive result – while the overall riparian acreage in the first set of estimates was twice as high as those in the Committee's second set of estimates, the overall amount of evapotranspiration in the first set of estimates was half of the value estimated in the Committee's second set. Further analysis revealed that this was a direct artifact of the different methodologies and datasets used.

The USGS remote-sensing data used in the Committee's first set of estimates superimposed a 100 m buffer over a watershed's drainage network. The network of drainages tends to get more extensive and complex as you move up a watershed, with many small drainages branching off of larger ones. As noted above, using a 100 m buffer to estimate riparian habitat likely underestimates riparian extent in valley bottoms but probably captures considerable acreage of non-riparian vegetation types higher up in watersheds. Conversely, the riparian studies used for the Committee's second set of estimates attempted to delineate discrete patches of riparian habitat, which should have omitted much of the areas higher up in watersheds that do not contain riparian vegetation types.

The difference in evapotranspiration between the two sets of estimates is likely the result of the evapotranspiration rates applied to the two riparian datasets. The USGS remote-sensing study used a variable evapotranspiration rate based on reflectance values in the remotely-sensed imagery. True riparian vegetation types have higher reflectance values (more evapotranspiration), so even though this method may have captured areas higher up in watersheds with non-riparian vegetation types, the evapotranspiration from those types would be relatively small. Conversely, because the riparian data used in the Committee's second set of estimates attempted to delineate discrete patches of riparian habitat and, thus, should have relatively little non-riparian vegetation included, the Committee used a constant rate of evapotranspiration taken from Nagler's empirical studies of cottonwood-willow types across the southwestern U.S. Evapotranspiration rates for cottonwood-willow are among the highest rates documented, so while the Committee's second set of riparian estimates are lower, the constant evapotranspiration rate applied across this acreage is likely higher than that used in the USGS's study that relied on remotely-sensed imagery.

Despite these differences in data and methodologies, the overall flow volumes from the two sets of estimates are within ten percent of one another. The close correspondence of the two overall estimates increases the overall certainty of the result and illustrates the benefit of using the two different approaches in a comparative manner.

Methods and Data Used in the Commission's Estimate of Riparian Habitat Extent

Below is a list of specific habitats selected and excluded from 1993 AGFD dataset used for estimating riparian habitat. Also explained below are the modifications AGFD made to the SW ReGAP data for their State Wildlife Action Plan.

Habitat types from the 1993 AGFD riparian data included in estimate of riparian acreage

Cottonwood Willow (11,400 acres)

Mixed Broadleaf (18,861 acres)

Tamarisk (5207 acres)

Russian Olive (0)

Strand (5732 acres)

These types represent tree-dominated riparian habitat types. Tree types are what we have ET estimates for from the scientific literature.

Habitats excluded and rationale

Areas not Ground Verified (no way to know what if any vegetation was present; total acres = 428)

Conifer Oak (not a riparian habitat type)

Mountain Scrub (not a riparian habitat type)

Mesquite (excluded from this dataset but is captured by the second dataset we are using – SW ReGAP/SWAP, which covers a larger area and thus will capture more of the mesquite habitat type throughout the state; total unique acres not captured by SW ReGAP/SWAP = 849)

Marsh (we do not have ET values for emergent wetland habitat types; total = 51 acres)

Wet Meadow (we do not have ET values for emergent wetland habitat types; 771 acres)

Flood Scoured (flood scoured habitats are areas of bare sand that are likely spots for future riparian recruitment; total acres = 7,000). Including these areas would likely have overestimated riparian acreage.

Methodology AGFD Used to Refine the SW ReGAP Riparian Data for Use in the Department's State Wildlife Action Plan

At the time this model was developed, two sources of riparian data were available for Arizona: the Southwest Regional Gap Analysis Project (SWReGAP) landcover database (Lowry et al., 2007) and the Department's Riparian Inventory (Valencia, 1993). Both were reviewed for accuracy by an internal team familiar with riparian areas throughout the state. The SWReGAP landcover layer was found to under represent riparian in much of the state while misclassifying large areas of mesquite woodlands as riparian. These misclassified pixels were re-assigned to mesquite forest in the original data. The 1993 Department's Riparian Inventory was discovered to be out-of-date and incomplete since riparian vegetation was only mapped along perennial drainages and not intermittent ones.

In an attempt to fill in the blanks left by those datasets, the Department modeled the potential riparian vegetation along lakes and perennial and intermittent streams by calculating cost weighted distance from each stream and lake using slope as the cost surface, essentially mapping the flood plain around each stream and lake. The resulting output was constrained by an upper cost limit and by distance from the stream or lake. The model was combined with the Department's riparian inventory and the SWReGAP riparian categories to create a comprehensive map of potential riparian vegetation. Known areas of development, agriculture or dewatering were erased from the model. In recognizing the importance of riparian vegetation in Arizona, the Department chose methodology that over represents the presence of riparian habitat in Arizona as opposed to methodology that under represents riparian habitat.

Rationale for the Baseflow Estimates Selected for the Bill Williams and Lower San Pedro Rivers

Estimates of baseflow were not available in the scientific literature for the Bill Williams and Lower San Pedro rivers. Due to the importance of these two systems for riparian and aquatic natural resources, the Commission evaluated available gage data to estimate baseflow values.

For the San Pedro River available data were compiled in the table below. Based on a review of the data, the Commission selected 5 cfs, which is close to the median value, for baseflow in the San Pedro River below Benson.

Base flow for the San Pedro River below Benson

Name	GageNo	Median
San Pedro River at Winkelman (66-78)	09473500	3.4
San Pedro near Winkelman (1962-1965)	09473400	9
San Pedro River bl Aravaipa Creek nr Mammoth (Oct 79 - Sep 83)	09473100	12
San Pedro River near Mammoth (May 31 - Jun 41)	09472500	0
San Pedro River near Benson (1966-1976; 2006-Oct2010)	09471800	0
Gage 3400 and Gage 3500 (1962 - 1978)	------	4.9
Average of all instantaneous measurements at San Pedro River Preserve	------	4.5

For the Bill Williams River, data was reviewed from the following gages:

Bill Williams River **near Parker** gage record is from 10/1/1988 to present; **median flow = 8 cfs**

Bill Williams River **below Alamo Dam** gage is from 10/1939 to present; **pre-dam period (1940-1967), median flow = 9.4 cfs; for the concurrent period of record (10/1/1988 to present) median flow = 25 cfs**

Based on a review of these data, the Commission selected 8 cfs as the baseflow value for the Bill Williams River, which is the median flow near the Parker gage. This value represents current conditions in the watershed.

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Environmental Flow – Figures

Figure 1: First Approximation of Current Flow Volumes Supporting Water-Dependent Natural Resources

First Approximation of Current Flow Volumes Supporting Water-Dependent Natural Resources (acre-feet/year)

River	USGS Estimate	Commission Estimate
Agua Fria River	*36,265*	*29,599*
Aravaipa Creek	*28,283*	*19,384*
Arivaca Creek	*2,440*	*3,492*
Bill Williams River	*85,307*	*132,040*
Cienega Creek	*8,819*	*9,096*
Gila River	*234,456*	*279,071*
Salt River	*373,140*	*365,156*
Upper San Pedro River	*32,307*	*58,676*
Lower San Pedro River	*65,709*	*62,805*
Santa Cruz River	*24,018*	*38,805*
Tonto Creek	*36,295*	*36,675*
Verde River	*309,308*	*340,332*
Total	***1,236,347***	***1,375,131***

Arizona Water Resources Development Commission, Environment Committee (March 1, 2011)
The information in this workbook was based on the best available scientific information and compiled to provide a first approximation of current river flow volumes supporting water-dependent natural resources, such as riparian habitat, fish and other aquatic organisms. The 11 rivers selected were based on the availability of suitable data. Flow estimates in the scientific literature have been developed using several methods. Results can vary depending upon the data, methods, and assumptions used. To better understand the magnitude of this variation, the Committee developed two sets of flow estimates using different datasets.

This summary page contains a snapshot of the two sets of estimates.

The tabs to the right labeled *"USGS Est"* and *"Commission Est"* present the data used to derive the two sets of estimates. "USGS Est" refers to estimates derived from data provided by the U.S. Geological Survey. "Commission Est" refers to the estimates prepared by the WRDC's Environment Committee from several data sources in the scientific literature.

The Metadata tab provides additional information on the data, methods, and scientific studies used to support the Commission's work as well as the Environment Committee members and other contributors who prepared the estimates.

Figure 2: Estimates of Current Flow Volumes Supporting Water-Dependent Natural Resource Using Data from the U.S. Geological Survey (Estimate 1)

River/ Watershed	Annual Baseflow (acre-ft/yr)	Groundwater Underflow (acre-ft/yr)	Riparian Extent (acres)	Average Annual ET (acre-ft/yr)	First Approximation of Current Flow Supporting Water-Dependent Natural Resources (acre-ft/yr)
Agua Fria River	1,811		27,028	34,454	36,265
Aravaipa Creek	11,591		12,565	16,692	28,283
Arivaca Creek	304		1,190	2,136	2,440
Bill Williams River	5,796		79,733	79,511	85,307
Cienega Creek	797		5,683	8,022	8,819
Gila River	127,503		87,695	106,953	234,456
Salt River	236,170		87,271	136,970	373,140
Upper San Pedro River	9,417	440	17,916	22,890	32,747
Lower San Pedro River	3,622		43,368	62,087	65,709
Santa Cruz River	11,591		7,710	12,427	24,018
Tonto Creek	15,213		14,130	21,082	36,295
Verde River	194,151		82,334	115,157	309,308
Total	**617,966**	**440**	**466,623**	**618,381**	**1,236,787**

Flow volume estimates are in acre-feet/year using the following formula:

flow volume = (baseflow + groundwater underflow + (riparian acres x ac-ft of ET))

All flow volumes are for the watershed area above the specific USGS gage used to estimate baseflow. See Figure 4 for USGS gages used.

These estimates were based on the following studies:

baseflow: adapted from the methods of Blasch et al. (2006); Marshall et al. (2010); Fisk et al. (2006)

groundwater underflow: Correll et al. (2006)

evapotranspiration [ET]: adapted from the methods of Tillman et al. (in review) and Nagler et al. (2009)

riparian extent: adapted from Tillman et al. (in review)

Figure 3: Estimates of Current Flow Volumes Supporting Water-Dependent Natural Resources Using Alternative Datasets (Estimate 2)

River/ Watershed	Annual Baseflow (acre-ft/yr)	Groundwater Underflow (acre-ft/yr)	Riparian Extent (acres)	Average Annual ET (acre-ft/yr)	First Approximation of Current Flow Supporting Water-Dependent Natural Resources (acre-ft/yr)
Agua Fria River	1,811		9,861	27,788	29,599
Aravaipa Creek	11,591		2,766	7,793	19,384
Arivaca Creek	304		1,131	3,188	3,492
Bill Williams River	5,796		44,799	126,244	132,040
Cienega Creek	797		2,945	8,299	9,096
Gila River	127,503		53,786	151,568	279,071
Salt River	236,170		45,772	128,986	365,156
Upper San Pedro River	9,417	440	17,480	49,259	59,116
Lower San Pedro River	3,622		21,002	59,183	62,805
Santa Cruz River	11,591		9,657	27,214	38,805
Tonto Creek	15,213		7,616	21,462	36,675
Verde River	194,151		51,874	146,181	340,332
Total	**617,966**	**440**	**268,689**	**757,165**	**1,375,571**

Flow volume estimates are in acre-feet/year using the following formula:

flow volume = (baseflow + groundwater underflow + (riparian acres x ac-ft of ET))

All flow volumes are for the watershed area above the specific USGS gage used to estimate baseflow. See Figure 4 for USGS gages used.

These estimates were based on the following studies:

baseflow: adapted from the methods of Blasch et al. (2006); Marshall et al. (2010); Fisk et al. (2006)

groundwater underflow: Correll et al. (2006)

evapotranspiration [ET]: adapted from the methods of Nagler et al. (2005)

riparian extent: adapted from Valencia et al. (1993); Lowry et al. (2007)

Figure 4: USGS Gages and Riparian Habitat Acreages

USGS Gages and Riparian Habitat Acreages Used in WRDC Study			Riparian acres USGS	Riparian acres SWAP/AGFD
River	**Gage #**	**Gage Name**	**(Tillman & others 2011)**	**(Valencia & others 1993; Lowry & others 2007)**
Agua Fria River	9512800	Agua Fria River near Rock springs	27,028	9,861
Aravaipa Creek	9473000	Aravaipa Creek Near Mammoth	12,565	2,766
Arivaca Creek	9486590	Arivaca Wash near Arivaca	1,190	1,131
Bill Williams River	9426620	Bill Williams near Parker	79,733	44,799
Cienega Creek	9484600	Pantano Wash Near Vail	5,683	2,945
Gila River	9448500	Gila River At Head Of Safford Valley Near Solomon	87,695	53,786
Salt River	9498500	Salt River near Roosevelt	87,271	45,772
Upper San Pedro River	9471000	San Pedro River at Charleston	17,916	17,480
Lower San Pedro River	9473500	San Pedro at Winkelman	43,368	21,002
Santa Cruz River	9481740	Santa Cruz River at Tubac	7,710	9,657
Tonto Creek	9499000	Tonto Creek abv Gunn Creek	14,130	7,616
Verde River	9508500	Verde River below Tangle Creek	82,334	51,874

BASIN TABLES

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Agua Fria	None	Agua Fria	Yavapai & Maricopa	B22, C8.1, C8.2, C14.1, C14.2	5 amphibian; 13 bird; 6 fish; 1 invertebrate; 6 mammal; 3 reptile species. Of these, 3 fish, 2 bird and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.	Agua Fria River	48 miles of perennial flow	1,811	27,788 - 34,454	29,599 - 36,265	YES			
						Perennial tributary reaches of Ash, Big Bug, Black Canyon, Grapevine, Humbug, Indian, Little Ash, Little Sycamore, Silver, Sycamore and Turkey creeks, Horner Gulch and Little Hackberry Wash	60 miles of perennial flow				YES			
						Instream Flow[4]	2 applications: Big Bug Creek (1) and Turkey Creek (1); 2 certificates: Ash Creek (1) and Sycamore Creek (1)				YES			
						Springs	5 major springs with flow range from 14 to 340 gpm					870		
							14 minor springs with flow range from 1 to 6 gpm					65		
							294-297 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	32 stream miles, 1 major spring				YES			
						Effluent/Other Water[5]	WWTP discharge to Agua Fria (at Black Canyon City) and unnamed watercourse (at Mayer)					NR		
						Reservoirs (5 total)	1 large reservoir (Lake Pleasant)						1,108,600	
							2 small reservoirs						63	
							2 small reservoirs							13
						Stockponds/Wildlife Catchments	527 stockponds / 13 catchments							
					TOTALS			1,811	27,788 - 34,454	29,599 - 36,265		935	1,108,663	13

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.
[2] Baseflow measurement on the Agua Fria River at the Rock Springs gage.
[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.
[4] Data from the Arizona Department of Water Resource's Surface Water Division.
[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.
NR = not reported
NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Agua Fria Basin

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources					Max. Reservoir Storage	
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Combined Volume (acre-ft)	Combined Surface Area (acres)
Aravaipa Canyon	**None**	**Lower San Pedro**	**Graham, Pinal**	**B1, C5.1, C5.2, C12.1, C12.2**	**4 amphibian; 19 bird; 8 fish; 6 mammal; 2 reptile species. Of these, 4 fish, 3 bird and 1 amphibian species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Aravaipa Creek**	18 miles of perennial flow; ADEQ Outstanding Arizona Water	**11,591**	**7,793 - 16,692**	**19,384 - 28,283**	**YES**			
						Perennial tributary reaches of Deer, Parsons Canyon, Turkey, Virgus Canyon creeks	32 miles of perennial flow				**YES**			
						Instream Flow[4]	1 application: Oak Grove Canyon; 4 certificates: Aravaipa Creek				**YES**			
						Springs	7 major springs with flow range from 10 to 100 gpm					**339**		
							15 minor springs with flow range from 1 to 6 gpm					**70**		
							87- 116 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	33 stream miles, 4 major springs				**YES**			
						Effluent/Other Water[5]	None							
						Reservoirs (4 total)	2 small reservoirs						**117**	
							2 small reservoirs							**38**
						Stockponds/Wildlife Catchments	349 stockponds/5 catchments							
					TOTALS			**11,591**	**7,793 - 16,692**	**19,384 - 28,283**		**409**	**117**	**38**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.
[2] Baseflow measurement at Aravaipa Creek near Mammoth gage.
[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.
[4] Data from the Arizona Department of Water Resource's Surface Water Division.
[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.
NR = not reported
NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Big Sandy	**Fort Rock, Wikieup**	**Big Sandy, Hualapai Wash**	**Yavapai & Mohave**	**B2, C9.1, C.9.2, C14.1, C14.2**	**4 amphibian; 12 bird; 5 fish; 5 mammal; 2 reptile species. Of these, 3 bird and 1 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Big Sandy River**	11 miles of perennial flow				**YES**			
						Perennial reaches of Cottonwood, Knight, Trout, and Wright creeks	38 miles of perennial flow				**YES**			
						Instream Flow[4]	1 application: Big Sandy River				**YES**			
						Springs	6 major springs with flow range from 10 to 1600 gpm					**4742**		
							11 minor springs with flow range from 1 to 5 gpm					**50**		
							165 - 179 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	None							
						Reservoirs (11 total)	1 large reservoir						**117**	
							3 small reservoirs						**492**	
							7 small reservoirs							**92**
						Stockponds/Wildlife Catchments	426 stockponds / 4 catchments							
					TOTALS							**4,792**	**609**	**92**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Bill Williams	**Alamo Reservoir, Burro Creek, Clara Peak, Santa Maria, Skull Valley**	**Big Sandy, Burro, Santa Maria, Bill Williams, Centennial Wash**	**Yavapai, Mohave, La Paz**	**B3, C7.1, C7.2, C9.1, C.9.2, C14.1, C14.2**	**3 amphibian; 16 bird; 9 fish; 6 mammal; 2 reptile species. Of these, 5 fish and 4 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Bill Williams**	22 miles of perennial flow	**5,796**	**79,511 - 126,244**	**85,307 - 132,040**	**YES**			
						Big Sandy	20 miles of perennial flow				**YES**			
						Burro Creek	37 miles of perennial flow; ADEQ Outstanding Arizona Water				**YES**			
						Perennial reaches of Bland, Boulder, Bridle, Conger, Date, Francis, Kirkland, Peeple's Canyon, Pine, Spencer, Sycamore, Waterman and Wilder creeks, Copper Basin Wash, Mountain Spring Wash, Colorado and Santa Maria rivers	73 miles of perennial flow. Francis and Peeple's Canyon creeks are ADEQ Outstanding Arizona Waters				**YES**			
						Instream Flow[4]	4 applications: Big Sandy River (1), Bill Williams River (1), Burro Creek (1), Francis Creek (1); 1 certificate: Bill Williams River; 1 permit: Peoples Canyon Creek				**YES**			
						Springs	6 major springs with flow range from 18 to 228 gpm					**886**		
							13 minor springs with flow range from 1 to 9 gpm					**75**		
							249 - 303 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	37 stream miles				**YES**			
						Effluent/Other Water[5]	None							
						Reservoirs (21 total)	2 large reservoir (Alamo, Havasu)						**117**	
							3 small reservoirs						**504**	
							16 small reservoirs							**203**
						Stockponds/Wildlife Catchments	796 stockponds / 29 catchments							
					TOTALS			**5,796**	**79,511 - 126,244**	**85,307 - 132,040**		**961**	**621**	**203**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] Baseflow measurement at Bill Williams River near Parker gage.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Bonita Creek	**None**	**Upper Gila-San Carlos Reservoir, San Carlos**	**Graham**	**B16, C5.1, C5.2**	**4 amphibian; 14 bird; 6 fish; 4 mammal; 3 reptile species. Of these, 1 amphibian, 3 bird, 2 fish and 1 reptile species are federally listed as endangered, threatened or candidate species under the Environmental Species Act.**	**Bonita Creek**	14 miles of perennial flow; ADEQ Outstanding Arizona Water				**YES**			
						Instream Flow[4]	1 application: Bonita Creek				**YES**			
						Springs	1 major spring with flow of 20 gpm					**32**		
							4 minor springs with flow range from 2 to 8 gpm					**25**		
							37-41 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	14 stream miles				**YES**			
						Effluent/Other Water[5]	None					**NR**		
						Reservoirs (17 total)	1 large reservoir							**59**
							2 small reservoirs						**289**	
							14 small reservoirs							**121**
						Stockponds/Wildlife Catchments	24 stockponds / 0 catchments							
					TOTALS							**57**	**289**	**180**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Butler Valley	**None**	**Bouse Wash**	**La Paz**	**B23, C7.1, C7.2**	**1 amphibian; 4 bird; 4 mammal species. Of these, 1 bird species is federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial Streams**	None							
						Instream Flow[4]	None							
						Springs	1 spring < 1 gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	None							
						Reservoirs (1 total)	1 large (Cunningham)							**143**
						Stockponds/Wildlife Catchments	7 stockponds / 3 catchments							
					TOTALS									**143**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
Cienega Creek	**None**	**Rillito, Upper San Pedro, Upper Santa Cruz**	**Santa Cruz, Pima, Cochise**	**B27, C2.1, C2.2, C11.1, C11.2, C13.1, C13.2**	**6 amphibian, 19 bird, 7 fish, I invertebrate, 4 mammal and 3 reptile species; of these 2 amphibian, 3 bird, 3 fish, 1 invertebrate and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Cienega Creek**	12 miles of perennial flow; ADEQ Outstanding Arizona Water	**797**	**8,022 - 8,299**	**8,819 - 9,095**	**YES**			
						Perennial reaches of Sonoita, Red Rock Canyon, Alum Gulch, Harshaw Canyon and Mattie Canyon	34 miles of perennial flow; Davidson Canyon ADEQ Outstanding Arizona Water				**YES**			
						Instream Flow[4]	6 applications: Big Casa Blanca Canyon Creek (1), Cave Creek (1), Gardner Canyon Creek (1), Harshaw Creek, Redrock Canyon Creek (1) and Temporal Gulch (1); 1 certificate: Cienega Creek				**YES**			
						Springs	8 major springs with flow range from 10 to 430 gpm					**1,318**		
							2 minor springs with flow range from 3 to 4 gpm					**11**		
							78 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	10 stream miles, 1 spring				**YES**			
						Effluent/Other Water[5]	Effluent-Dependent Water: Sonoita Creek (0.16 mi.)					**73**		
						Reservoirs (4 total)	2 small						**68**	
							2 small							**10**
						Stockponds/Wildlife Catchments	426 stockponds / 5 catchments							
					TOTAL			**797**	**8,022 - 8,299**	**8,819 - 9,095**		**1,402**	**68**	**10**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.
[2] Baseflow measurement at Pantano Wash near Vail gage in the Tucson AMA.
[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.
[4] Data from the Arizona Department of Water Resource's Surface Water Division.
[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.
NR = not reported
NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
Coconino Plateau	**None**	**Lower Little Colorado, Moenkopi Wash, Lower Colorado-Marble Canyon, Grand Canyon, Havasu Canyon**	**Coconino**	**B4N, B4S, C3.1N, C3.1S, C3.2N, C3.2S**	**5 amphibian; 13 bird; 9 fish; 3 invertebrate; 7 mammal; 1 reptile species. Of these, 4 fish, 3 bird and 1 invertebrate species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	153 miles of perennial (regulated) flow				**NO**			
						Perennial reaches of Little Colorado River, Boulder, Monument, Garden, Pipe, Hermit, Matkatamiba, Havasu, Royal Arch, Three Springs, West Cataract and Diamond creeks	44 miles of perennial flow				**YES**			
						Instream Flow[4]	None							
						Springs	29 major springs with flow range from 10 to 101,600 gpm					**218,245**		
							28 minor springs with flow range from 1 to 8 gpm					**132**		
							87- 116 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	128 stream miles, 10 major springs				**YES (some streams)**			
						Effluent/Other Water[5]	WWTP discharge to unnamed wash (Valle Airport); Cataract Creek, Bright Angel Wash (South Rim); Coconino Wash (Tusayan) and Mohawk Canyon (Williams)					**NR**		
							Effluent-Dependent Waters: Bright Angel Wash (7 mi.) and Cataract Creek (0.62 mi)							
						Reservoirs (57 total)	5 large reservoirs						**4,939**	
							7 large reservoirs							**850**
							8 small reservoirs						**892**	
							37 small reservoirs							**521**
						Stockponds/Wildlife Catchments	757 stockponds / 40 catchments							
					TOTALS							**218,377**	**5,831**	**1,371**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Detrital Valley	**None**	**Detrital Wash, Lake Mead, Havasu-Mohave Lakes**	**Mohave**	**B9, C9.1, C9.2**	**3 amphibian; 11 bird; 1 fish; 1 invertebrate and 5 mammal species. Of these, 1 fish, 2 bird and 1 amphibian species are federally listed as endangered, threatened or candidate species under the Environmental Species Act.**	**Colorado River**	27 miles of perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	1 major spring normally submerged by Lake Mead					**1,200**		
							4 minor springs; flows range from 3 to 6 gpm					**34**		
							24 to 27 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	27 stream miles				**NO**			
						Effluent/Other Water[5]	None							
						Reservoirs (1 total)	1 large (Lake Mead)						**29,755,000**	
						Stockponds/Wildlife Catchments	43 stockponds / 3 catchments							
					TOTALS							**1,234**	**29,755,000**	

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
Donnelly Wash	**None**	**Middle Gila**	**Pinal**	**B1; C12.1, C12.2**	**2 amphibian; 13 bird; 4 fish; 3 mammal and 2 reptile species. Of these, 1 fish and 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Gila River**	Regulated flow; may be perennial				**YES**			
						Perennial reach of Box Canyon	3 miles of perennial flow				**YES**			
						Instream Flow[4]	None							
						Springs	12 to 14 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	None							
						Reservoirs (2 total)	2 small reservoirs							**10**
						Stockponds/Wildlife Catchments	89 stockponds / 4 catchments							
					TOTALS									**10**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Douglas	**None**	**Whitewater Draw, Willcox Playa**	**Cochise**	**B5, C2.1, C2.2**	**3 amphibian; 17 bird; 3 fish; 4 mammal and 4 reptile species. Of these, 1 amphibian, 1 fish, 3 bird and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial reach of Leslie Creek**	2 miles of perennial flow				**YES**			
						Instream Flow[4]	1 certificate: Leslie Creek				**YES**			
						Springs	6 minor springs; flows range from 1 to 4 gpm					**21**		
							6-10 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	2 stream miles				**YES**			
						Effluent/Other Water[5]	WWTP discharge to Whitewater Draw							
						Reservoirs (3 total)	3 small							**28**
						Stockponds/Wildlife Catchments	254 stockponds / 1 catchment							
					TOTALS							**21**		**28**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
Dripping Springs Wash	**None**	**Middle Gila, San Carlos**	**Pinal, Gila**	**B1, C4,1, C4,2, C12.1, C12.2**	**3 amphibian; 18 bird; 5 fish; 4 mammal and 2 reptile species. Of these, 1 amphibian, 2 fish and 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Gila River**	3 miles perennial (regulated) flow				**NO**			
						Perennial reach of Mescal Creek and Dripping Springs Wash	4 miles perennial flow				**YES**			
						Instream Flow[4]	1 certificate: Mescal Creek				**YES**			
						Springs	2 major springs with flow range from 165 to 200 gpm					**589**		
							76-99 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	2 stream miles, 1 major spring				**YES**			
						Effluent/Other Water[5]	None							
						Reservoirs	None							
						Stockponds/Wildlife Catchments	79 stockponds / 6 catchments							
					TOTALS							**589**		

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Duncan Valley	**None**	**Upper Gila-Mangas**	**Greenlee, Cochise**	**B6, C2.1, C2.2, C6.1, C6.2**	**4 amphibian; 13 bird; 3 fish; 5 mammal and 2 reptile species. Of these, 1 amphibian and 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Gila River**	26 miles perennial flow				**YES**			
						Instream Flow[4]	1 application: Gila River				**YES**			
						Springs	2 major springs with flow range from 15 to 30 gpm					**73**		
							1 minor spring with flow of 6 gpm					**10**		
							30 to 36 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	6 stream miles, 1 major spring				**YES**			
						Effluent/Other Water[5]	None							
						Reservoirs (3 total)	1 large							**124**
							2 small							**38**
						Stockponds/Wildlife Catchments	373 stockponds / 3 catchments							
					TOTALS							**83**		**162**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Gila Bend	**None**	**Lower Gila-Painted Rock Reservoir, Tenmile Wash**	**Maricopa**	**B7, C8.1, C8.2**	**4 amphibian; 12 bird; 4 mammal and 2 reptile species. Of these, 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Gila River**	Effluent and agricultural return flows may support flow				**NO**			
						Instream Flow[4]	None							
						Springs	0 to 1 spring							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	Effluent-Dependent Water: unnamed wash (2 mi.)							
						Reservoirs (3 total)	1 large (Painted Rock, usually dry)						**4,831,500**	
							2 small						**171**	
						Stockponds/Wildlife Catchments	24 stockponds / 21 catchments							
					TOTALS								**4,831,671**	

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage Combined Volume (acre-ft)	Max. Reservoir Storage Combined Surface Area (acres)
Grand Wash	**None**	**Grand Wash, Lake Mead**	**Mohave**	**B8, C9.1, C9.2**	**3 amphibian; 11 bird; 3 fish; 1 invertebrate and 5 mammal species. Of these, 1 amphibian, 1 fish and 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	4 miles perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	6 major springs with flow range from 13 to 75 gpm					**372**		
							9 minor spring with flow of 2 to 9 gpm					**43**		
							47 to 52 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	4 stream miles, 5 major springs				**NO**			
						Effluent/Other Water[5]	None							
						Reservoirs (1 total)	1 large (Lake Mead - see Lake Mohave Basin)							
						Stockponds/Wildlife Catchments	109 stockponds / 16 catchments							
					TOTALS							**415**		

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Harquahala	**None**	**Centennial Wash, Bouse Wash**	**Maricopa; La Paz**	**B23, C7.1, C7.2, C8.1, C8.2**	**2 amphibian; 10 bird and 4 mammal species. Of these, 2 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial Streams**	None							
						Instream Flow[4]	None							
						Springs	0 to 1spring <1 gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	None							
						Reservoirs (1 total)	1 small							**17**
						Stockponds/Wildlife Catchments	42 stockponds / 9 catchments							
					TOTALS									**17**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Hualapai Valley	**None**	**Lake Mead, Red Lake, Detrital Wash**	**Mohave**	**B9, C9.1, C9.2**	**4 amphibian; 14 bird; 1 fish and 5 mammal species. Of these, 1 amphibian, 1 fish and 4 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	21 miles perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	3 major springs with flow range from 10 to 25 gpm					**86**		
							19 minor springs with flow of 1 to 7 gpm					**79**		
							30 to 36 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	21 stream miles				**NO**			
						Effluent/Other Water[5]	None							
						Reservoirs (4 total)	2 large (Lake Mead - see Lake Mohave Basin, and Red Lake)							**13,412**
							2 small						**145**	**12**
						Stockponds/Wildlife Catchments	72 stockponds / 9 catchments							
					TOTALS							**165**		**13,424**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage Combined Volume (acre-ft)	Max. Reservoir Storage Combined Surface Area (acres)
Kanab Plateau	**None**	**Fort Pierce Wash, Kanab, Lower Colorado-Marble Canyon**	**Coconino, Mohave**	**B10, C3.1N, C3.1S, C3.2N, C3.2S, C9.1, C9.2**	**5 amphibian; 11 bird; 8 fish;1 invertebrate and 7 mammal species. Of these, 2 bird, 4 fish and 1 invertebrate species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	49 miles perennial (regulated) flow				**NO**			
						Kanab Creek	24 miles perennial flow				**YES**			
						Perennial reaches of Bright Angel, Clear, Crystal, Deer, Dragon, Nankoweap, North Canyon, Phantom, Roaring Springs, Shinumo, Tapeats, Thunder River and White creeks, North Canyon Wash and Paria River and unnamed watercourse	65 miles perennial flow				**YES**			
						Instream Flow[4]	None							
						Springs	38 major springs with flow range from 10 to 18,763 gpm					**85,130**		
							23 minor springs with flow of 1 to 9 gpm					**102**		
							181 to 190 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	52 stream miles, 28 major springs				**YES (some streams)**			
						Effluent/Other Water[5]	Effluent-Dependent Water: Trancept Canyon (2.44 mi.)							
						Reservoirs (13 total)	1 large (Fredonia)						**2,710**	
							2 large							**83**
							1 small						**104**	
							9 small							**112**
						Stockponds/Wildlife Catchments	705 stockponds / 36 catchments							
					TOTALS							**85,232**	**2,814**	**195**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Lake Havasu	**None**	**Sacramento Wash, Havasu-Mohave Lakes**	**Mohave**	**B11, C9.1, C9.2**	**2 amphibian; 15 bird; 3 fish; 6 mammal and 2 reptile species. Of these, 1 amphibian, 4 bird and 3 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	38 miles perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	3 springs < 1gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	8 stream miles				**NO**			
						Effluent/Other Water[5]	None							
						Reservoirs (1 total)	1 large (Lake Havasu)						**651,000**	
						Stockponds/Wildlife Catchments	0 stockponds / 8 catchments							
					TOTALS								**651,000**	

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
Lake Mohave	**None**	**Havasu-Mohave Lakes**	**Mohave**	**B12N, B12S, C9.1, C9.2**	**3 amphibian; 13 bird; 3 fish; 1 invertebrate and 5 mammal species. Of these, 1 amphibian, 2 fish and 4 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	122 miles perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	10 major springs with flow range from 20 to 400 gpm					**1,344**		
							2 minor springs with flow of 1 to 5 gpm					**10**		
							27 to 29 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	80 stream miles, 9 major springs; CO River entitlement of 41,839 acre-ft/yr for the Havasu National Wildlife Refuge				**NO**			
						Effluent/Other Water[5]	WWTP discharge to Fort Mohave Treatment Wetland					**45**		
							WWTP discharge to unidentified watercourse at Bullhead City					**78**		
						Reservoirs[6] (7 total)	2 large (Mead and Mohave lakes)						**31,573,300**	
							3 large (Topock Marsh, Lost Lake, Beal Lake)							**4,868**
							2 small							**30**
						Stockponds/Wildlife Catchments	3 stockponds / 20 catchments							
					TOTALS							**1,477**	**31,573,300**	**4,898**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

[6] Lake Mead extends into Detrital, Grand Wash, Meadview and Hualapai basins.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Little Colorado River Plateau	None	Lower Lake Powell, Lower San Juan-Four Corners, Middle San Juan, Chaco, Chinle, Lower San Juan, Little Colorado River Headwaters, Upper little Colorado, Carrizo Wash, Zuni, Silver, Upper Puerco, Lower Puerco, Middle Little Colorado, Leroux Wash, Chevelon Canyon, Cottonwood Wash, Corn-oraibi, Polacca Wash, Jadito Wash, Canyon Diablo, Lower Little Colorado, Dinnebito Wash, Moenkopi Wash	Coconino, Apache, Navajo	B13N, B13C, B13S, C1.1N, C1.1S, C1.2N, C1.2S, C3.1N, C3.1S, C3.2N, C3.2S, C10.1N, C10.1S, C10.2N, C10.2S	7 amphibian; 18 bird; 14 fish; 4 invertebrate, 9 mammal and 2 reptile species. Of these, 1 amphibian, 4 bird, 7 fish, 1 invertebrate and 1 mammal species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.	Little Colorado River	72 miles perennial (regulated) flow				YES			
						Perennial reaches of Colorado River, Silver Creek, Chevelon Canyon, East Clear Creek, Navajo Creek, Walker Creek and 80 other watercourses	812 miles perennial flow. Colorado River and Silver Creek flow regulated. Lee Valley Creek and West Fork Little Colorado River ADEQ Outstanding Arizona Waters				YES			
						Instream Flow[4]	12 applications: Billy Creek (3), Brown Creek (1), Chevelon Creek (2), Coyote Creek (1), East Clear Creek (1), Mineral Creek (1), Porter Creek (1), Show Low Creek (1) and Walnut Creek (1); No Certificates				YES			
						Springs	67 major springs with flow range from 10 to 3,648 gpm					20,320		
							161 minor springs with flows of 1 to 9 gpm					678		
							1,222 to 1,305 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	86 stream miles, 2 major springs				YES			
						Effluent/Other Water[5]	WWTP discharge to Black Creek at Window Rock, to unidentified washes at Dilkon and Many Farms, and to Laguna and Chinle Wash at Kayenta					1,815		
							WWTP discharge to Ruby Wash at Winslow, Rio de Flag at Flagstaff and to wildlife areas at Flagstaff, Eagar, Pinetop/Lakeside, Show Low and Springerville					NR		
							Effluent-Dependent Water: Reach of Rio de Flag							
						Reservoirs (779 total)	62 large (Lake Powell)						20,672,620	
							32 large							10,269
							416 small						13,343	
							269 small							3,907
						Stockponds/Wildlife Catchments	6,113 stockponds / 43 catchments							
					TOTALS							22,813	20,685,963	14,176

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Lower Gila	**Wellton-Mohawk, Childs Valley, Dendora Valley**	**Lower Gila, Tenmile Wash, San Cristobol Wash, Tule Desert, Imperial Reservoir**	**Maricopa, Pima, Yuma, La Paz**	**B14N, B14S, C7.1, C7.2, C8.1, C8.2, C11.1, C11.2, C15.1, C15.2**	**4 amphibian; 15 bird; 2 fish; 6 mammal and 1 reptile species. Of these, 3 bird and 1 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	11 miles perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	6 to 8 springs < 1gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	5 stream miles; CO River entitlement of 28,000 acre-ft/yr for the Imperial National Wildlife Refuge				**NO**			
						Effluent/Other Water[5]	None							
						Reservoirs (11 total)	1 large (Imperial)						**160,000**	
							4 large							**1,159**
							6 small							**70**
						Stockponds/Wildlife Catchments	65 stockponds / 64 catchments							
					TOTALS								**160,000**	**1,229**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Lower San Pedro	**Mammoth, Camp Grant Wash**	**Lower San Pedro, Middle Gila**	**Cochise, Gila, Graham, Pinal, Pima**	**B15N, B15S, C2.1, C2.2, C4.1, C4.2, C5.1, C5.2, C11.1, C11.2, C12.1, C12.2**	**4 amphibian; 21 bird; 9 fish; 5 mammal and 2 reptile species. Of these, 1 amphibian, 5 fish and 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**San Pedro River**	33 miles perennial flow	**3,622**	**59,183 - 62,087**	**62,805 - 65,709**	**YES**			
						Perennial reaches of Aravaipa Creek, Bass Canyon, Buehman Canyon Creek, Copper Creek, Devils Canyon, Hot Springs Canyon, Mill Creek, Mineral Creek, Redfield Canyon Creek, and Swamp Springs Canyon Creek	44 miles perennial flow. Buehman Canyon Creek ADEQ Outstanding Arizona Water				**YES**			
						Instream Flow[4]	7 applications: Buehman Canyon Creek (2), Paige Creek (1), Peppersauce Wash (1), San Pedro River (2), and Swamp Springs Canyon/Redfield Canyon (1); 4 certificates: Aravaipa (1), Hot Springs Canyon (2), Wildcat Canyon (1)				**YES**			
						Springs	12 major springs with flow range from 11 to 1000 gpm					**3115**		
							30 minor springs with flow of 1 to 8 gpm					**142**		
							203 to 209 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	6 stream miles				**YES**			
						Effluent/Other Water[5]	WWTP discharge to Gila River at Winkelman					**38**		
							WWTP discharge to watercourse and wildlife area					**NR**		
							Effluent-Dependent Water: unnamed tributary (1.77 mi.)					**NR**		
						Reservoirs (7 total)	4 small						**360**	
							3 small							**33**
						Stockponds/Wildlife Catchments	648 stockponds / 4 catchments							
					TOTALS			**3,622**	**59,183 - 62,087**	**62,805 - 65,709**		**3,295**	**360**	**33**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] Baseflow measurement at San Pedro River at Winkelman gage.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
McMullen Valley	**None**	**Centennial Wash**	**Maricopa, Yavapai, La Paz**	**B23, C7.1, C7.2, C8.1, C8.2, C14.1, C14.2**	**2 amphibian; 7 bird and 3 mammal species. Of these, 1 bird species is federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial Flow**	None							
						Instream Flow[4]	None							
						Springs	2 springs < 1 GPM							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	None							
						Reservoirs (2 total)	1 small						**374**	
							1 small							**7**
						Stockponds/Wildlife Catchments	146 stockponds / 6 catchments							
					TOTALS								**374**	**7**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

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Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Meadview	**None**	**Lake Mead, Red Lake**	**Mohave**	**B9, C9.1, C9.2**	**3 amphibian; 10 bird; 3 fish and 5 mammal species. Of these, 1 amphibian, 1 fish and 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	7 miles perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	6 major springs with flow range from 16 to 108 gpm					**450**		
							2 minor springs with flow of 1 to 7 gpm					**12**		
							8 to 10 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	7 stream miles				**NO**			
						Effluent/Other Water[5]	None							
						Reservoirs (1 total)	1 large (Lake Mead - See Lake Mohave Basin)							
						Stockponds/Wildlife Catchments	14 stockponds / 1 catchment							
					TOTALS							**462**		

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

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Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Morenci	**None**	**San Francisco, Upper Gila-San Carlos Reservoir, Upper Gila-Mangas**	**Apache, Greenlee, Graham**	**B16, C5.1, C5.2, C6.1, C6.2**	**7 amphibian; 16 bird; 11 fish; 8 mammal and 4 reptile species. Of these, 1 amphibian, 7 fish, 3 bird, 1 mammal and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Blue River**	50 miles perennial flow				**YES**			
						Eagle Creek	56 miles perennial flow				**YES**			
						San Francisco River	54 miles perennial flow				**YES**			
						Perennial flow in reaches of Ash, Beeler, Bob Thomas, Campbell Blue, Cave, Chase, Chitty Canyon, Cienega, Coleman, Dix, Dutch Blue, East Eagle, Foote, Grant, Hannah Springs, Jackson, KP, Lanphier, Left Prong Dix, Little Blue, Little, Pace, Pigeon, Point of Pines, Raspberry, Right Fork Foote, Sardine, Silver, Squaw, Stone, Strayhorse, Thomas, Turkey and Willow creeks, Long Cienega and unnamed watercourses	195 miles of perennial flow. KP Creek ADEQ Outstanding Arizona Water				**YES**			
						Instream Flow[4]	6 applications: Blue River (1), Dix Creek (1), Eagle Creek (1), San Francisco River (3); No Certificates				**YES**			
						Springs	9 major springs with flow range from 10 to 200 gpm					**968**		
							8 minor springs with flows of 1 to 5 gpm					**32**		
							308 to 358 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	81 stream miles, 1 major spring				**YES**			
						Effluent/Other Water[5]	None							
						Reservoirs (20 total)	3 large						**7,522**	
							1 large							**229**
							4 small						**1,327**	
							12 small							**138**
						Stockponds/Wildlife Catchments	673 stockponds / 1 catchment							
					TOTALS							**1,000**	**8,849**	**367**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

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Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
Paria	**None**	**Paria, Lower Lake Powell, Lower Colorado-Marble Canyon**	**Coconino**	**B17, C3.1N, C3.1S**	**5 amphibian; 11 bird; 4 fish and 7mammal species. Of these, 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Paria River**	19 miles perennial flow				**YES**			
						Colorado River	5 miles perennial (regulated) flow				**NO**			
						Unnamed watercourse	2 miles perennial flow				**YES**			
						Instream Flow[4]	None							
						Springs	2 to 3 springs < 1 gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	26 stream miles				**YES (some streams)**			
						Effluent/Other Water[5]	None							
						Reservoirs (1 total)	1 large (Lake Powell - see Little Colorado River Plateau Basin)							
						Stockponds/Wildlife Catchments	57 Stockponds / 4 wildlife catchments							
					TOTALS									

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

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Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Parker	**La Posa Plains, Cibola Valley, Colorado River Indian Reservation**	**Imperial Reservoir, Tyson Wash, Bouse Wash, Bill Williams**	**La Paz, Yuma**	**B18N, B18S, C7.1, C7.2, C14.1, C14.2**	**2 amphibian; 16 bird; 2 fish and 6 mammal species. Of these, 4 bird and 2 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	144 miles perennial (regulated) flow				**NO**			
						Perennial reach of Twelvemile Slough and unnamed watercourse	3 mile perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	11 to 12 springs < 1 gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	47 stream miles; CO River entitlement of 34,500 acre-ft/yr for the Cibola National Wildlife Refuge				**NO**			
						Effluent/Other Water[5]	WWTP discharge to watercourse at Buckskin Mtn. State Park					**11**		
							WWTP discharge to watercourse at Parker					**NR**		
						Reservoirs (10 total)	2 large (Lake Havasu and Moovalya Lake)						**671,000**	
							3 large							**829**
							5 small							**188**
						Stockponds/Wildlife Catchments	5 stockponds / 29 catchments							
					TOTALS							**11**	**671,000**	**1,017**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

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Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Peach Springs	**None**	**Big Chino-Williamson Valley, Grand Canyon, Hualapai Wash, Lake Mead**	**Coconino, Yavapai, Mohave**	**B19, C3.1N, C3.1S, C3.2N, C3.2S, C9.1, C9.2, C14.1, C14.2**	**4 amphibian; 11 bird; 6 fish and 5 mammal species. Of these, 1 amphibian, 2 fish and 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	14 miles perennial (regulated) flow				**NO**			
						Perennial reach of Diamond Creek	< 1 mile perennial flow				**YES**			
						Instream Flow[4]	None							
						Springs	14 major springs with flow range from 12 to 1,730 gpm					**9,409**		
							5 minor springs with flow of 1 to 9 gpm					**29**		
							28 to 29 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	6 stream miles				**NO**			
						Effluent/Other Water[5]	None							
						Reservoirs (10 total)	2 small						**451**	
							8 small							**93**
						Stockponds/Wildlife Catchments	135 stockponds / 7 catchments							
					TOTALS							**9,438**	**451**	**93**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Phoenix AMA	**East Salt River Valley, West Salt River Valley, Lake Pleasant, Rainbow Valley, Hassayampa, Fountain Hills, Carefree**	**Lower Salt, Lower Verde, Lower Gila-Painted Rock, Agua Fria, Hassayampa, Centennial Wash, Lower Santa Cruz, Middle Gila**	**Maricopa, Pinal, Yavapai**	**B20E, B20W, C8.1, C8.2, C12.1, C12.2, C14.1, C14.2**	**3 amphibian; 16 bird; 15 fish; 6 mammal and 2 reptile species. Of these, 8 fish and 4 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Gila River**	37 miles perennial flow				**YES**			
						Verde River	26 miles of perennial (regulated) flow				**NO**			
						Perennial reaches of Arnett, Camp, Queen, and Skunk creeks; Hassayampa, New and Salt rivers; Seven Springs Wash and unnamed watercourses	31 miles of perennial flow				**YES (some streams)**			
						Instream Flow[4]	3 applications: Cave Creek (1), New River (1), and Queen Creek (1); 6 certificates: Arnett Creek (1), Camp Creek (1), Cave Creek (1), Hassayampa River (1), Seven Springs Wash (1), Sycamore Creek (1)				**YES**			
						Springs	2 major springs with flows of 75 gpm					**242**		
							4 minor springs with flow range of 1 to 3 gpm					**16**		
							110 to 132 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	10 stream miles							
						Effluent/Other Water[5]	WWTP discharge to watercourse at Avondale, Queen Valley and Superior					**4,337**		
							WWTP discharge to watercourse at Buckeye, Canyon Lake Marina, Cave Creek, Goodyear, Litchfield Park, Mesa, Sun City. Phoenix, Tolleson and to a wildlife area at Phoenix and Gilbert							
							Effluent-Dependent Waters: Agua Fria River (2.4 mi.), Gila River (44.6 mi.), Queen Creek (7 mi.), Salt River (22.2 mi.) and unnamed watercourses (5.4 mi.)							
						Reservoirs (46 total)	4 large (Lake Pleasant)						**1,114,386**	
							1 large							**132**
							2 small						**250**	
							39 small							**643**
						Stockponds/Wildlife Catchments	711 stockponds / 75 catchments							
					TOTALS							**4,595**	**1,114,636**	**775**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Phoenix AMA

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Pinal AMA	**Maricopa-Stanfield, Eloy, Santa Rosa Valley, Vekol Valley, Aguirre Valley**	**Middle Gila, Aguirre Valley, Santa Rosa Wash, Lower Santa Cruz, Brawley Wash, Lower Gila-Painted Rock Reservoir**	**Pinal, Maricopa, Pima**	**B21N, B21S, C8.1, C8.2, C11.1, C11.2, C12.1, C12.2**	**4 amphibian; 16 bird; 5 fish; 5 mammal and 3 reptile species. Of these, 4 bird and 2 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial Streams**	None							
						Instream Flow[4]	None							
						Springs	5 to 6 springs < 1 gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	WWTP discharge to watercourse at Maricopa and Redrock					**58**		
							WWTP discharge to watercourse at Arizona City, Casa Grande and Florence Prison					**NR**		
							Effluent-Dependent Waters: Gila River (3.2 mi.), N. Branch Santa Cruz River (5.5 mi.) and Santa Cruz River (15.2 mi.)							
						Reservoirs (15 total)	2 large						**384,100**	
							1 large (Picacho)							**2,238**
							12 small							**150**
						Stockponds/Wildlife Catchments	315 stockponds / 35 catchments							
					TOTALS							**58**	**384,100**	**2,388**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
Prescott AMA	**Upper Agua Fria, Little Chino**	**Agua Fria, Upper Verde**	**Yavapai**	**B22, C14.1, C14.2**	**3 amphibian; 9 bird; 7 fish; 7 mammal and 3 reptile species. Of these, 3 fish and 2 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial reaches of Agua Fria River and Granite Creek**	5 miles perennial flow				**YES**			
						Instream Flow[4]	None							
						Springs	1 major spring with flow of 874 gpm					**1,410**		
							9 minor springs with flow range from 1 to 9 gpm					**46**		
							57 to 65 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	0.3 stream miles, 1 major spring				**YES**			
						Effluent/Other Water[5]	WWTP discharge to watercourse at Dewey and Prescott Valley							
							Effluent-Dependent Waters: Agua Fria River (4.3 mi.) and unnamed watercourse at Prescott WWTP (2.3 mi.)							
						Reservoirs (17 total)	4 large						**16,163**	
							5 small							**888**
							8 small							**91**
						Stockponds/Wildlife Catchments	216 stockponds / 5 catchments							
					TOTALS							**1,456**	**16,163**	**979**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage Combined Volume (acre-ft)	Max. Reservoir Storage Combined Surface Area (acres)
Ranegras Plain	**None**	**Bouse Wash, Tyson Wash**	**La Paz & Yuma**	**B23, C7.1, C7.2, C15.1, C15.2**	**1 amphibian; 8 bird and 4 mammal species. Of these, 1 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial Streams**	None							
						Instream Flow[4]	None							
						Springs	2 springs < 1 gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	None							
						Reservoirs	None							
						Stockponds/Wildlife Catchments	16 stockponds / 8 catchments							
					TOTALS									

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Sacramento Valley	**None**	**Sacramento Wash, Havasu-Mohave Lakes, Bill Williams**	**Mohave**	**B11, C9.1, C9.2**	**5 amphibian; 16 bird; 4 fish; 1 invertebrate; 5 mammal and 2 reptile species. Of these, 1 amphibian, 4 bird and 3 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	5 miles perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	12 major springs with flow range from 10 to 50 gpm					**418**		
							45 minor springs with flow range from 1 to 8 gpm					**210**		
							90 to 100 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	2.5 stream miles				**NO**			
						Effluent/Other Water[5]	Effluent-Dependent Water: Holy Moses Wash (1.9 mi.)							
						Reservoirs (6 total)	1 large (Havasu - see Lake Havasu Basin)							
							3 small						**110**	
							2 small							**16**
						Stockponds/Wildlife Catchments	44 stockponds / 14 catchments							
					TOTALS							**628**	**110**	**16**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Safford	**San Carlos Valley, Gila Valley, San Simon Valley**	**Upper Gila, San Carlos Reservoir, San Simon, San Carlos**	**Greenlee, Cochise, Graham, Gila**	**B24N, B24S, C2.1, C2.2, C4.1, C4.2, C5.1, C5.2, C6.1, C6.2**	**5 amphibian; 22 bird; 12 fish; 2 invertebrate; 6 mammal and 4 reptile species. Of these, 1 amphibian, 8 fish, 3 bird and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Gila River**	35 miles perennial flow	**127,071**	**106,953 - 151,568**	**234,456 - 279,071**	**YES**			
						San Carlos River	32 miles perennial flow				**YES**			
						Perennial reaches of Ash, Bonita, Cave, South Fork Cave , Cima, Crazy horse, Deadman Canyon, Eagle, East Turkey, Fishhook, Frye Canyon, Marijilda, North Fork Cave creeks and San Francisco River and unnamed watercourses	90 miles of perennial flow. Cave Creek and South Fork of Cave Creek ADEQ Outstanding Arizona Waters				**YES**			
						Instream Flow[4]	12 applications: Ash Creek (1), Carter Canyon Creek (1), Cave Creek (1), Crazy Horse Creek (1), Deadman Canyon Creek (1), Frye Creek (1), Gibson Creek (1), Marijilda Canyon Creek (1), South Fork Cave Creek (1), Spring Canyon (1) and Wet Canyon Creek (2); No certificates				**YES**			
						Springs	23 major springs with flow range from 10 to 3,398 gpm					**7,966**		
							31 minor springs with flow range from 1 to 6 gpm					**108**		
							379 to 387 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	26 stream miles, 2 major springs				**YES**			
						Effluent/Other Water[5]	WWTP discharge to Bennett Wash at Fort Grant					**NR**		
							Effluent-Dependent Waters: Bennett Wash (4.4 mi.) and unnamed watercourse (1.2 mi.)							
						Reservoirs (69 total)	10 large (San Carlos)						**1,100,575**	
							2 large							**501**
							25 small						**3,862**	
							32 small							**328**
						Stockponds/Wildlife Catchments	1,429 stockponds / 34 catchments							
					TOTALS			**127,071**	**106,953 - 151,568**	**234,456 - 279,071**		**8,074**	**1,104,437**	**829**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] Baseflow measurement at Gila River at head of Safford Valley near Solomon gage.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Safford Basin

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Salt River	**Black River, Salt River Canyon, Salt River Lakes, White River**	**Upper Salt, Carrizo, White, Black, Lower Salt, Tonto**	**Apache, Coconino, Gila, Graham, Greenlee, Maricopa, Pinal**	**B25E, B25W, C1.1, C1.2, C3.1, C3.2, C4.1, C4.2, C5.1, C5.2, C6.1, C6.2, C8.1, C8.2, C12.1, C12.2**	**7 amphibian; 21 bird; 15 fish; 2 invertebrate, 9 mammal and 4 reptile species. Of these, 1 amphibian, 4 bird, 7 fish, 1 invertebrate, 1 mammal and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Salt River**	91 miles perennial flow	**236,170**	**128,986 - 136,969**	**365,156 - 373,140**	**YES**			
						Black River	114 miles perennial flow				**YES**			
						Perennial reaches of Big Bonito, Canyon, Carrizo, Cherry, Cibecue, Pinto and Tonto creeks and the East and North Fork White River and 98 other watercourses	982 miles of perennial flow. Bear Wallow Creek, North and South Fork of Bear Wallow Creek, Hay Creek, Snake Creek and Stinky Creek ADEQ Outstanding Arizona Waters				**YES**			
						Instream Flow[4]	18 applications: Ash Creek (1), Beaver Creek (1), Black River (1), Canyon Creek (1), Cherry Creek (2), Coon Creek (1), East Fork Black River (1), Fish Creek (1), Lewis and Pranty Creek (1), North Fork of East Fork Black River (1), Pinal Creek (1), Rock Creek (1), Tortilla Creek (1),West Fork Black River (1), Workman Creek (1); 2 certificates: Pinto Creek (1), Reynolds Creek (1)				**YES**			
						Springs	26 major springs with flow range from 10 to 8,980 gpm					**28,555**		
							2 minor springs with flow range from 2 to 5 gpm					**11**		
							624 to 822 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	65 stream miles, 1 major spring				**YES**			
						Effluent/Other Water[5]	WWTP discharge to Miami Wash at Claypool					**11**		
							WWTP discharge to unnamed wash to Pinal Creek at Globe					**NR**		
							Effluent-Dependent Waters: Pinal Creek (3.3 mi.) and unnamed wash at Globe WWTP (1.4 mi.)							
						Reservoirs (74 total)	11 large (Roosevelt, Apache, Saguaro, Canyon lakes)						**2,042,636**	
							1 large							**69**
							26 small						**3,239**	
							36 small							**410**
						Stockponds/Wildlife Catchments	807 stockponds / 15 catchments							
					TOTALS			**236,170**	**128,986 - 136,969**	**365,156 - 373,140**		**28,577**	**2,045,875**	**479**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] Baseflow measurement at Salt River at Roosevelt gage.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
San Bernardino Valley	**None**	**San Bernardino Valley, Whitewater Draw, San Simon**	**Cochise**	**B5, C2.1, C2.2**	**4 amphibian; 15 bird; 7 fish; 1 invertebrate, 4 mammal and 3 reptile species. Of these, 1 amphibian, 2 bird, 3 fish, 1 invertebrate and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial reach of Black Draw**	2 miles perennial flow				**YES**			
						Instream Flow[4]	None							
						Springs	1 minor spring with flow of 3 gpm					**5**		
							6 to 10 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	2 stream miles				**YES**			
						Effluent/Other Water[5]	None							
						Reservoirs (6 total)	1 large							**401**
							1 small						**45**	
							4 small							**22**
						Stockponds/Wildlife Catchments	151 stockponds / 0 catchments							
					TOTALS							**5**	**45**	**423**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
San Rafael Valley	**None**	**Upper Santa Cruz, Upper San Pedro**	**Santa Cruz, Cochise**	**B27, C2.1, C2.2, C13.1, C13.2**	**7 amphibian; 16 bird; 6 fish; 1 invertebrate, 4 mammal and 3 reptile species. Of these, 2 amphibian, 3 bird, 3 fish, 1 invertebrate and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial reaches of Santa Cruz River, Ramsey Canyon and unnamed watercourses**	14 miles perennial flow				**YES**			
						Instream Flow[4]	7 applications: Bear Creek (1), Cave Canyon Creek (1), Lone Mountain Canyon (1), Parker Canyon Creek (1), Scotia Canyon Creek (1), Sunnyside Canyon Creek (1), Sycamore Canyon Creek (1); No certificates				**YES**			
						Springs	1 minor spring with flow of 1 gpm					**2**		
							23 to 24 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	12 stream miles				**YES**			
						Effluent/Other Water[5]	None							
						Reservoirs (2 total)	1 large (Parker Canyon)						**4,400**	
							1 small							**6**
						Stockponds/Wildlife Catchments	258 stockponds / 0 catchments							
					TOTALS							**2**	**4,400**	**6**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
San Simon Wash	**None**	**San Simon Wash, Rio Sonoyta**	**Pima & Maricopa**	**B26, C8.1, C8.2, C11.1, C11.2**	**3 amphibian; 12 bird; 4 mammal and 2 reptile species. Of these, 1 amphibian and 1 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial Reaches**	None							
						Instream Flow[4]	None							
						Springs	11 to 17 < 1gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	None							
						Reservoirs (13 total)	1 large (Menegers Lake)						**15,000**	
							12 small							**144**
						Stockponds/Wildlife Catchments	3 stockponds / 0 catchments							
					TOTALS								**15,000**	**144**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Santa Cruz AMA	**None**	**Upper Santa Cruz**	**Santa Cruz, Pima**	**B27, C11.1, C11.2, C13.1, C13.2**	**6 amphibian; 20 bird; 6 fish; 4 mammal and 3 reptile species. Of these, 1 amphibian, 2 bird, 2 fish and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Santa Cruz River**	12 miles perennial flow	**11,591**	**12,427 - 27,214**	**24,018 - 38,805**	**YES**			
						Perennial flow in Cox Gulch, East Nogales Wash, Nogales Wash, Potrero Creek, and Sonoita Creek	20 miles perennial flow				**YES**			
						Instream Flow[4]	3 applications: Peck Canyon Creek (1) and Sonoita Creek (2); No certificates				**YES**			
						Springs	2 major springs with flow range from 40 to 377 gpm					**673**		
							1 minor spring with flow of 4 gpm					**6**		
							46 to 48 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	7 stream miles				**YES**			
						Effluent/Other Water[5]	WWTP discharge to Santa Cruz River at Nogales					**16,221**		
							WWTP discharge to watercourse and wildlife area at Tubac					**NR**		
							Effluent-Dependent Water: Santa Cruz River (48 mi.)							
						Reservoirs (6 total)	2 large (Pena Blanca)						**8,780**	
							1 small						**200**	
							3 small							**26**
						Stockponds/Wildlife Catchments	452 stockponds / 2 catchments							
					TOTALS			**11,591**	**12,427 - 27,214**	**24,018 - 38,805**		**16,900**	**8,980**	**26**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] Baseflow measurement at Santa Cruz River near Tubac gage.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
Shivwits Plateau	**None**	**Fort Pierce Wash, Lower Virgin, Grand Canyon, Lake Mead**	**Mohave**	**B28N, B28S, C9.1, C9.2**	**4 amphibian; 12 bird; 5 fish and 5 mammal and 2 reptile species. Of these, 1 amphibian, 3 bird and 2 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	57 miles perennial (regulated) flow				**NO**			
						Perennial reaches of Boulder Wash, Diamond and Spring Canyon creeks	4 miles of perennial flow				**YES**			
						Instream Flow[4]	None							
						Springs	1 major spring with flow of 331 gpm					**534**		
							5 minor springs with flow range of 1 to 3 gpm					**13**		
							51 to 56 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	0.14 stream miles, 1 major spring				**YES (partial)**			
						Effluent/Other Water[5]	None							
						Reservoirs (3 total)	1 large (Wolf Hole)							**58**
							1 small						**20**	
							1 small							**10**
						Stockponds/Wildlife Catchments	369 stockponds / 20 catchments							
					TOTALS							**547**	**20**	**68**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Tiger Wash	**None**	**Centennial Wash**	**Maricopa**	**B23, C8.1, C8.2**	**2 amphibian; 5 bird and 3 mammal species. Of these, 1 bird species is federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial flow**	None							
						Instream Flow[4]	None							
						Springs	3 springs < 1gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	None							
						Reservoirs	None							
						Stockponds/Wildlife Catchments	9 stockponds / 0 catchments							
					TOTALS									

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values: Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources: Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Tonto Creek	**None**	**Tonto, Chevelon Canyon**	**Gila, Coconino**	**B29, C3.1, C3.2, C4.1, C4.2**	**7 amphibian; 15 bird; 11 fish; 5 mammal and 24 reptile species. Of these, 1 amphibian, 3 bird, 5 fish and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Tonto Creek**	60 miles perennial flow	**15,213**	**21,082 - 21,462**	**36,296 - 36,675**	**YES**			
						Perennial reaches of Christopher, Del Shay, Dick Williams, East Fork Horton, Gordon Canyon, Greenback, Haigler, Horton, Houston, Lambing, Marsh, Rye and Spring creeks	69 miles perennial flow				**YES**			
						Instream Flow[4]	9 applications: Gordon Canyon Creek (1), Green Valley Creek (1), Greenback Creek (1), Haigler Creek (1), Oak Creek (1), Rye Creek (1), Sharp Creek (1), Spring Creek (1), Tonto Creek (1); 1 certificate: Christopher Creek				**YES**			
						Springs	10 major springs with flow range from 15 to 1,291 gpm					**4,543**		
							7 minor springs with flow range from 1 to 8 gpm					**50**		
							169 to 175 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	38 stream miles				**YES**			
						Effluent/Other Water[5]	WWTP discharge to Houston Creek at Star Valley					**13**		
						Reservoirs (1 total)	1 small						**20**	
						Stockponds/Wildlife Catchments	389 stockponds / 10 catchments							
					TOTALS			**15,213**	**21,082 - 21,462**	**36,296 - 36,675**		**4,606**	**20**	

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] Baseflow measurement at Tonto Creek above Gunn Creek.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values: Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources: Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Tucson AMA	**Upper Santa Cruz, Avra Valley**	**Rio De La Concepcion, Brawley Wash, Upper Santa Cruz, Rillito, Lower Santa Cruz, Middle Gila**	**Pima, Pinal, Santa Cruz**	**B30N, B30S, C11.1, C11.2, C12.1, C12.2, C13.1, C13.2**	**7 amphibian; 24 bird; 10 fish; 4 mammal and 4 reptile species. Of these, 1 amphibian, 4 bird, 7 fish and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Arivaca Creek**	1 mile perennial flow	**304**	**2,136 - 3,188**	**2,440 - 3,492**	**YES**			
						Sabino Creek	16 miles perennial flow				**YES**			
						Perennial reaches of Cienega, Madera Canyon, Romero Canyon creeks, Santa Cruz River, Sutherland Wash, Sycamore Canyon and unnamed tributary to Madera Canyon Creek	25 miles perennial flow; Davidson Canyon ADEQ Outstanding Arizona Water				**YES**			
						Instream Flow[4]	11 applications: California Gulch (1), Canada del Oro (1), Rincon Creek (1), Romero Canyon Creek (1), Sabino Canyon (5), Sycamore Canyon (1) and Tanque Verde Creek (1); No certificates				**YES**			
						Springs	8 major springs with flow range from 10 to 250 gpm					**774**		
							2 minor springs with flow range from 1 to 3 gpm					**6**		
							162 to 187 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	19 stream miles and 1 major spring				**YES**			
						Effluent/Other Water[5]	WWTP discharges to watercourses at Avra Valley, Tucson and Marana and to wildlife areas at Tucson and Sahuarita							
							Effluent-Dependent Water: Santa Cruz River (57 mi.)							
						Reservoirs (38 total)	1 large (Arivaca)						**2,915**	
							1 large (Aguirre)							**51**
							8 small						**600**	
							28 small							**338**
						Stockponds/Wildlife Catchments	1,538 stockponds / 53 catchments							
					TOTALS			**304**	**2,136 - 3,188**	**2,440 - 3,492**		**780**	**3,515**	**389**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.
[2] Baseflow measurement at Pantano Wash near Vail gage.
[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.
[4] Data from the Arizona Department of Water Resource's Surface Water Division.
[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.
NR = not reported
NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Upper Hassayampa	**None**	**Centennial Wash, Hassayampa**	**Maricopa & Yavapai**	**B22, C8.1, C8.2, C14.1, C14.2**	**3 amphibian; 13 bird; 7 fish; 3 mammal and 2 reptile species. Of these, 3 bird and 5 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Hassayampa River**	28 miles perennial flow				**YES**			
						Perennial reaches of Antelope, Ash, Lion Canyon, Minnehaha and Weaver creeks, French Gulch and unnamed watercourse	24 miles perennial flow				**YES**			
						Instream Flow[4]	1 certificate: Hassayampa River				**YES**			
						Springs	164 to 166 springs < 1 gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	None							
						Effluent/Other Water[5]	None							
						Reservoirs (7 total)	7 small						**1,684**	
						Stockponds/Wildlife Catchments	266 stockponds / 14 catchments							
					TOTALS								**1,684**	

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Upper San Pedro	**Sierra Vista & Allen Flat**	**Upper San Pedro, Lower San Pedro**	**Cochise, Santa Cruz, Pima**	**B21S, B21N, C2.1, C2.2, C11.1, C11.2, C13.1, C13.2**	**8 amphibian; 22 bird; 9 fish; 1 invertebrate; 5 mammal; 3 reptile. Of these, 5 fish, 3 bird, 2 amphibian, 1 reptile and 1 invertebrate species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**San Pedro River**	56 miles of perennial flow	**9,417**	**22,890 - 49,259**	**32,307 - 58,676**	**YES**			
						Perennial tributary reaches of Babocomari, Bass, Carr, Miller and Ramsey canyons and Double R Canyon, Garden Canyon and Turkey creeks and unnamed watercourse	45 miles of perennial flow				**YES**			
						Instream Flow[4]	8 applications: Babocomari River (2), Miller Canyon Creek (2), O'Donnell Creek (1), San Pedro River (2), and Turkey Creek (1); 6 certificates: San Pedro River (1), Ramsey Canyon (1), O'Donnell Creek (2) and Bass Canyon (2)				**YES**			
						Springs	12 major springs; flows range from 10 to 134 gpm					**1,930**		
							4 minor springs; flows range from 2 to 7 gpm					**52**		
							79-91 total springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	36 stream miles, 2 major springs				**YES**			
						Effluent/Other Water[5]	Created wetland-Sierra Vista EOP					**2,500**		
							Apache Nitrogen (ANP) Superfund cleanup wetland					**240**		
							WWTP Discharge to Greenbush Draw (Bisbee) and Walnut Gulch (Tombstone)					**NR**		
							Effluent-Dependent Water: Walnut Gulch (12 mi.)					**112**		
						Reservoirs (4 total)	2 small reservoirs (combined)						**247**	
							2 small reservoirs (combined)							**13**
						Stockponds/Wildlife Catchments	974 stockponds / 13 catchments							
					TOTALS			**9,417**	**22,890 - 49,259**	**32,307 - 58,676**		**4,834**	**247**	**13**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] Baseflow measurement at San Pedro River at Charleston gage.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Upper San Pedro Basin

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Verde River	**Big Chino, Verde Valley, Verde Canyon**	**Big Chino-Williamson Valley, Upper Verde, Lower Verde**	**Yavapai, Coconino, Gila, Maricopa**	**B32N, B32S, C3.1, C3.2, C4.1, C4.2, C8.1, C8.2, C14.1, C14.2**	**7 amphibian; 16 bird; 13 fish; 5 invertebrate, 8 mammal and 4 reptile species. Of these, 1 amphibian, 3 bird, 8 fish, 1 invertebrate and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Verde River**	150 miles perennial flow	**194,151**	**115,117 - 146,181**	**309,308 - 340,322**	**YES**			
						Perennial flow in reaches of East Fork Verde River, Fossil Creek, Oak Creek, Sycamore Creek and West Clear Creek	163 miles perennial flow; Fossil and Oak creeks ADEQ Outstanding Arizona Water				**YES**			
						Perennial flow in 38 tributary reaches	162 miles perennial flow; West Fork Oak Creek ADEQ Outstanding Arizona Water				**YES**			
						Instream Flow[4]	23 applications; 11 certificates: East Verde River (2), Fossil Creek (1), Spring Creek (1), Sycamore Creek (2),Verde River (2), Walker Creek (1), West Clear Creek (1) and Wet Beaver Creek (1)				**YES**			
						Springs	90 major springs with flow range from 10 to 21,647 gpm					**97,214**		
							95 minor springs with flow range from 1 to 9 gpm					**1,585**		
							493 to 571 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	153 stream miles and 21 major springs				**YES**			
						Effluent/Other Water[5]	WWTP discharge to Bitter Creek at Jerome, unnamed tributary to Oak Creek at Sedona and unnamed watercourse at Bellemont					**170**		
							WWTP discharge to American Gulch at Payson and unnamed tributaries at Lolo Mai Springs and Village of Oak Creek, and to wildlife area at Kachina Village and Sedona					**NR**		
							Effluent-Dependent Waters: American Gulch (3.8 mi.), Bitter Creek (1.6 mi.) and unnamed wash at Jacks Canyon Rd. (3.3 mi.)							
						Reservoirs (72 total)	7 large						**314,817**	
							6 large							**1,666**
							27 small						**3,592**	
							32 small							**496**
						Stockponds/Wildlife Catchments	2,328 stockponds / 41 catchments							
					TOTALS			**194,151**	**115,117 - 146,181**	**309,308 - 340,322**		**98,969**	**318,409**	**2,162**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] Baseflow measurement at Verde below Tangle Creek gage.

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Verde River Basin

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage	
													Combined Volume (acre-ft)	Combined Surface Area (acres)
Virgin River	**None**	**Lower Virgin**	**Mohave**	**B33, C9.1, C9.2**	**3 amphibian; 11 bird; 7 fish; 1 invertebrate, and 5 mammal species. Of these, 2 bird and 3 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Virgin River**	37 miles perennial flow				**YES**			
						Beaver Dam Wash and unnamed watercourse	10 miles perennial flow				**YES**			
						Instream Flow[4]	7 applications: Beaver Dam Wash (1) and Virgin River (6); No certificates				**YES**			
						Springs	2 major springs with flow range from 1,120 to 22,400 gpm					**37,937**		
							23 to 25 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	9 stream miles				**YES**			
						Effluent/Other Water[5]	WWTP discharge to watercourse at Beaver Dam					**6**		
						Reservoirs (1 total)	1 small							**6**
						Stockponds/Wildlife Catchments	45 stockponds / 7 catchments							
					TOTALS							**37,943**		**6**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Western Mexican Drainage	**None**	**Rio Sonoyta, Tule Desert**	**Pima & Yuma**	**B34, C11.1, C11.2, C15.1, C15.2**	**1 amphibian; 9 bird; 1 invertebrate, 2 mammal and 1 reptile species. Of these, 1 bird and 1 reptile species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial Flow**	None							
						Instream Flow[4]	None							
						Springs	1 major spring with flow of 28 gpm					**45**		
							2 minor springs with flow range of 1 to 4 gpm					**8**		
							4 to 6 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	1 major spring							
						Effluent/Other Water[5]	None							
						Reservoirs	None							
						Stockponds/Wildlife Catchments	0 stockponds / 1 catchment							
					TOTALS							**53**		

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Willcox	**None**	**Willcox Playa, Whitewater Draw**	**Graham & Cochise**	**B35N, B35S, C2.1, C2.2, C5.1, C5.2**	**4 amphibian; 19 bird; 5 fish; 6 mammal and 3 reptile species. Of these, 1 amphibian, 3 bird and 2 fish species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Perennial reaches of Big Bend, Big, Grant, Leslie, Post, Soldier, Turkey creeks and Rucker and Ward canyons**	32 miles perennial flow				**YES**			
						Instream Flow[4]	1 certificate on Leslie Canyon Creek				**YES**			
						Springs	8 minor springs with flow range from 1 to 3 gpm					**21**		
							87 to 92 springs							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	9 stream miles				**YES**			
						Effluent/Other Water[5]	Effluent discharged to Cochise Lake					**NR**		
						Reservoirs (6 total)	2 large (Willcox Playa)						**29,809**	
							2 small						**185**	
							2 small							**182**
						Stockponds/Wildlife Catchments	762 stockponds / 3 catchments							
					TOTALS							**21**	**29,994**	**182**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.

Groundwater Basin	Groundwater Sub-basin	Watershed	County	Map #	Environmental Resource Values			Current Quantifiable Flows and Volumes Supporting Water-Dependent Natural Resources						
					Riparian, Aquatic and/or Marshland Habitat-Dependent Wildlife Species[1]	Water Feature	Water Feature Characteristics	Baseflow[2] (acre-ft/yr)	Riparian ET (acres x ET rate)[3] (acre-ft/yr)	Total Flow (acre-ft/yr)	Current Flood Flow Component	Spring and Effluent Discharge (acre-ft/yr)	Max. Reservoir Storage: Combined Volume (acre-ft)	Max. Reservoir Storage: Combined Surface Area (acres)
Yuma	**None**	**Yuma Desert, Lower Colorado, Lower Gila**	**Yuma**	**B36, C15.1, B15.2**	**1 amphibian; 14 bird; 2 fish; 5 mammal and 1 reptile species. Of these, 3 bird species are federally listed as endangered, threatened or candidate species under the Endangered Species Act.**	**Colorado River**	53 miles perennial (regulated) flow				**NO**			
						Instream Flow[4]	None							
						Springs	1 spring < 1 gpm							
						Perennial Flow/Major Springs within Federal/State Designated Conservation Lands	0.3 stream miles				**NO**			
						Effluent/Other Water[5]	WWTP discharge to Colorado River at Yuma					**9,555**		
							WWTP discharge to Colorado River at Somerton					**NR**		
						Reservoirs (4 total)	2 large						**6,010**	
							2 small							**25**
						Stockponds/Wildlife Catchments	0 stockponds / 1 catchment							
					TOTALS							**9,555**	**6,010**	**25**

[1] Data from the Arizona Game & Fish Department's State Wildlife Action Plan (SWAP) Habitat Distribution Models. These models predict the distribution of a species by assessing the characteristics and quality of a habitat.

[2] No baseflow measurements

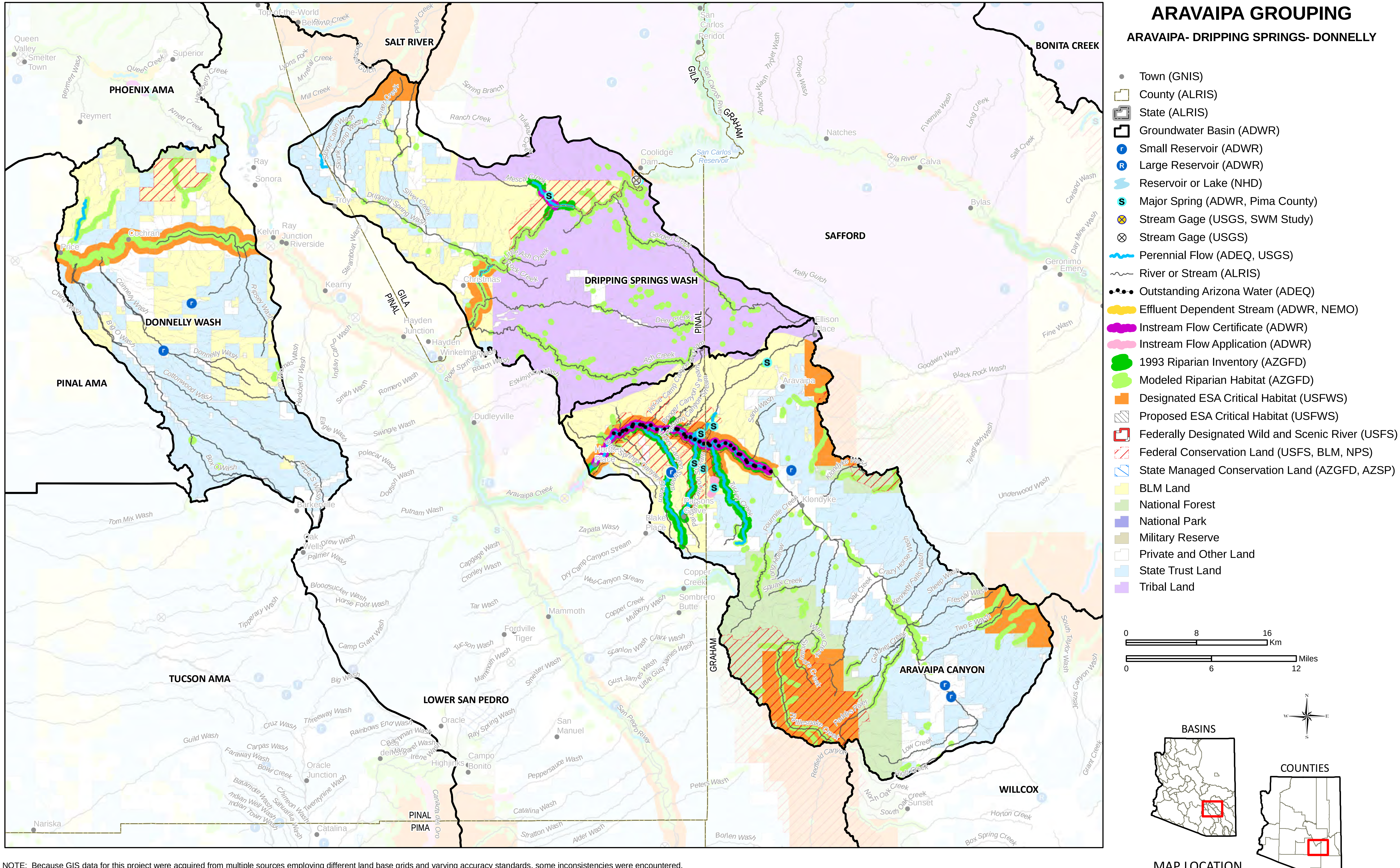
[3] For more information, please see the Methodology Section of the Environmental Working Group's Report.

[4] Data from the Arizona Department of Water Resource's Surface Water Division.

[5] Water features receiving discharge from wastewater treatment plants may not be Effluent-Dependent Waters. Effluent-Dependent Waters are presented in the basin maps.

NR = not reported

NOTE : The number of springs and reservoirs presented in the basin table may differ from the basin map due to overlapping features or a lack of locational data.



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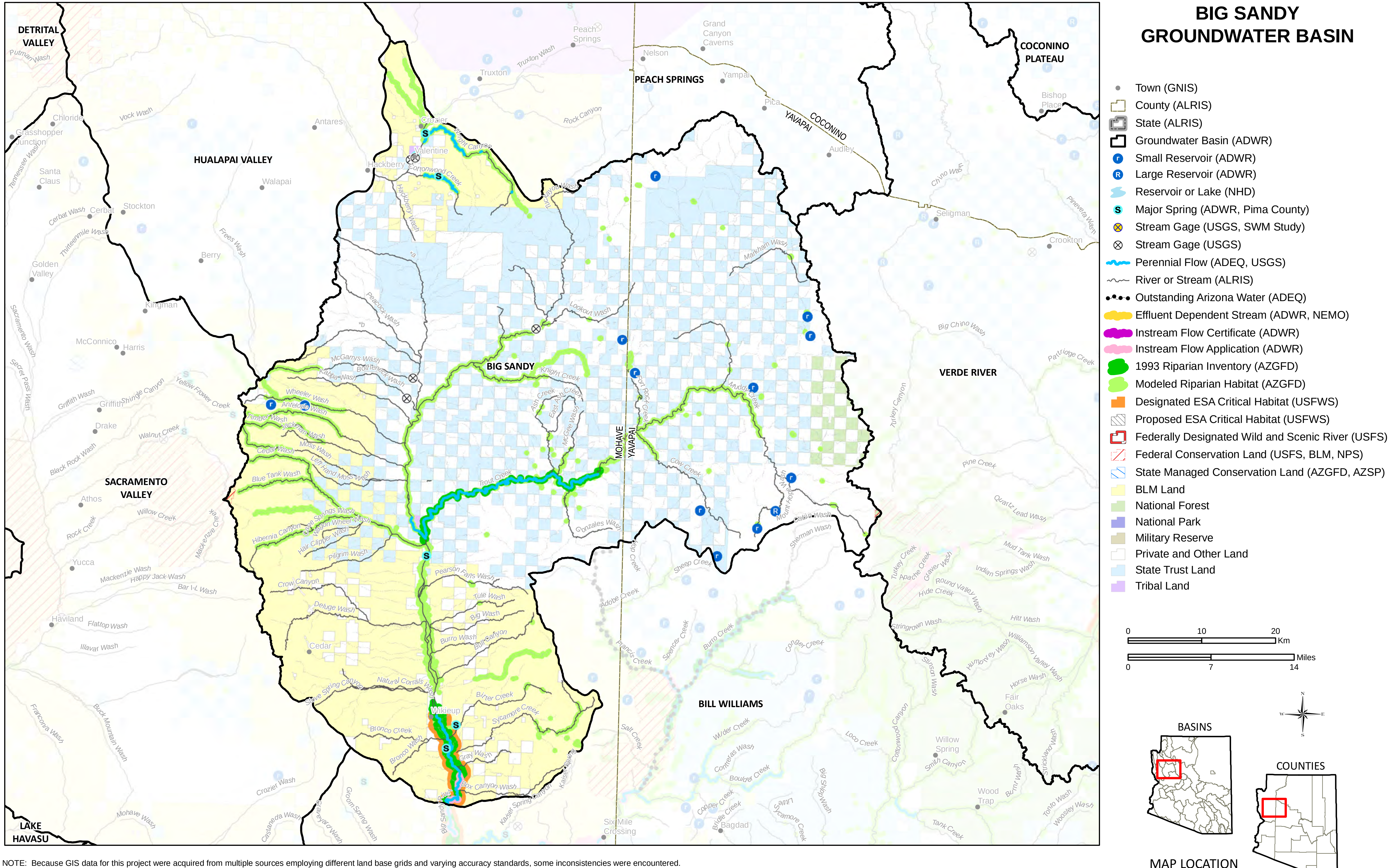

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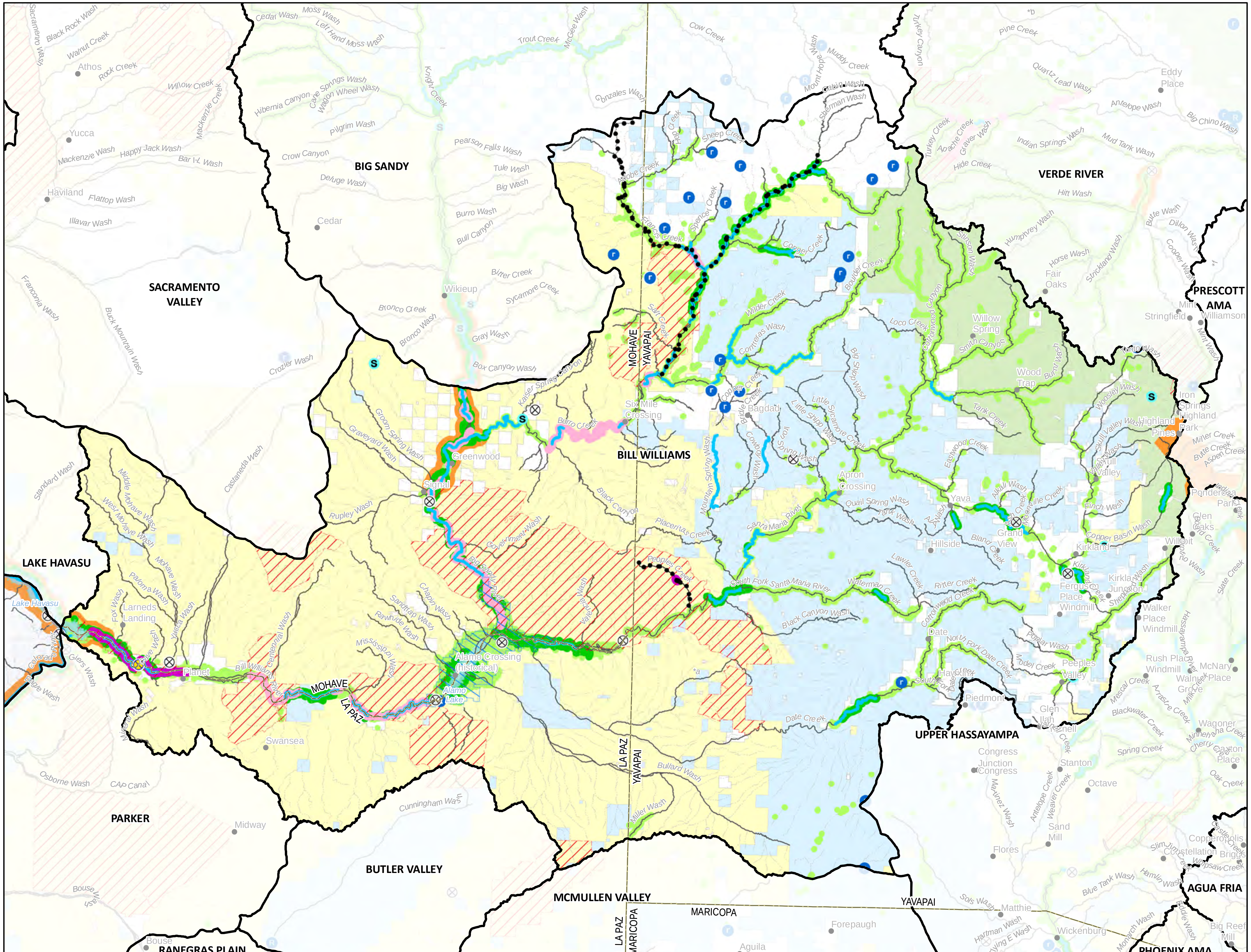
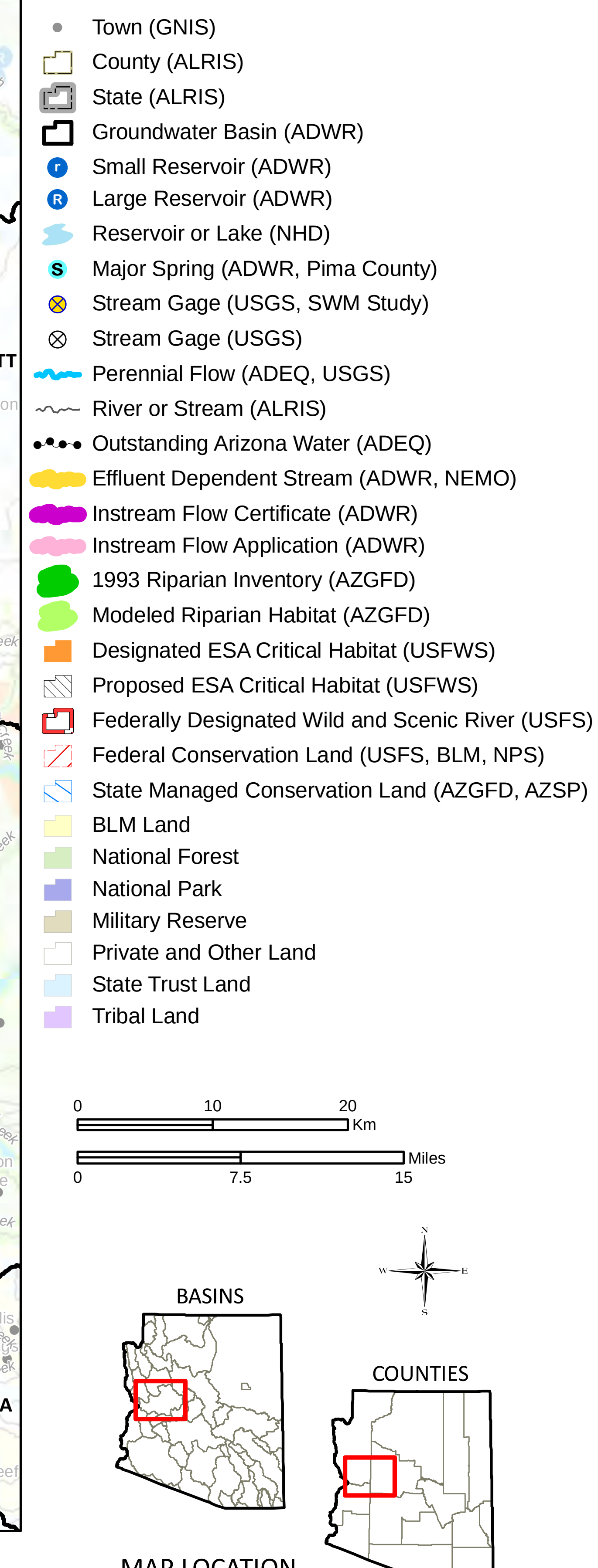
BILL WILLIAMS GROUNDWATER BASIN





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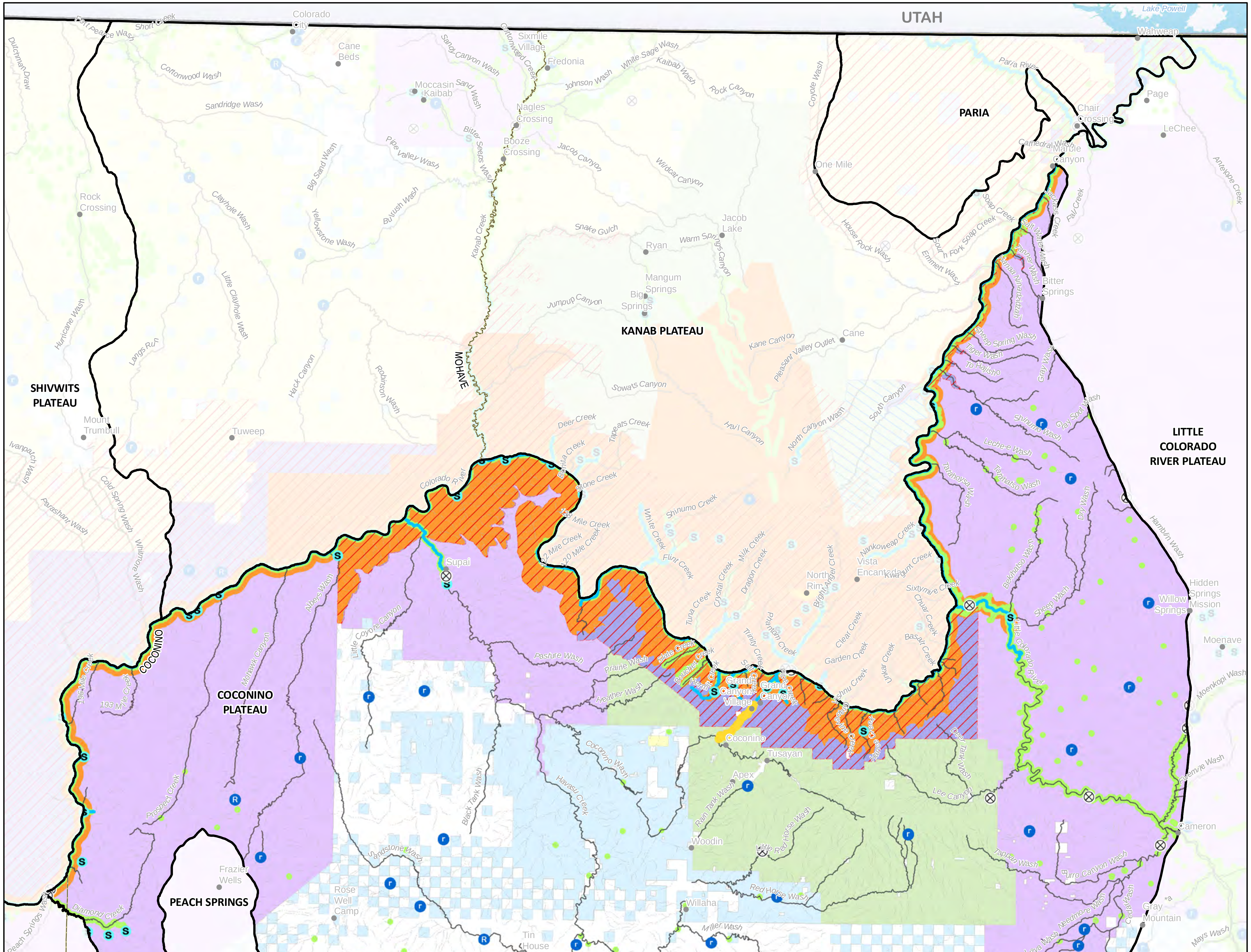
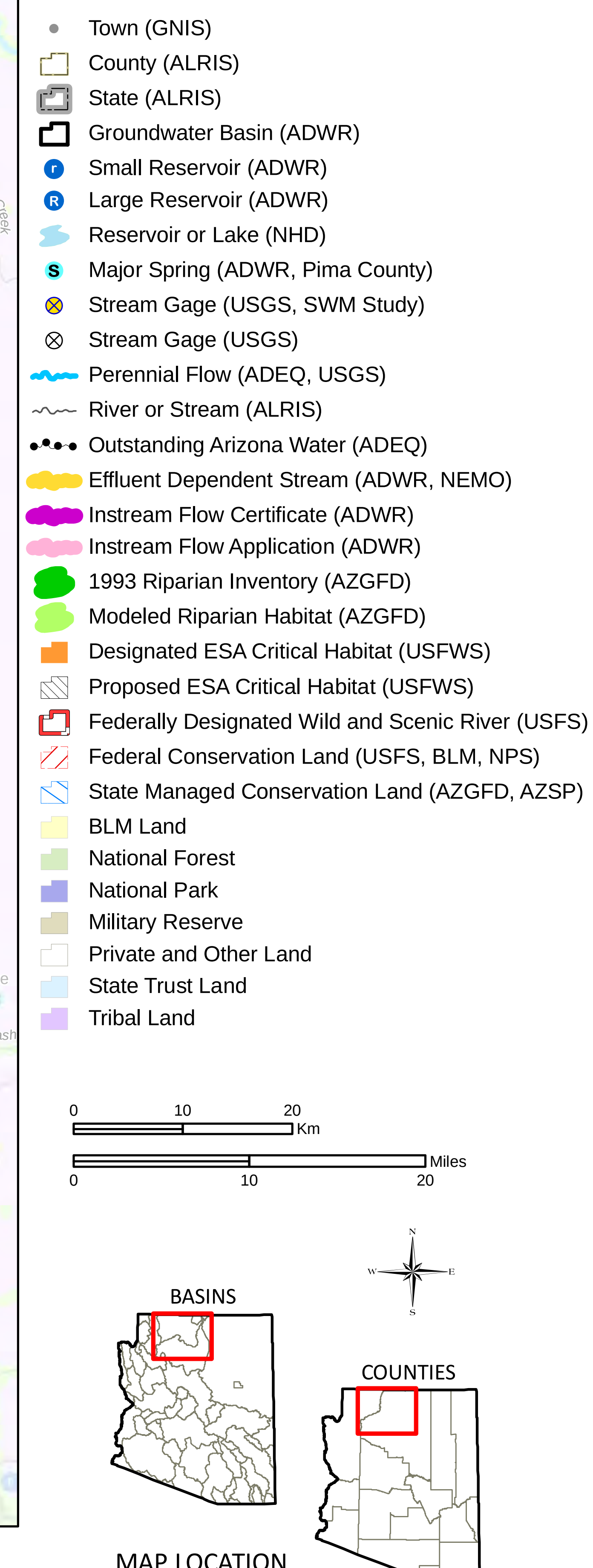
COCONINO PLATEAU NORTH GROUNDWATER BASIN





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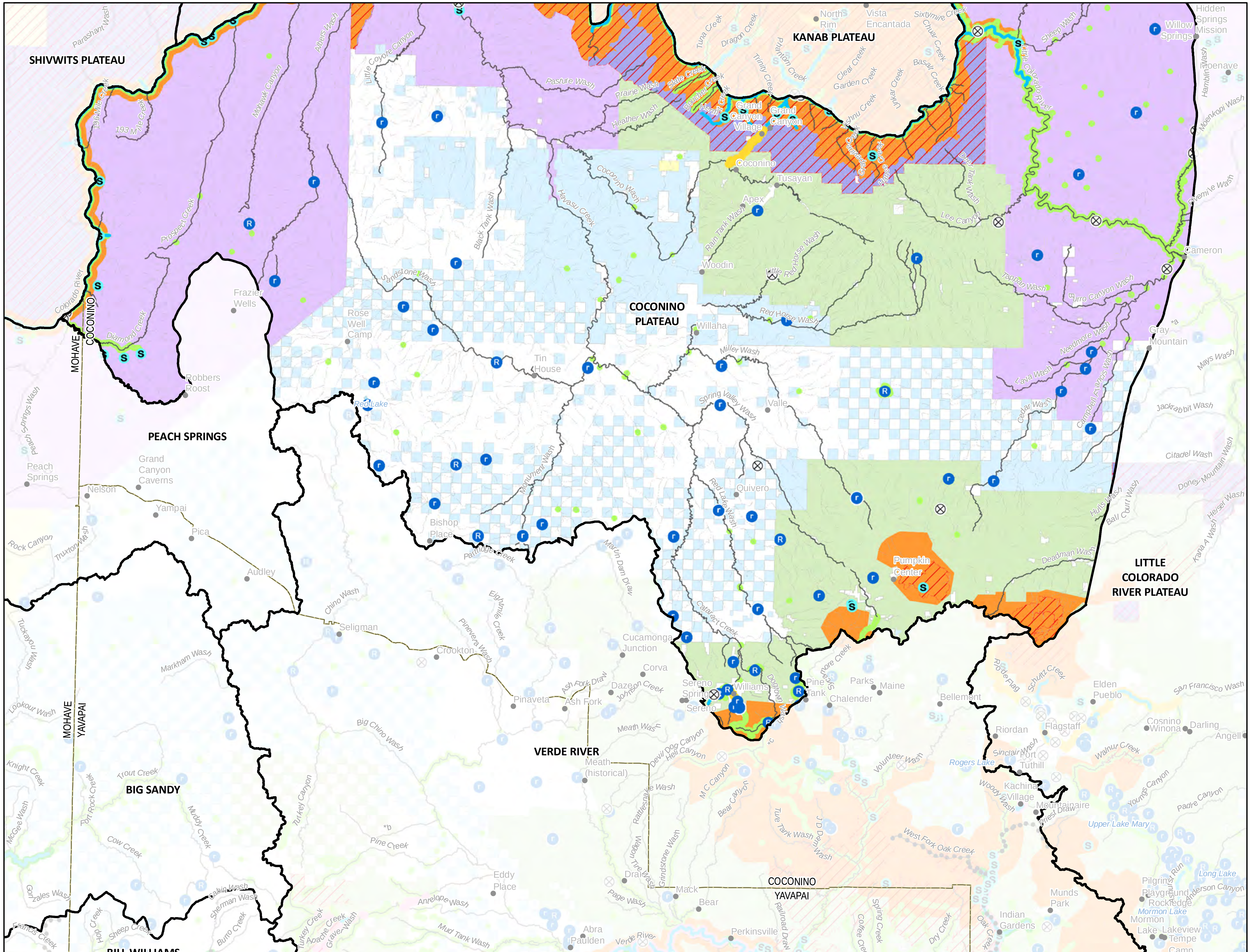

COCONINO PLATEAU SOUTH GROUNDWATER BASIN

- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
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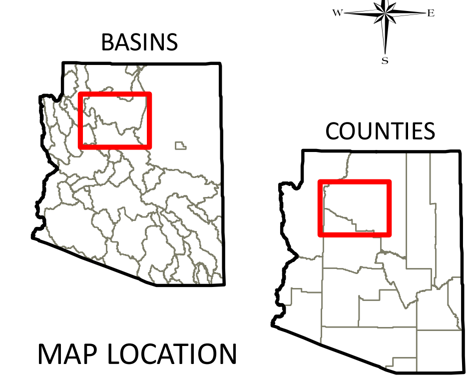
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

0 10 20 Km

0 10 20 Miles



MAP LOCATION

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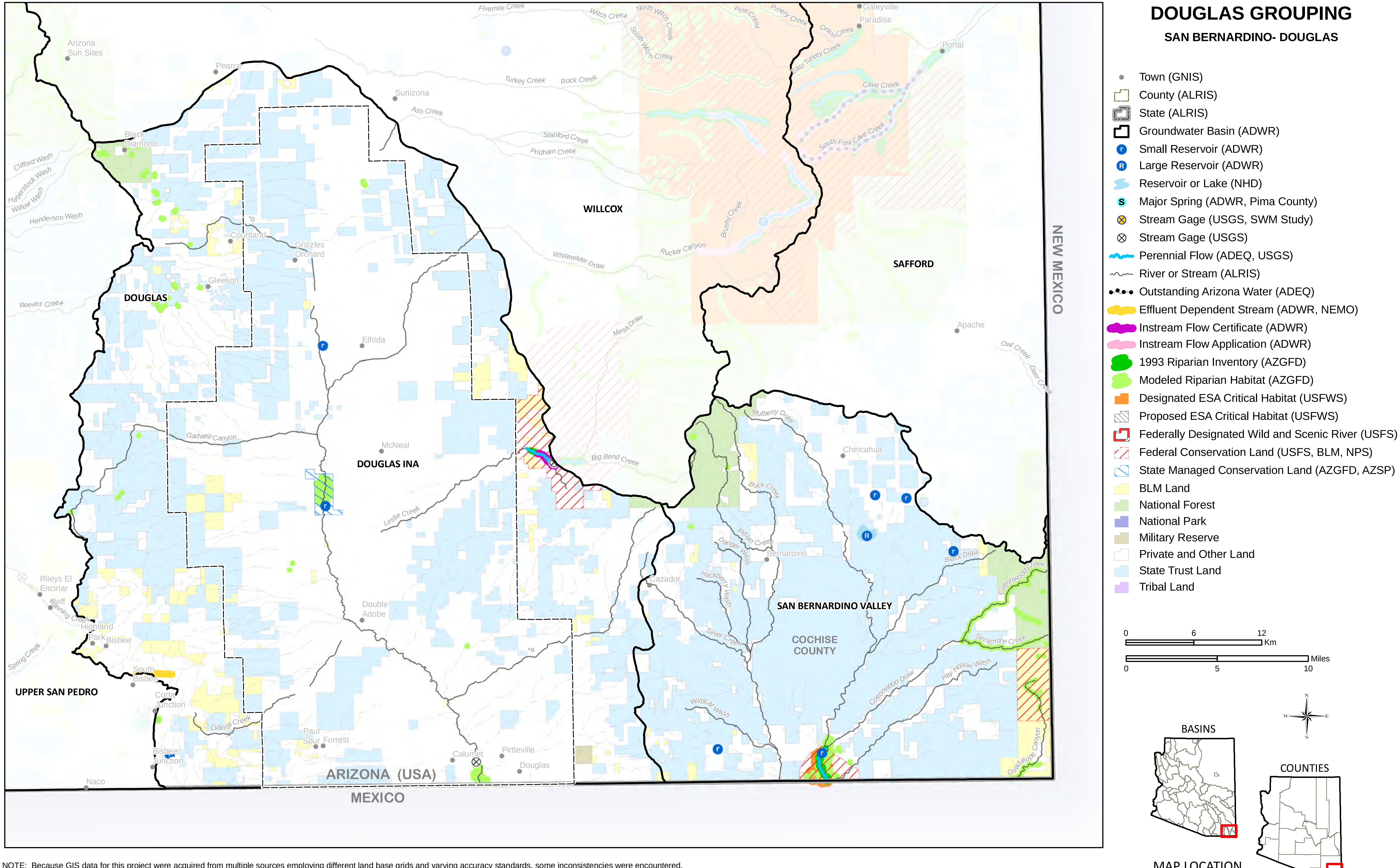

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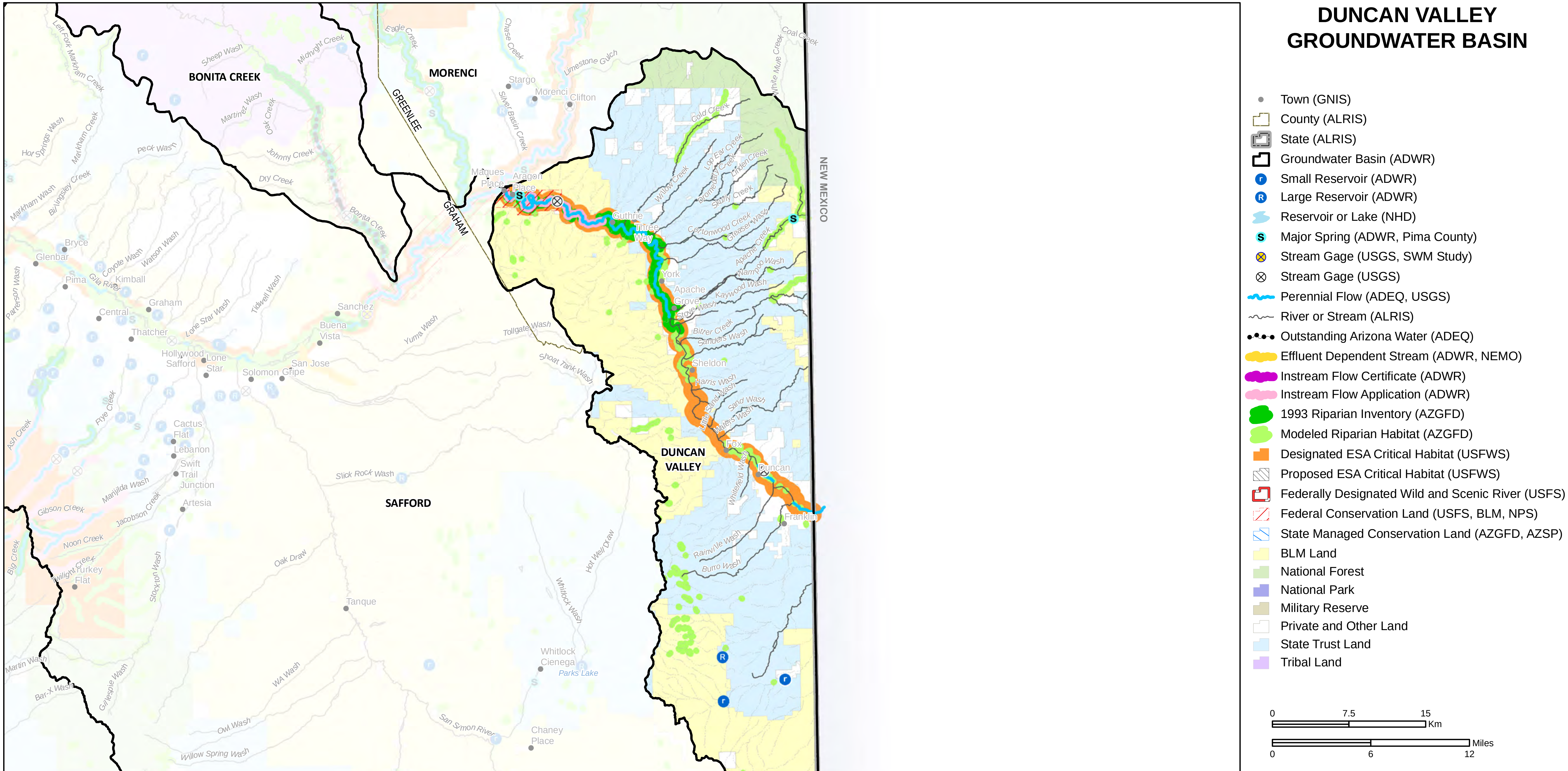
DUNCAN VALLEY GROUNDWATER BASIN



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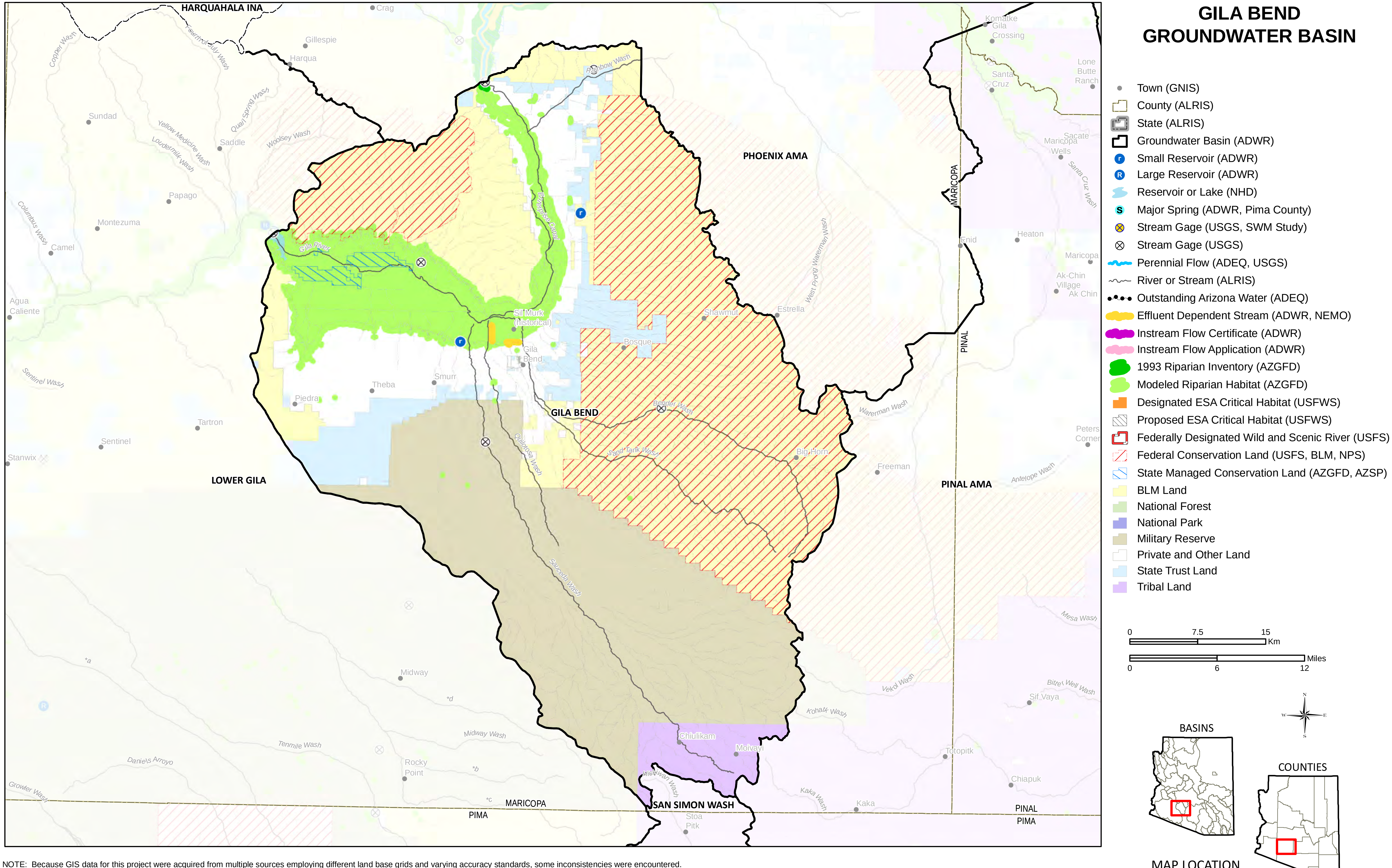

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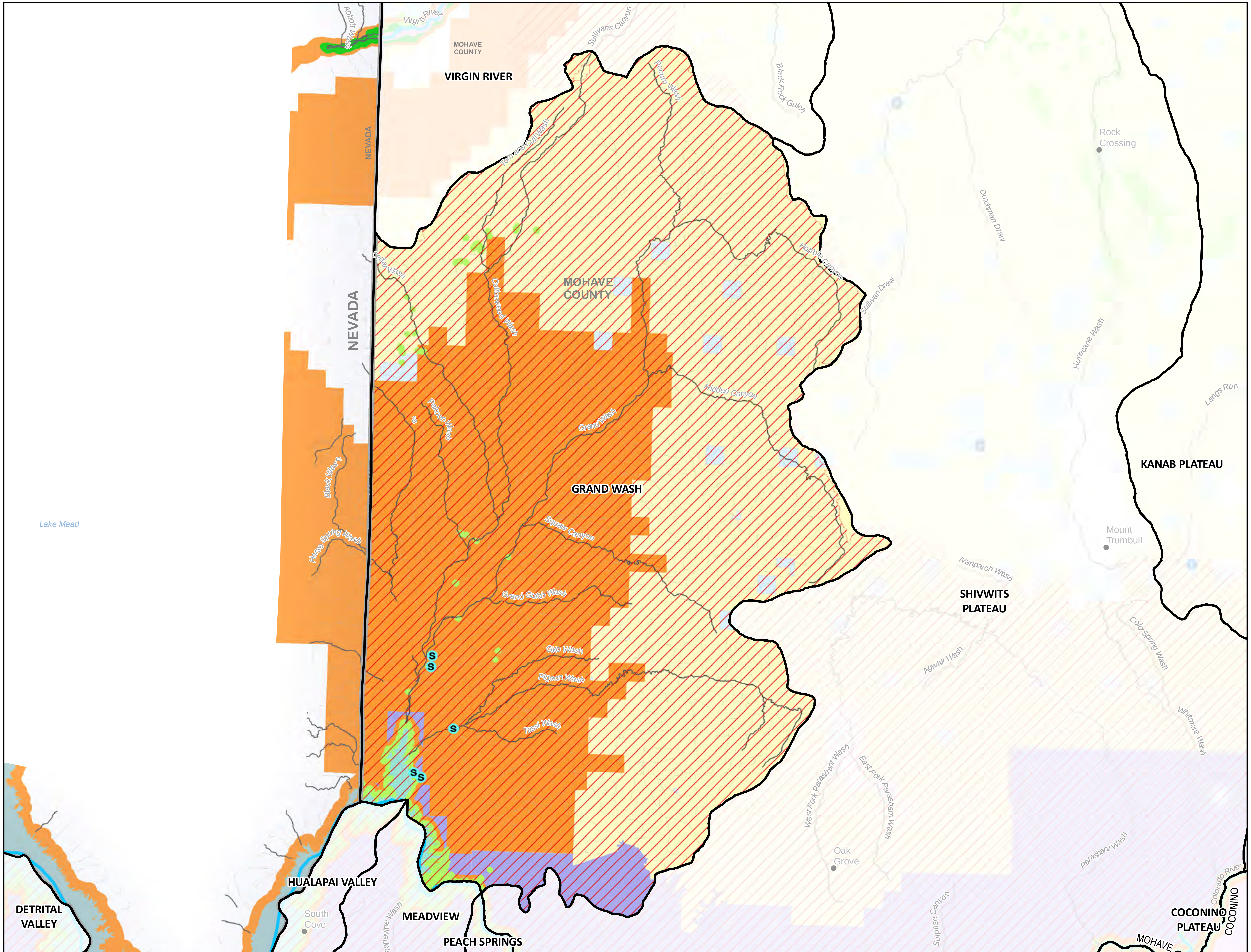
GRAND WASH GROUNDWATER BASIN



- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
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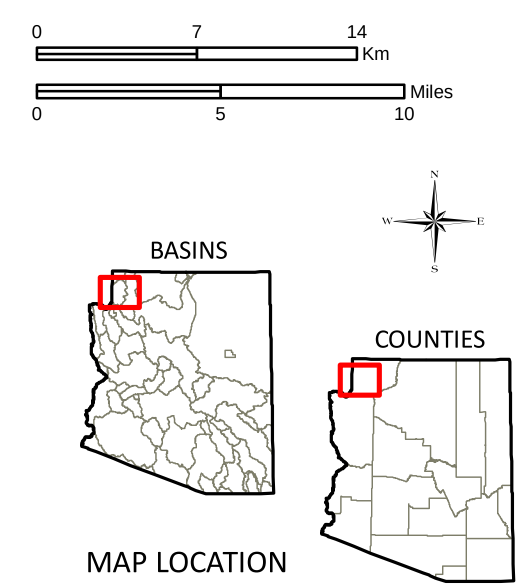

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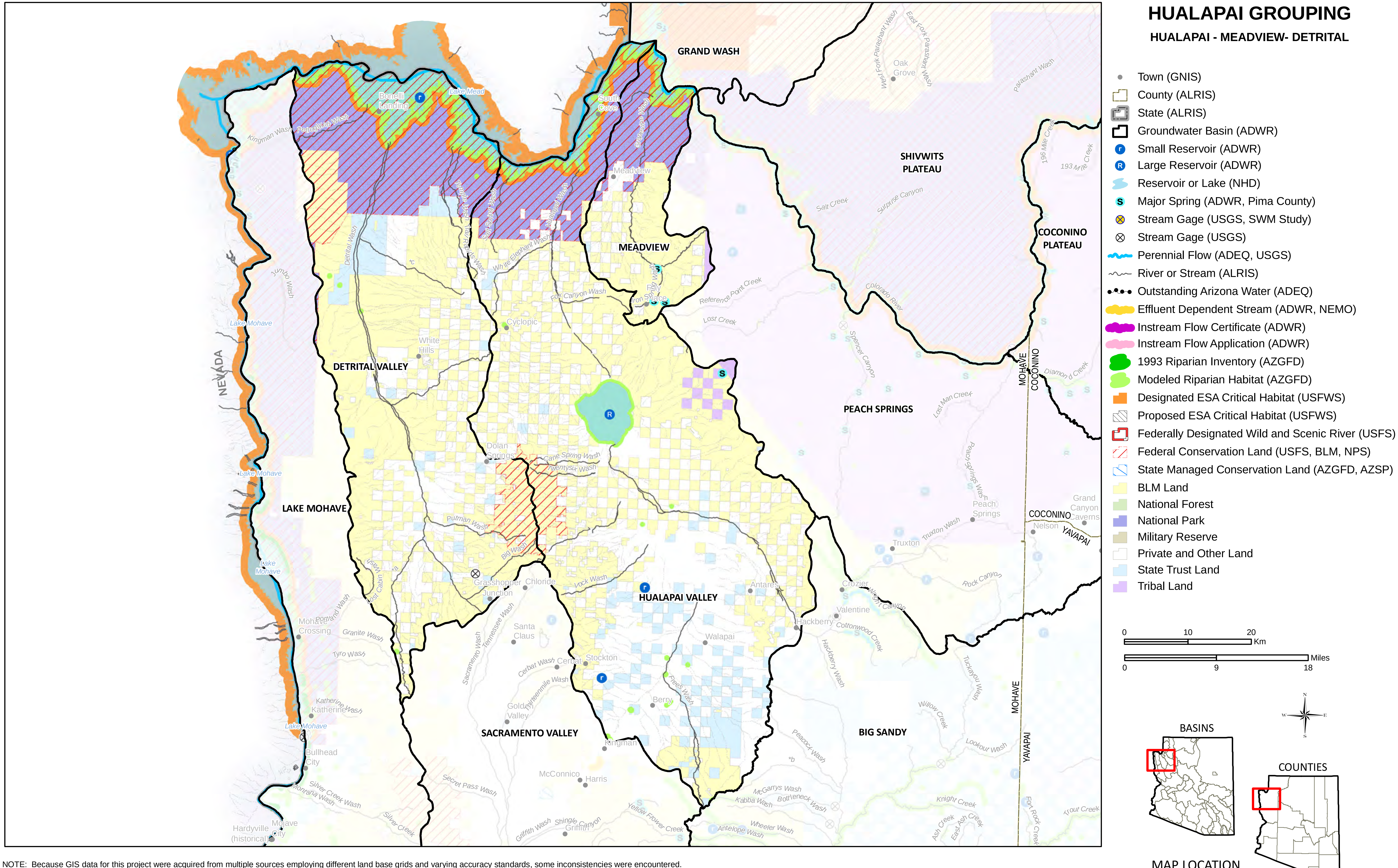

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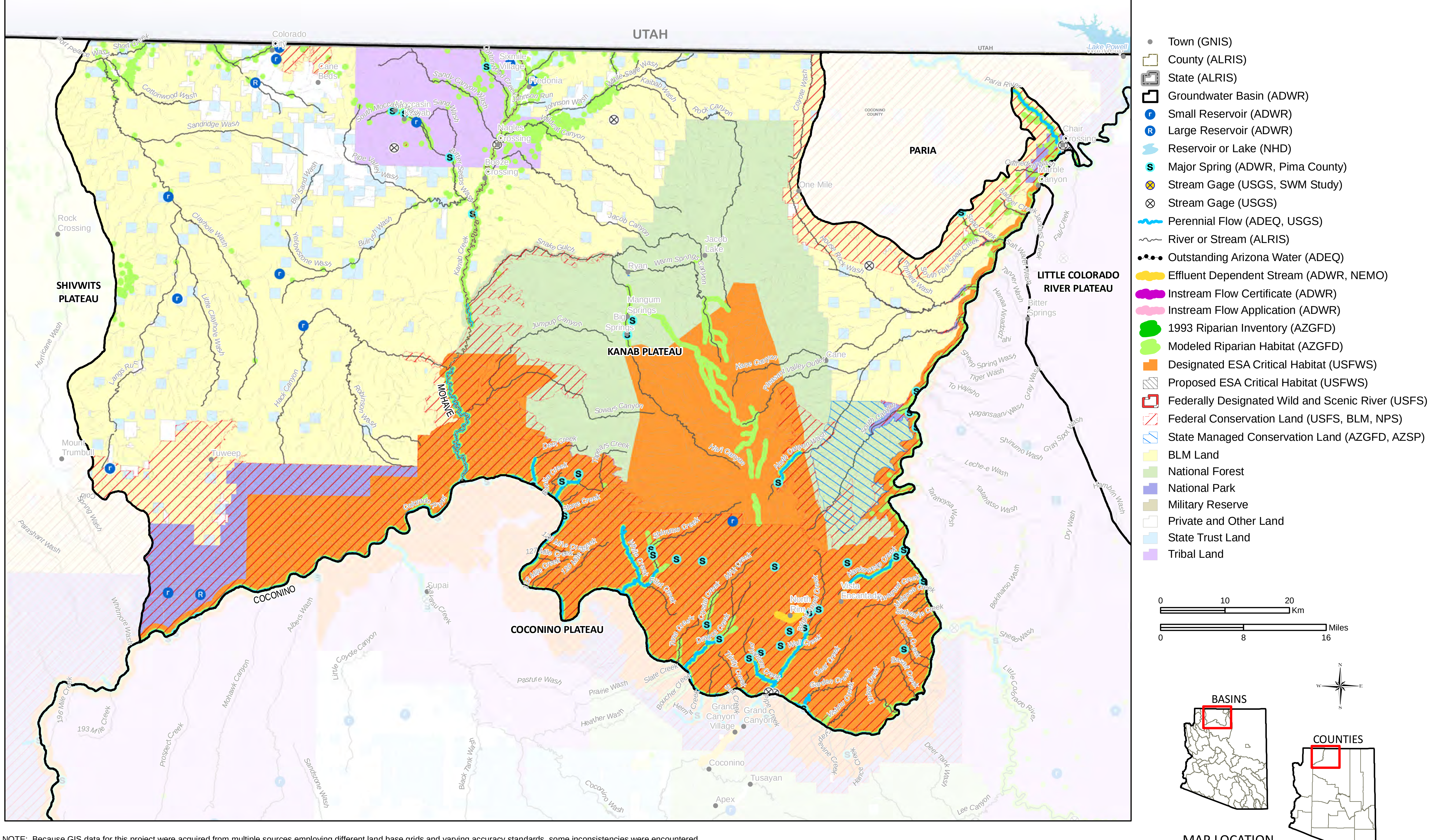
KANAB PLATEAU GROUNDWATER BASIN



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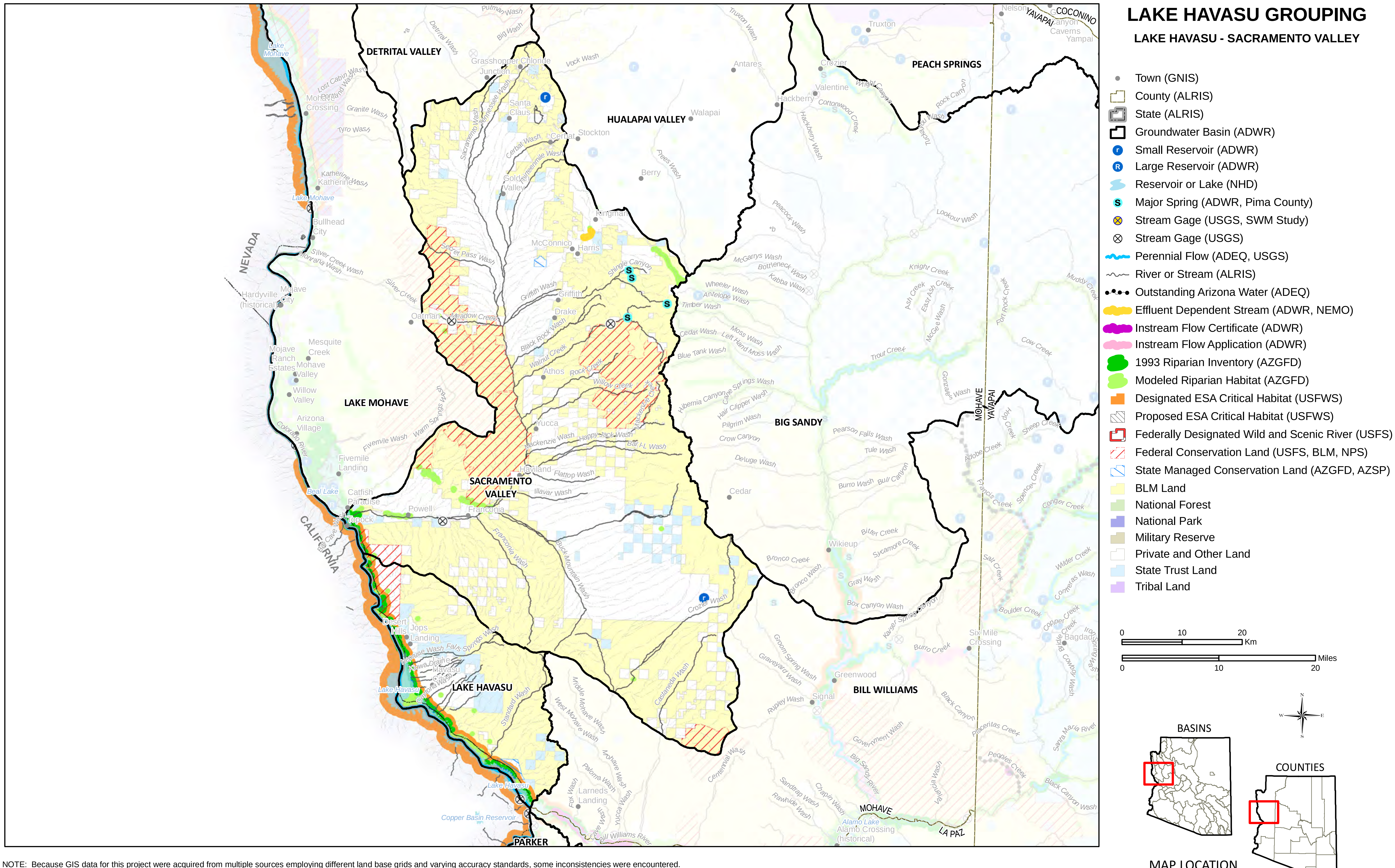

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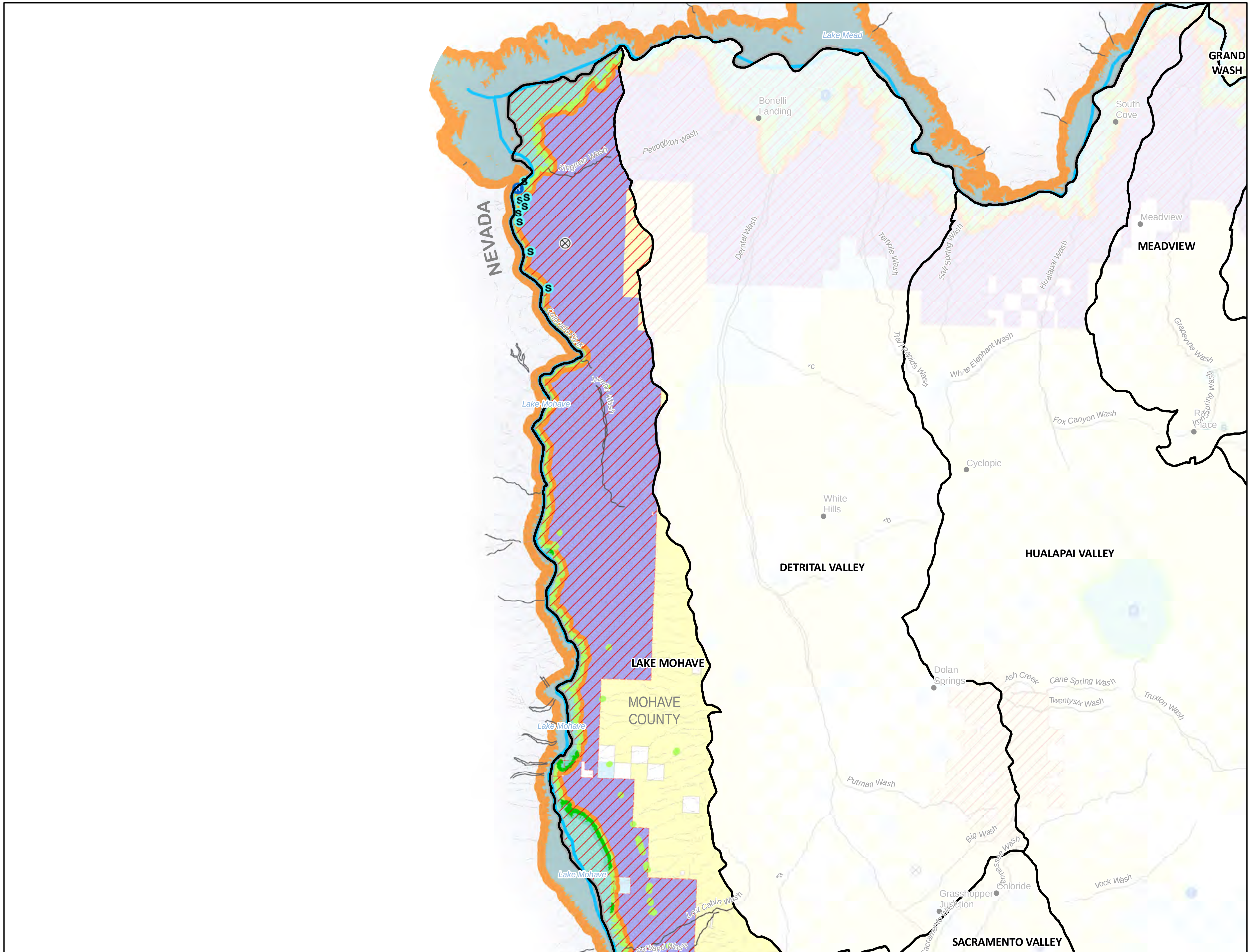
LAKE MOHAVE NORTH GROUNDWATER BASIN



- Town (GNIS)
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- State (ALRIS)
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- Small Reservoir (ADWR)
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- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
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- State Trust Land
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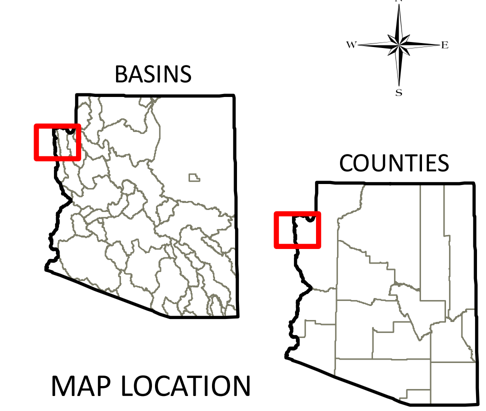
0 9 18 Km

0 9 18 Miles



MAP LOCATION

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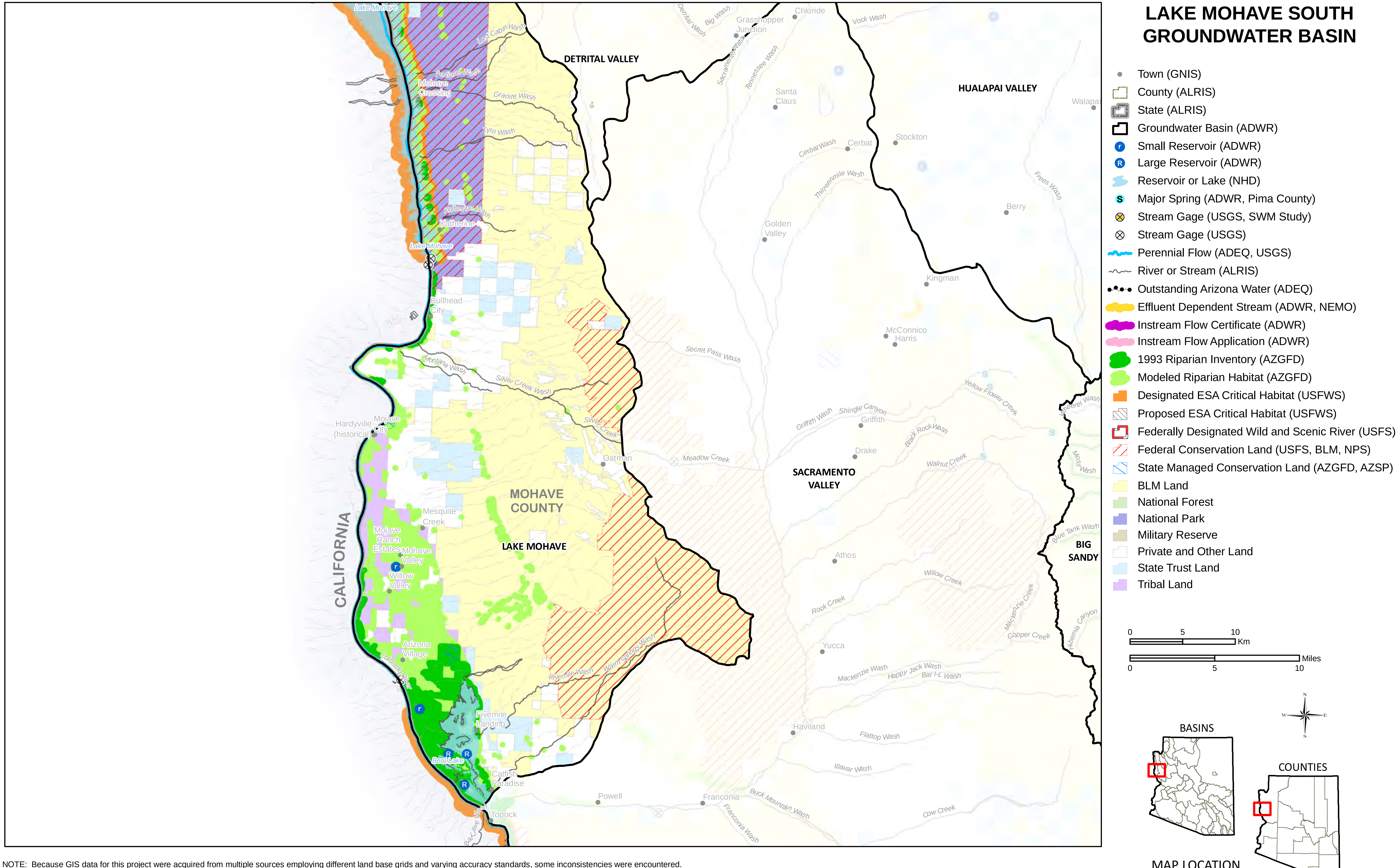

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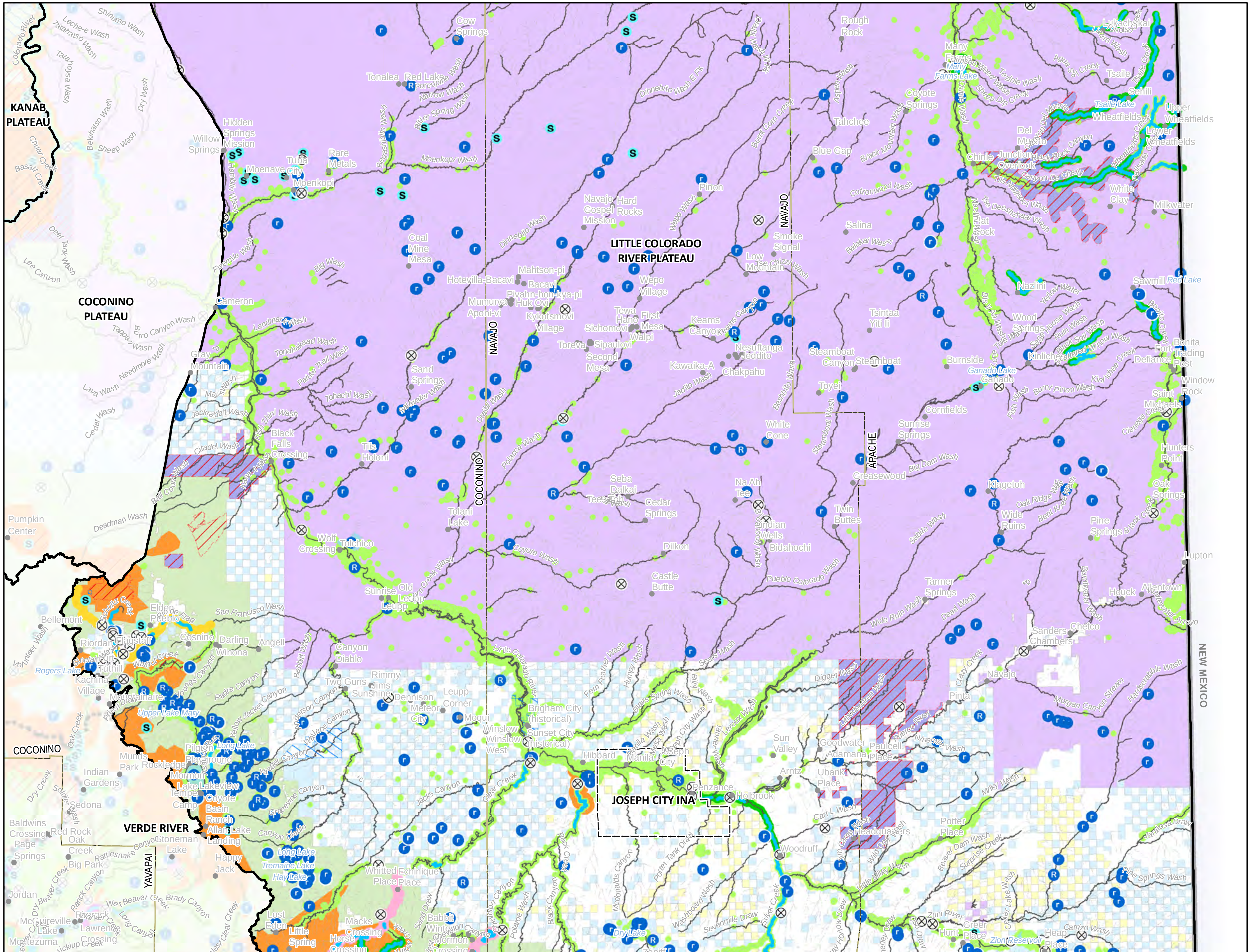
LITTLE COLORADO CENTRAL GROUNDWATER BASIN



- Town (GNIS)
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- State (ALRIS)
- Groundwater Basin (ADWR)
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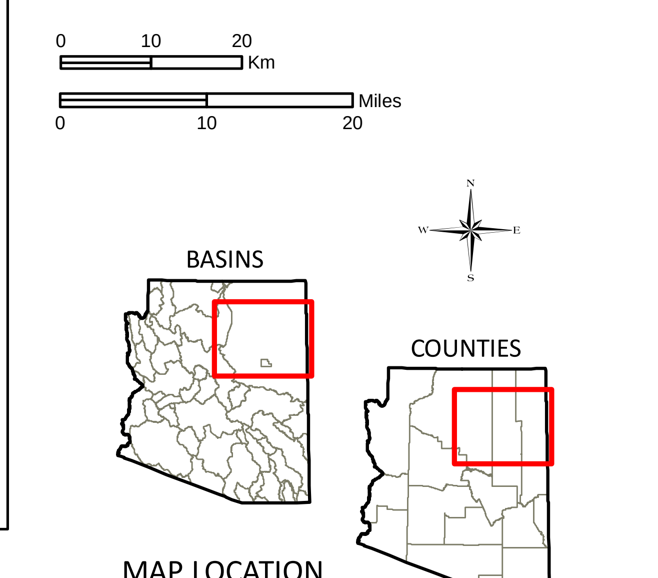

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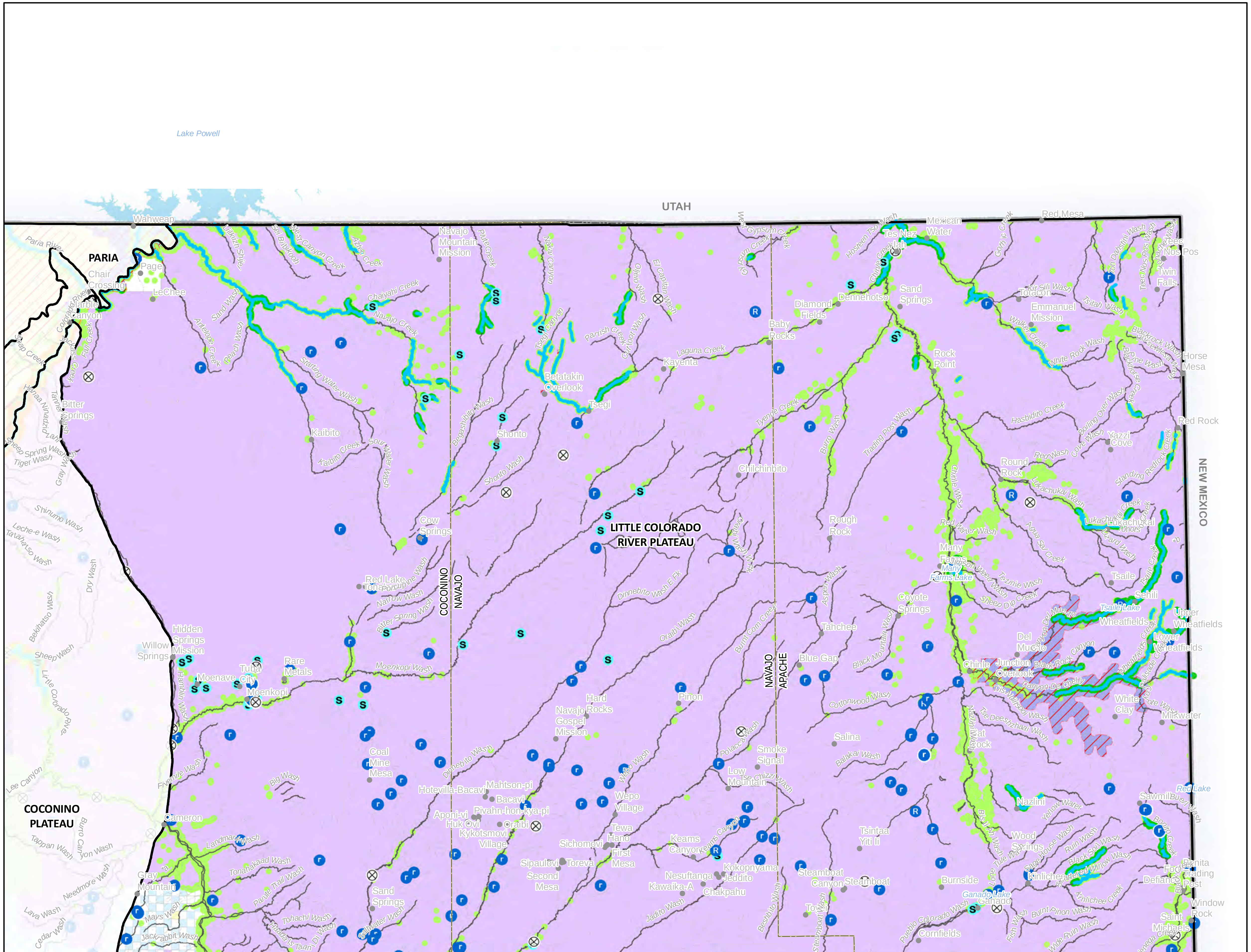
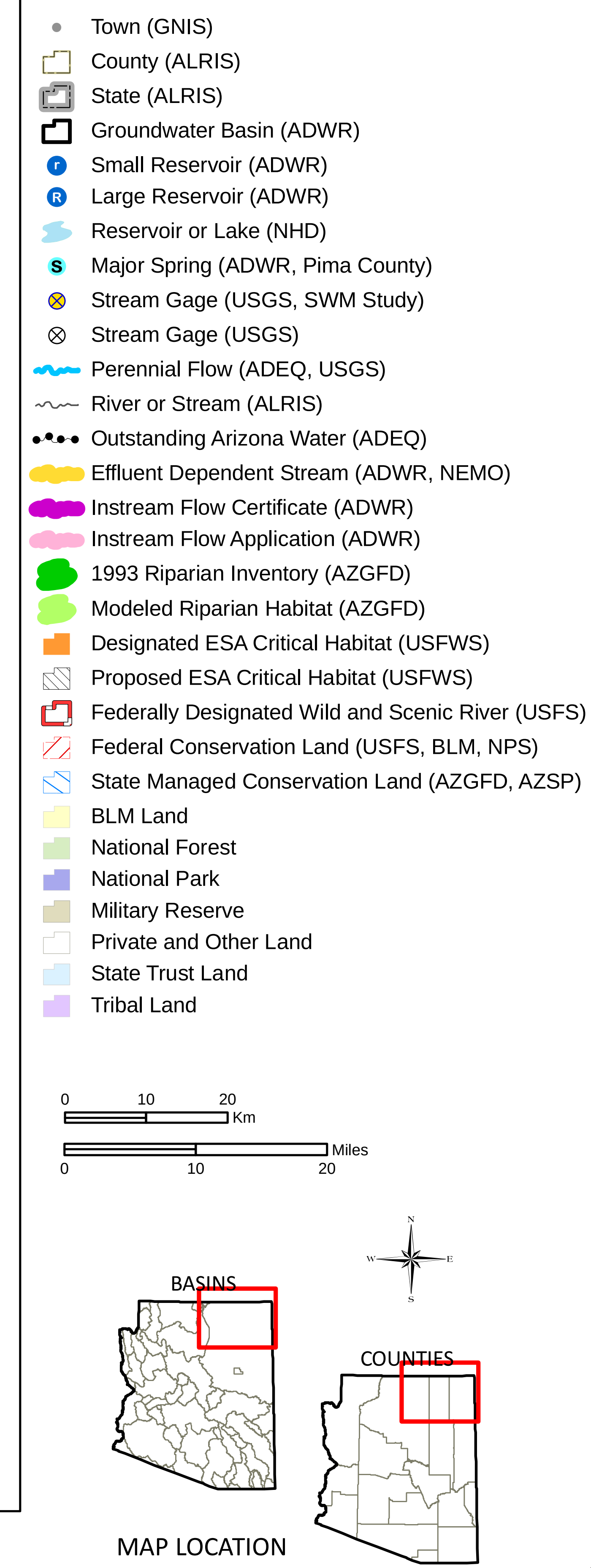
LITTLE COLORADO NORTH GROUNDWATER BASIN





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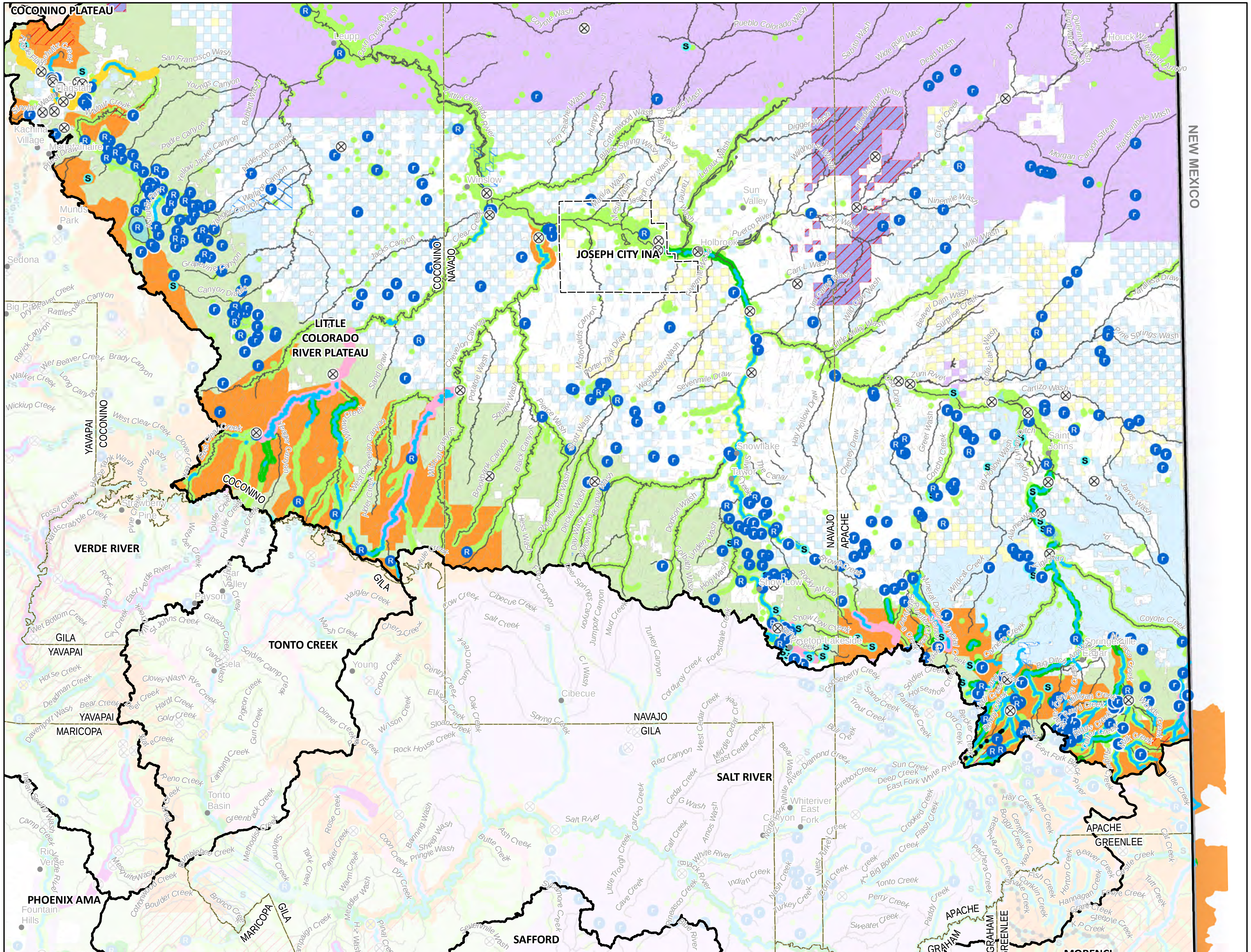
LITTLE COLORADO SOUTH GROUNDWATER BASIN



- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
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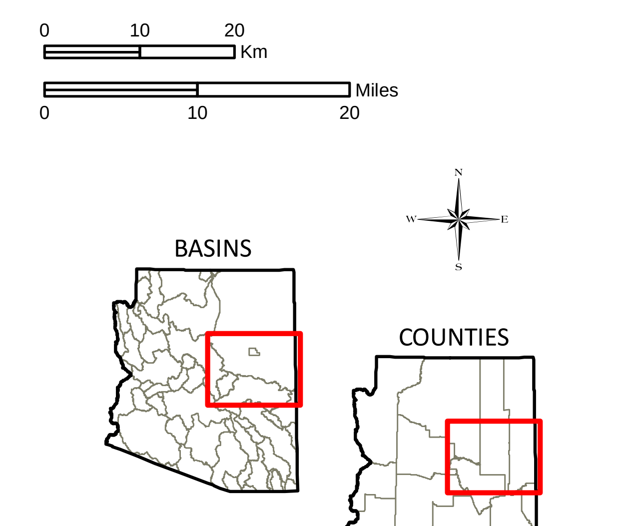

MAP LOCATION

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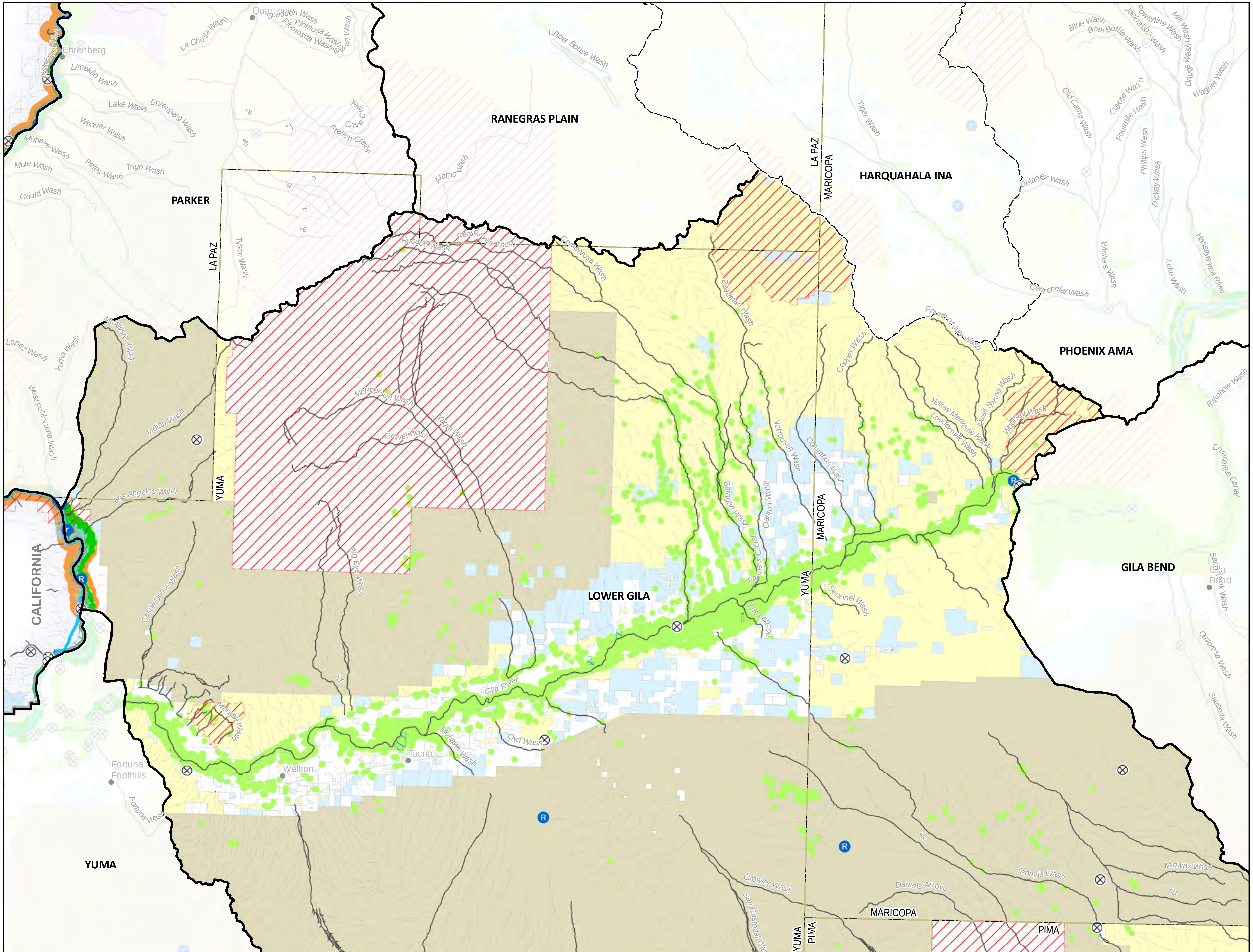

LOWER GILA NORTH GROUNDWATER BASIN

- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
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- Perennial Flow (ADEQ, USGS)
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- Effluent Dependent Stream (ADWR, NEMO)
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- Instream Flow Application (ADWR)
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- Proposed ESA Critical Habitat (USFWS)
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- Federal Conservation Land (USFS, BLM, NPS)
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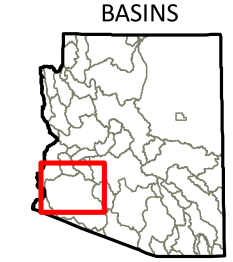
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

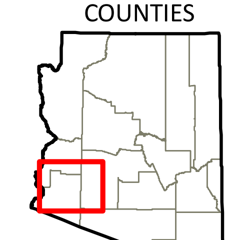
0 7.5 15 Km

0 7 14 Miles

BASINS



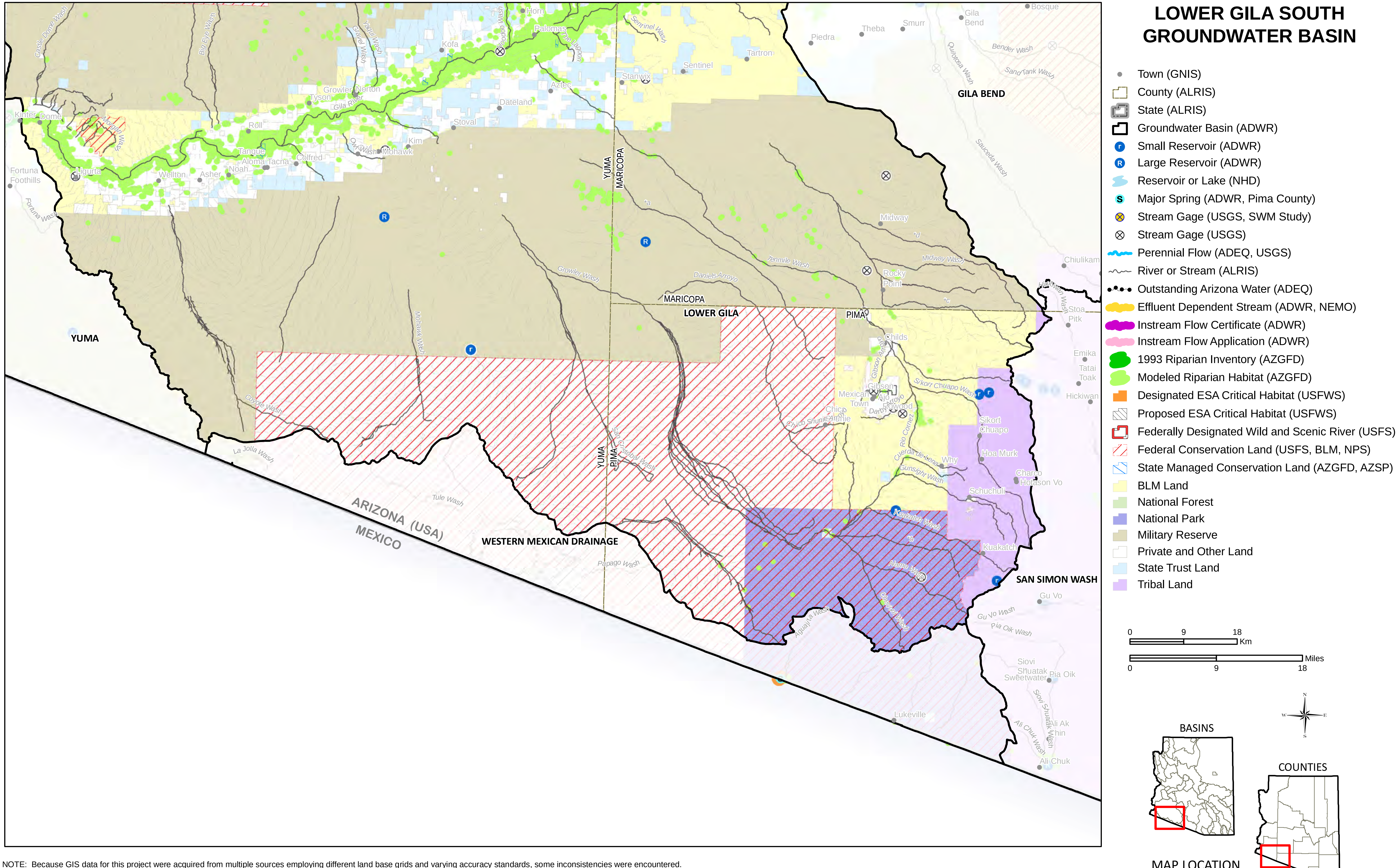
COUNTIES



MAP LOCATION

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.

LOWER GILA SOUTH GROUNDWATER BASIN



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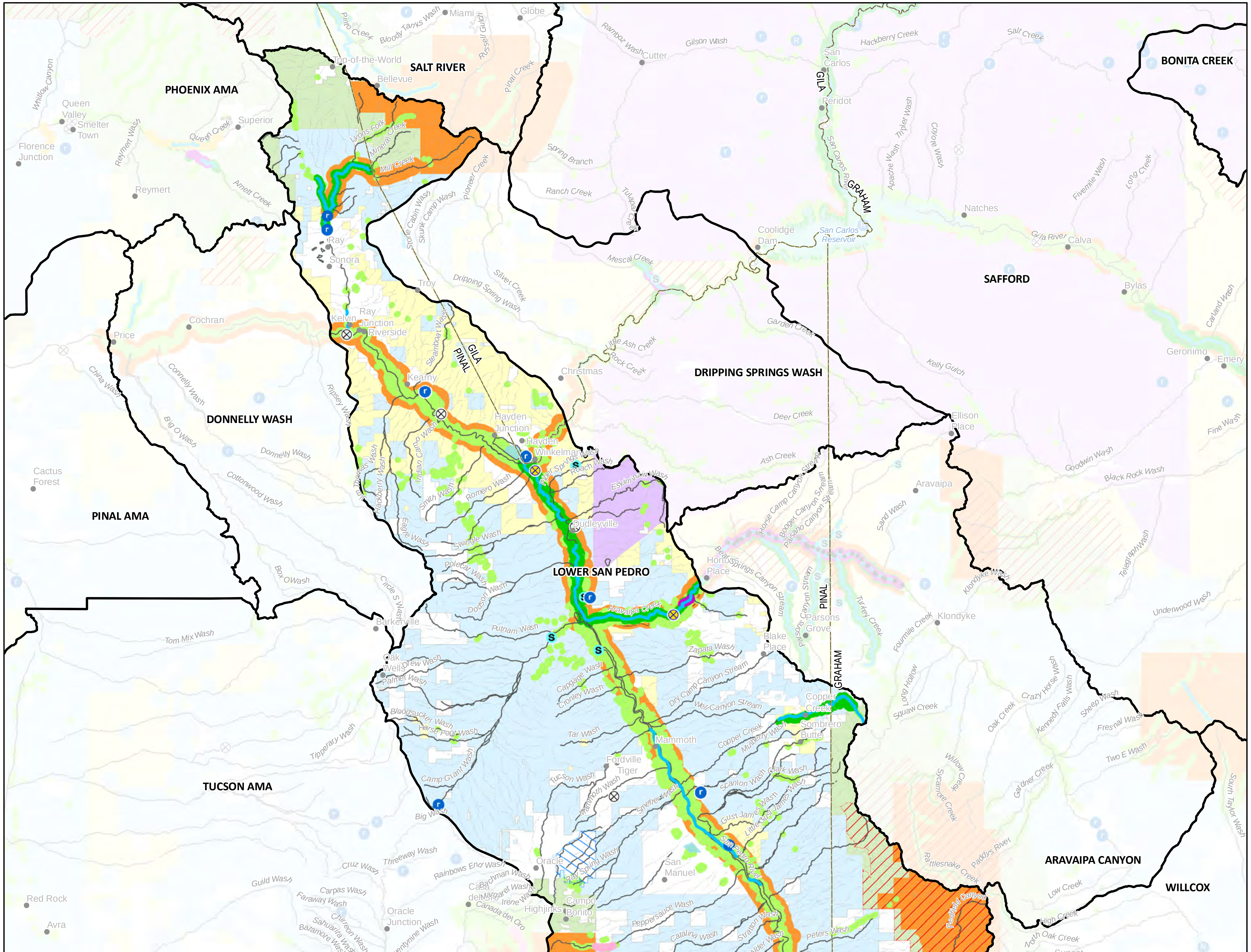

LOWER SAN PEDRO NORTH GROUNDWATER BASIN

- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (ADWR)
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- Designated ESA Critical Habitat (USFWS)
- Proposed ESA Critical Habitat (USFWS)
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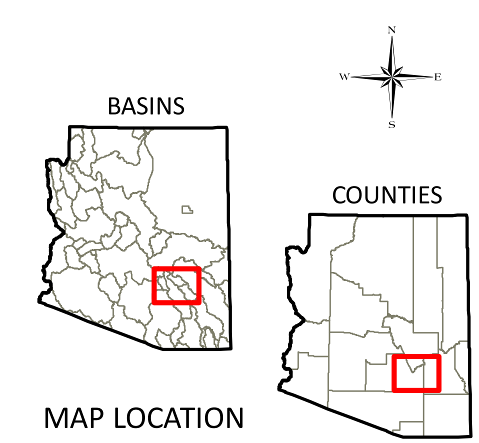
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

0 6 12 Km

0 6 12 Miles



MAP LOCATION

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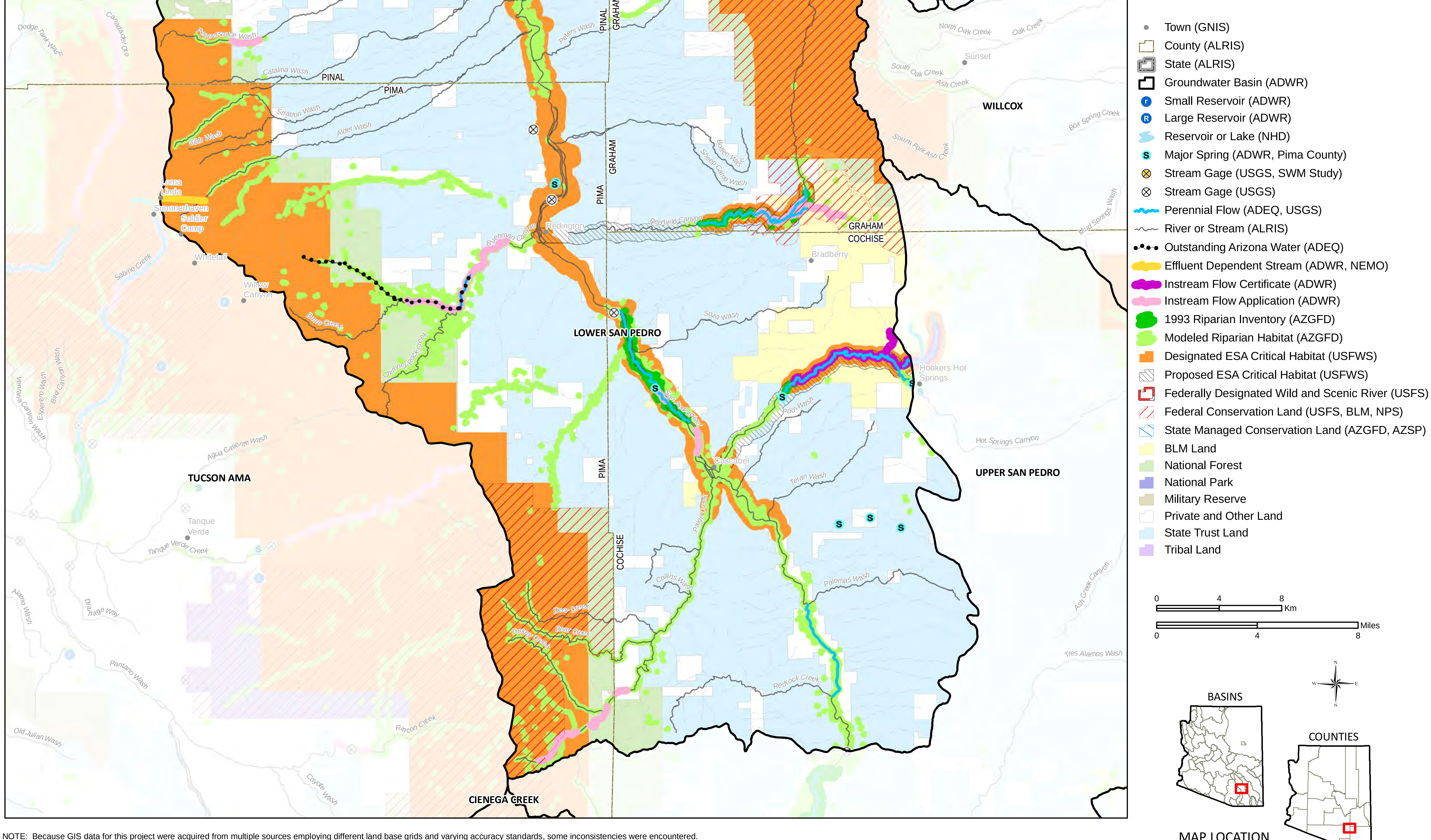
LOWER SAN PEDRO SOUTH GROUNDWATER BASIN



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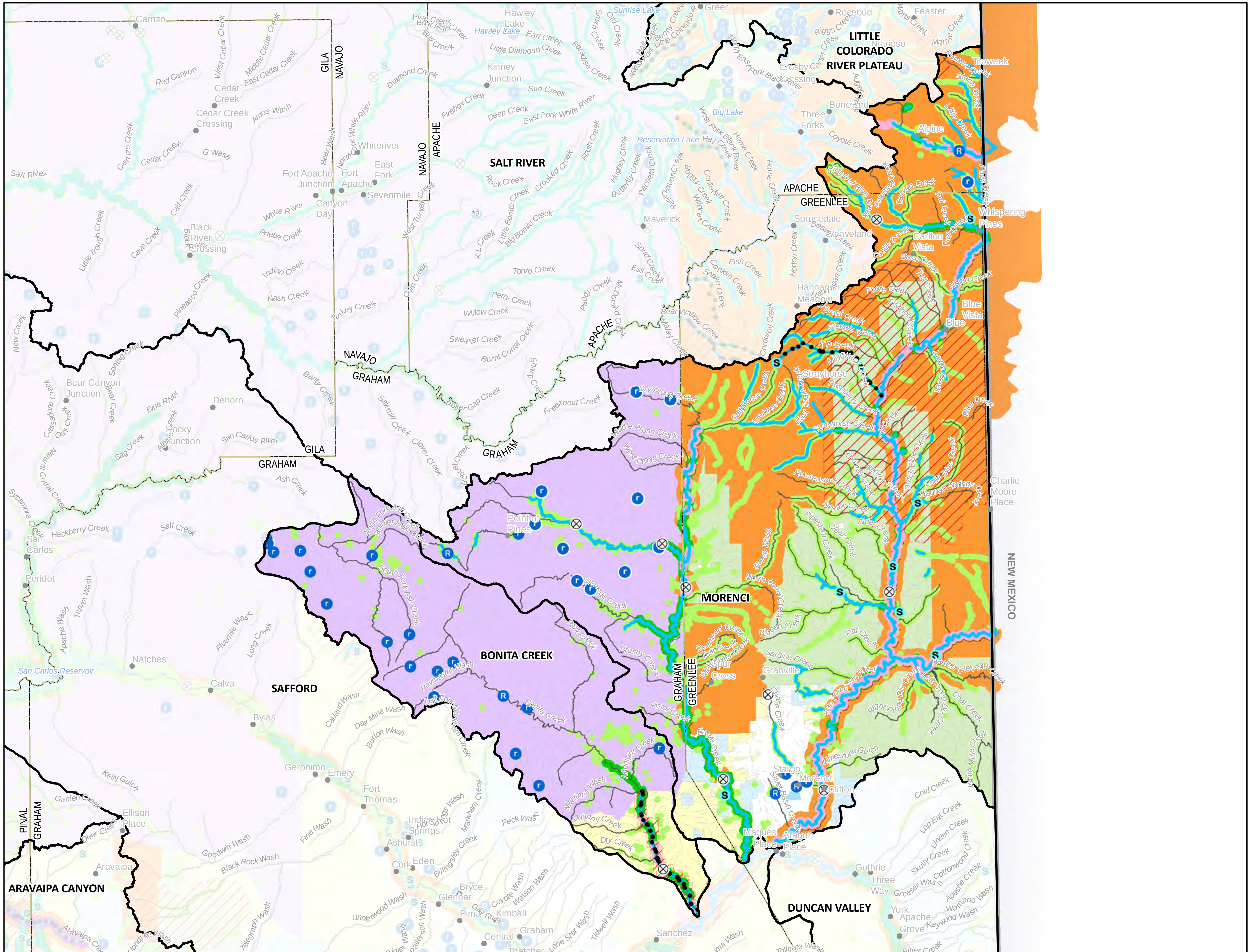
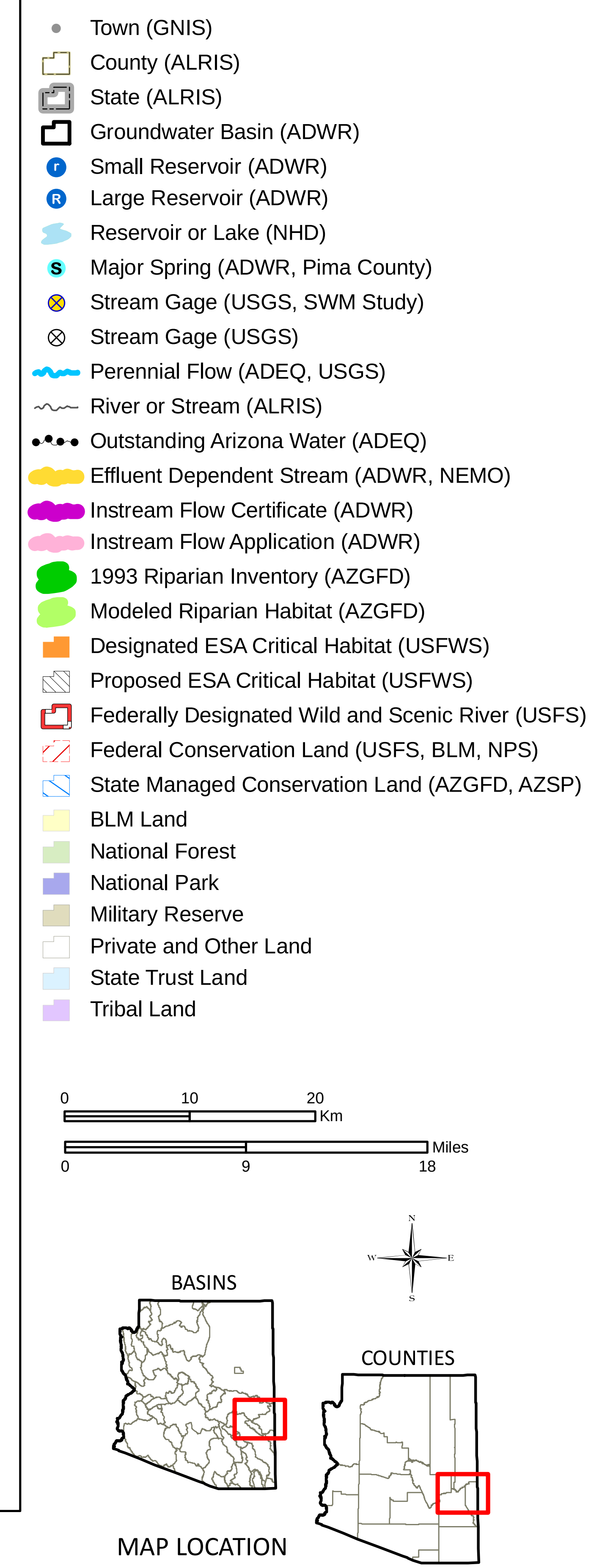
MORENCI GROUPING

BONITA CREEK- MORENCI





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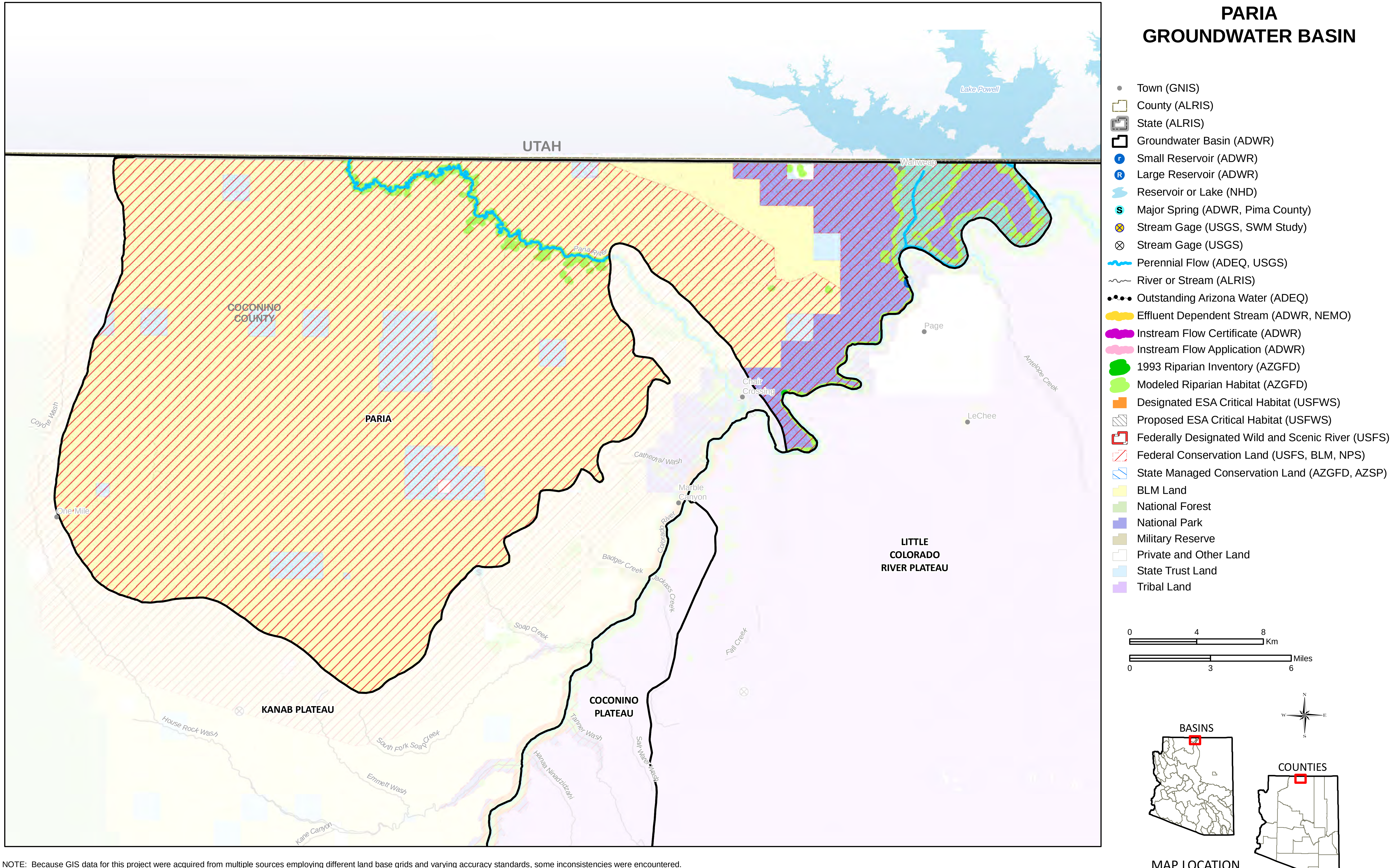
PARIA GROUNDWATER BASIN



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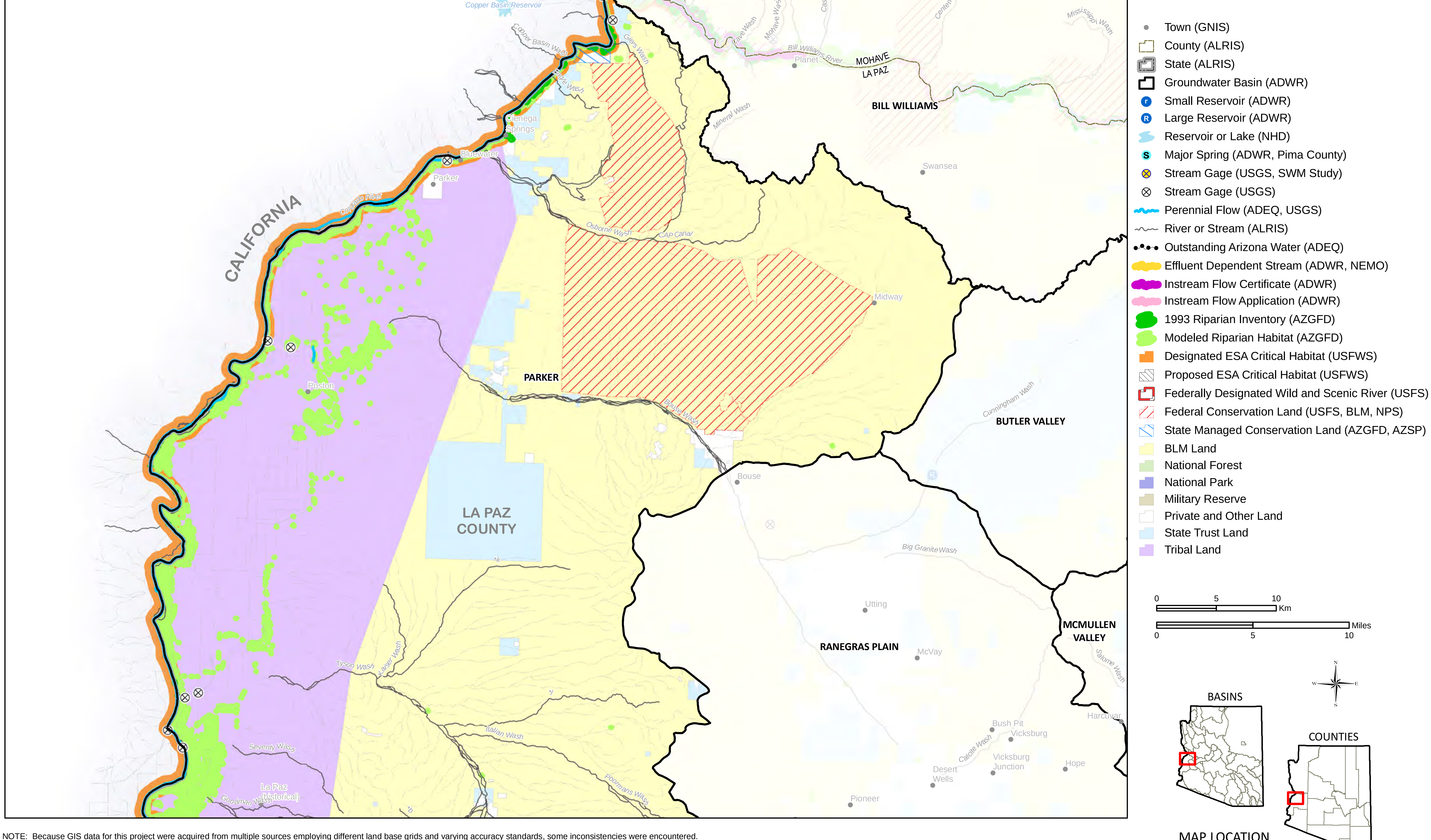
PARKER NORTH GROUNDWATER BASIN



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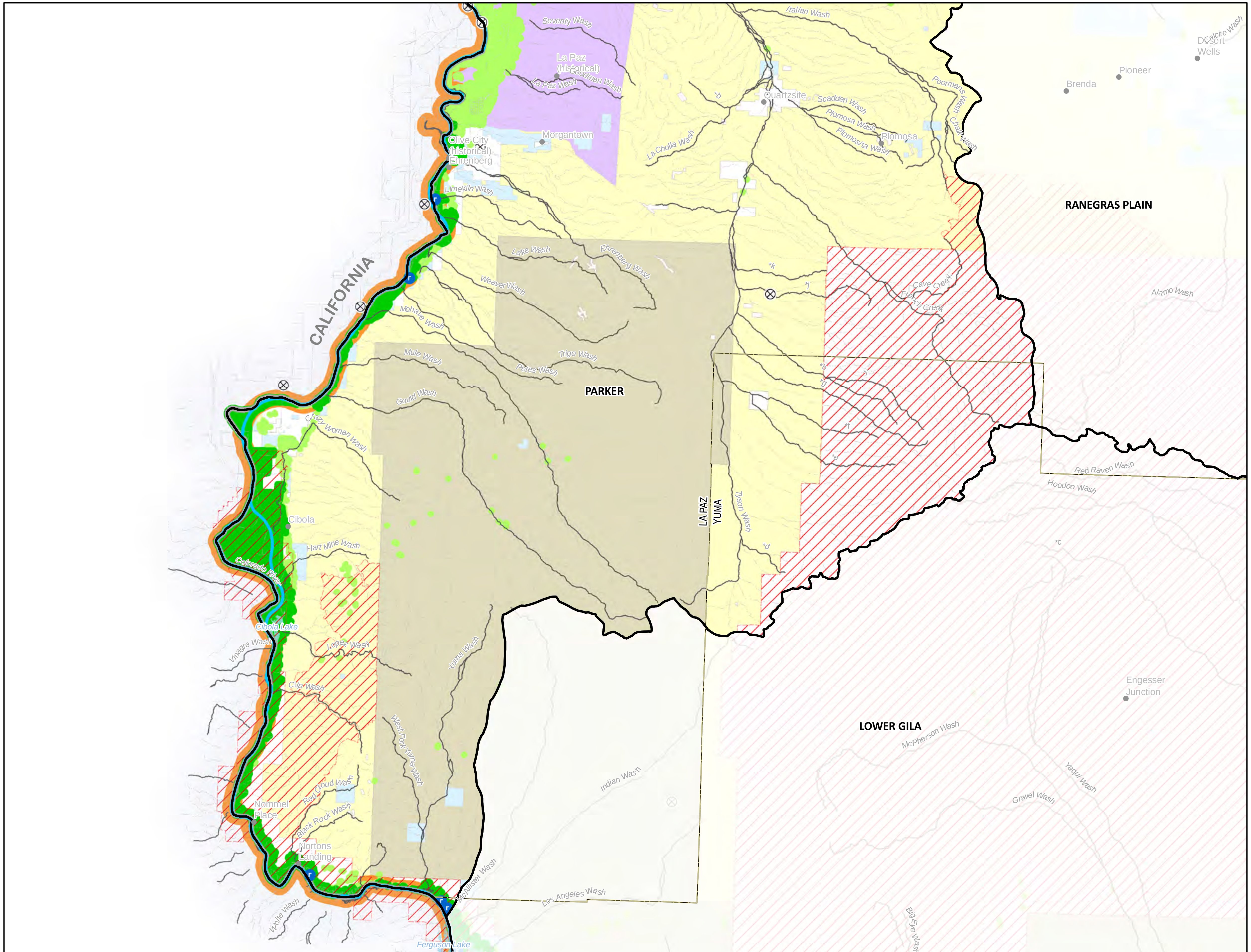
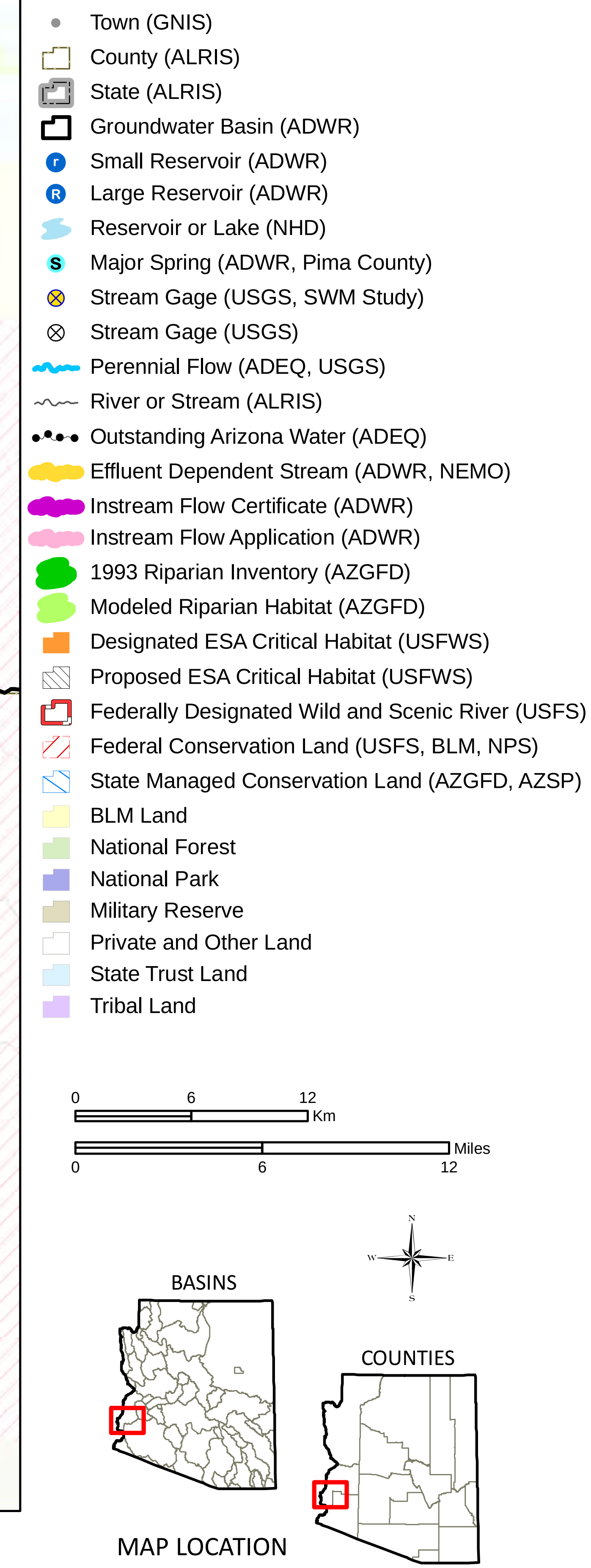
PARKER SOUTH GROUNDWATER BASIN





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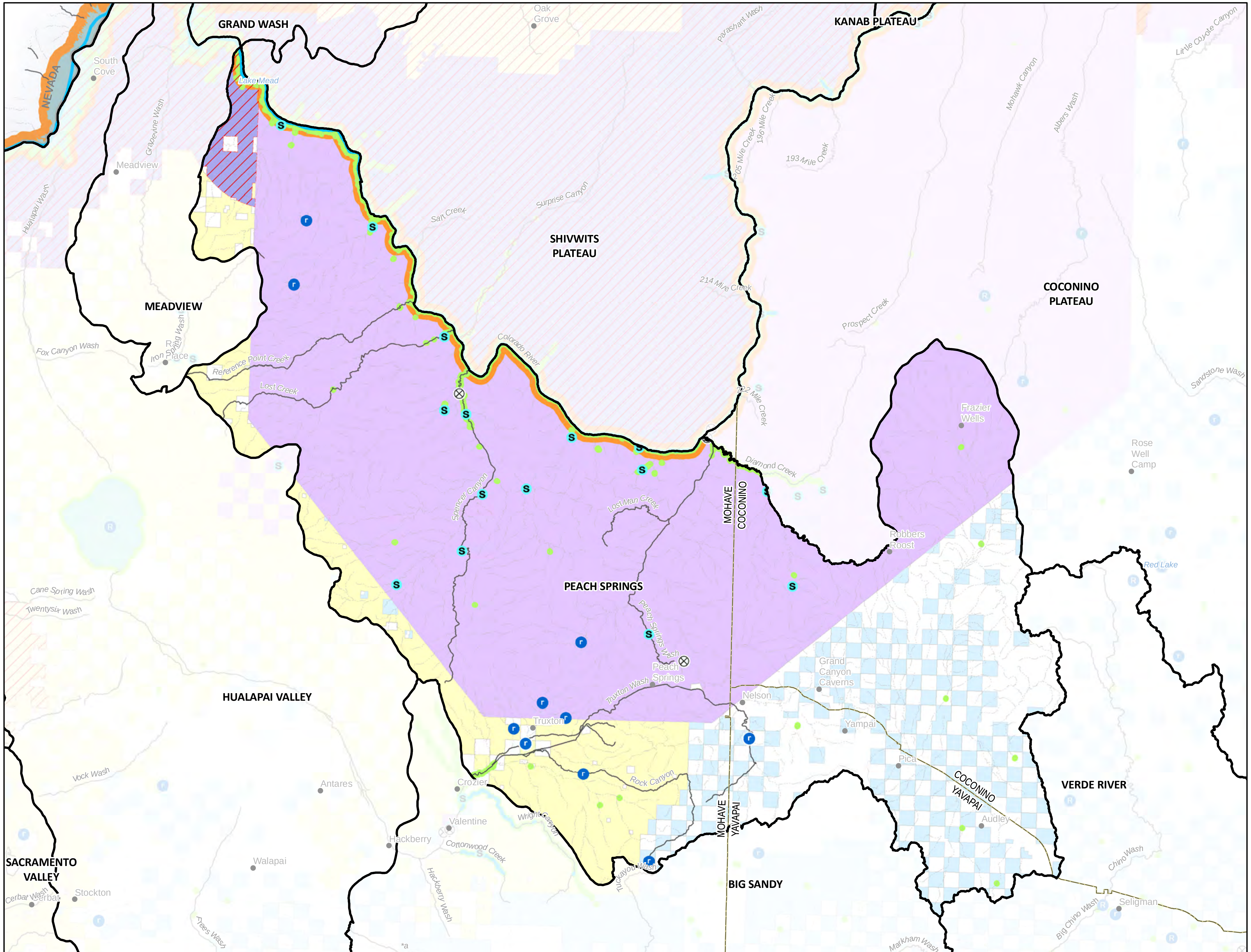
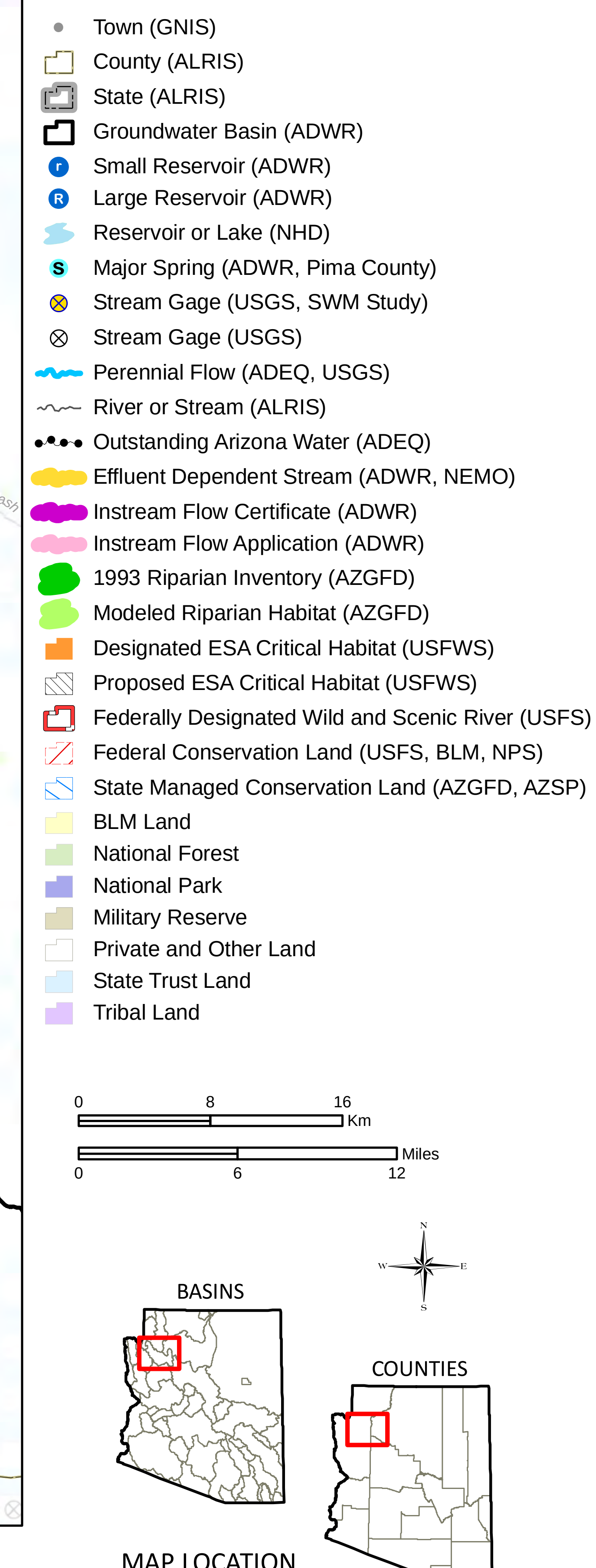
PEACH SPRINGS GROUNDWATER BASIN





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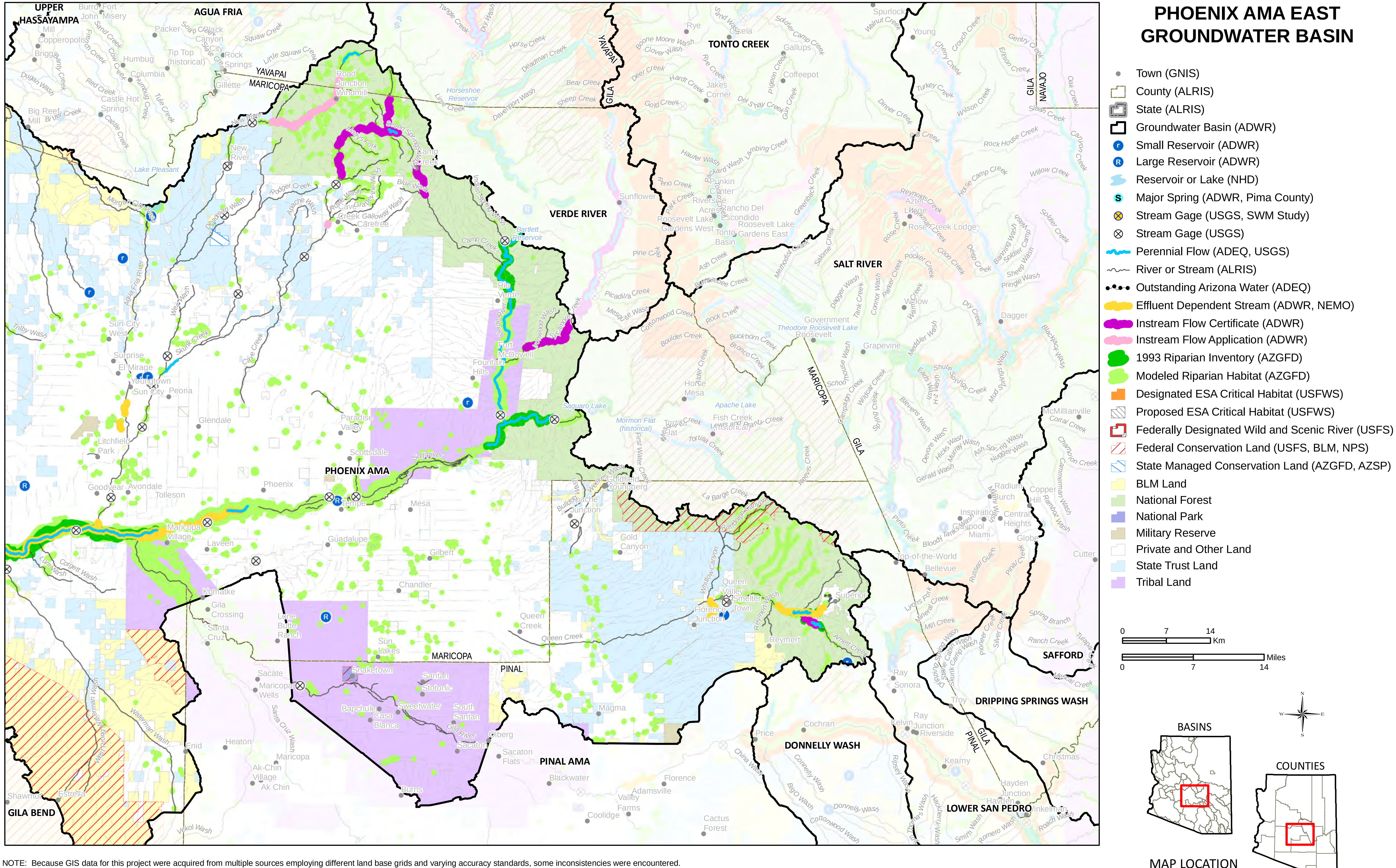
PHOENIX AMA EAST GROUNDWATER BASIN



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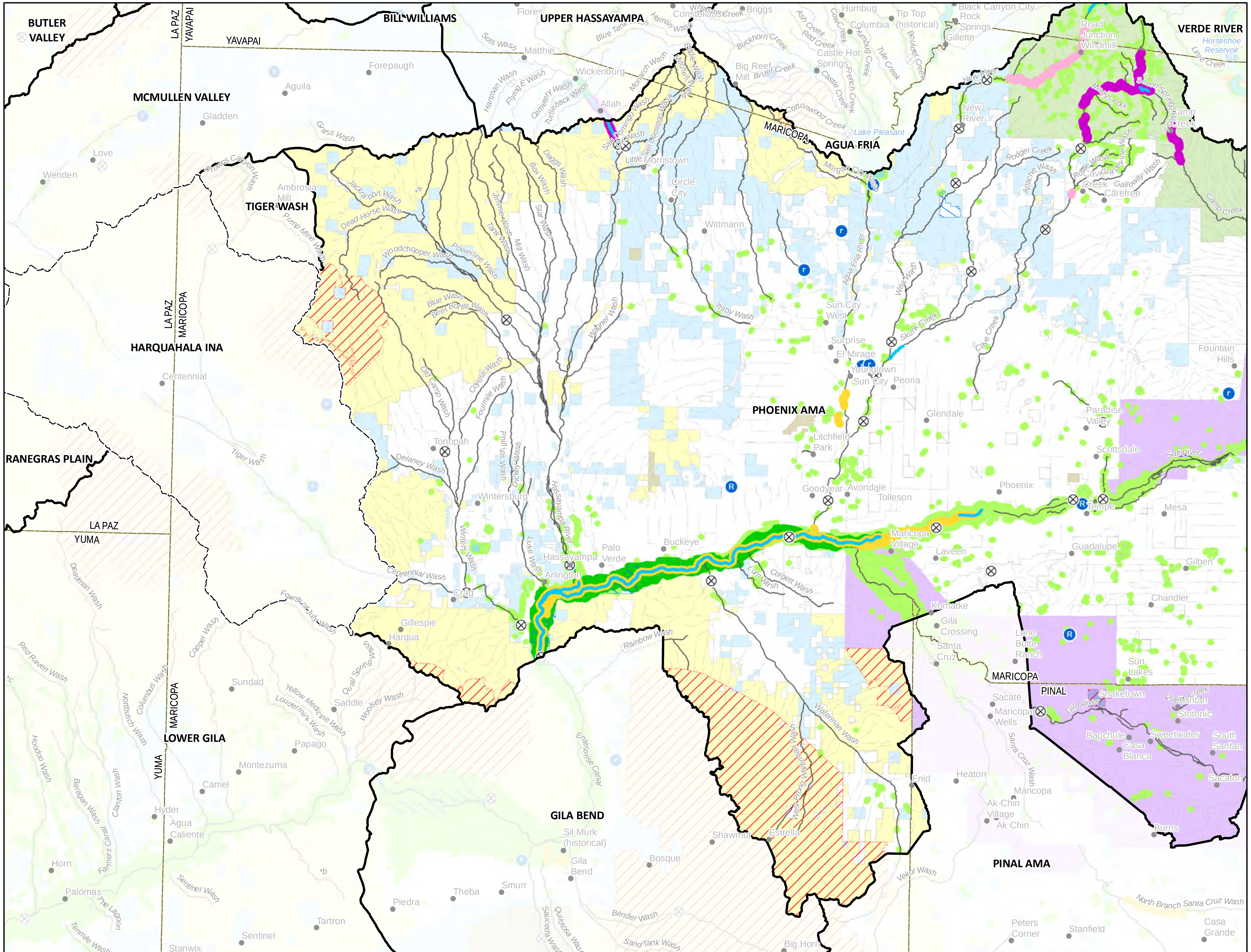
PHOENIX AMA WEST GROUNDWATER BASIN



- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (ADWR)
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- Proposed ESA Critical Habitat (USFWS)
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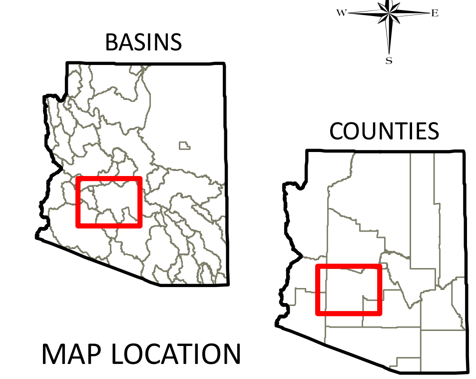
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

0 7 14 Km

0 7 14 Miles



MAP LOCATION

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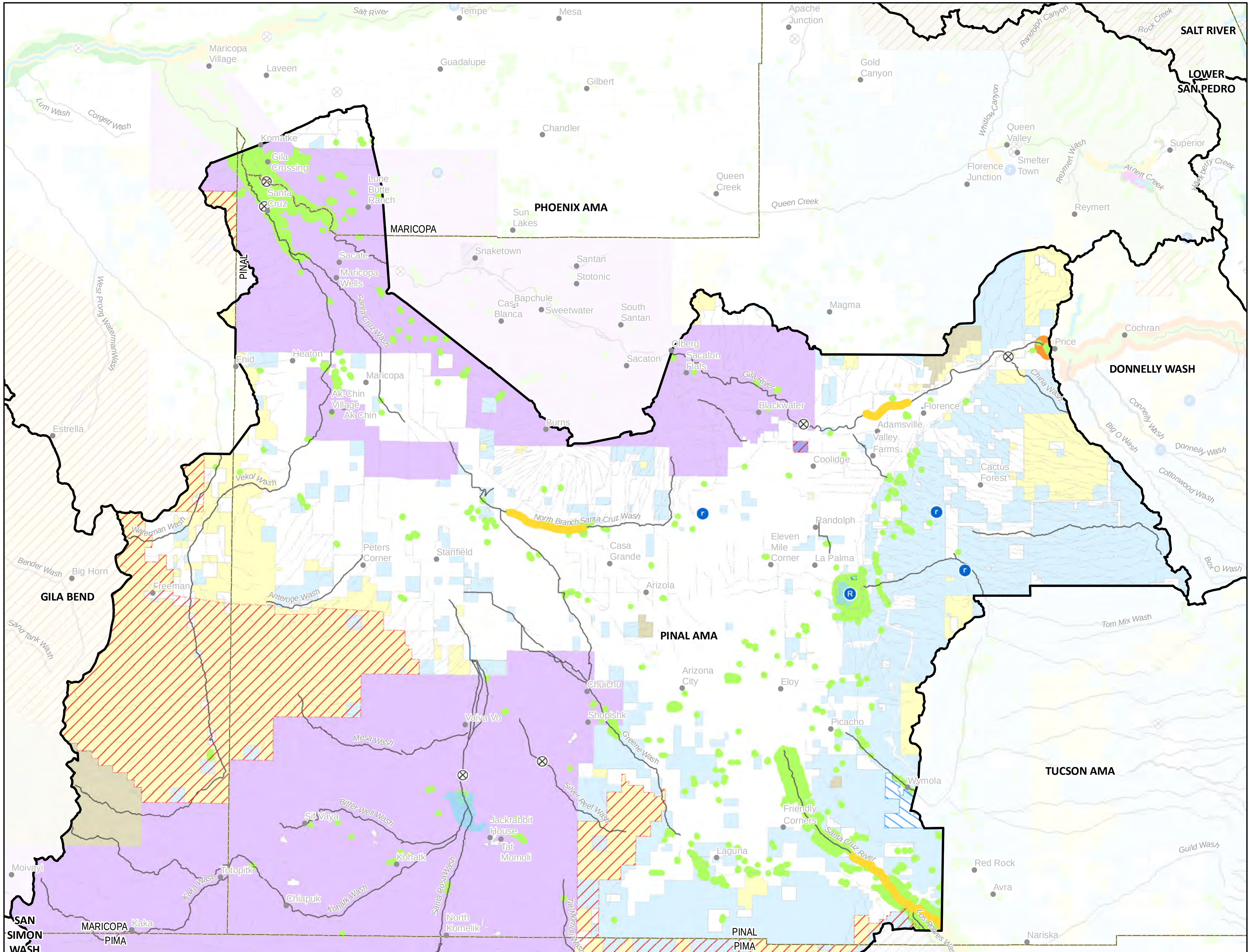
PINAL AMA NORTH GROUNDWATER BASIN



- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
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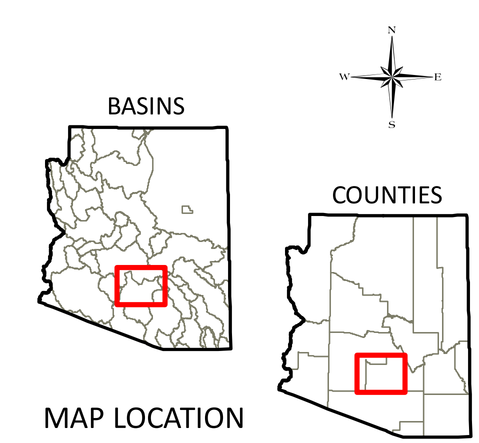
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

0 7.5 15 Km

0 7.5 15 Miles



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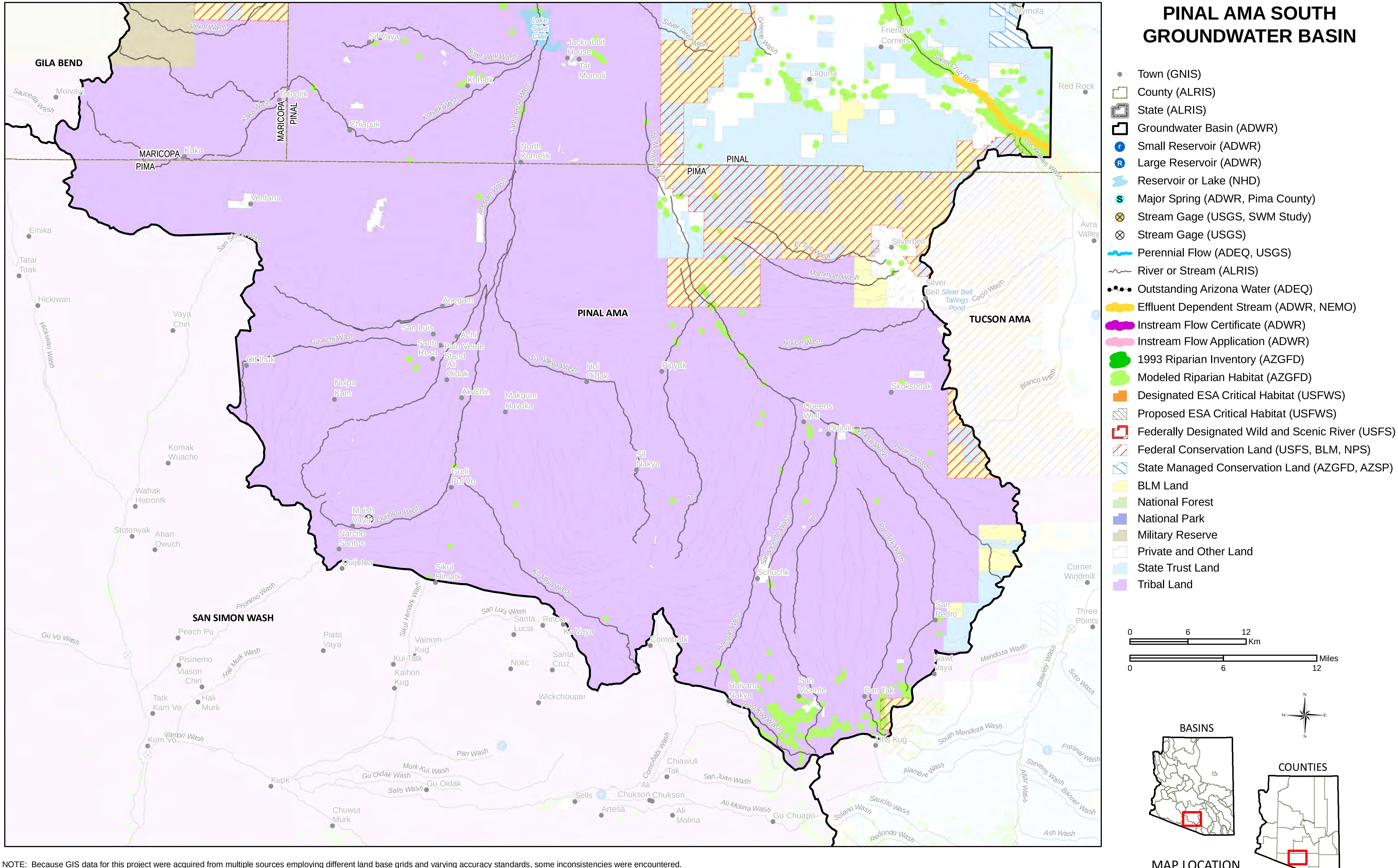
PINAL AMA SOUTH GROUNDWATER BASIN



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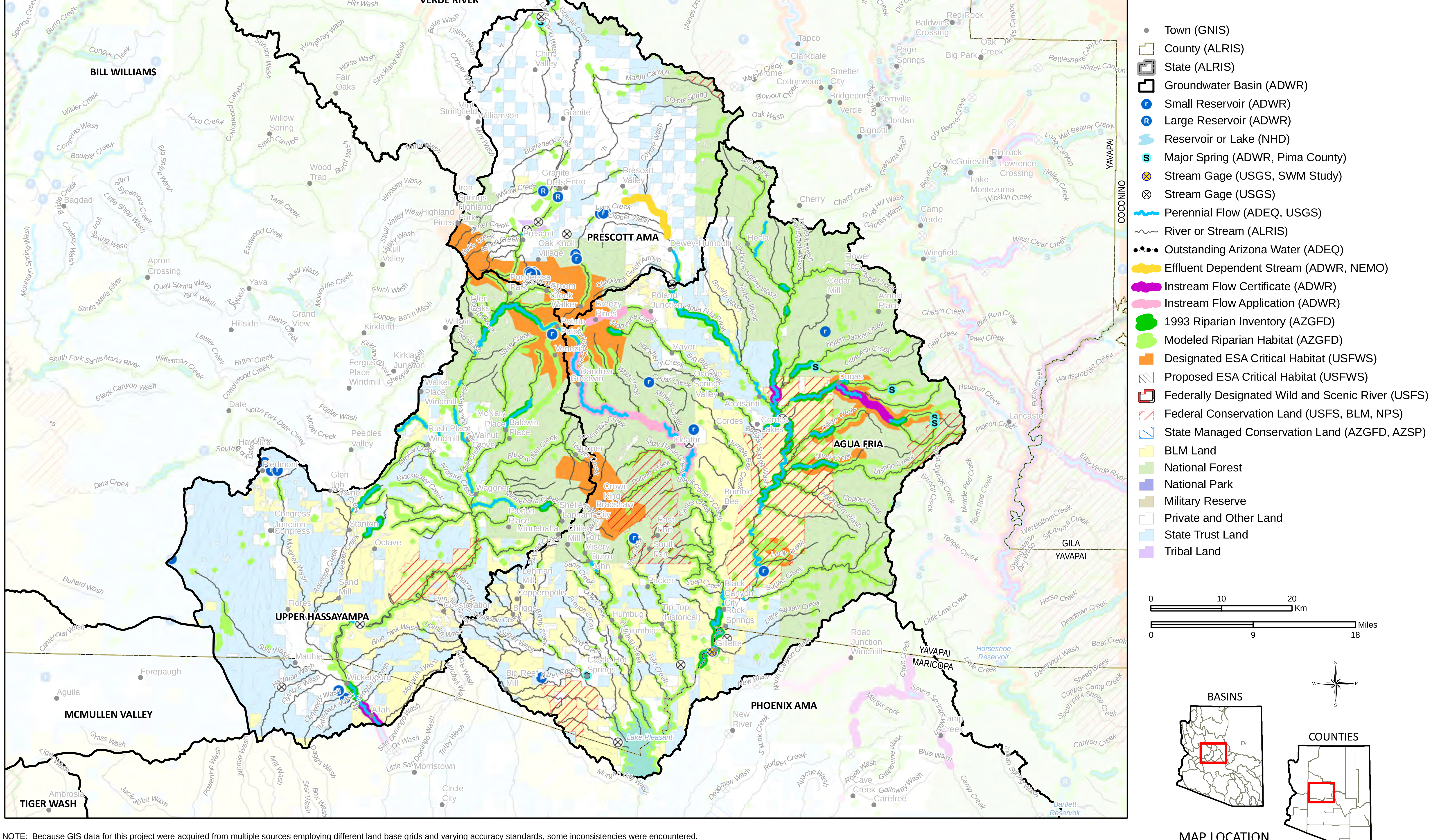
PRESCOTT GROUPING

PRESCOTT- AGUA FRIA- HASSAYAMPA



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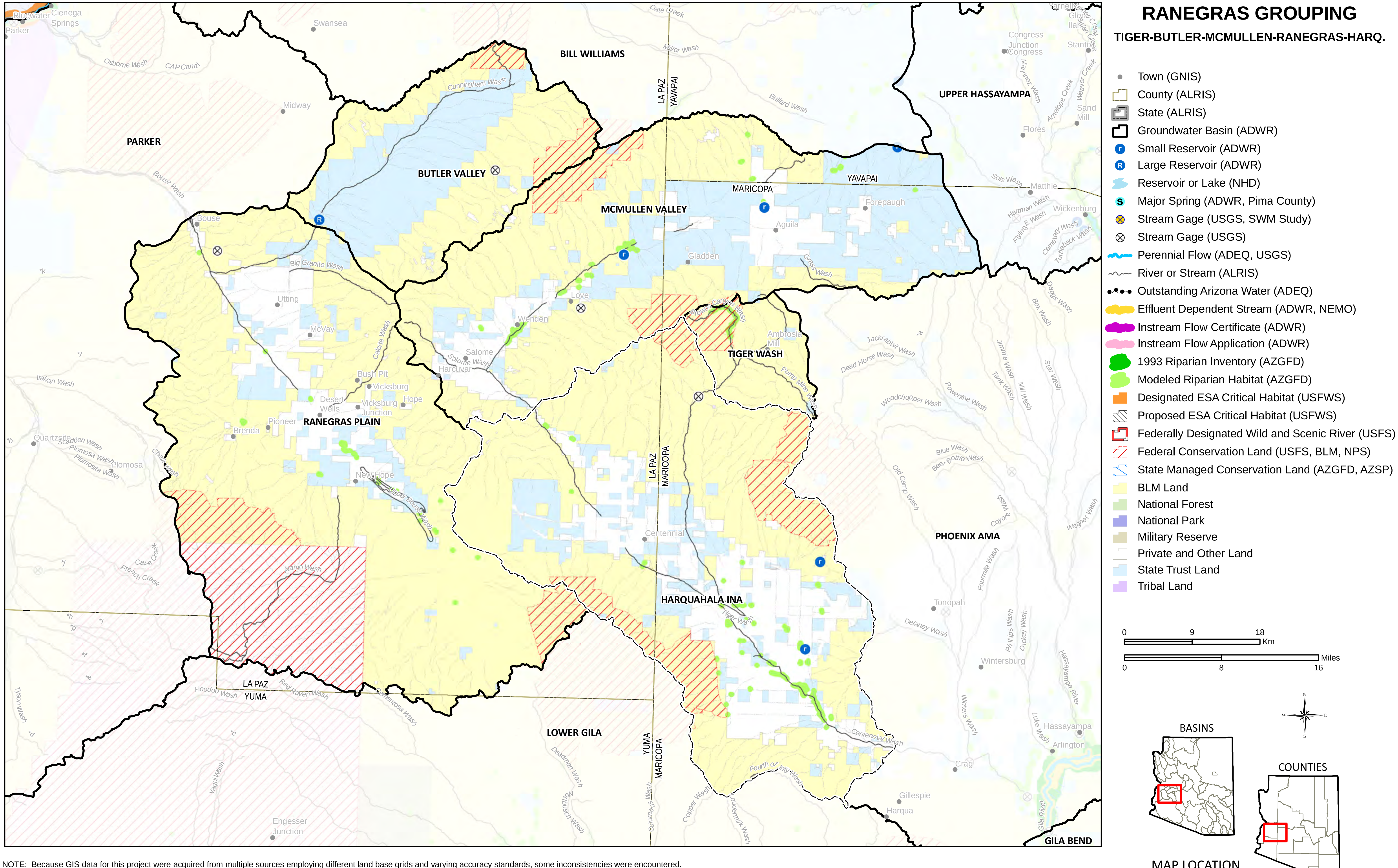

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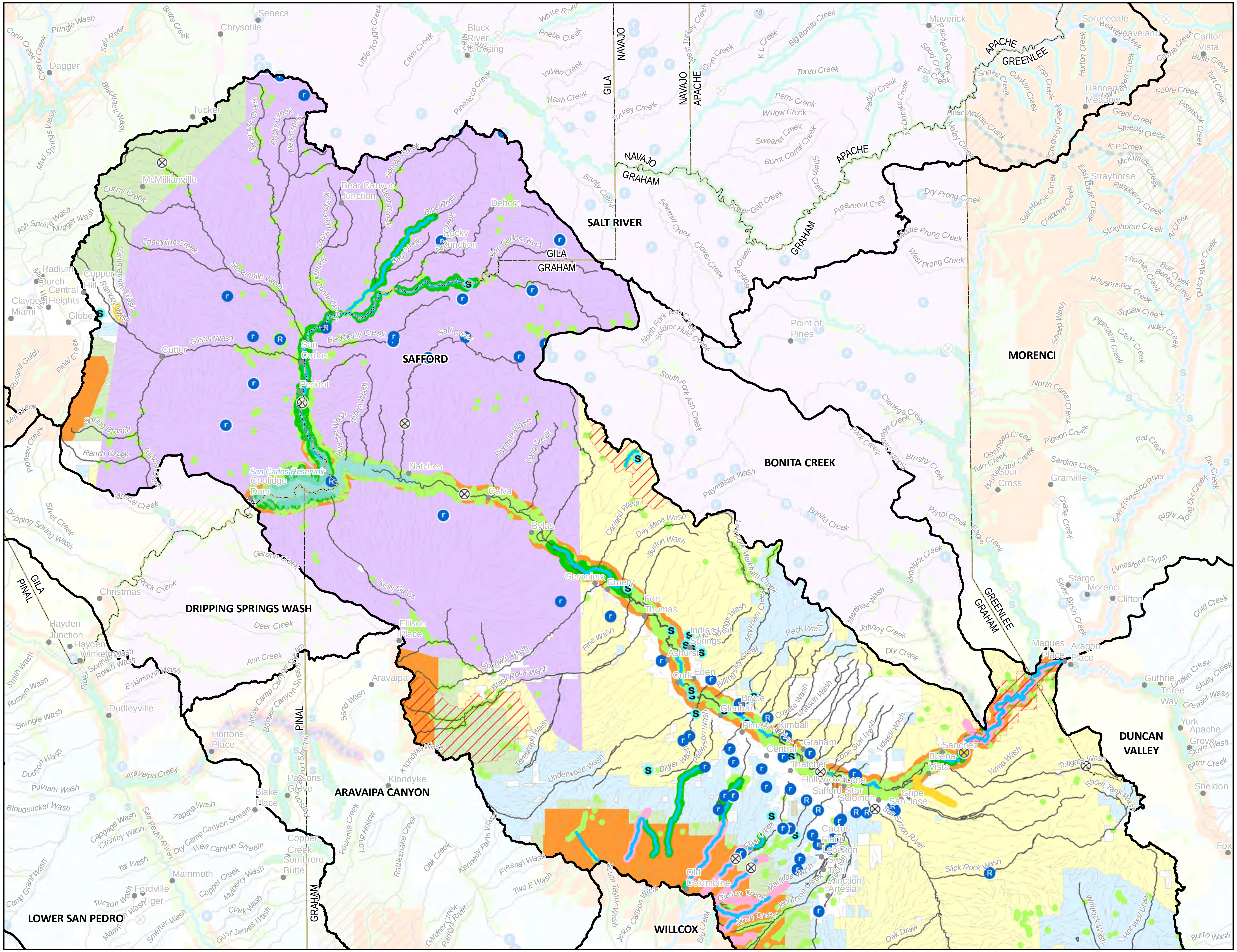
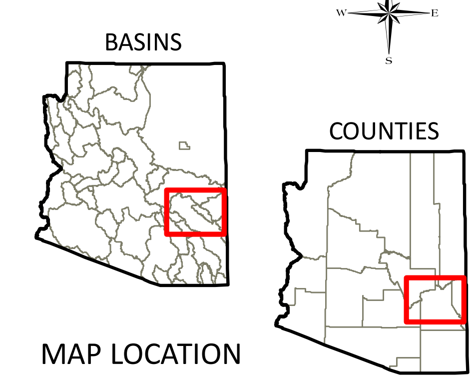


SAFFORD NORTH GROUNDWATER BASIN

- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (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)
- 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

0 7 14 Km

0 7 14 Miles



MAP LOCATION

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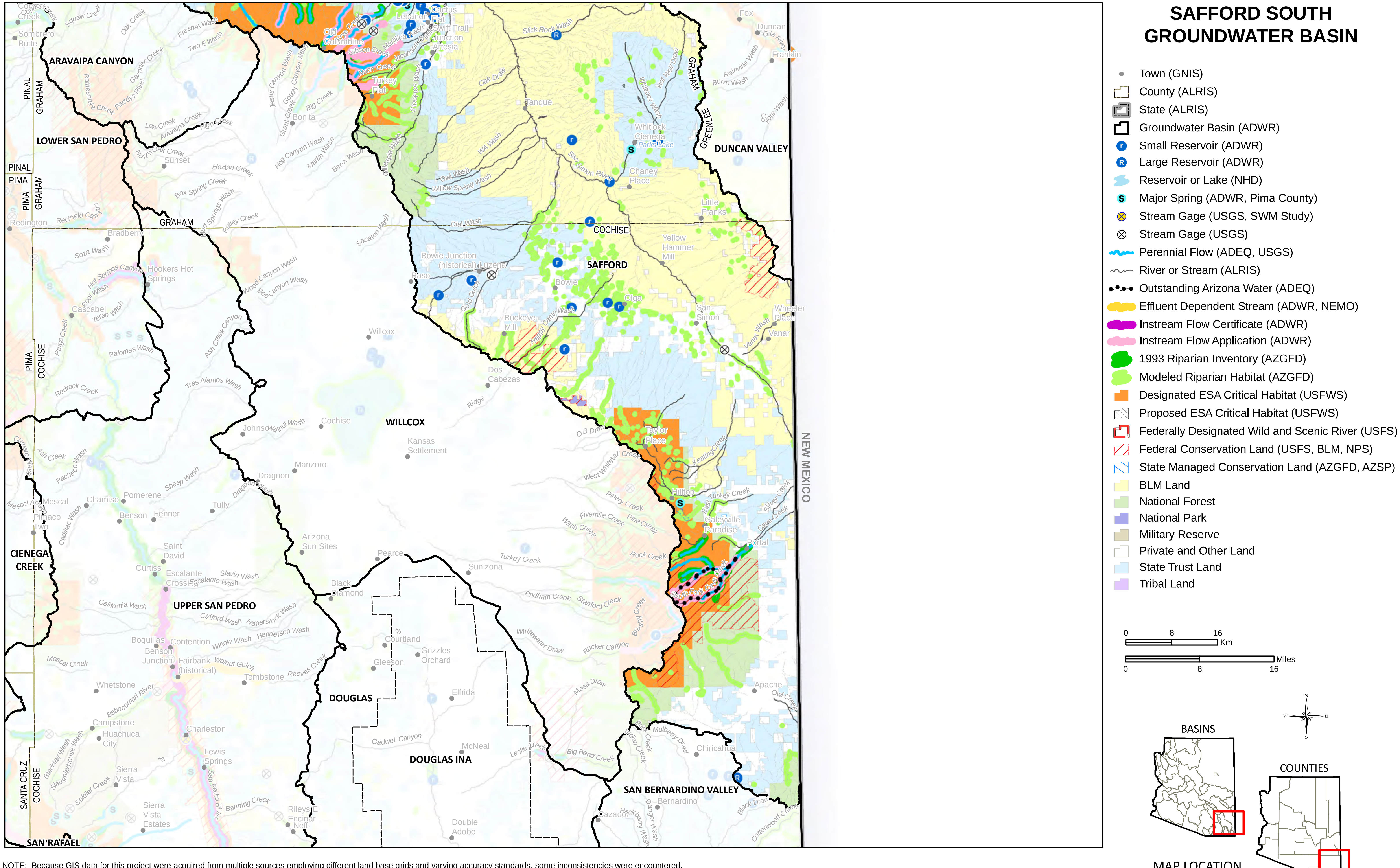

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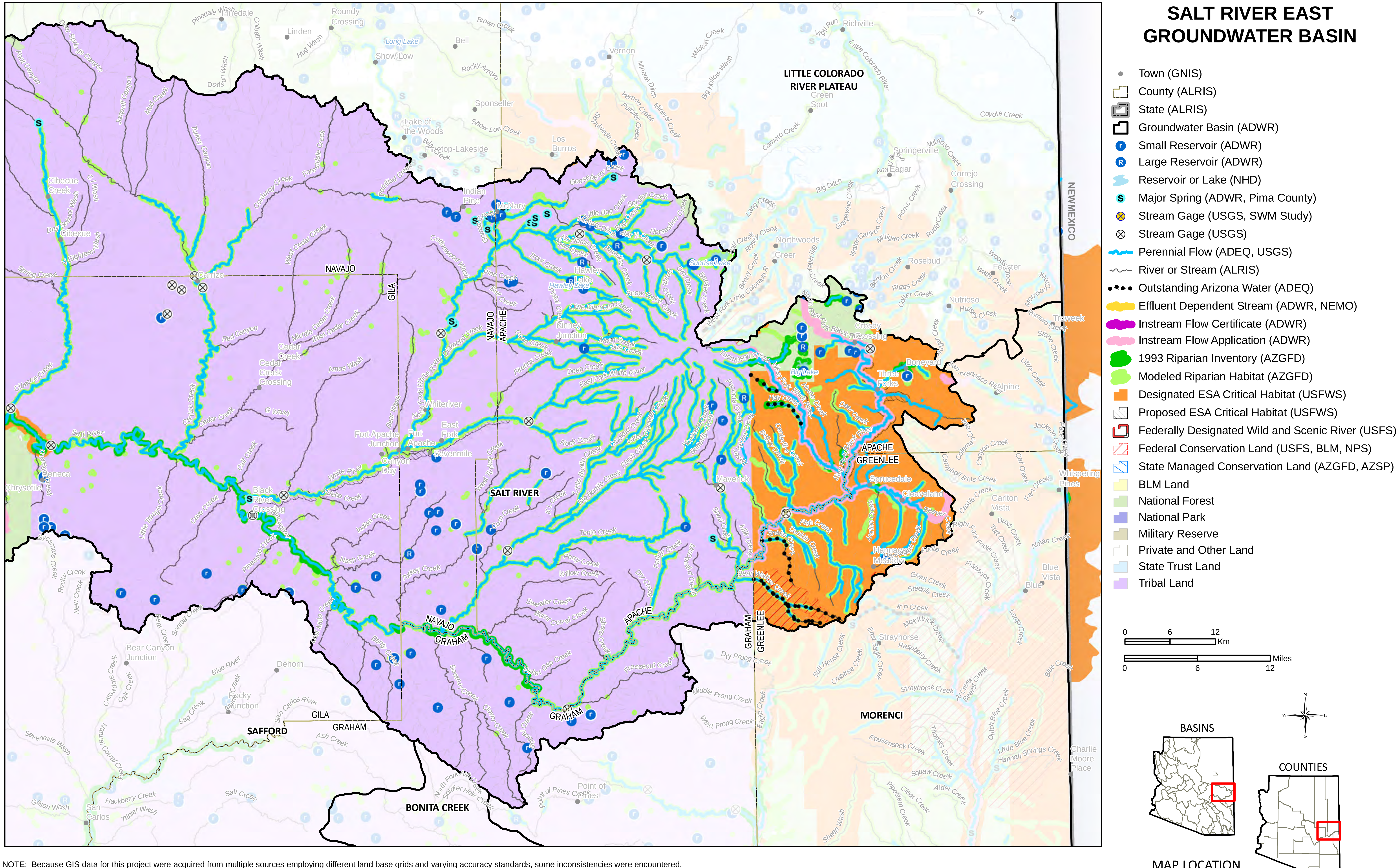

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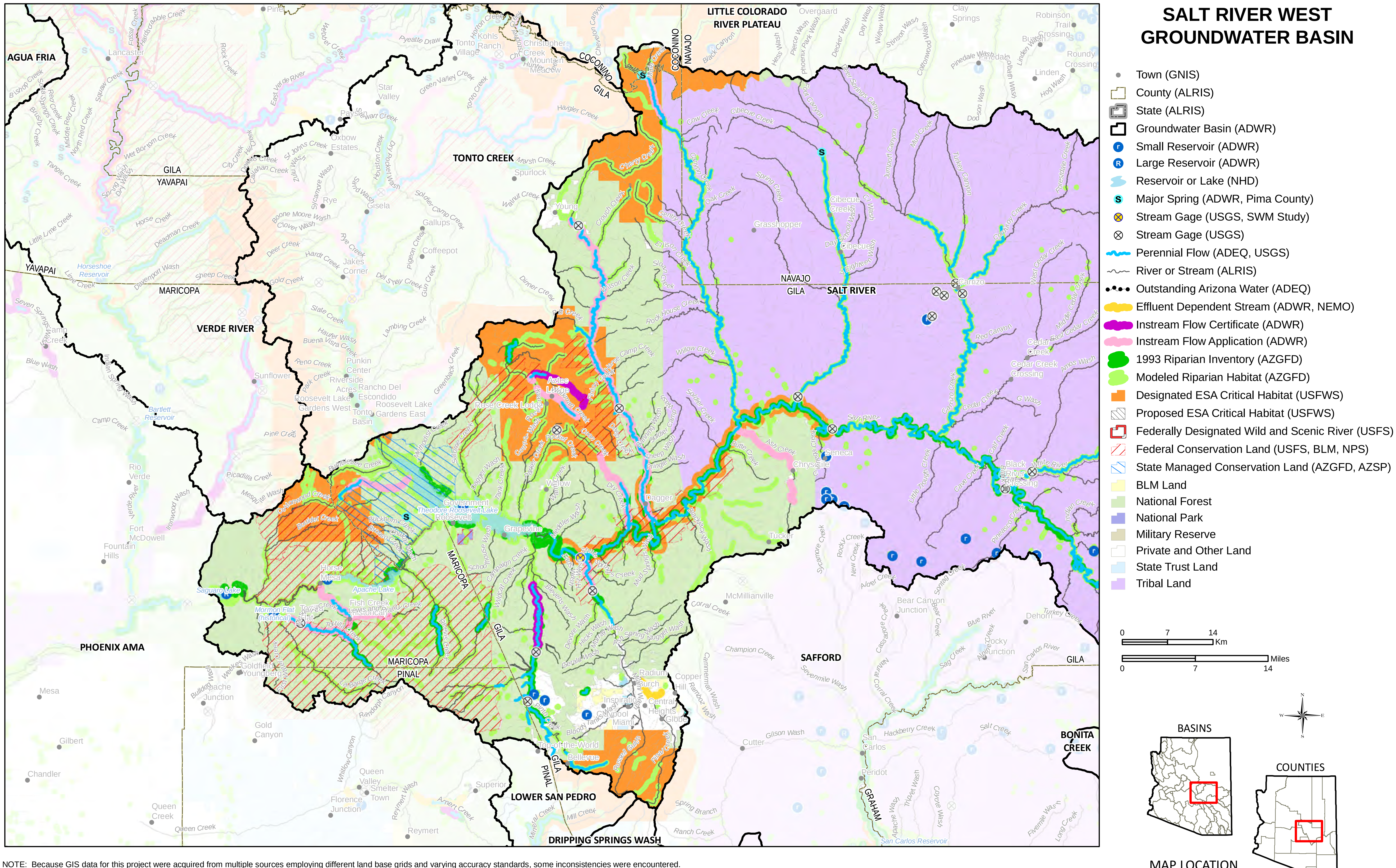
SALT RIVER WEST GROUNDWATER BASIN



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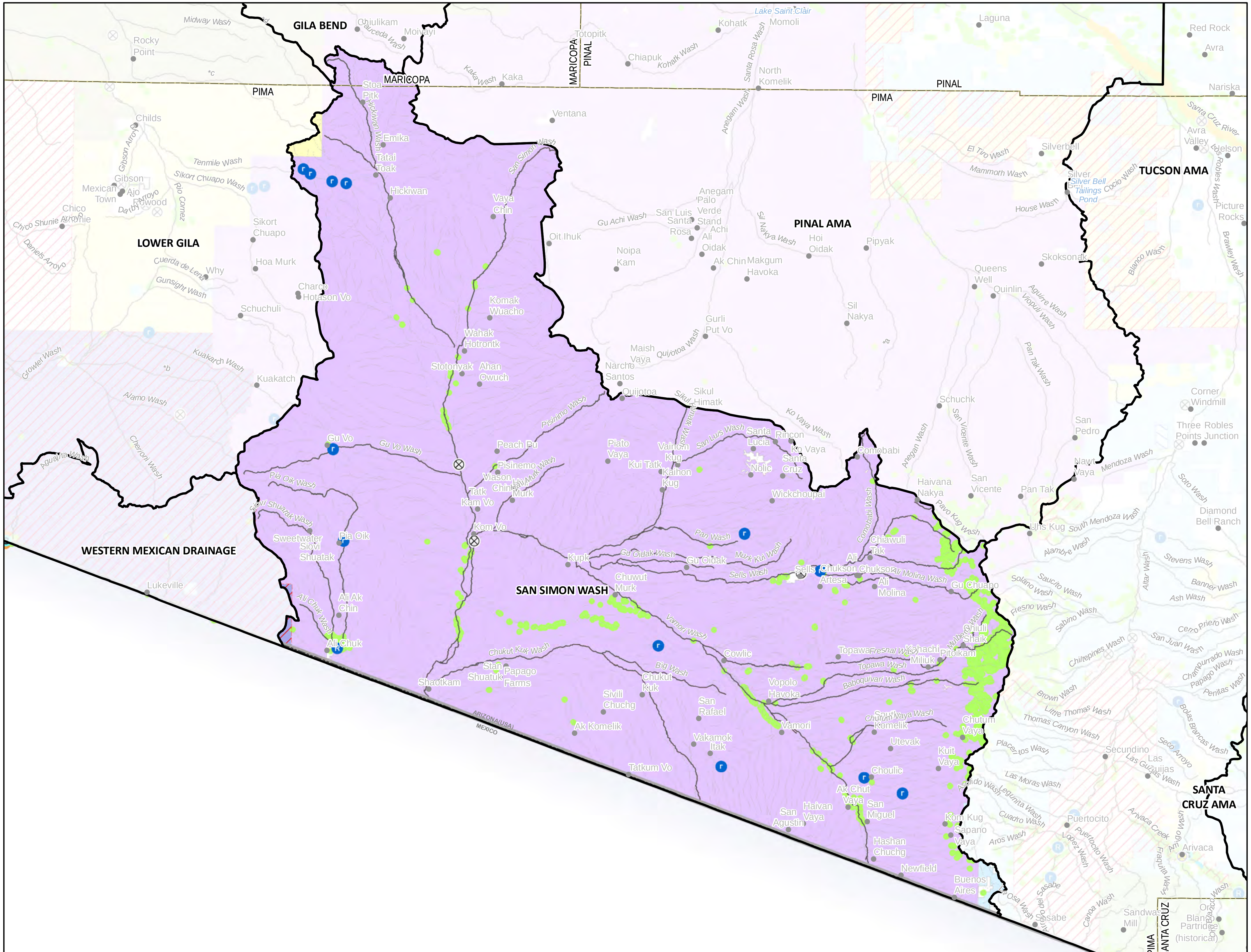
SAN SIMON WASH GROUNDWATER BASIN



- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
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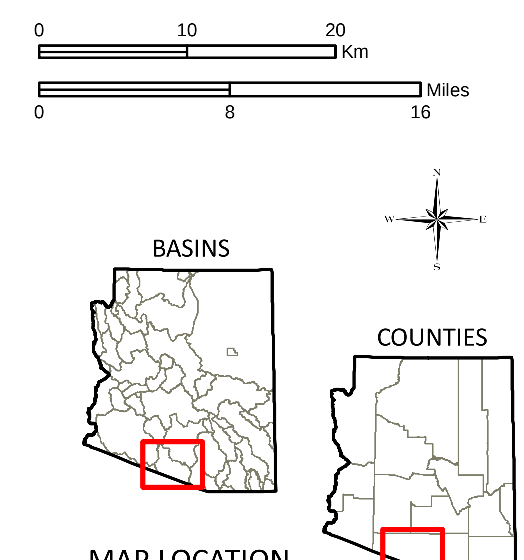
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land



MAP LOCATION

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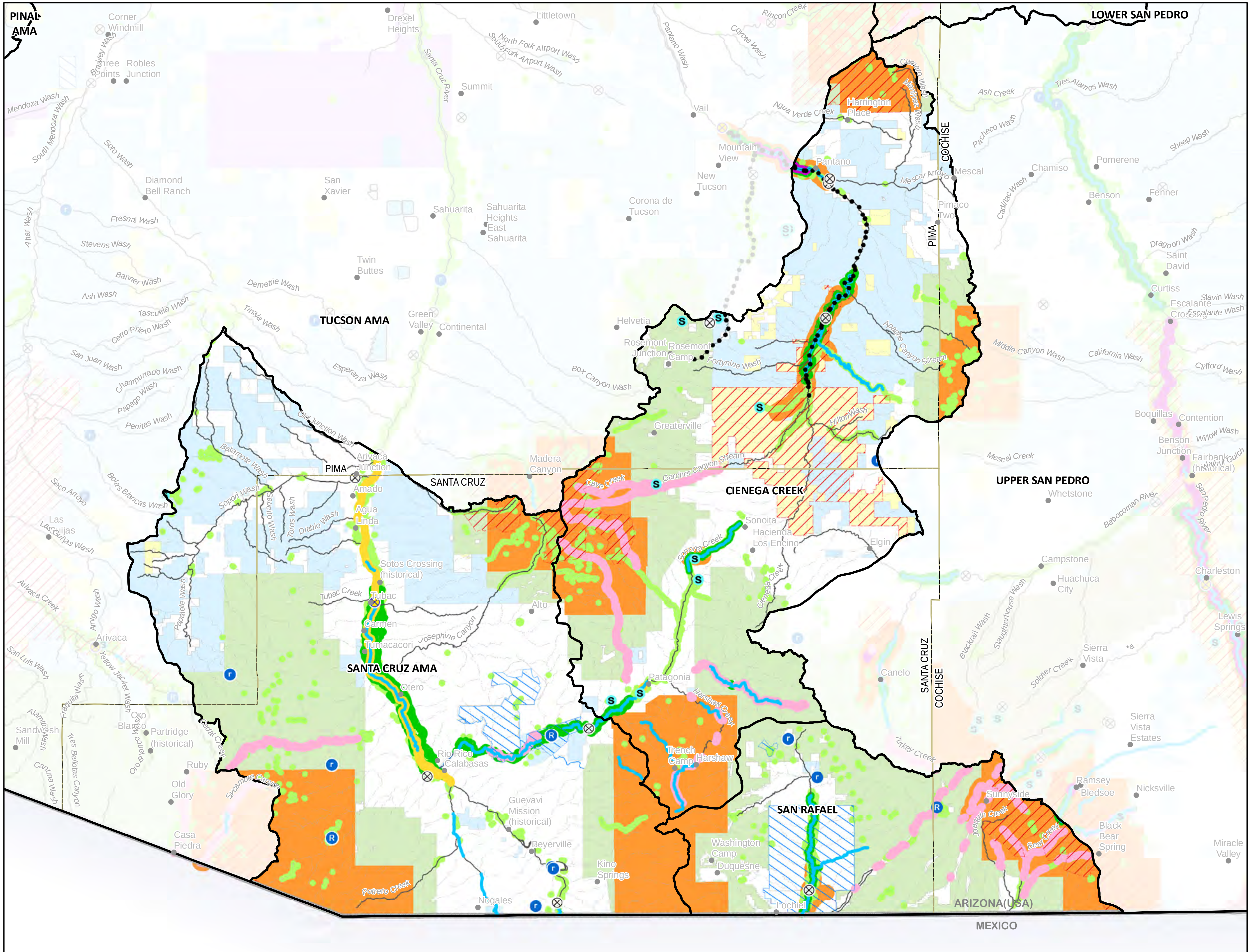
SANTA CRUZ GROUPING

SANTA CRUZ- SAN RAFAEL- CIENEGA



- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
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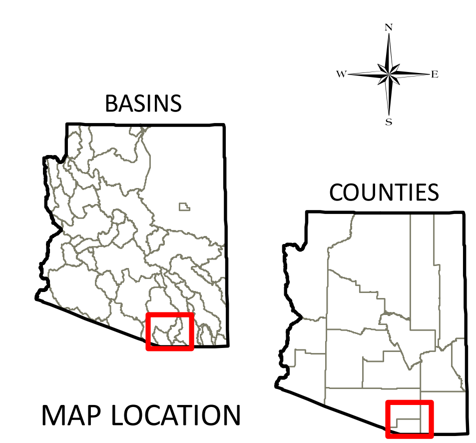
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private and Other Land
- State Trust Land
- Tribal Land

0 8 16 Km

0 6 12 Miles



MAP LOCATION

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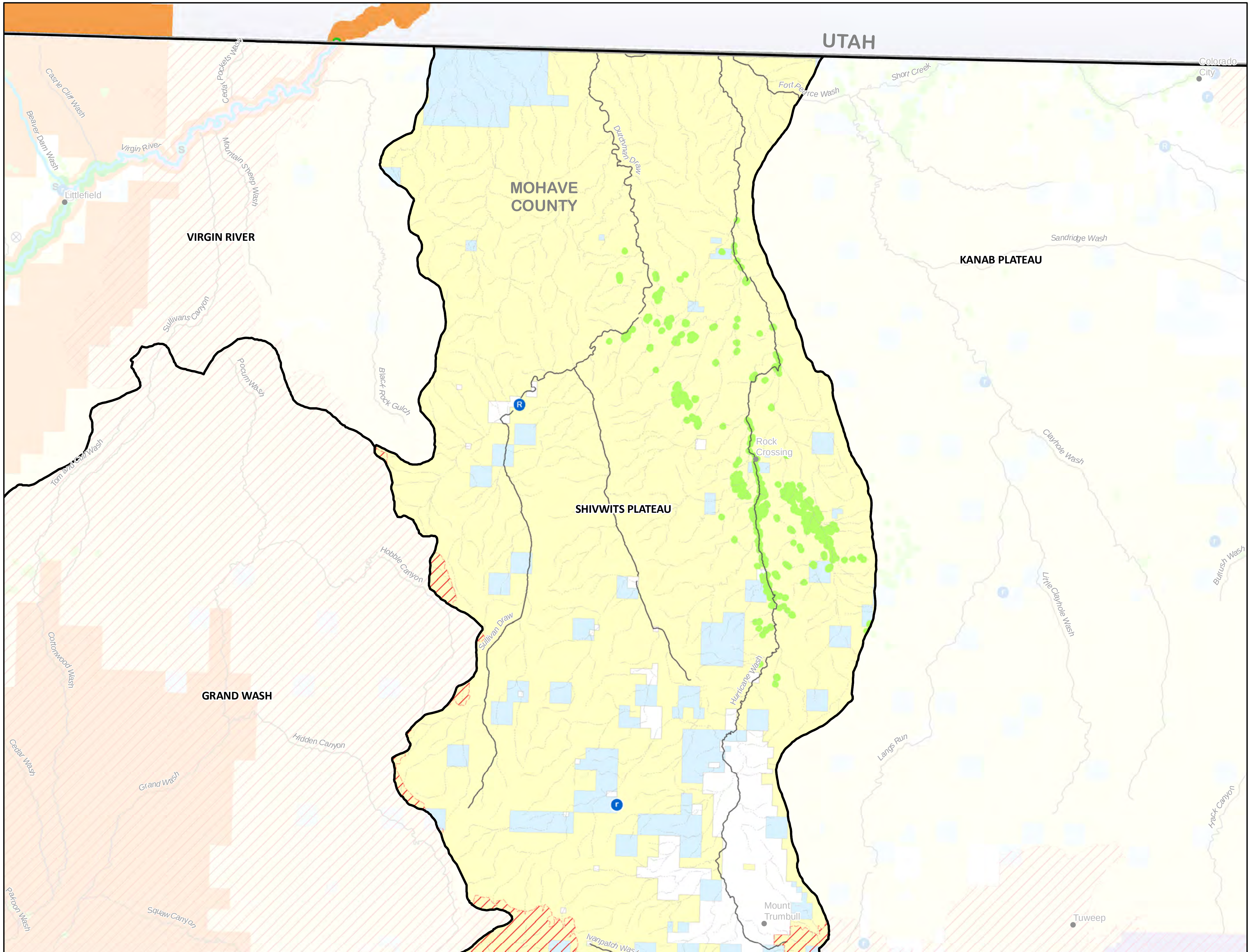
SHIVWITS PLATEAU NORTH GROUNDWATER BASIN



- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
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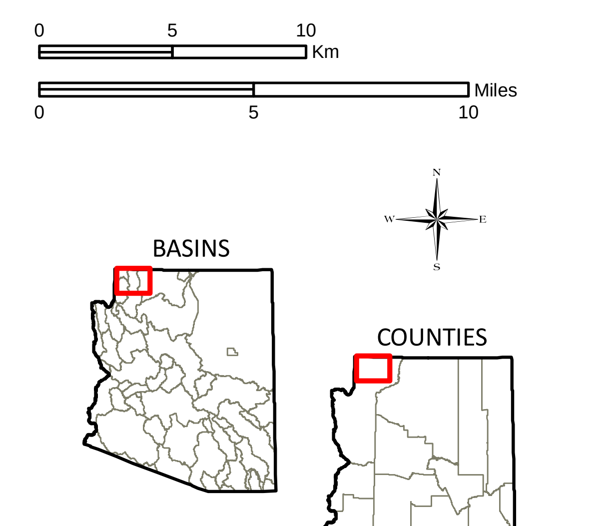

MAP LOCATION

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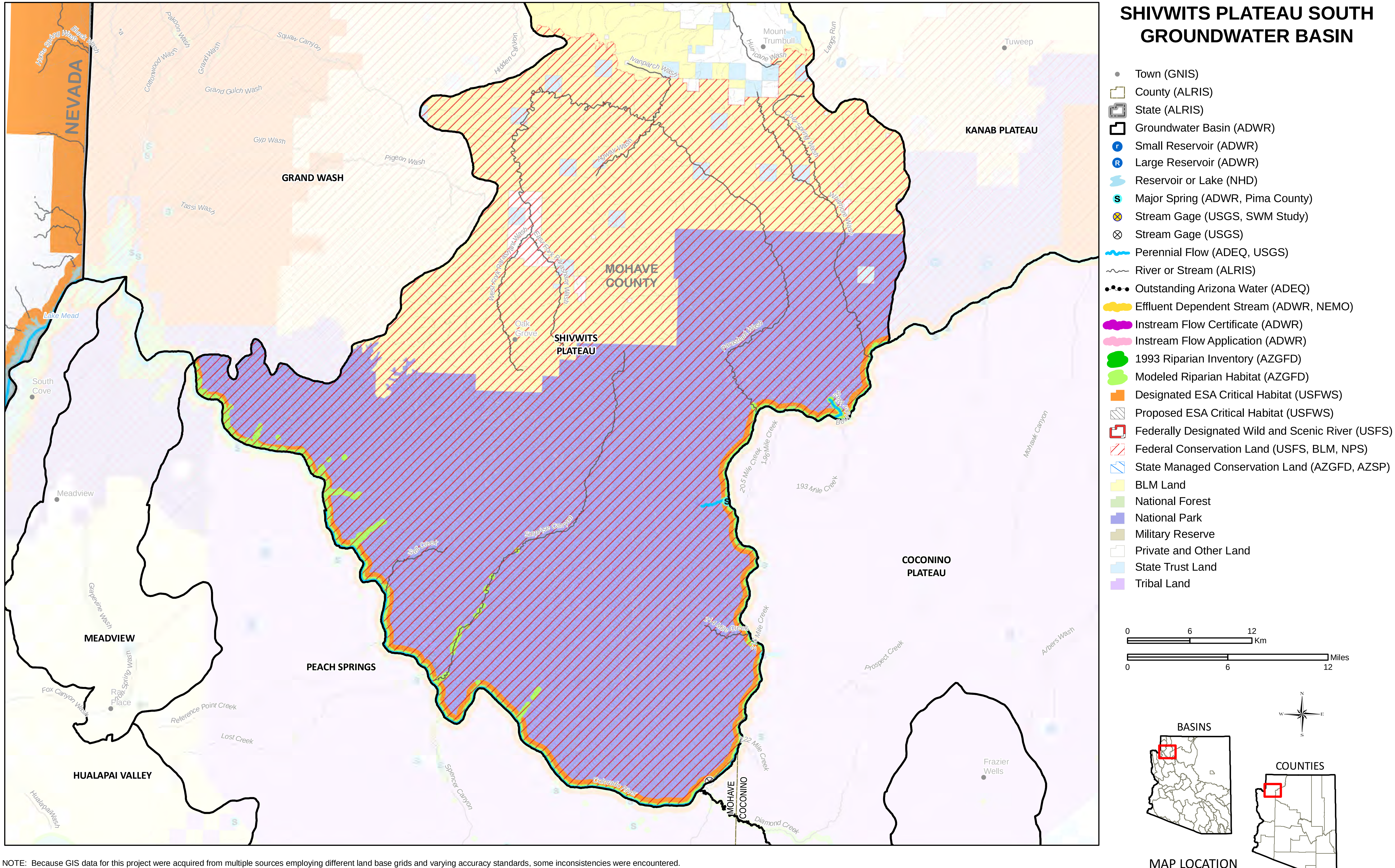

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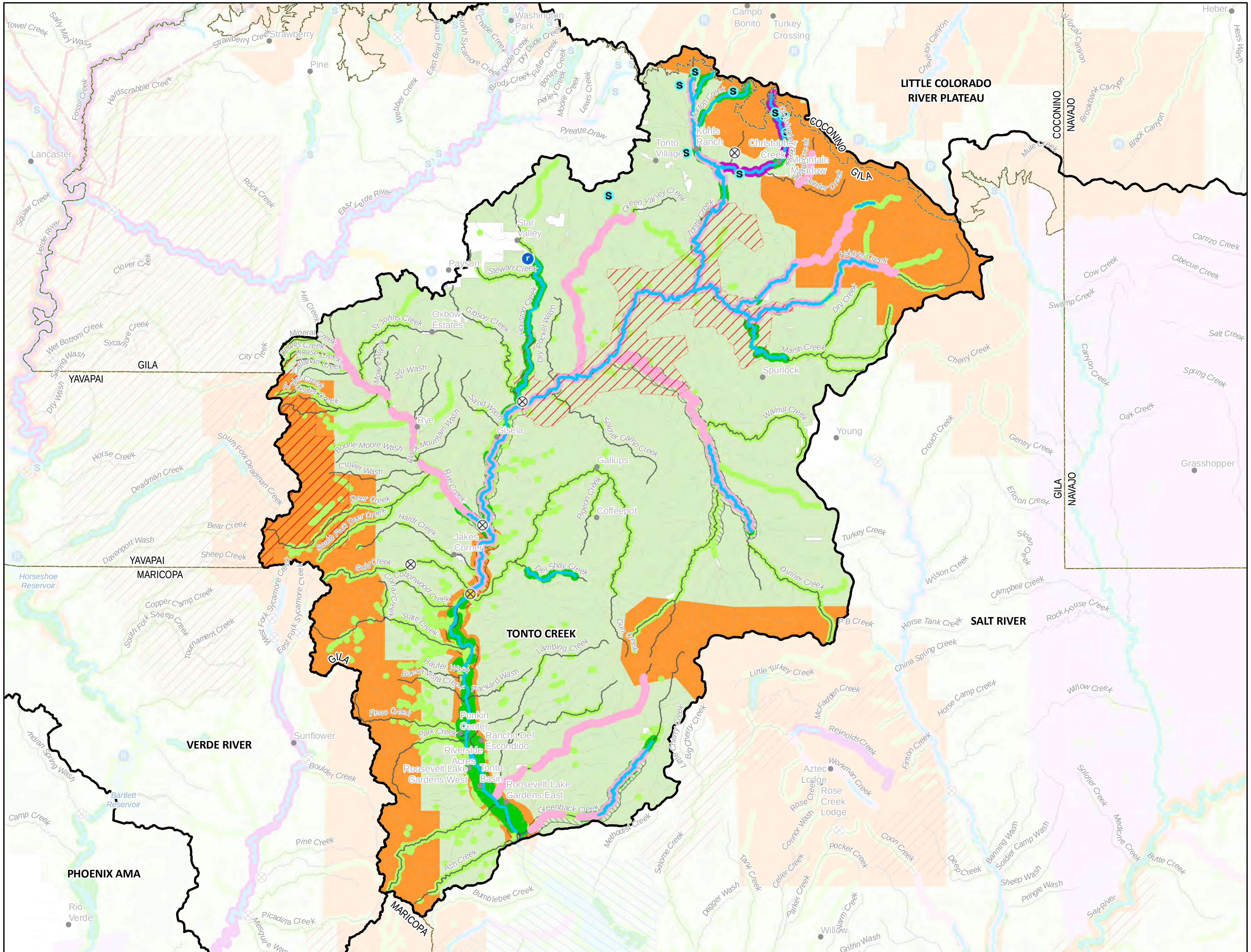
TONTO CREEK GROUNDWATER BASIN



- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
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- Perennial Flow (ADEQ, USGS)
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- National Park
- Military Reserve
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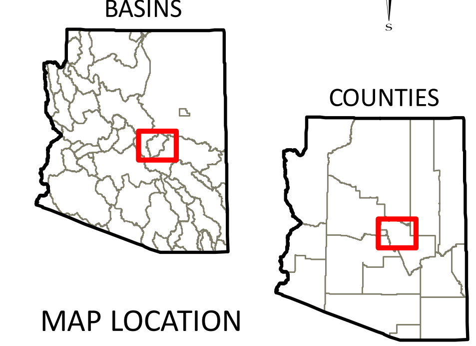
- Tribal Land

0 7 14 Km

0 5 10 Miles



MAP LOCATION

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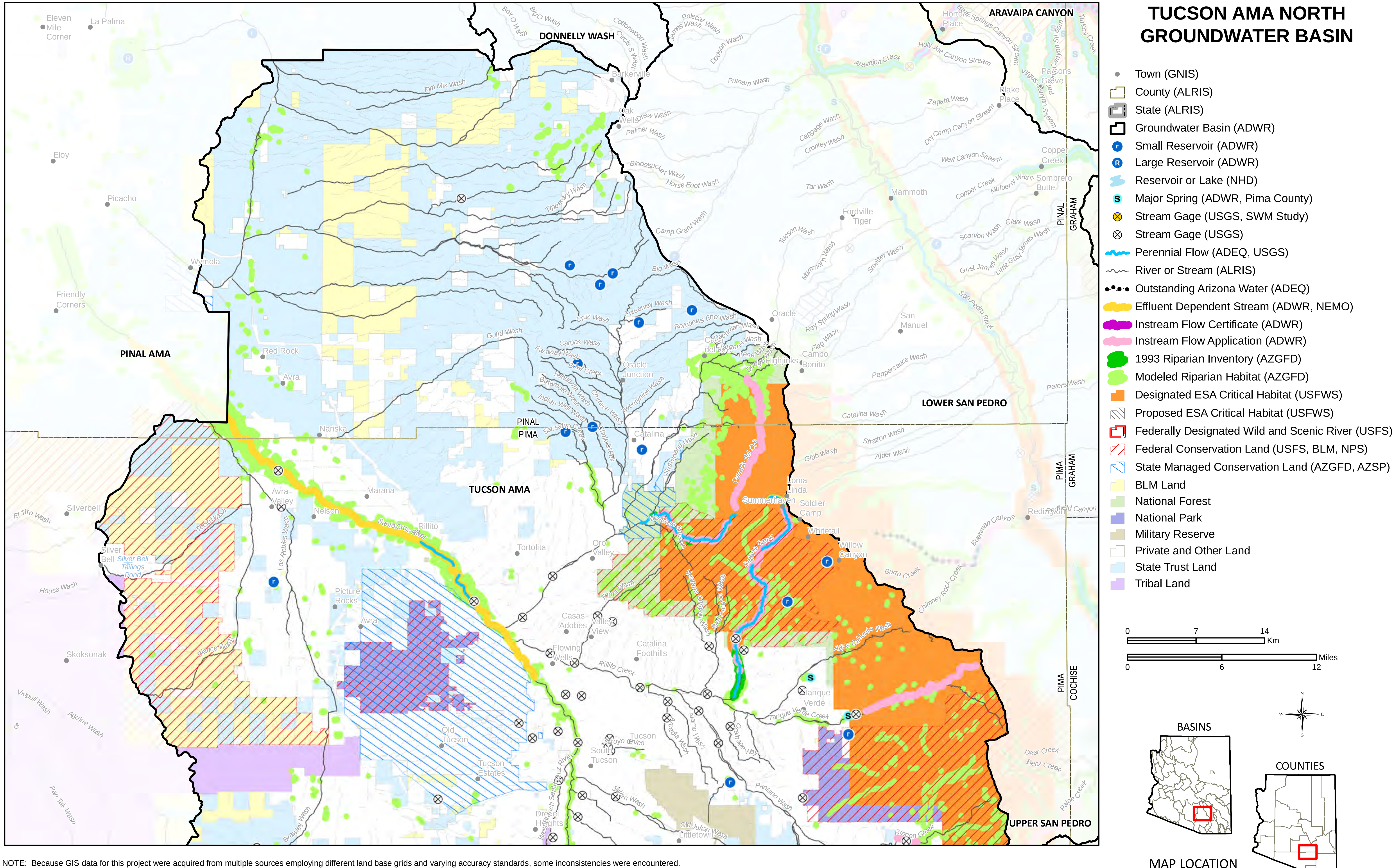
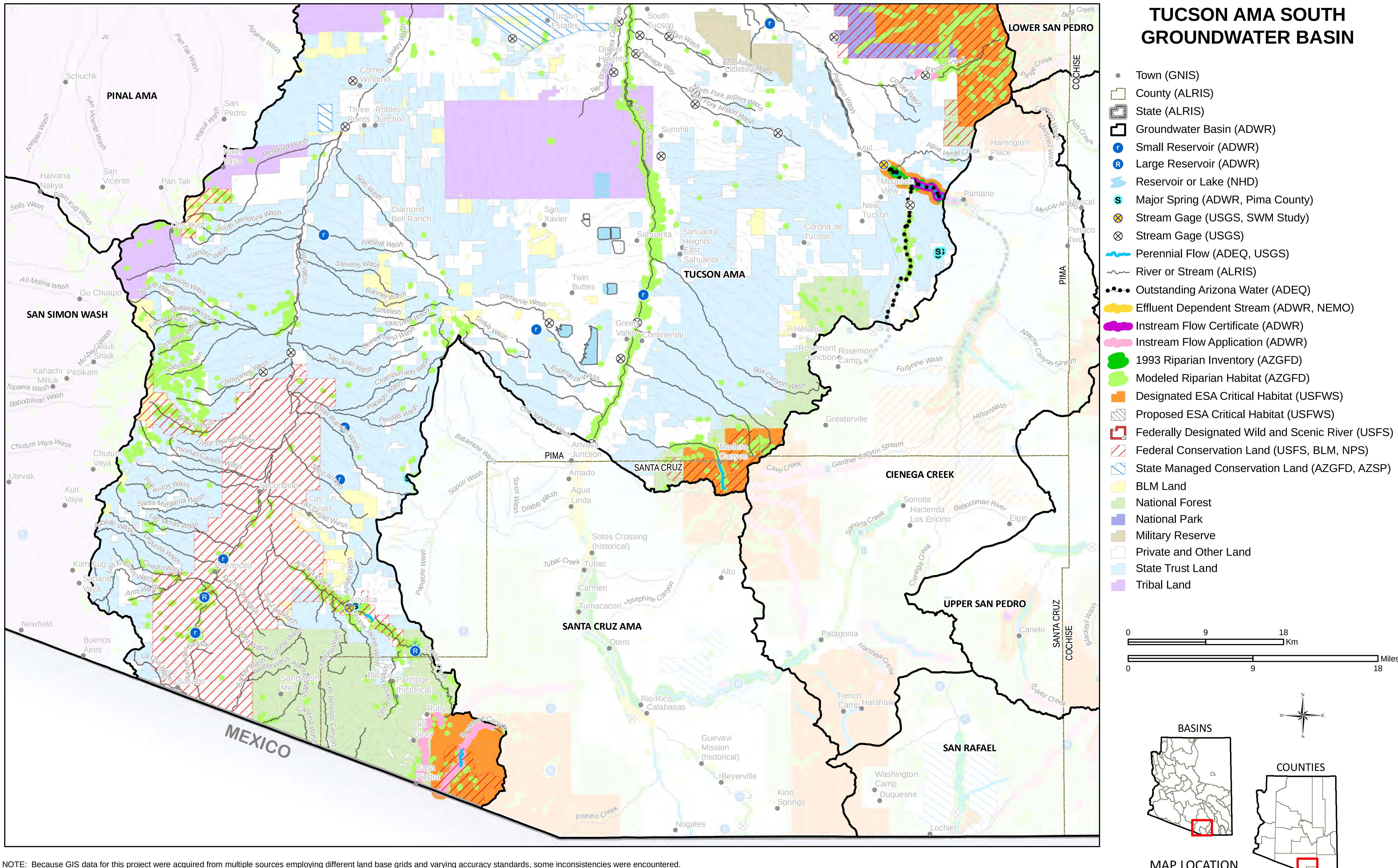
TUCSON AMA NORTH GROUNDWATER BASIN





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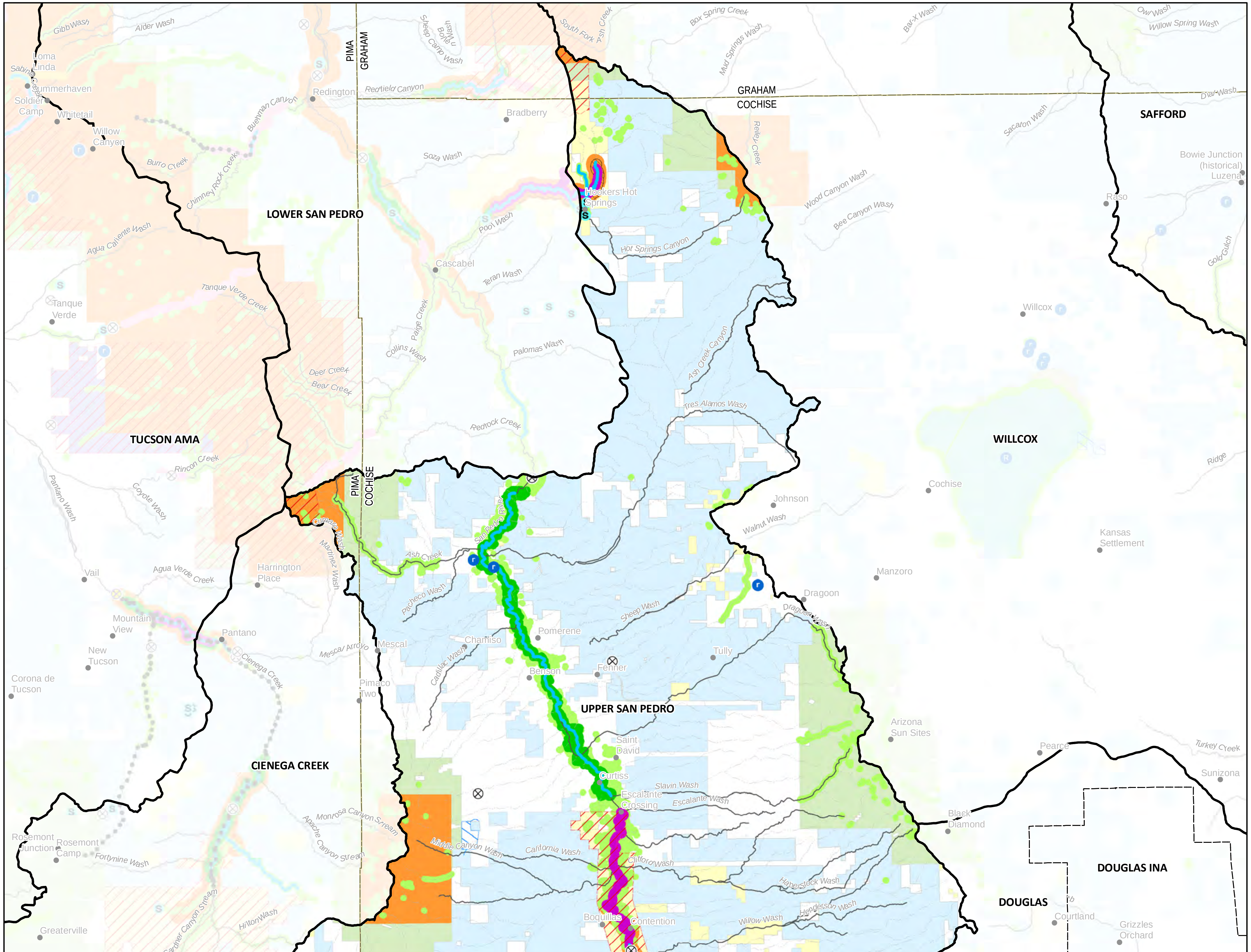
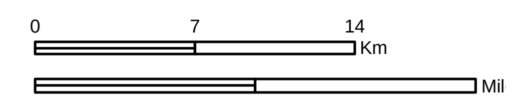
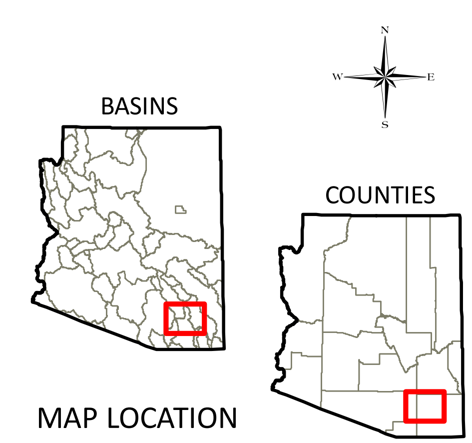
UPPER SAN PEDRO NORTH GROUNDWATER BASIN



- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (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)
- 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





MAP LOCATION

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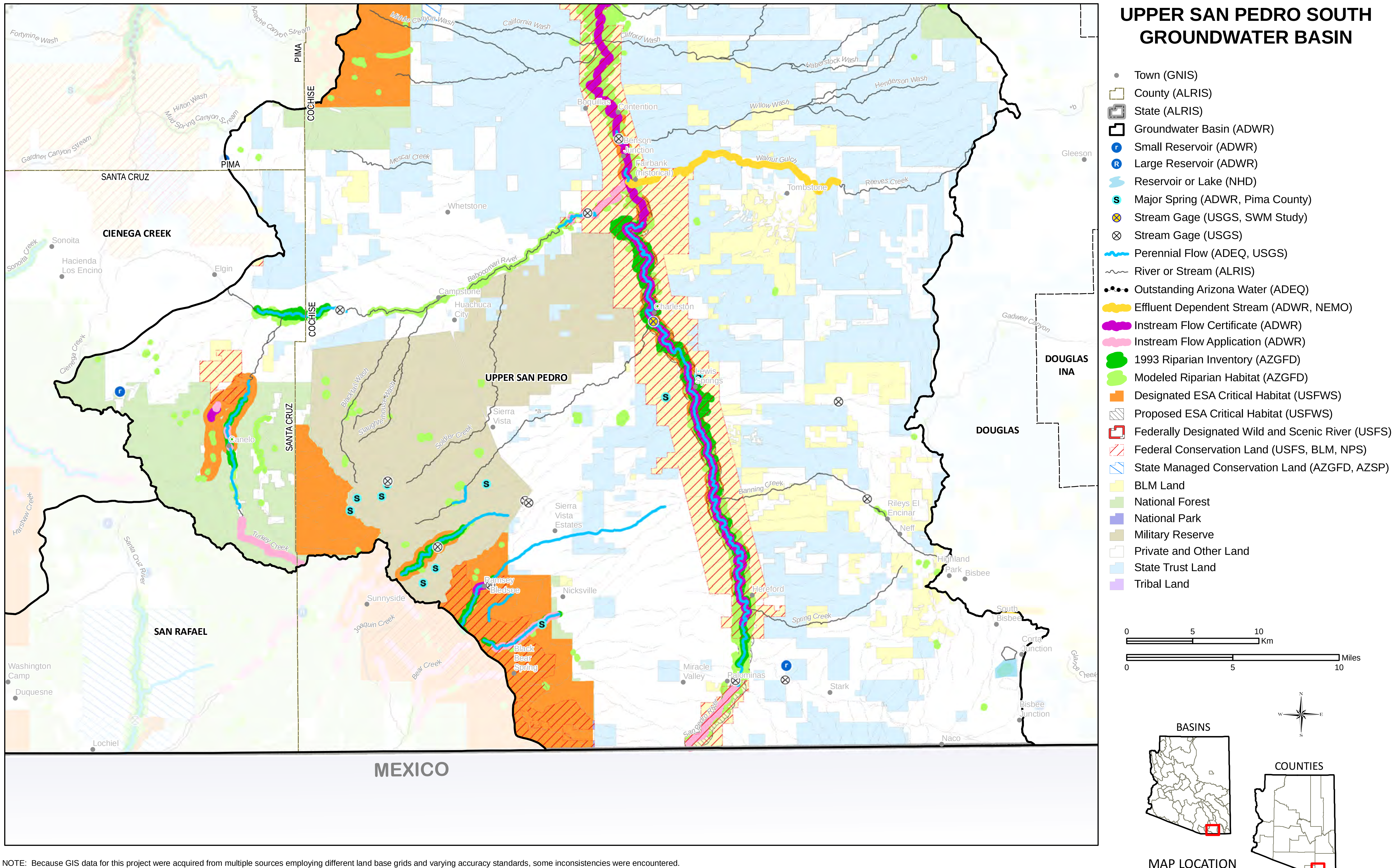

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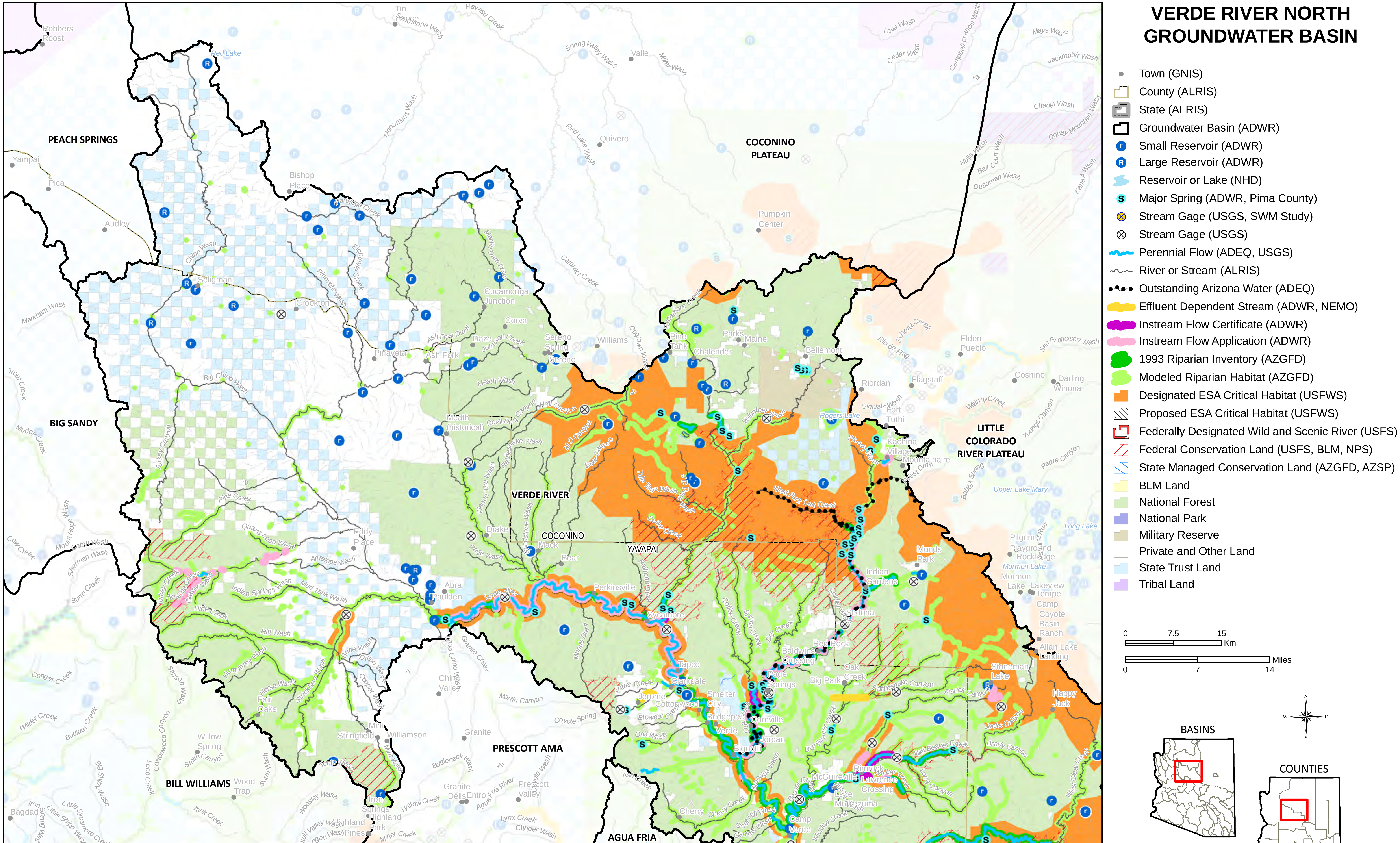

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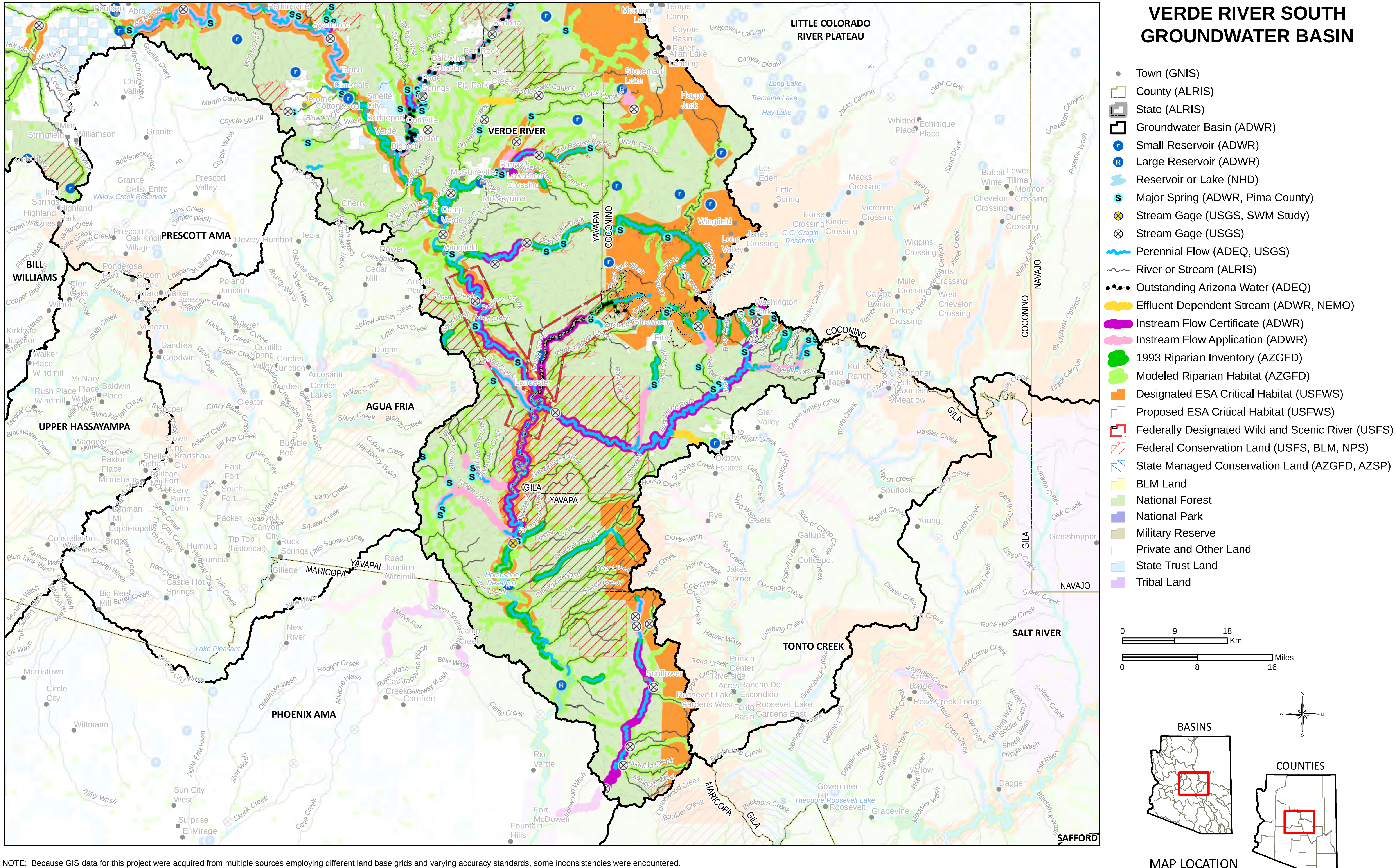
VERDE RIVER SOUTH GROUNDWATER BASIN



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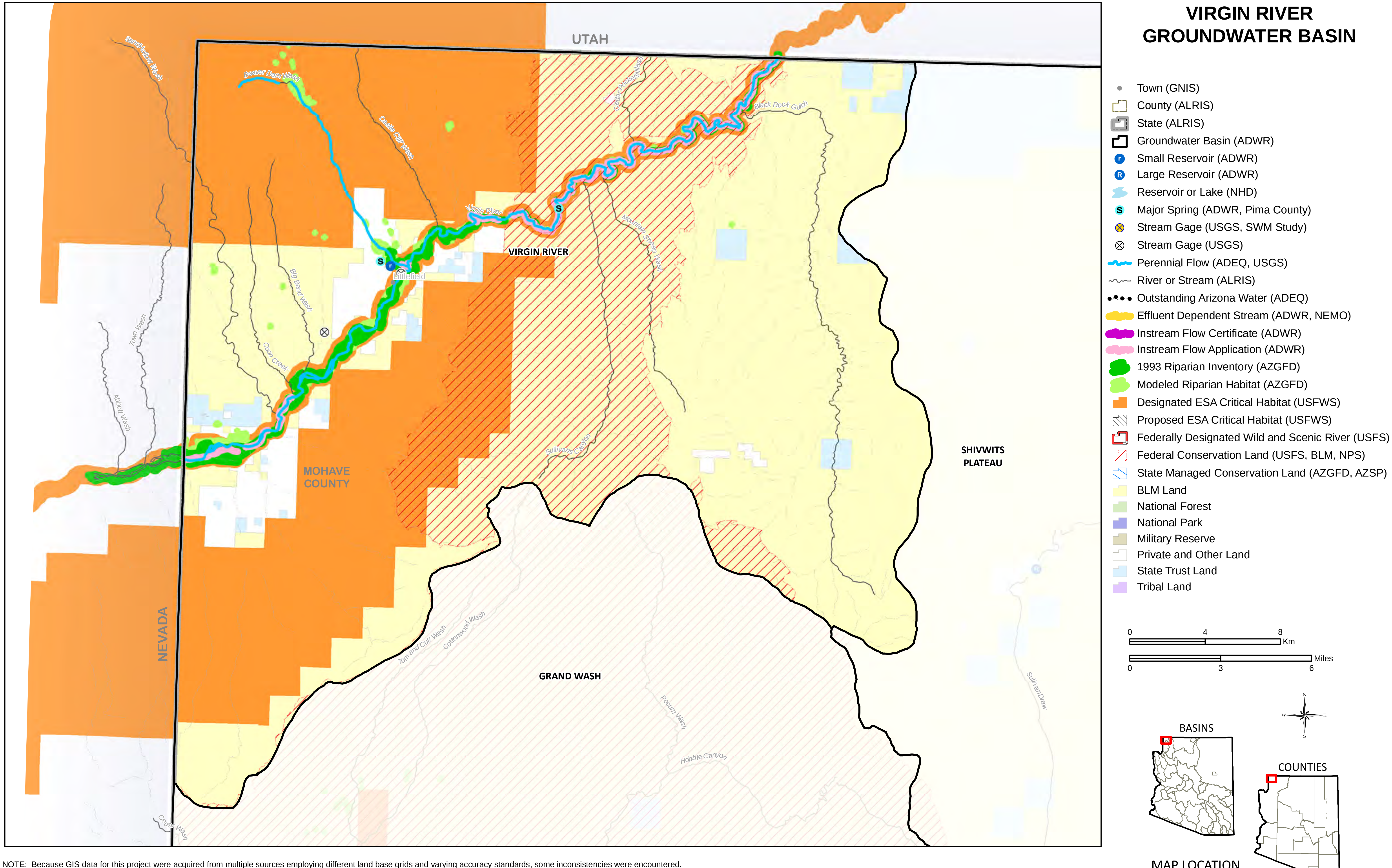
VIRGIN RIVER GROUNDWATER BASIN



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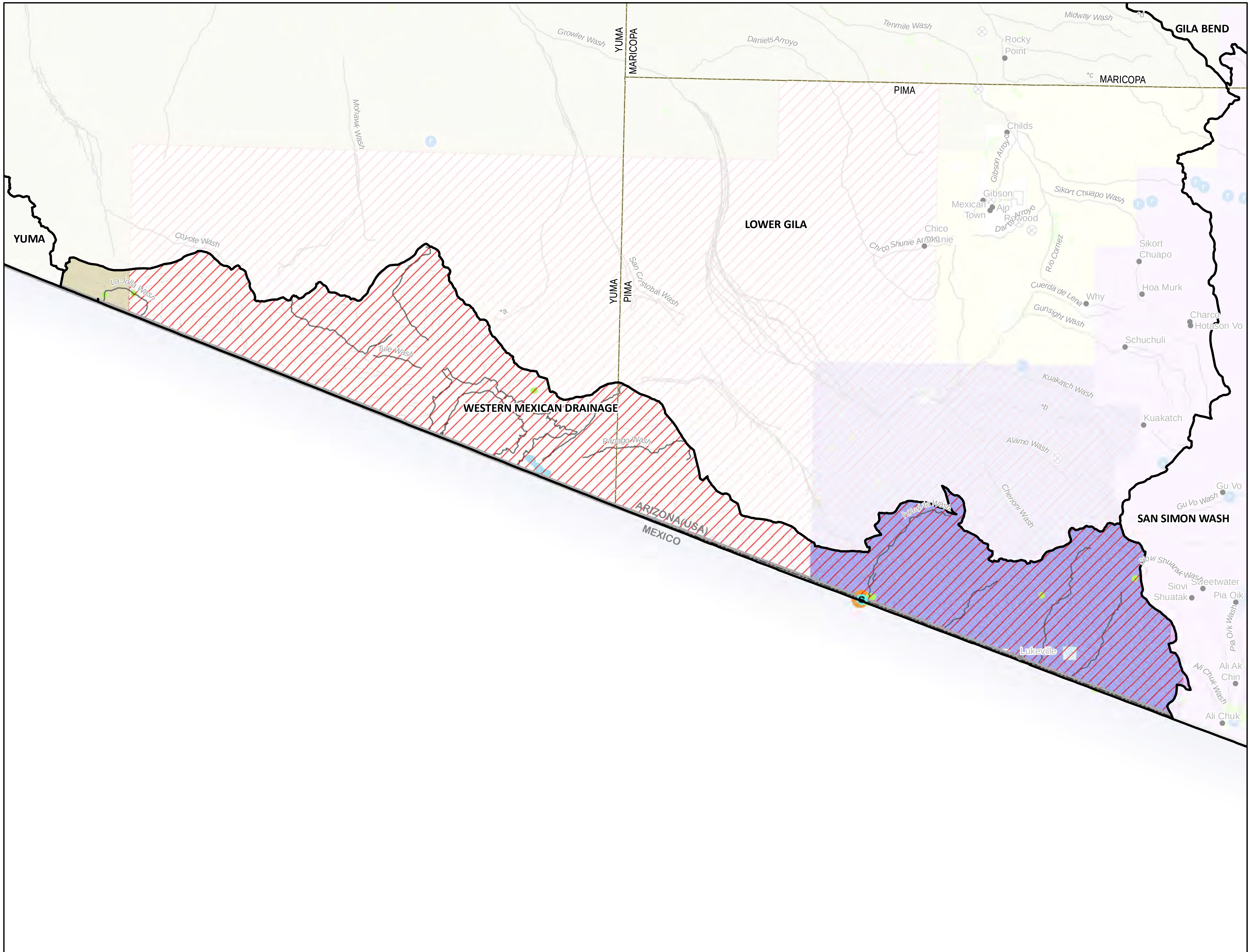
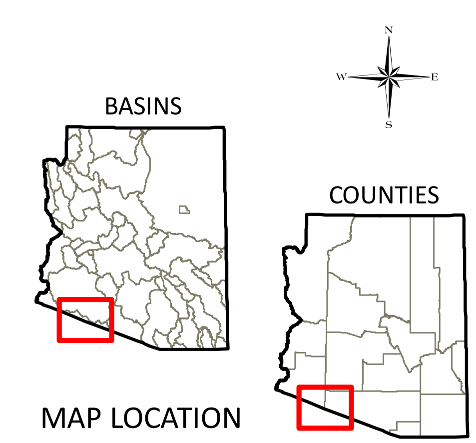


W. MEXICAN DRAINAGE GROUNDWATER BASIN

- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (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)
- 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

0 10 20 Km

0 8 16 Miles



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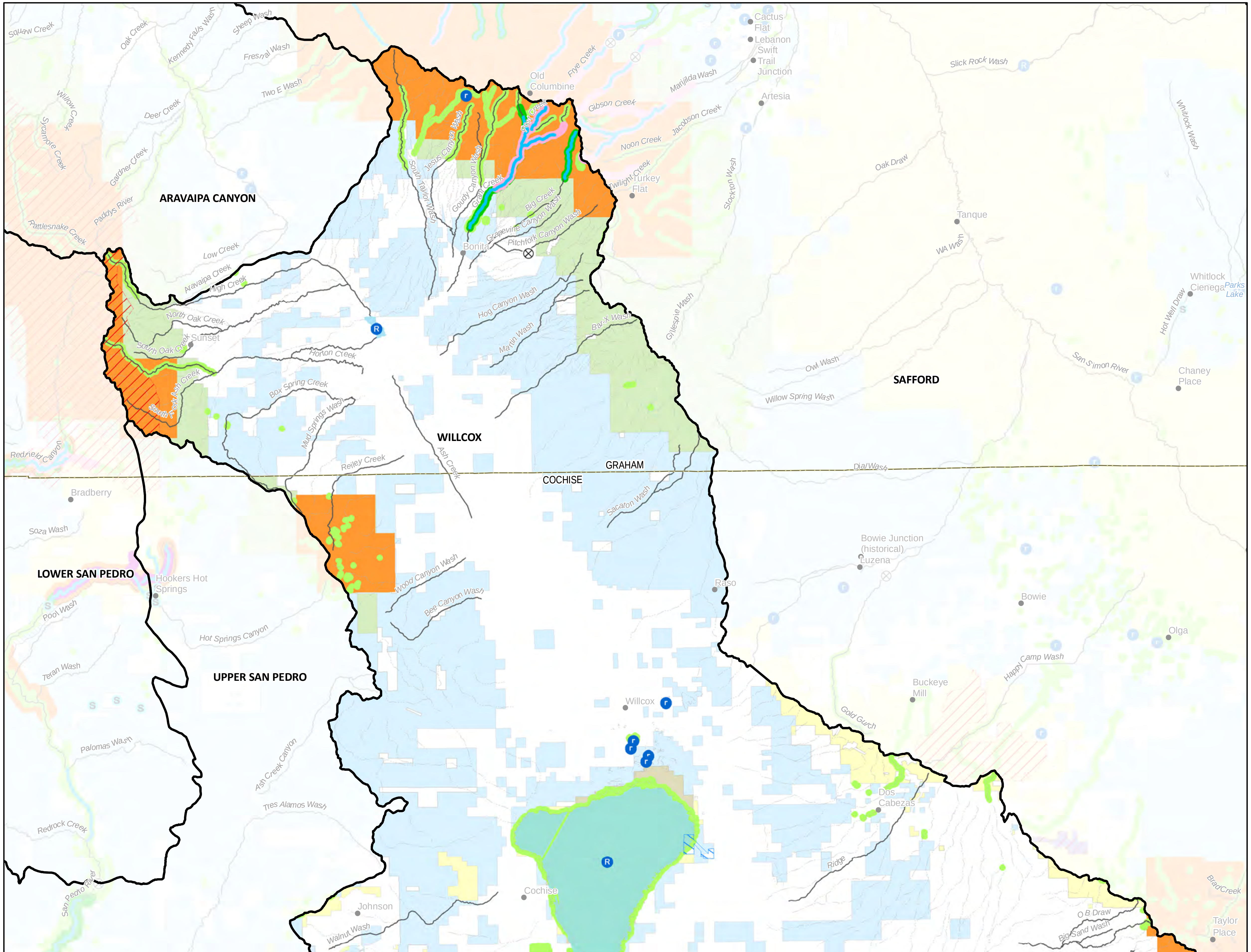
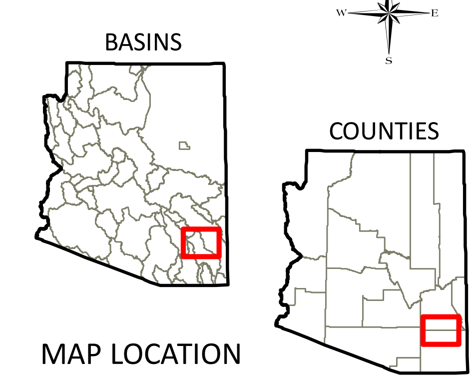


WILLCOX NORTH GROUNDWATER BASIN

- Town (GNIS)
- County (ALRIS)
- State (ALRIS)
- Groundwater Basin (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir or Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (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)
- 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

0 7.5 15 Km

0 7.5 15 Miles



MAP LOCATION

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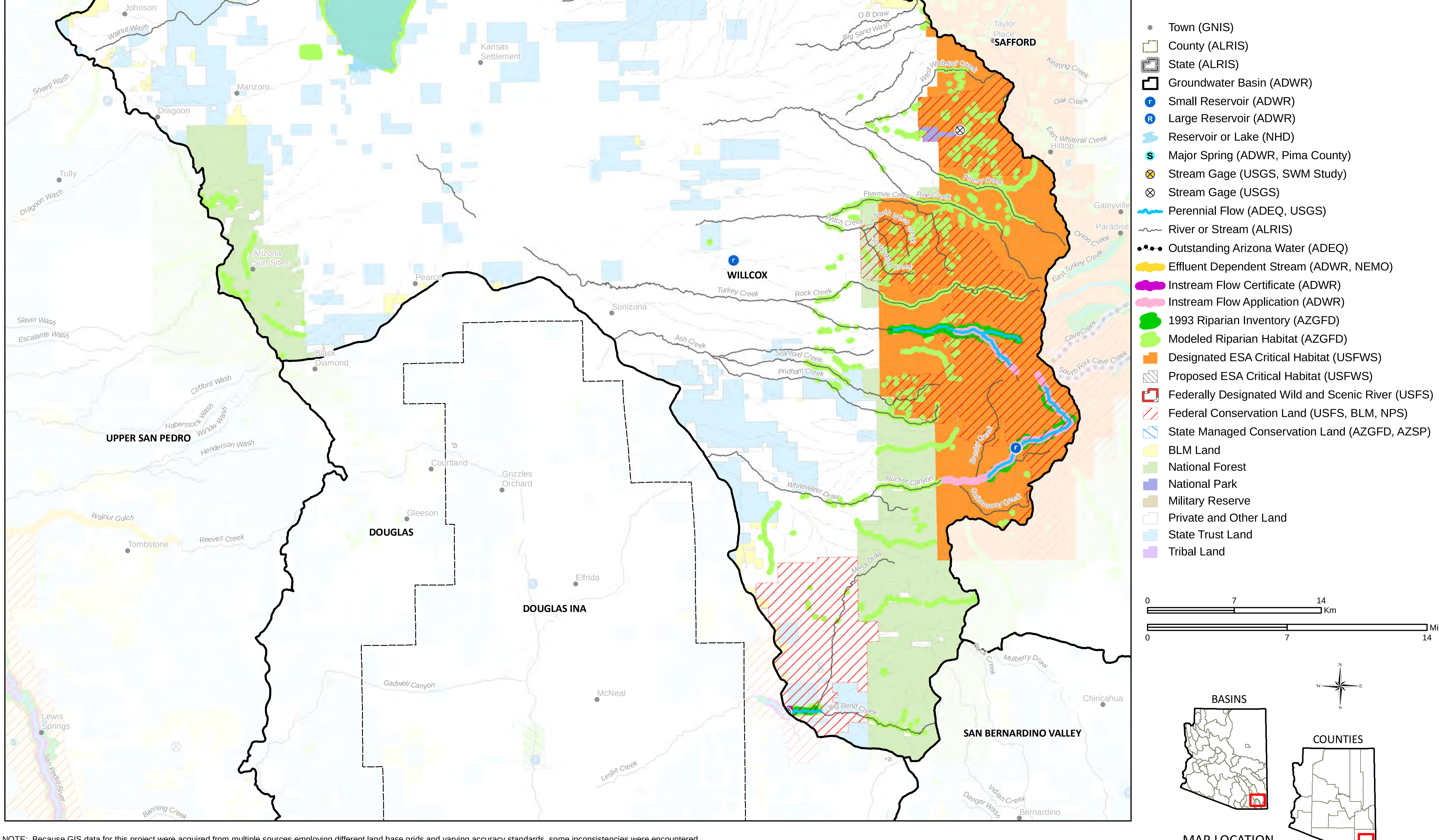
WILLCOX SOUTH GROUNDWATER BASIN



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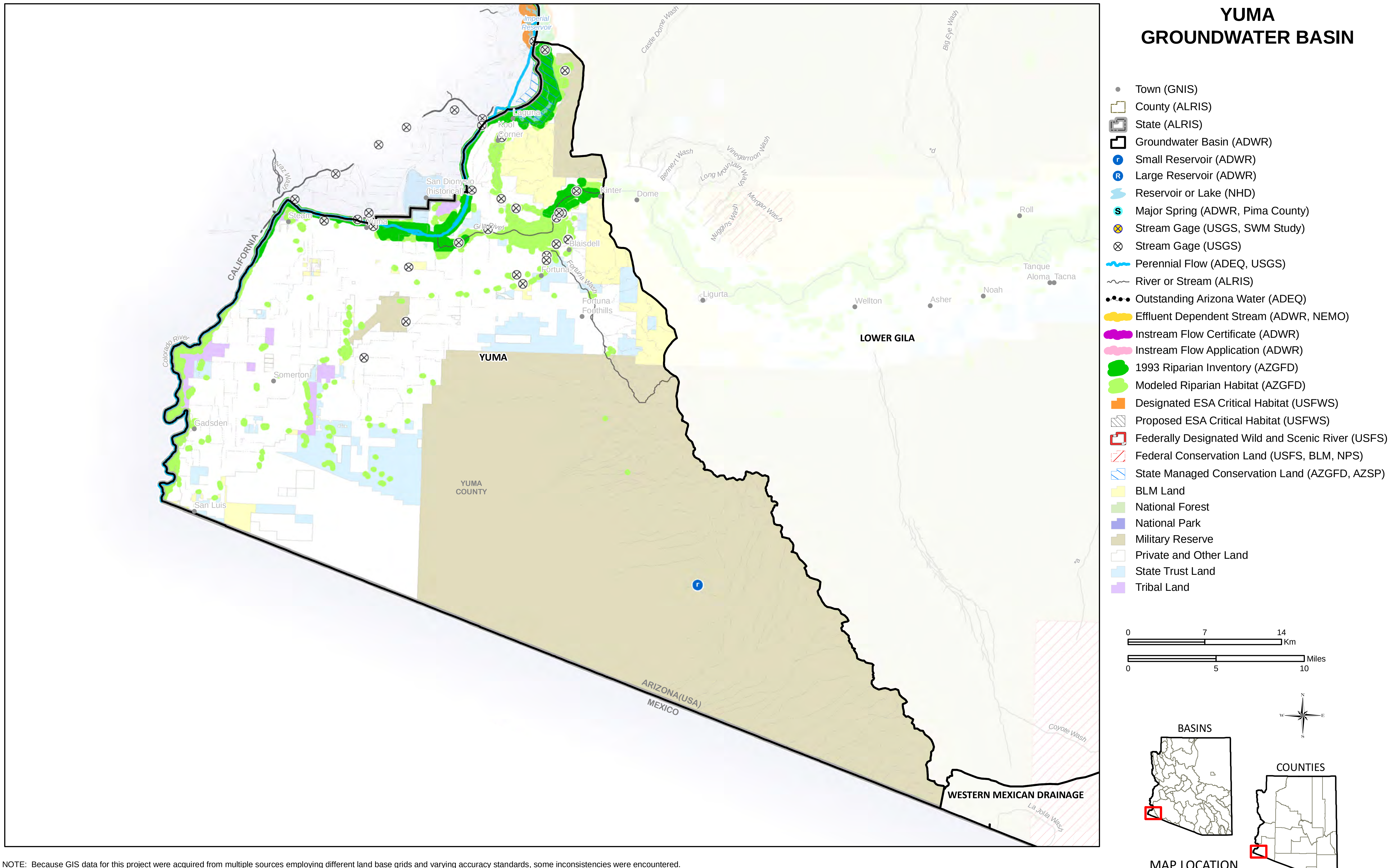

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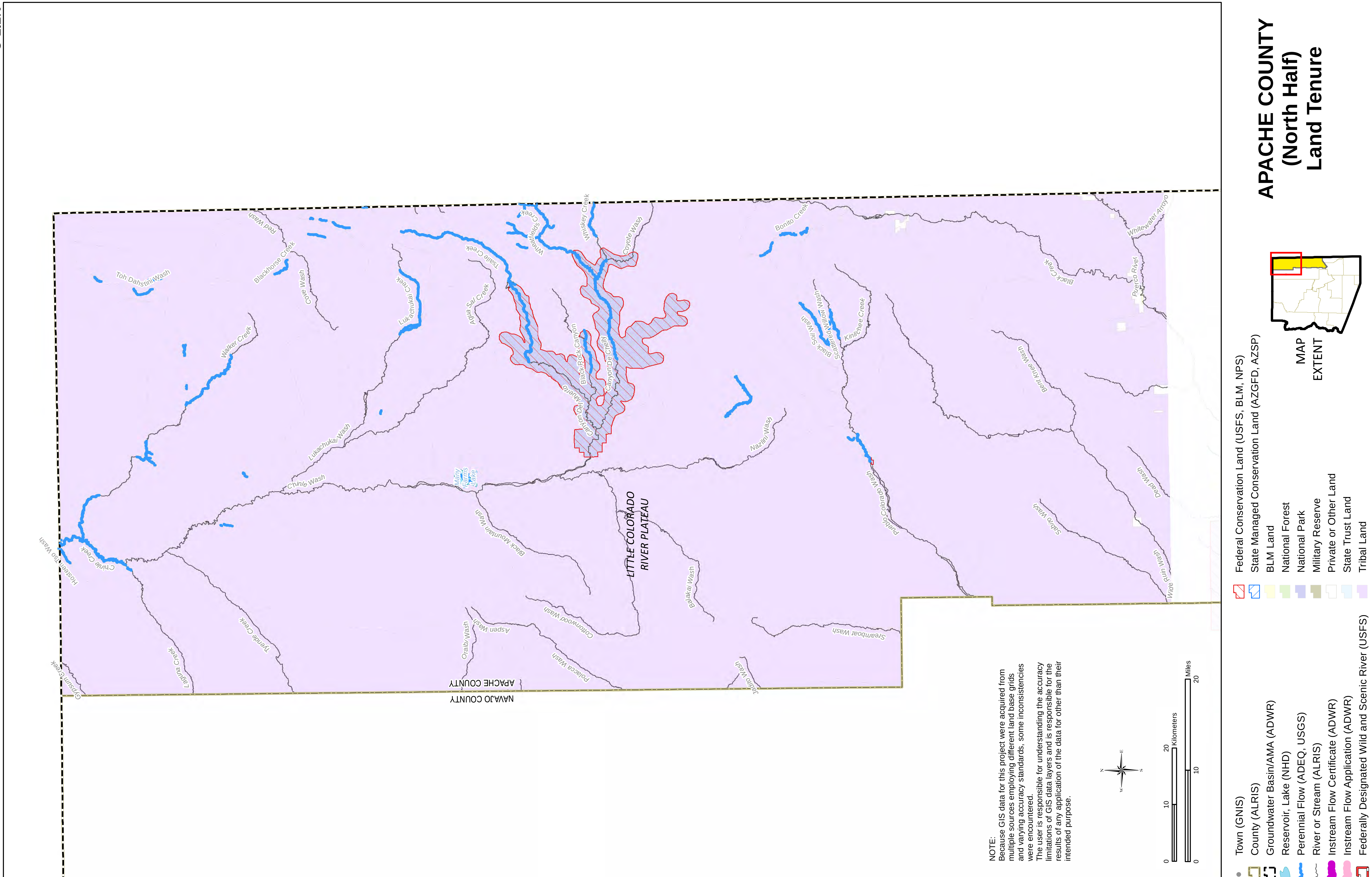
C-1.1N


APACHE COUNTY
(North Half)
Land Tenure
MAP EXTENT
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation Land (AZGFD, AZSP)
BLM Land
National Forest
National Park
Military Reserve
Private or Other Land
State Trust Land
Tribal Land
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Reservoir, Lake (NHD)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Instream Flow Certificate (ADWR)
Instream Flow Application (ADWR)
Federally Designated Wild and Scenic River (USFS)
Miles
Kilometers
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.
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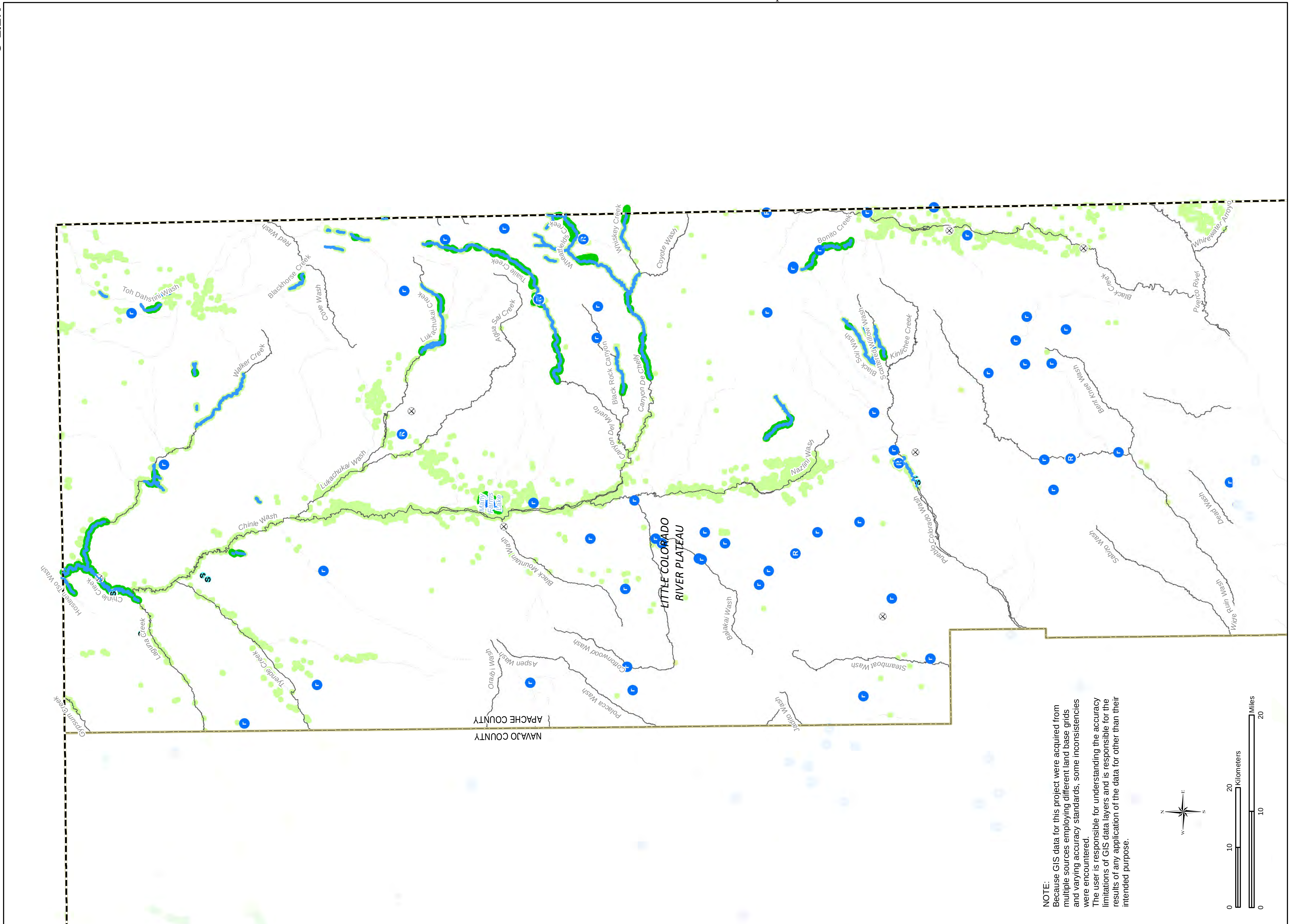
LITTLE COLORADO RIVER PLATEAU
APACHE COUNTY
NAVAJO COUNTY
Canyon De Chelly
Chinle Wash
Lukachukai Wash
Nazlini Wash
Pueblo Colorado Wash
Black Mountain Wash
Cottonwood Wash
Steamboat Wash
Walker Creek
Whiskey Creek
Wheatfields Creek
Tsaile Creek
Lukachukai Creek
Bonito Creek
Whitewater Arroyo
Black Creek
Red Wash
Cove Wash
Blackhorse Creek
Toh Dahstini Wash
Chinle Creek
Laguna Creek
Oraibi Wash
Aspen Wash
Polacca Wash
Jeddito Wash
Balakai Wash
Sabito Wash
Wide Ruin Wash
Bear Knee Wash

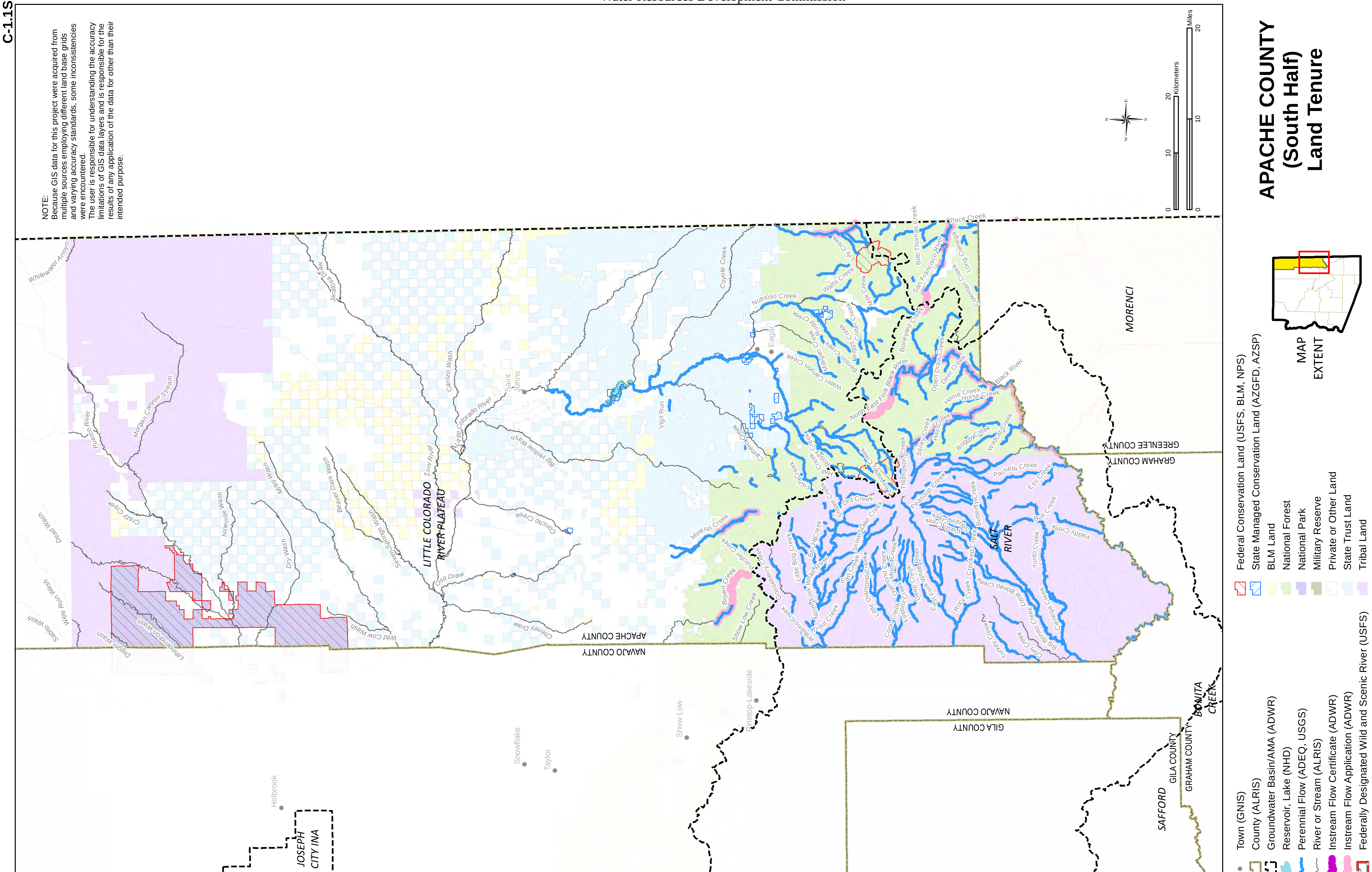
C-1.2N



APACHE COUNTY (North Half) Natural Resources

MAP EXTENT

- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Small Reservoir
- Large Reservoir
- Reservoir, Lake (NHD)
- Major Spring (ADWR)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- 1993 Riparian Inventory (AZGFD)
- Modeled Riparian Habitat (AZGFD)
- Designated ESA Critical Habitat Area (USFWS)
- Proposed ESA Critical Habitat (USFWS)


C-1.1S
APACHE COUNTY
(South Half)
Land Tenure
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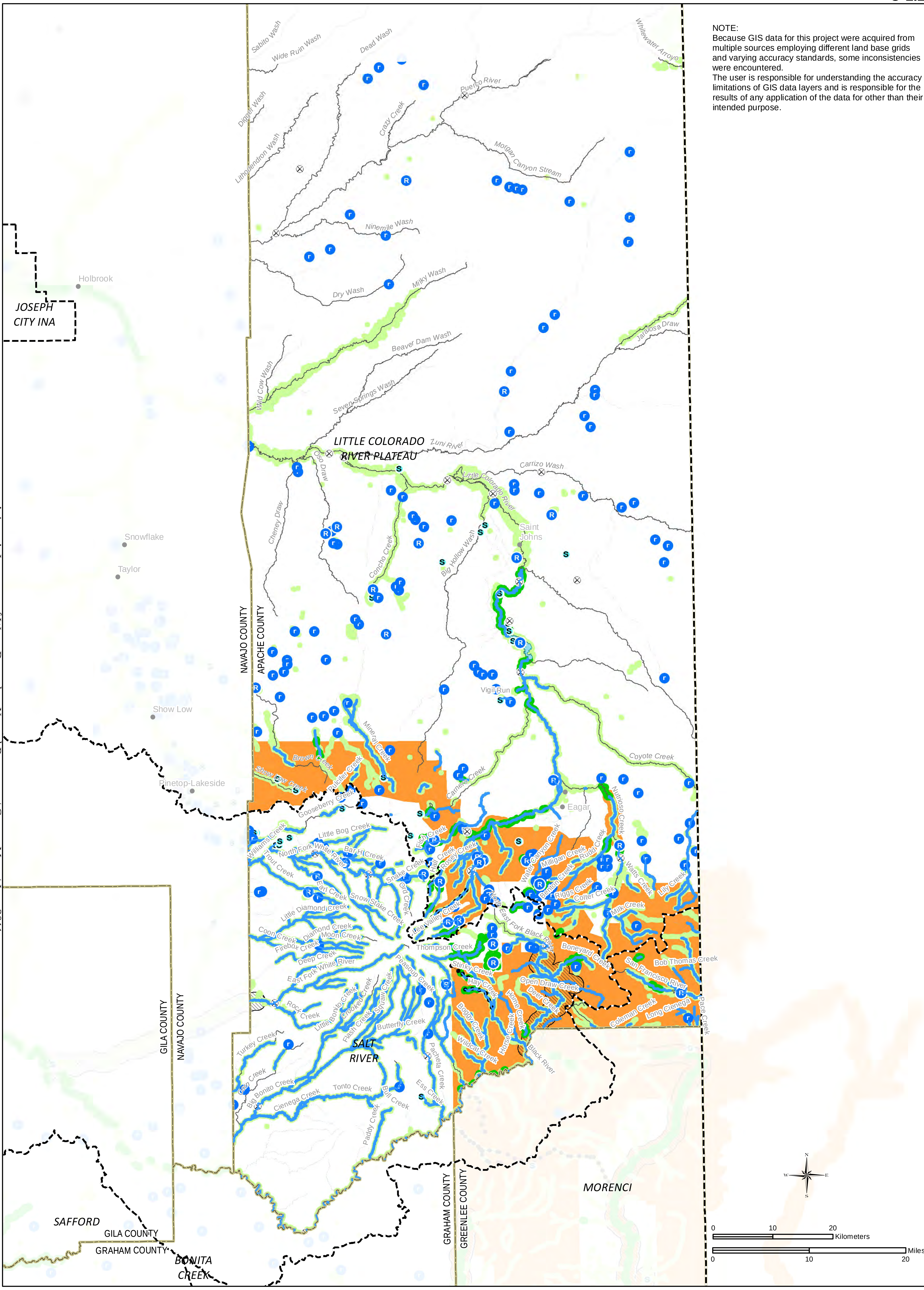
Kilometers
Miles
0
10
20
MAP EXTENT
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Reservoir, Lake (NHD)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Instream Flow Certificate (ADWR)
Instream Flow Application (ADWR)
Federally Designated Wild and Scenic River (USFS)
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation Land (AZGFD, AZSP)
BLM Land
National Forest
National Park
Military Reserve
Private or Other Land
State Trust Land
Tribal Land
LITTLE COLORADO RIVER PLATEAU
SALT RIVER
MORENCI
SAFFORD
BONITA CREEK
JOSEPH CITY INA
APACHE COUNTY
NAVAJO COUNTY
GREENLEE COUNTY
GRAHAM COUNTY
GILA COUNTY
Saint Johns
Eagar
Show Low
Pinetop-Lakeside
Snowflake
Taylor
Holbrook
Little Colorado River
Zuni River
Puerco River
Black River
Nutrioso Creek
Carrizo Wash
Concho Creek
Big Hollow Wash
Vigil Run
Coyote Creek
Mineral Creek
Pacheta Creek
Paddy Creek
Bull Creek
Tonto Creek
Whitewater Arroyo
Morgan Canyon Stream
Milky Wash
Dry Wash
Ninemile Wash
Beaver Dam Wash
Sevenmile Wash
Jaralosa Draw
Oso Draw
Cheney Draw
Wild Cow Wash
Dead Wash
Crazy Creek
Pace Creek

C-1.2S



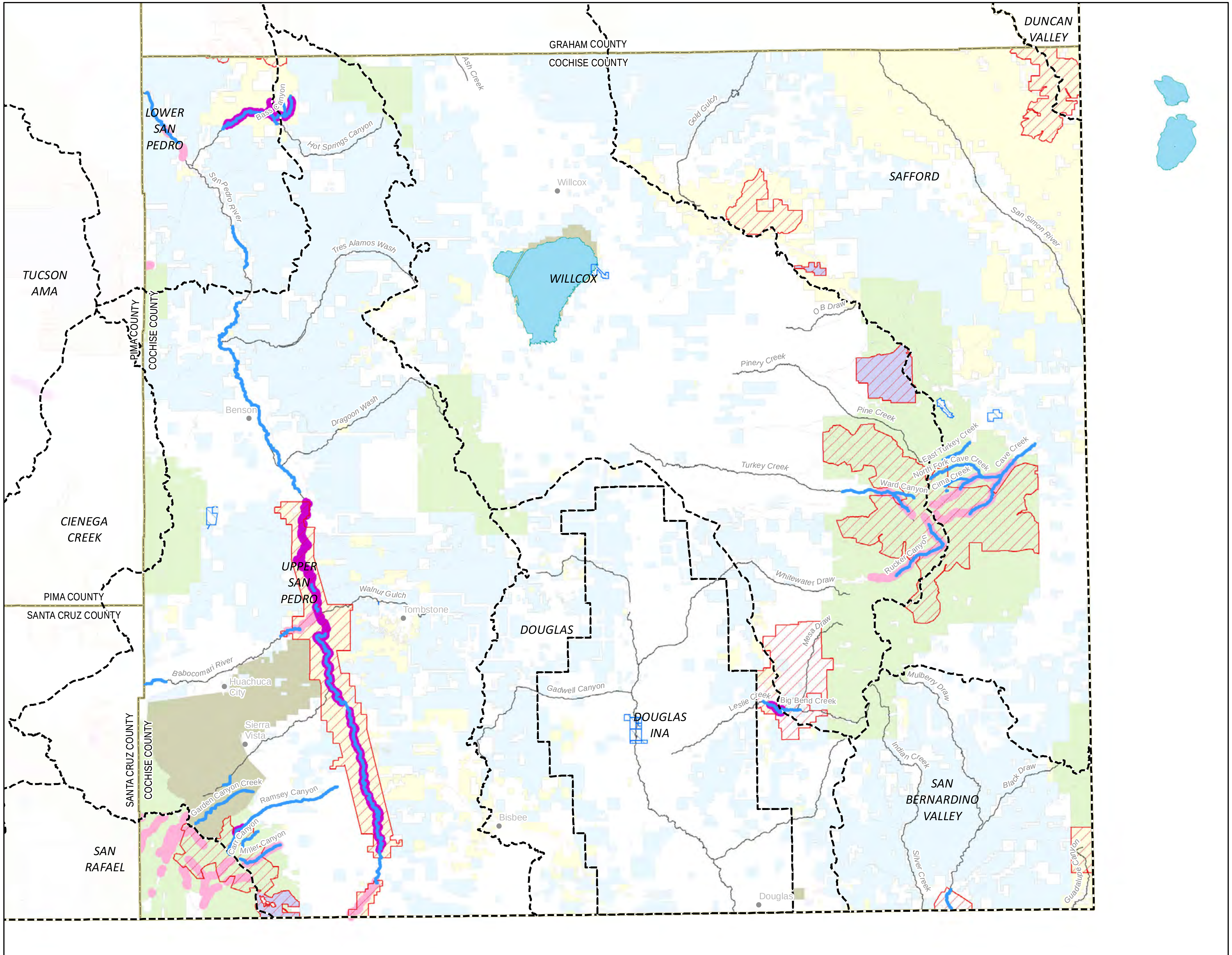
- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir, Lake (NHD)
- Major Spring (ADWR)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- 1993 Riparian Inventory (AZGFD)
- Modeled Riparian Habitat (AZGFD)
- Designated ESA Critical Habitat Area (USFWS)
- Proposed ESA Critical Habitat (USFWS)

MAP EXTENT

APACHE COUNTY (South Half) Natural Resources

C-2.1

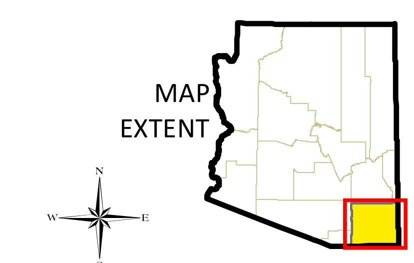
COCHISE COUNTY
Land Tenure



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Reservoir, Lake (NHD)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (ADWR)
- Federally Designated Wild and Scenic River (USFS)
- Federal Conservation Land (USFS, BLM, NPS)
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private or Other Land
- State Trust Land
- Tribal Land

0 10 20 Kilometers

0 10 20 Miles



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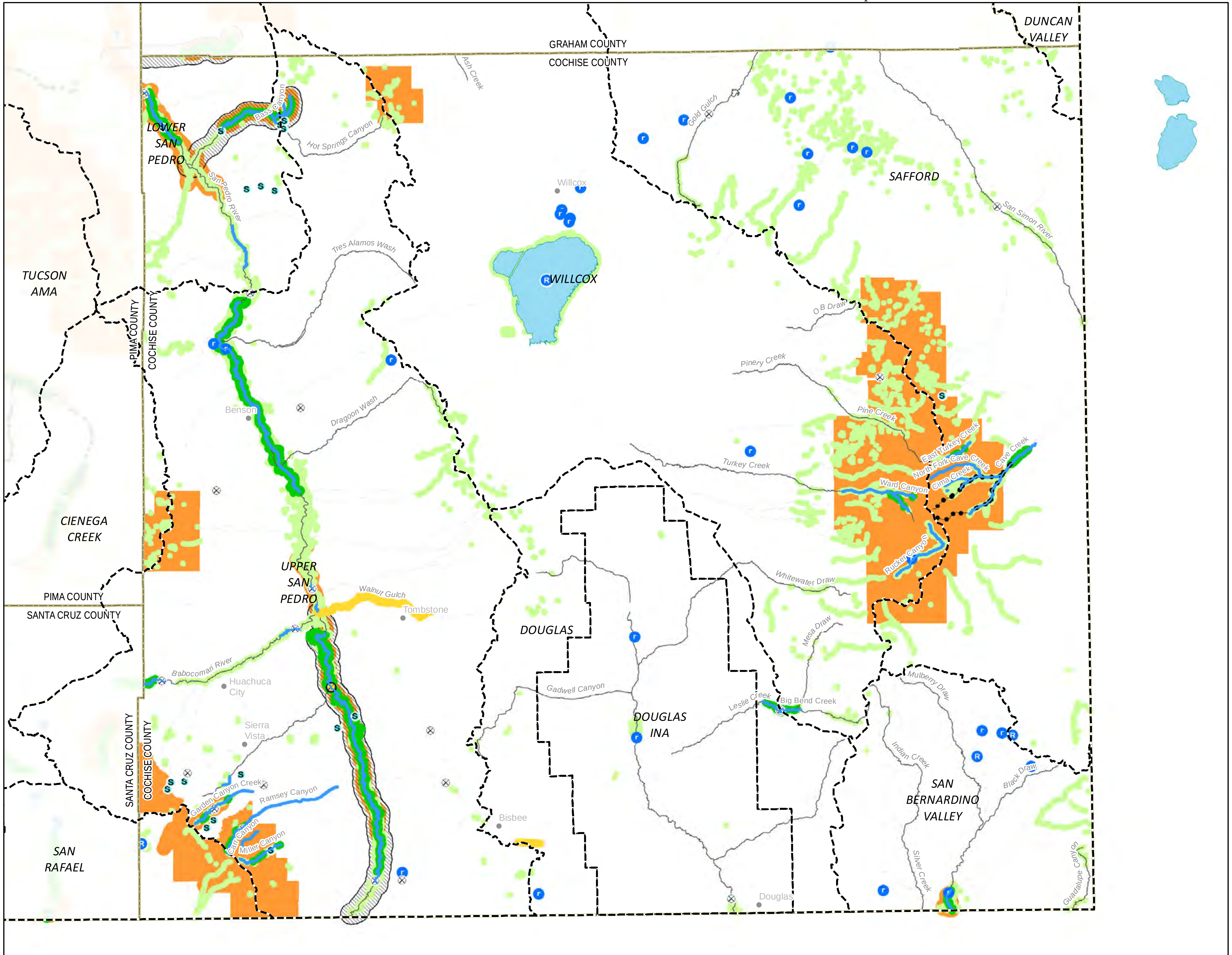
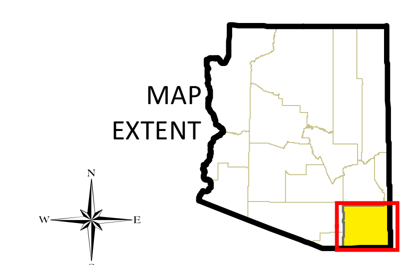
COCHISE COUNTY
Natural Resources



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir, Lake (NHD)
- Major Spring (ADWR)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- 1993 Riparian Inventory (AZGFD)
- Modeled Riparian Habitat (AZGFD)
- Designated ESA Critical Habitat Area (USFWS)
- Proposed ESA Critical Habitat (USFWS)

0 10 20 Kilometers

0 10 20 Miles



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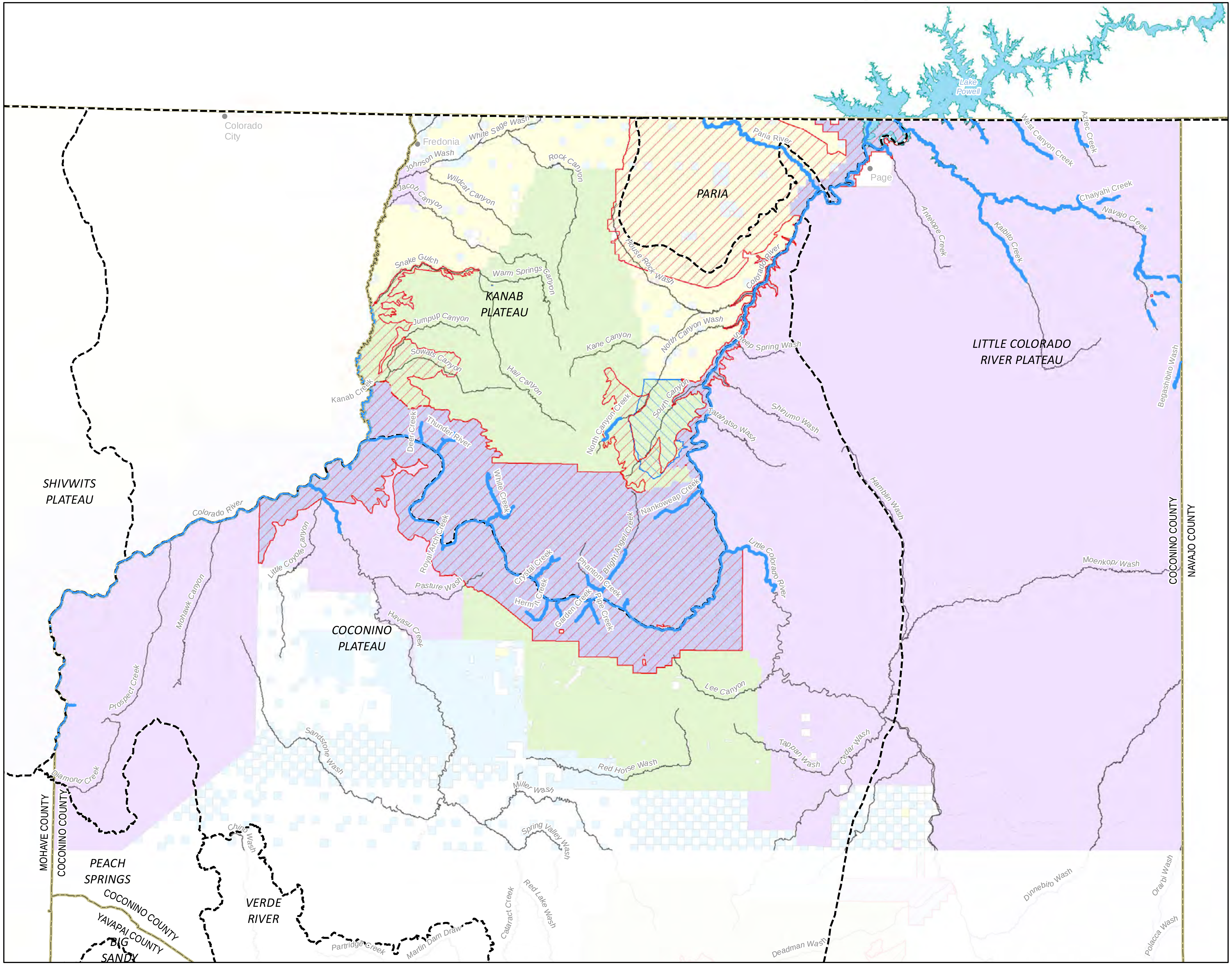
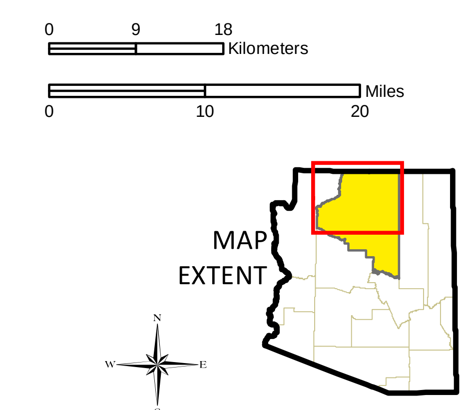
COCONINO COUNTY (North Half) Land Tenure



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Reservoir, Lake (NHD)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (ADWR)
- Federally Designated Wild and Scenic River (USFS)
- Federal Conservation Land (USFS, BLM, NPS)
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private or Other Land
- State Trust Land
- Tribal Land



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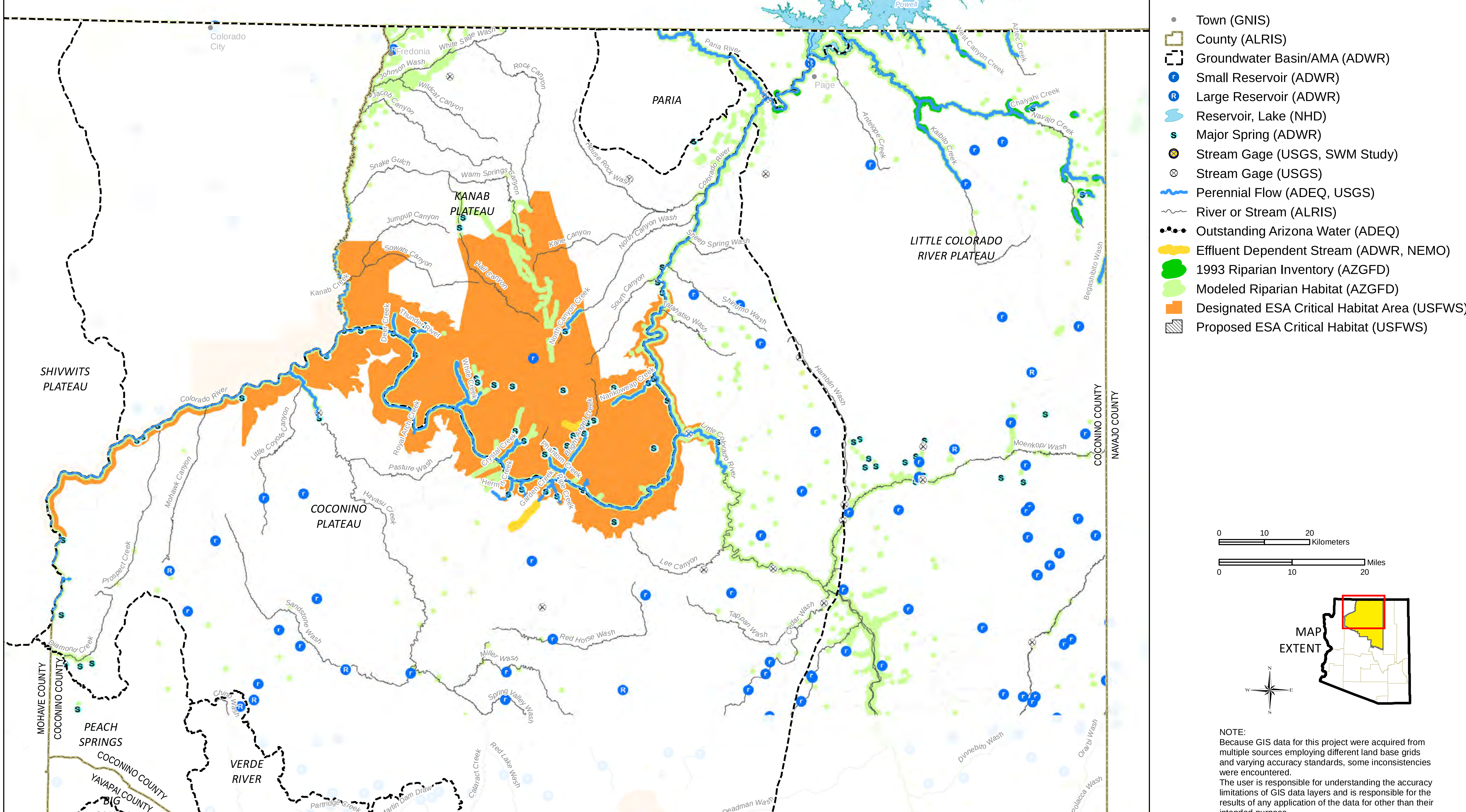
COCONINO COUNTY (North Half) Natural Resources



NOTE:
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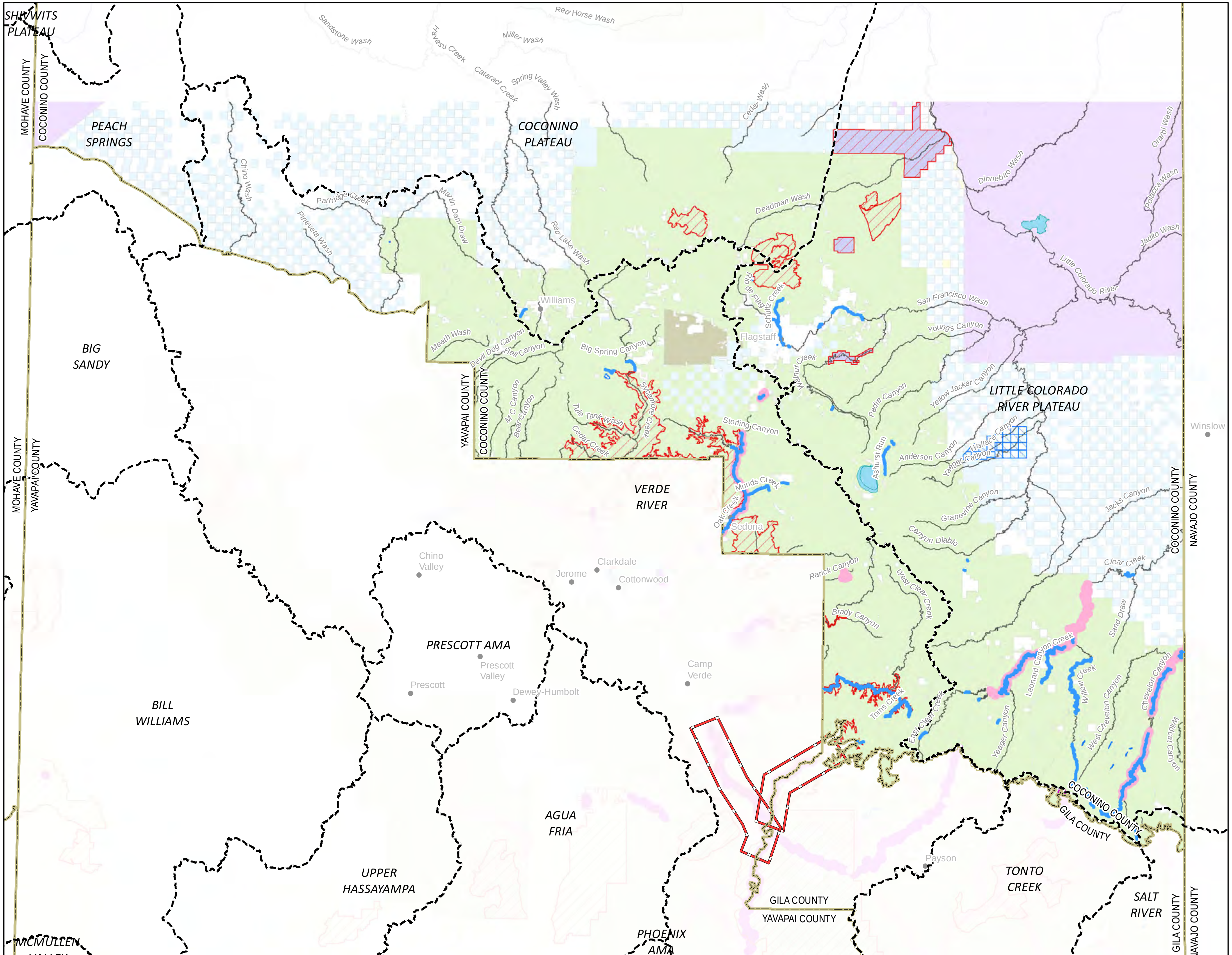
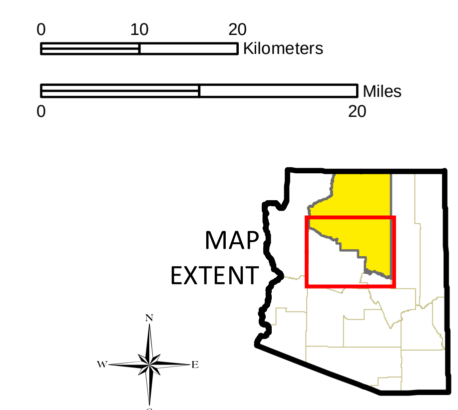
C-3.1S

COCONINO COUNTY (South Half) Land Tenure



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Reservoir, Lake (NHD)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (ADWR)
- Federally Designated Wild and Scenic River (USFS)
- Federal Conservation Land (USFS, BLM, NPS)
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private or Other Land
- State Trust Land
- Tribal Land



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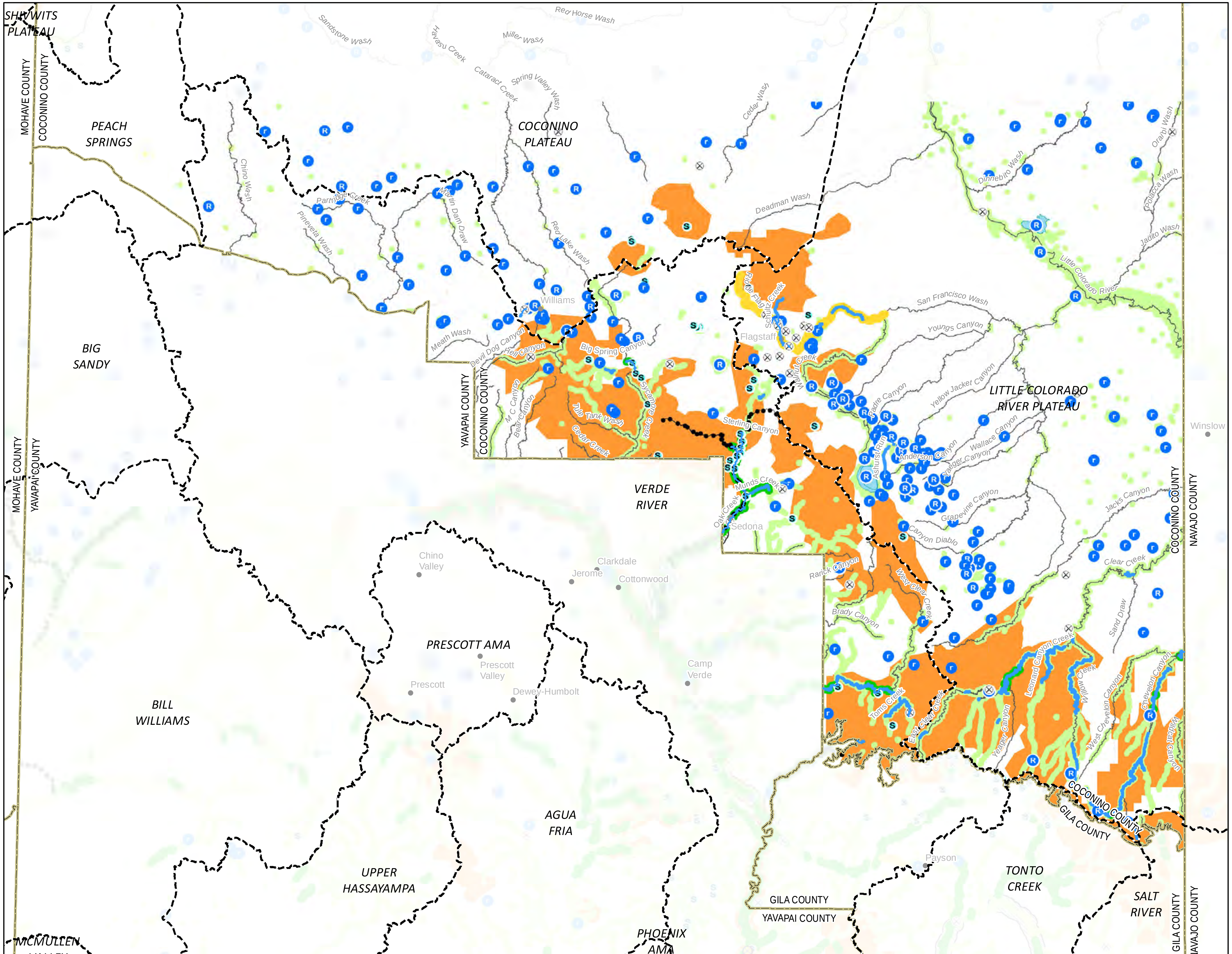
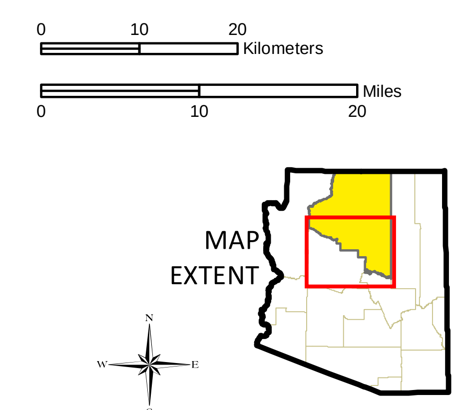
COCONINO COUNTY (South Half) Natural Resources



Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Small Reservoir (ADWR)
Large Reservoir (ADWR)
Reservoir, Lake (NHD)
Major Spring (ADWR)
Stream Gage (USGS, SWM Study)
Stream Gage (USGS)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Outstanding Arizona Water (ADEQ)
Effluent Dependent Stream (ADWR, NEMO)
1993 Riparian Inventory (AZGFD)
Modeled Riparian Habitat (AZGFD)
Designated ESA Critical Habitat Area (USFWS)
Proposed ESA Critical Habitat (USFWS)



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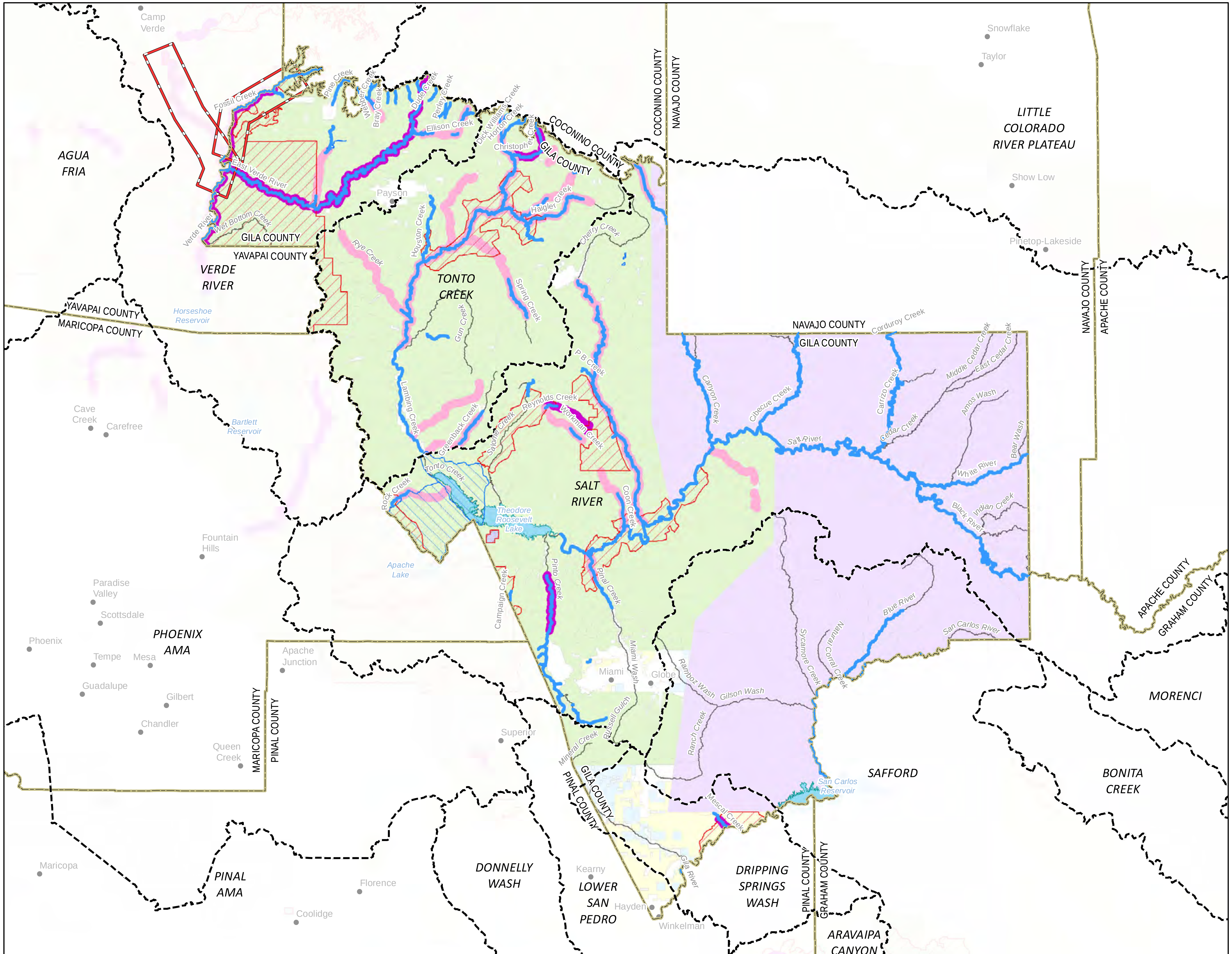
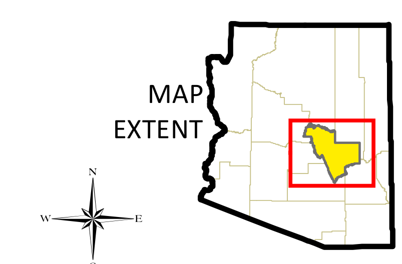
GILA COUNTY
Land Tenure



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Reservoir, Lake (NHD)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (ADWR)
- Federally Designated Wild and Scenic River (USFS)
- Federal Conservation Land (USFS, BLM, NPS)
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private or Other Land
- State Trust Land
- Tribal Land

0 10 20 Kilometers

0 20 Miles



NOTE:
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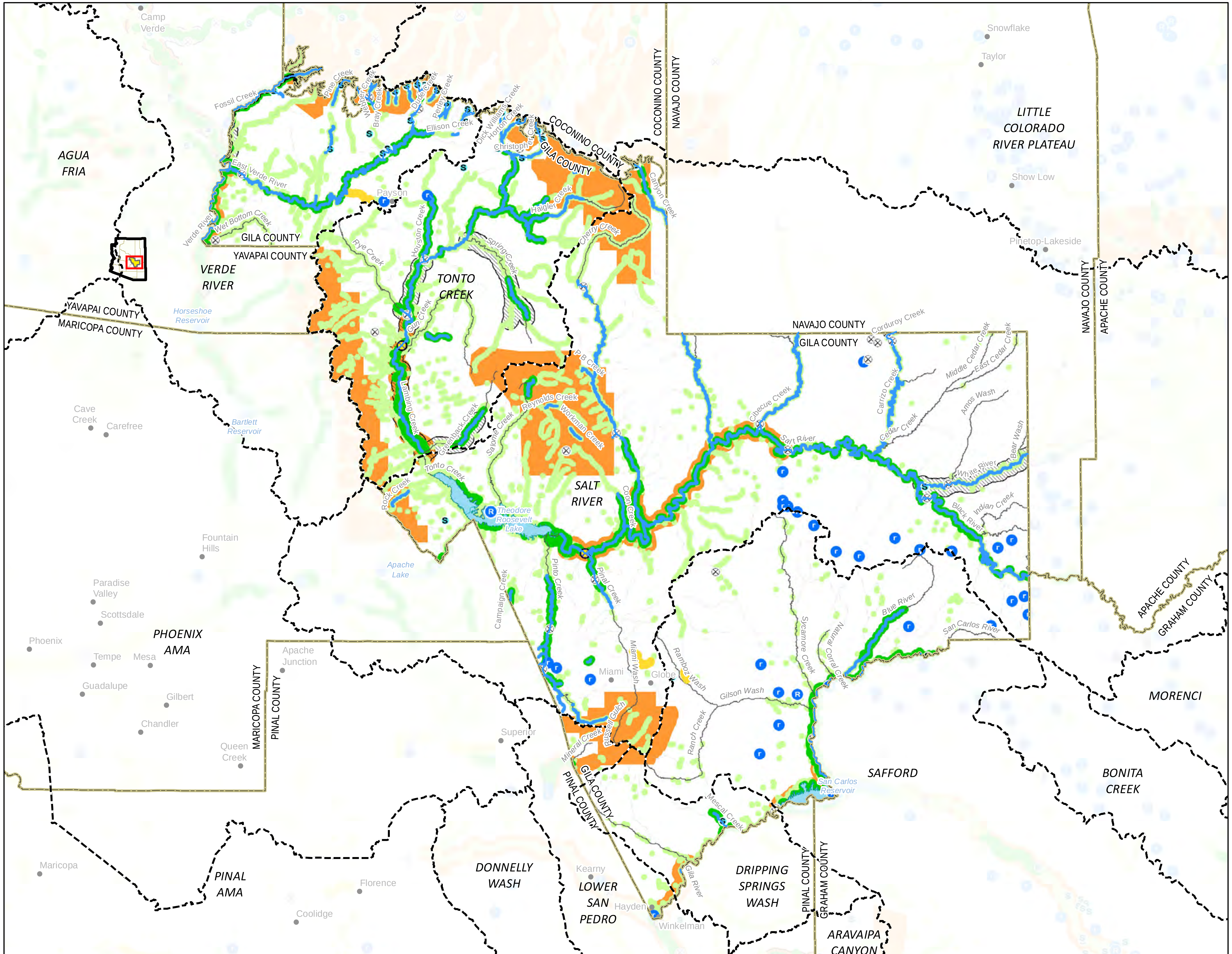
GILA COUNTY
Natural Resources



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir, Lake (NHD)
- Major Spring (ADWR)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- 1993 Riparian Inventory (AZGFD)
- Modeled Riparian Habitat (AZGFD)
- Designated ESA Critical Habitat Area (USFWS)
- Proposed ESA Critical Habitat (USFWS)

0 10 20 Kilometers

0 10 20 Miles

NOTE:
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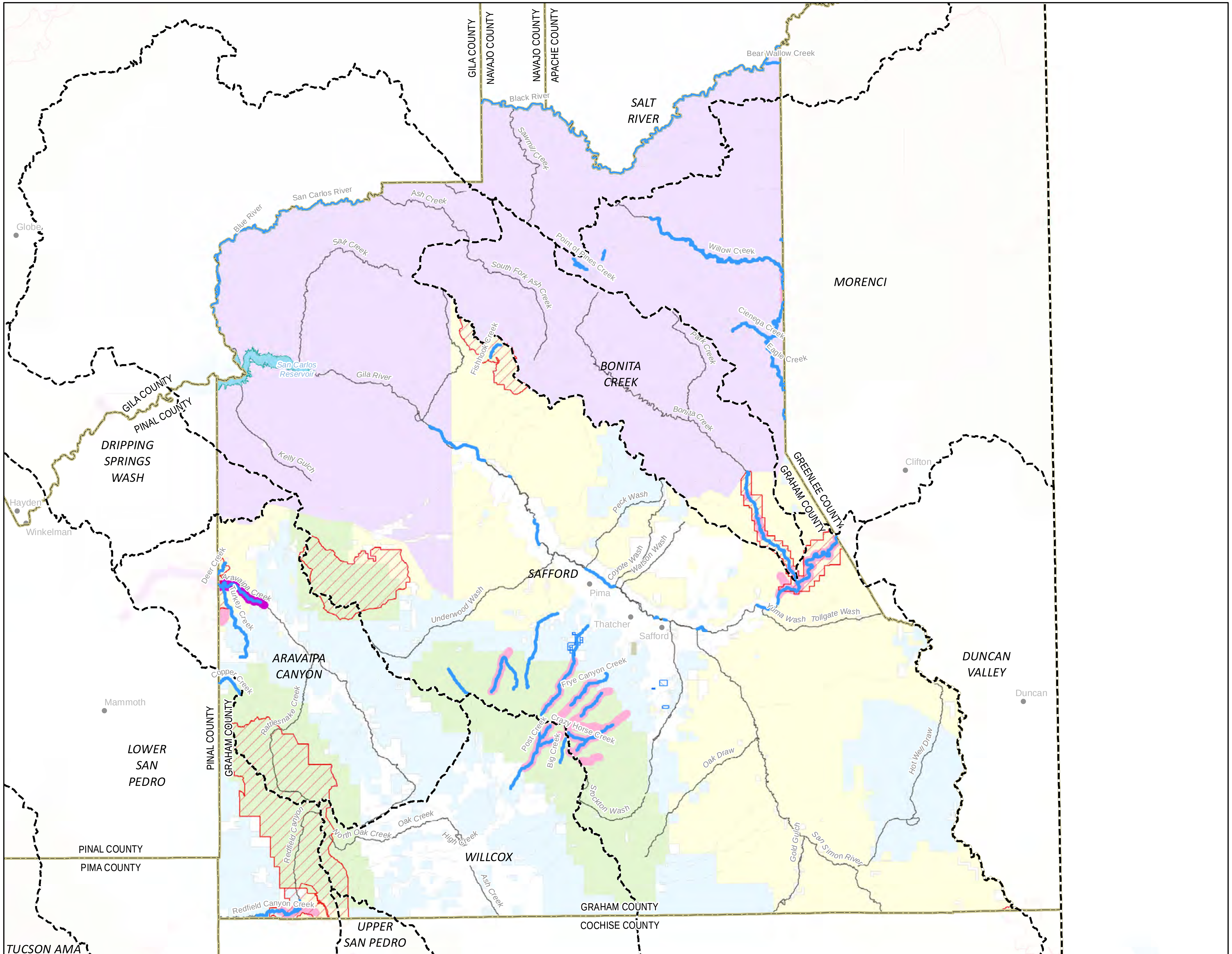
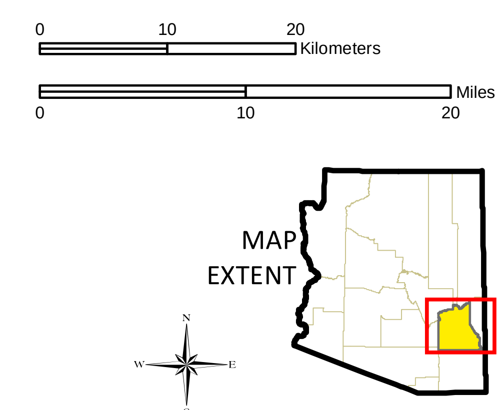
GRAHAM COUNTY
Land Tenure



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Reservoir, Lake (NHD)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (ADWR)
- Federally Designated Wild and Scenic River (USFS)
- Federal Conservation Land (USFS, BLM, NPS)
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private or Other Land
- State Trust Land
- Tribal Land



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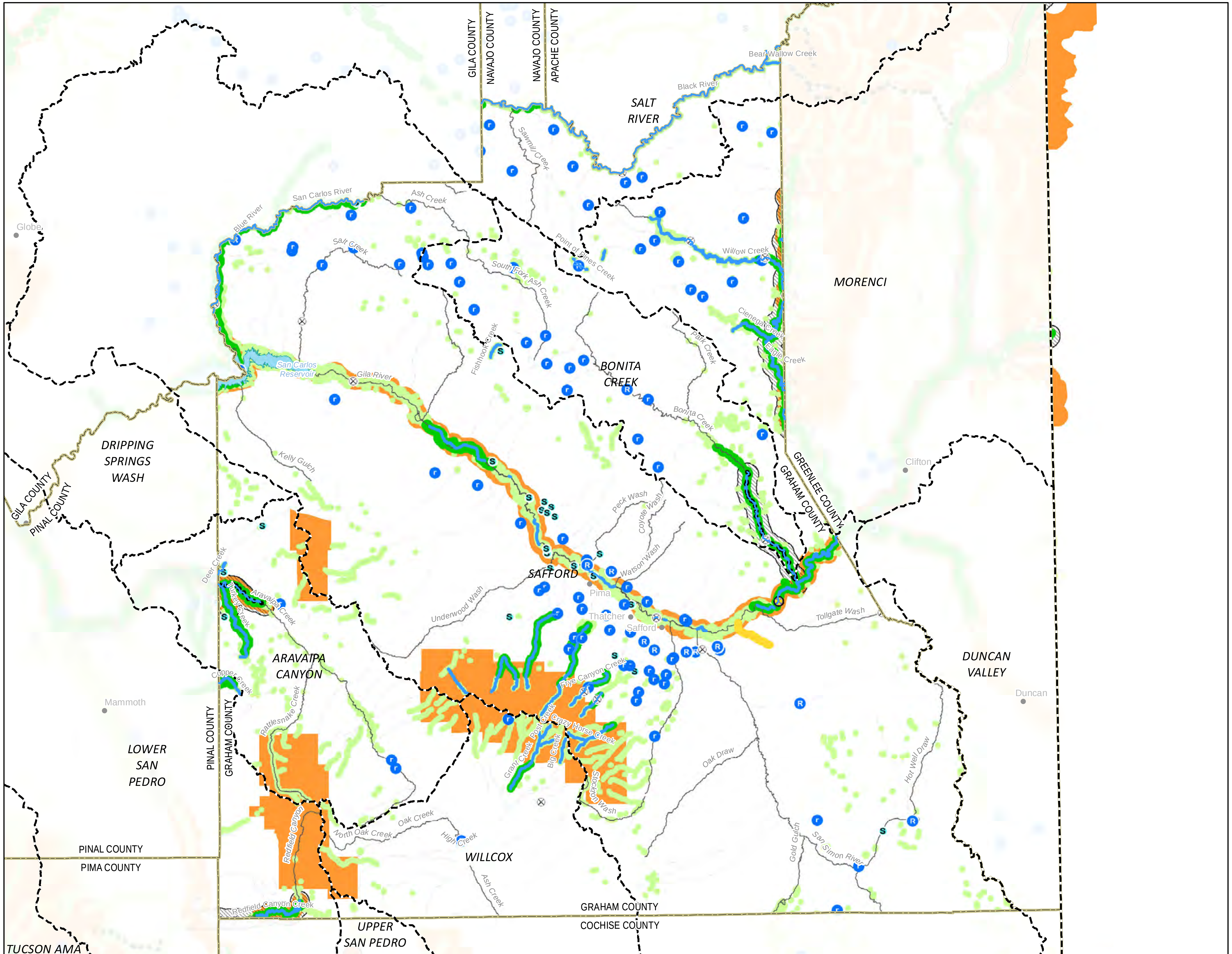
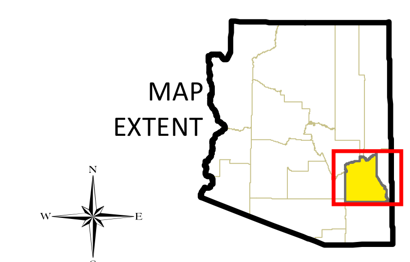
GRAHAM COUNTY
Natural Resources

- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir, Lake (NHD)
- Major Spring (ADWR)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- 1993 Riparian Inventory (AZGFD)
- Modeled Riparian Habitat (AZGFD)
- Designated ESA Critical Habitat Area (USFWS)
- Proposed ESA Critical Habitat (USFWS)



0 10 20 Kilometers

0 10 20 Miles



NOTE:
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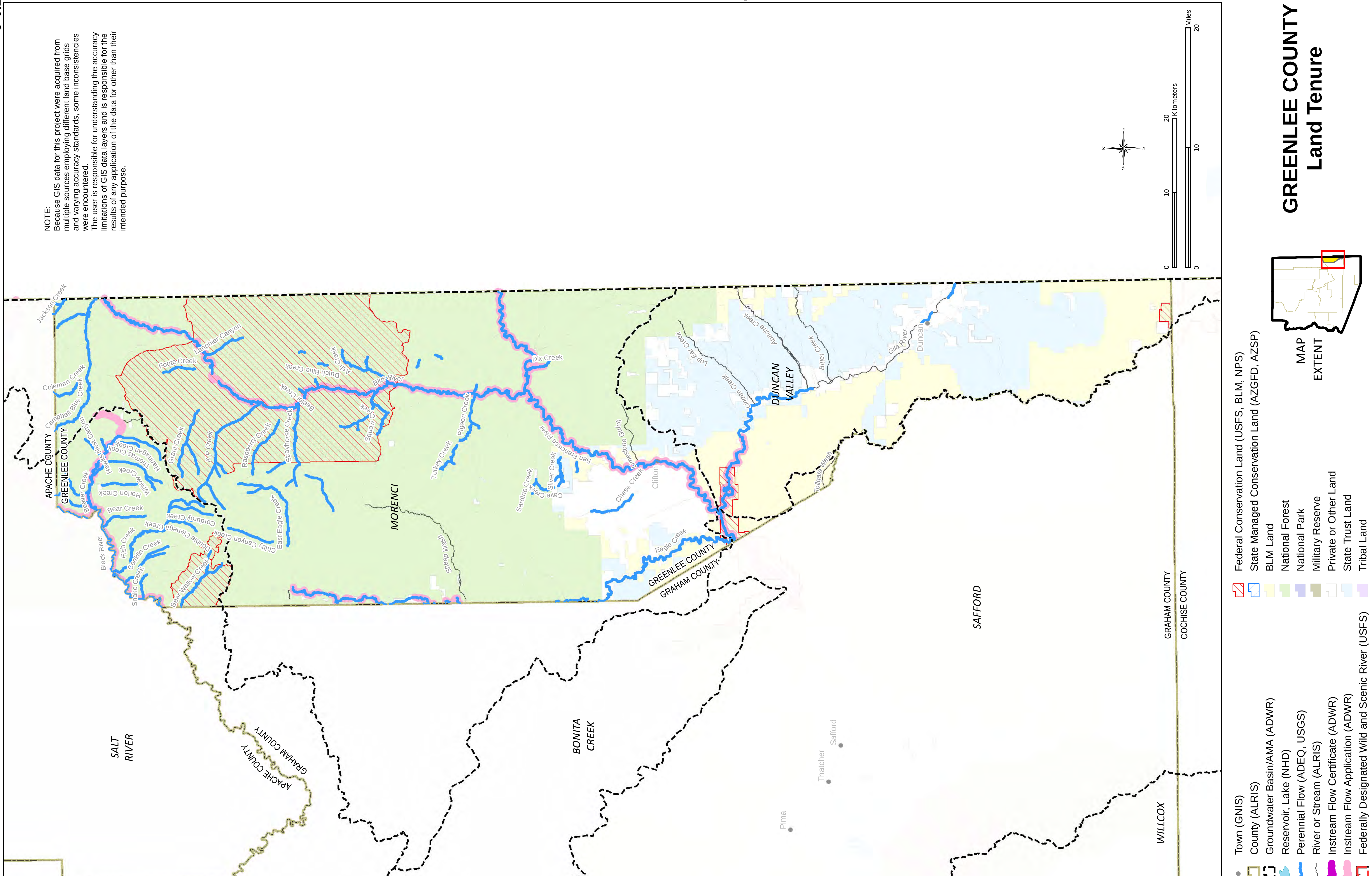
GREENLEE COUNTY
Land Tenure
MAP EXTENT
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Reservoir, Lake (NHD)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Instream Flow Certificate (ADWR)
Instream Flow Application (ADWR)
Federally Designated Wild and Scenic River (USFS)
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation Land (AZGFD, AZSP)
BLM Land
National Forest
National Park
Military Reserve
Private or Other Land
State Trust Land
Tribal Land
Kilometers
Miles
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.
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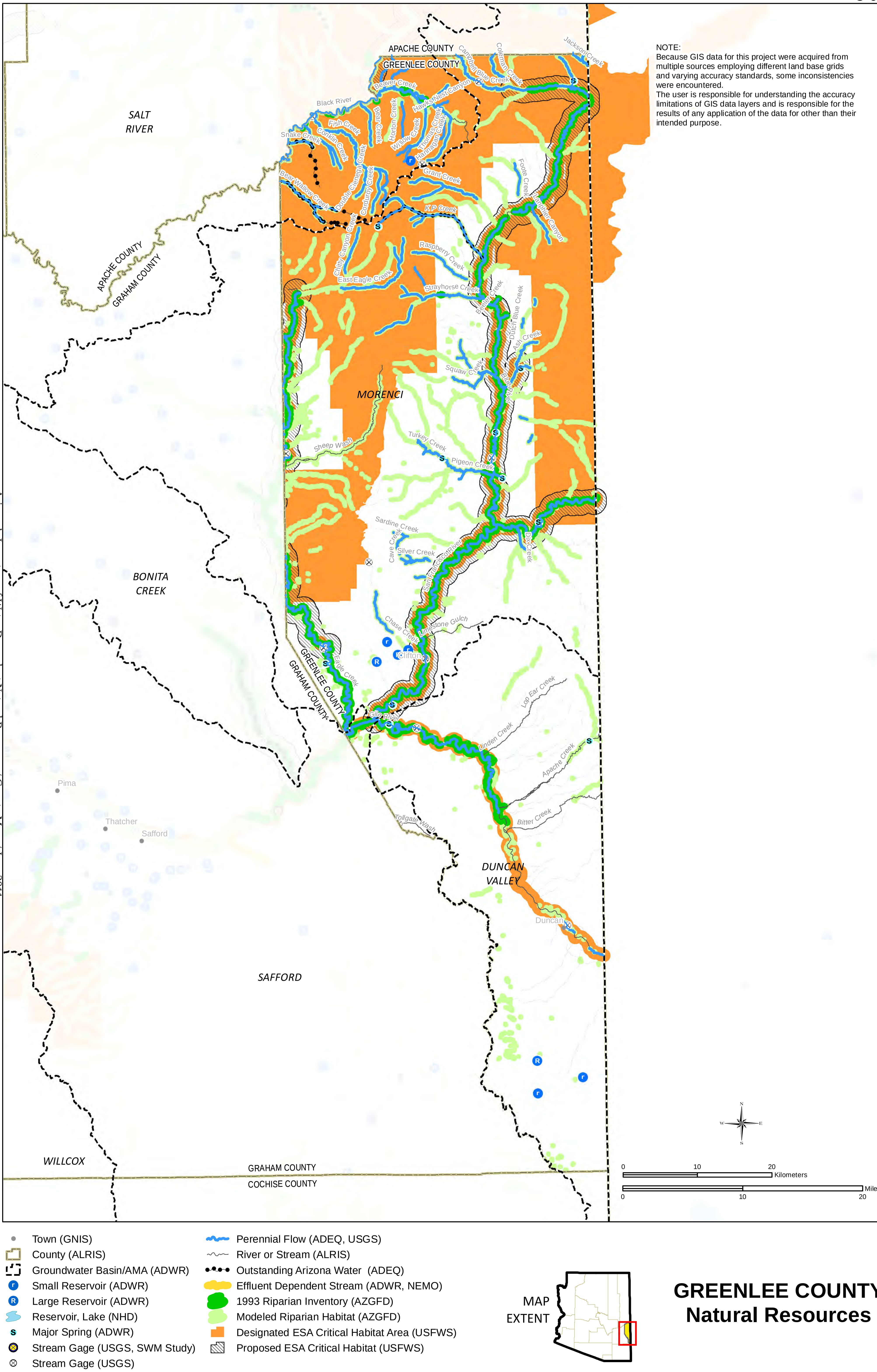
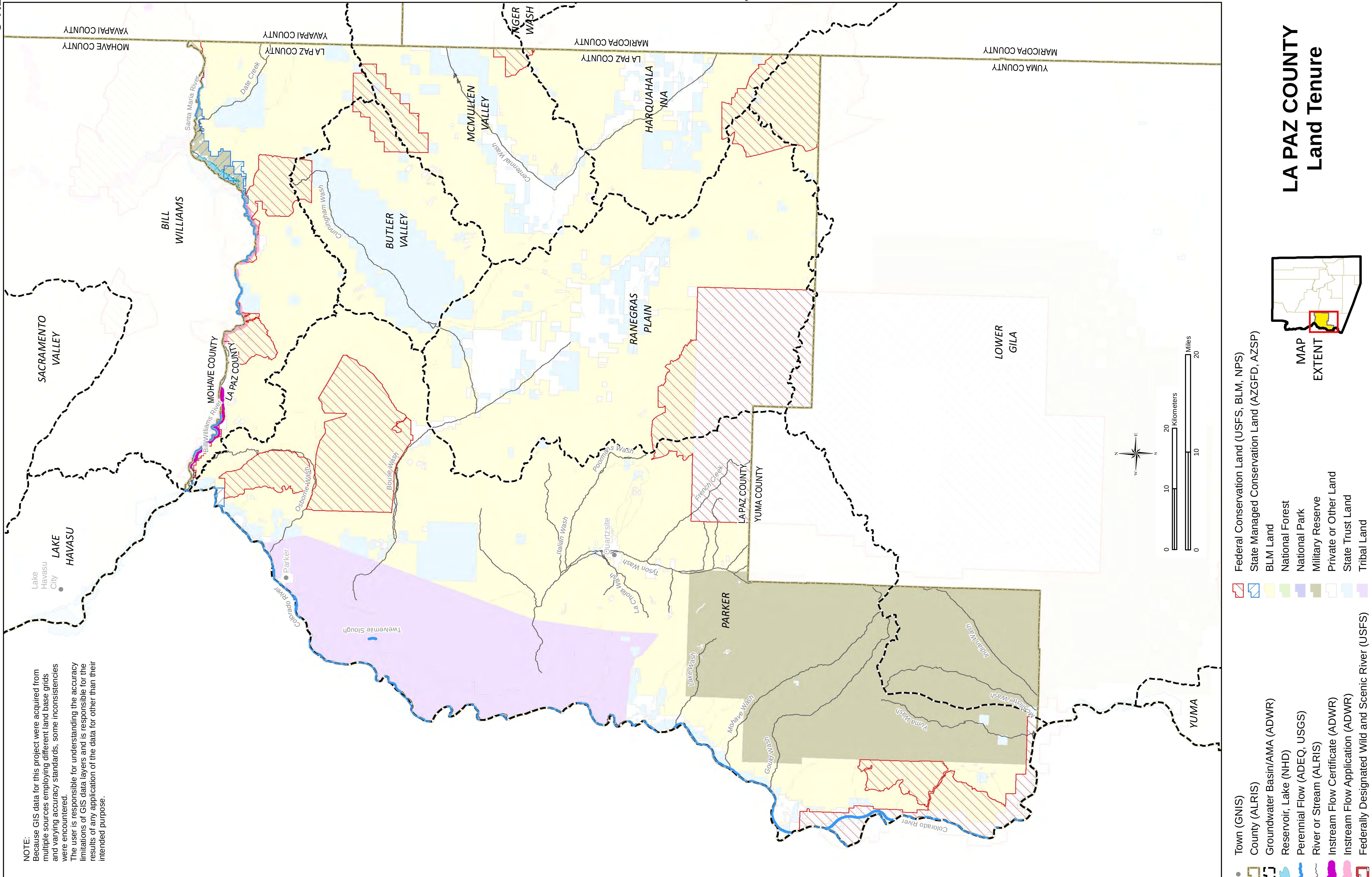
APACHE COUNTY
GREENLEE COUNTY
GRAHAM COUNTY
COCHISE COUNTY
SALT RIVER
BONITA CREEK
SAFFORD
WILLCOX
MORENCI
DUNCAN VALLEY
Clifton
Duncan
Safford
Thatcher
Pima
Blue River
San Francisco River
Gila River
Eagle Creek
Black River
Dix Creek
Chase Creek
Apache Creek
Bitter Creek
Foote Creek
Lanphier Canyon
Coleman Creek
Campbell Blue Creek
Jackson Creek
Beaver Creek
Horton Creek
Bear Creek
Fish Creek
Conklin Creek
Snake Creek
Bear Wallow Creek
Corduroy Creek
Chitty Canyon Creek
East Eagle Creek
Turkey Creek
Pigeon Creek
Sardine Creek
Silver Creek
Cave Creek
Limestone Gulch
Linden Creek
Sheep Wash

C-6.2

GREENLEE COUNTY
Natural Resources



C-7.1



LA PAZ COUNTY
Land Tenure
YAVAPAI COUNTY
MOHAVE COUNTY
LA PAZ COUNTY
MARICOPA COUNTY
YUMA COUNTY
BILL WILLIAMS
SACRAMENTO VALLEY
LAKE HAVASU
BUTLER VALLEY
MCMULLEN VALLEY
HARQUAHALA INA
RANEGRAS PLAIN
LOWER GILA
PARKER
YUMA
Lake Havasu City
Parker
Quartzsite
Santa Maria River
Date Creek
Bill Williams River
Colorado River
Cunningham Wash
Centennial Wash
Bouse Wash
Osborne Wash
Italian Wash
Tyson Wash
La Cholla Wash
French Creek
Twelvemile Slough
Lake Wash
Mohave Wash
Gould Wash
Yuma Wash
McAllister Wash
Indian Wash
Kilometers
Miles
0
10
20
MAP EXTENT
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation Land (AZGFD, AZSP)
BLM Land
National Forest
National Park
Military Reserve
Private or Other Land
State Trust Land
Tribal Land
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Reservoir, Lake (NHD)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Instream Flow Certificate (ADWR)
Instream Flow Application (ADWR)
Federally Designated Wild and Scenic River (USFS)
NOTE:
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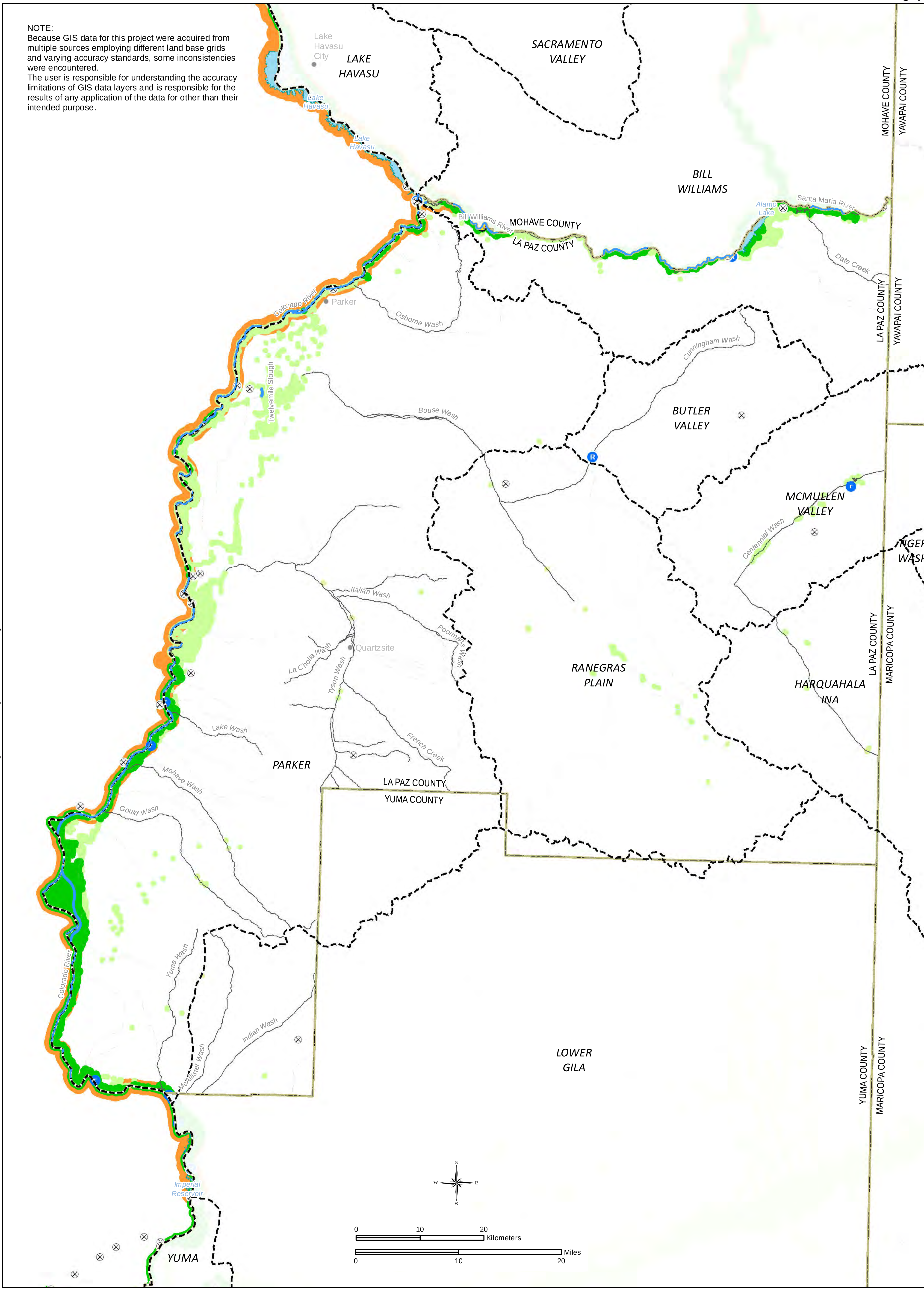
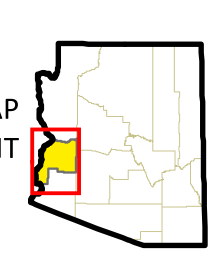
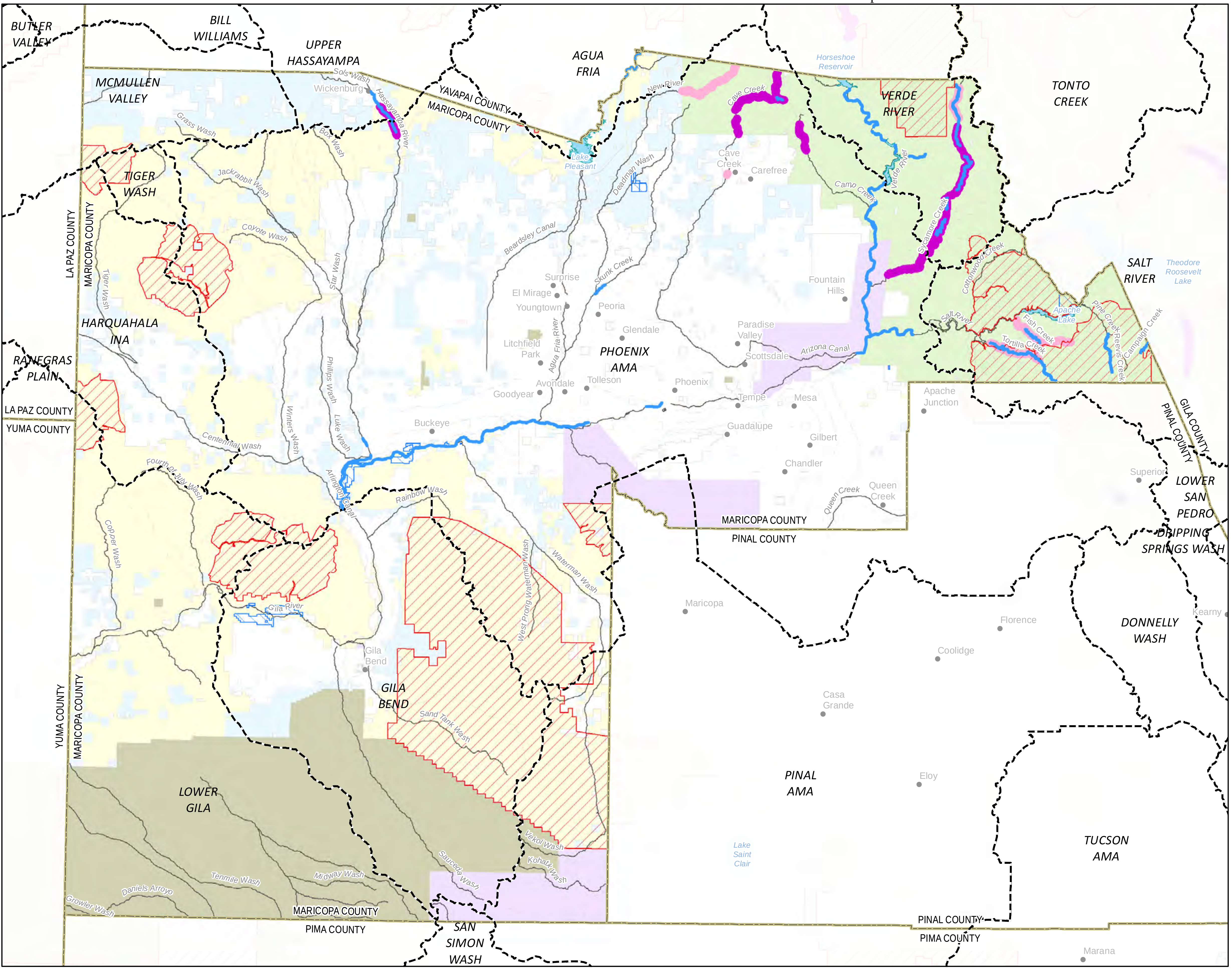
LA PAZ COUNTY
Natural Resources



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir, Lake (NHD)
- Major Spring (ADWR)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- 1993 Riparian Inventory (AZGFD)
- Modeled Riparian Habitat (AZGFD)
- Proposed ESA Critical Habitat (USFWS)
- Designated ESA Critical Habitat Area (USFWS)



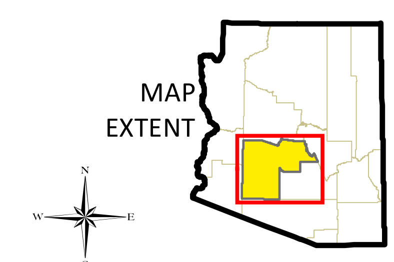
MARICOPA COUNTY Land Tenure



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Reservoir, Lake (NHD)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (ADWR)
- Federally Designated Wild and Scenic River (USFS)
- Federal Conservation Land (USFS, BLM, NPS)
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private or Other Land
- State Trust Land
- Tribal Land

0 10 20 Kilometers

0 10 20 Miles



NOTE:
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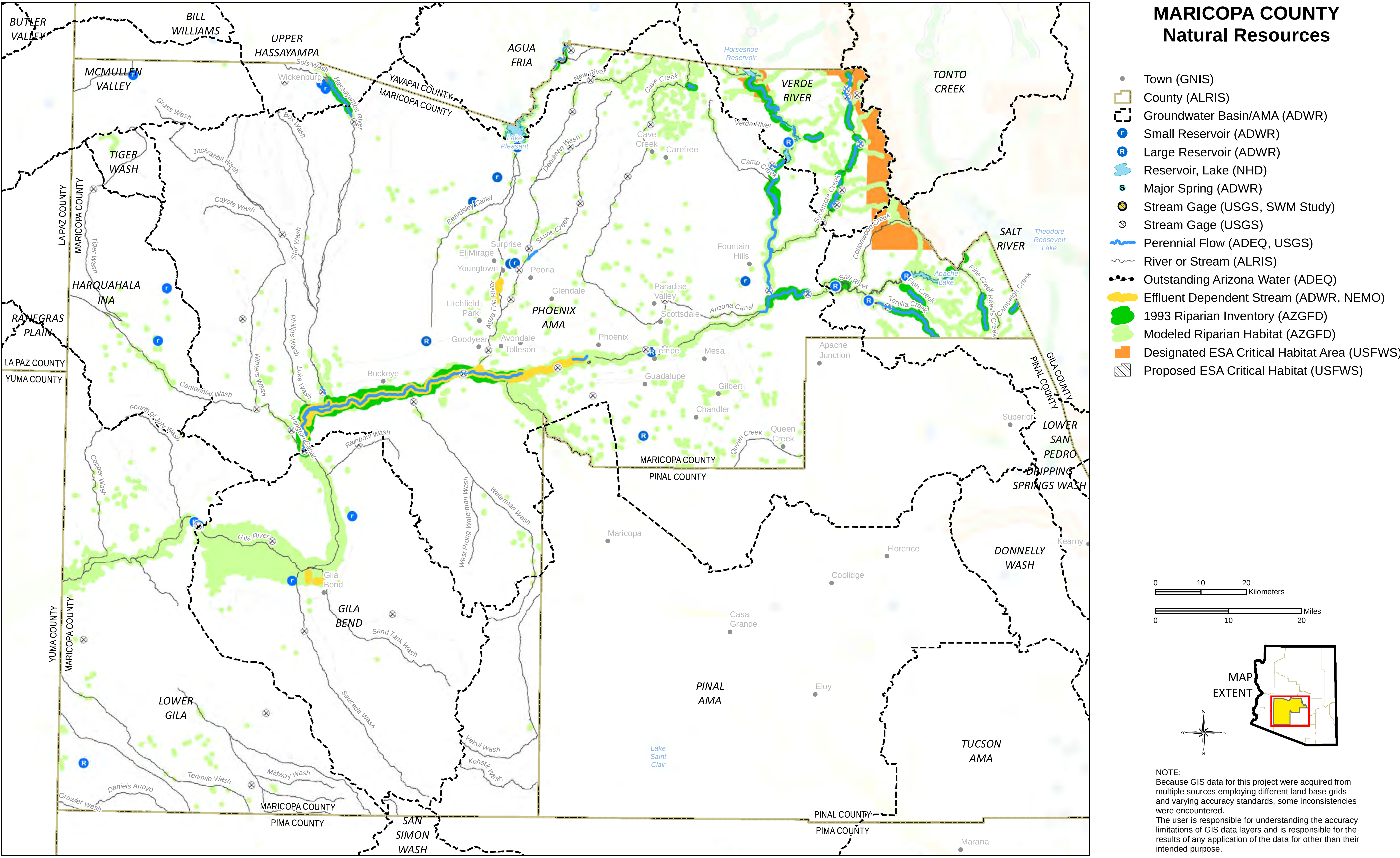

NOTE:
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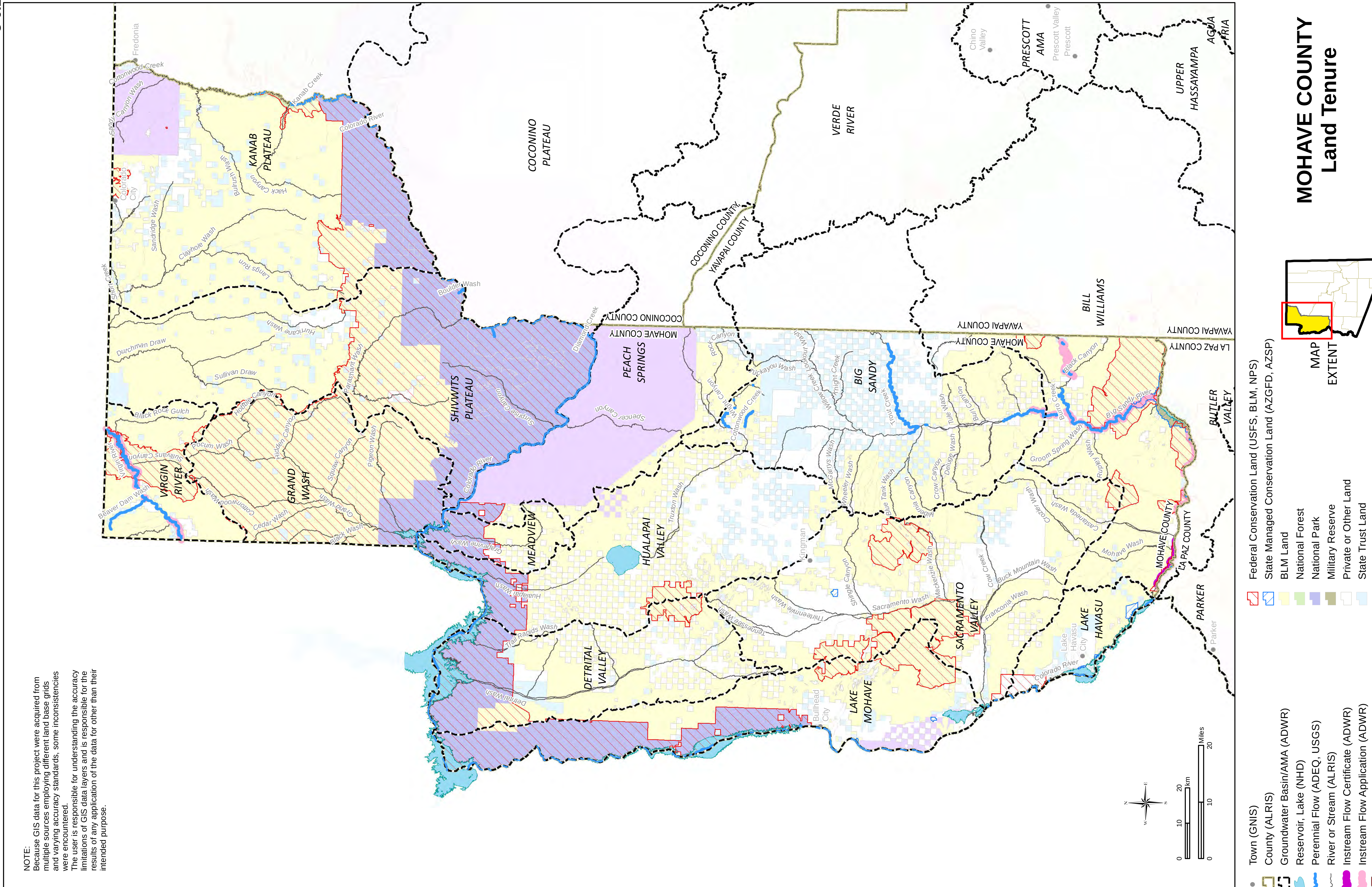
C-9.1


MOHAVE COUNTY
Land Tenure
MAP EXTENT
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Reservoir, Lake (NHD)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Instream Flow Certificate (ADWR)
Instream Flow Application (ADWR)
Federally Designated Wild and Scenic River (USFS)
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation Land (AZGFD, AZSP)
BLM Land
National Forest
National Park
Military Reserve
Private or Other Land
State Trust Land
Tribal Land
NOTE:
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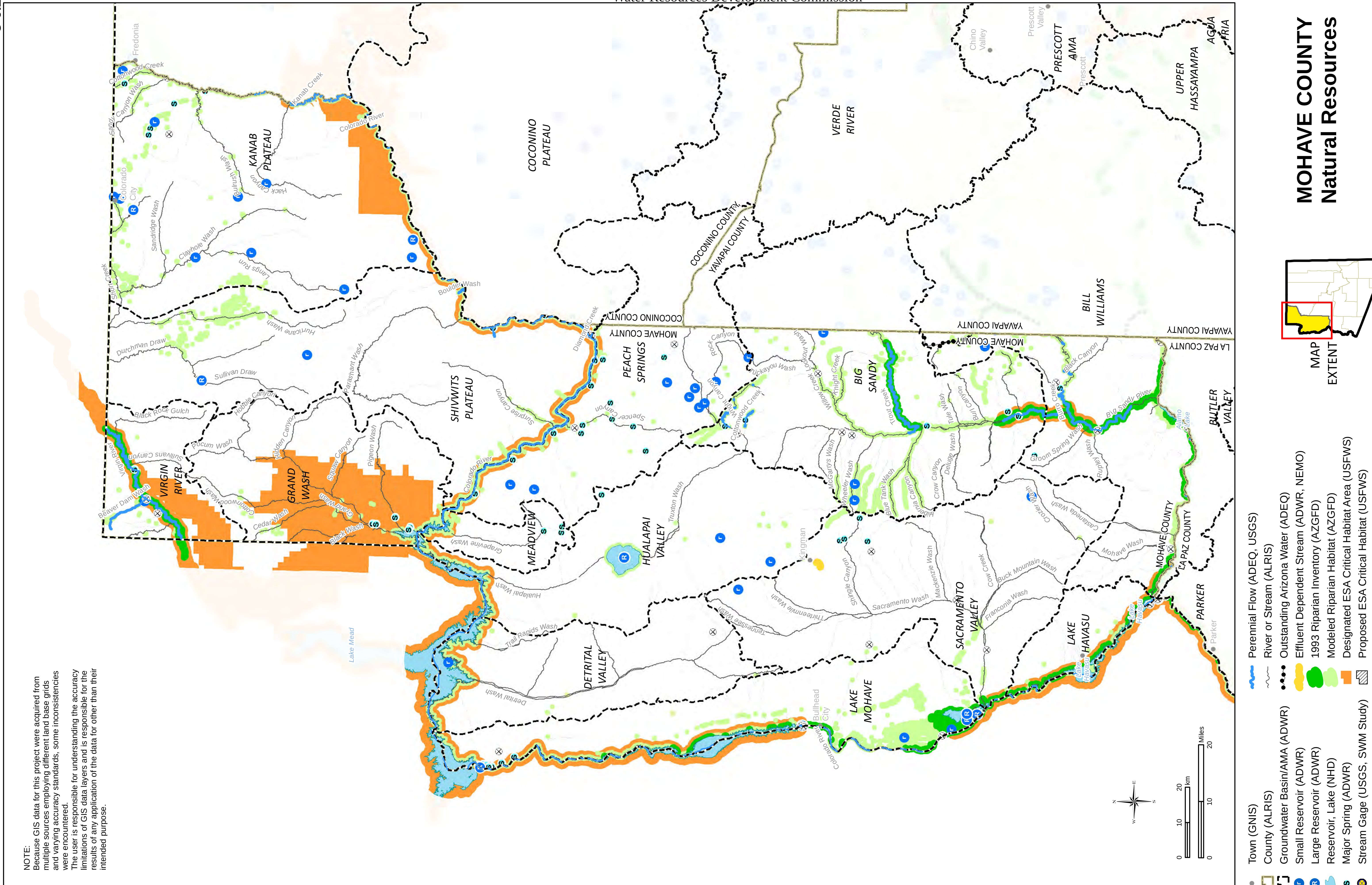
KANAB PLATEAU
COCONINO PLATEAU
VERDE RIVER
PRESCOTT AMA
UPPER HASSAYAMPA
AGUA FRIA
BILL WILLIAMS
SHIVWITS PLATEAU
PEACH SPRINGS
BIG SANDY
VIRGIN RIVER
GRAND WASH
MEADVIEW
HUALAPAI VALLEY
DETRITAL VALLEY
SACRAMENTO VALLEY
LAKE MOHAVE
LAKE HAVASU
BUTLER VALLEY
PARKER
COCONINO COUNTY
MOHAVE COUNTY
YAVAPAI COUNTY
LA PAZ COUNTY
Kingman
Bullhead City
Lake Havasu City
Colorado City
Fredonia
Miles
km



NOTE:
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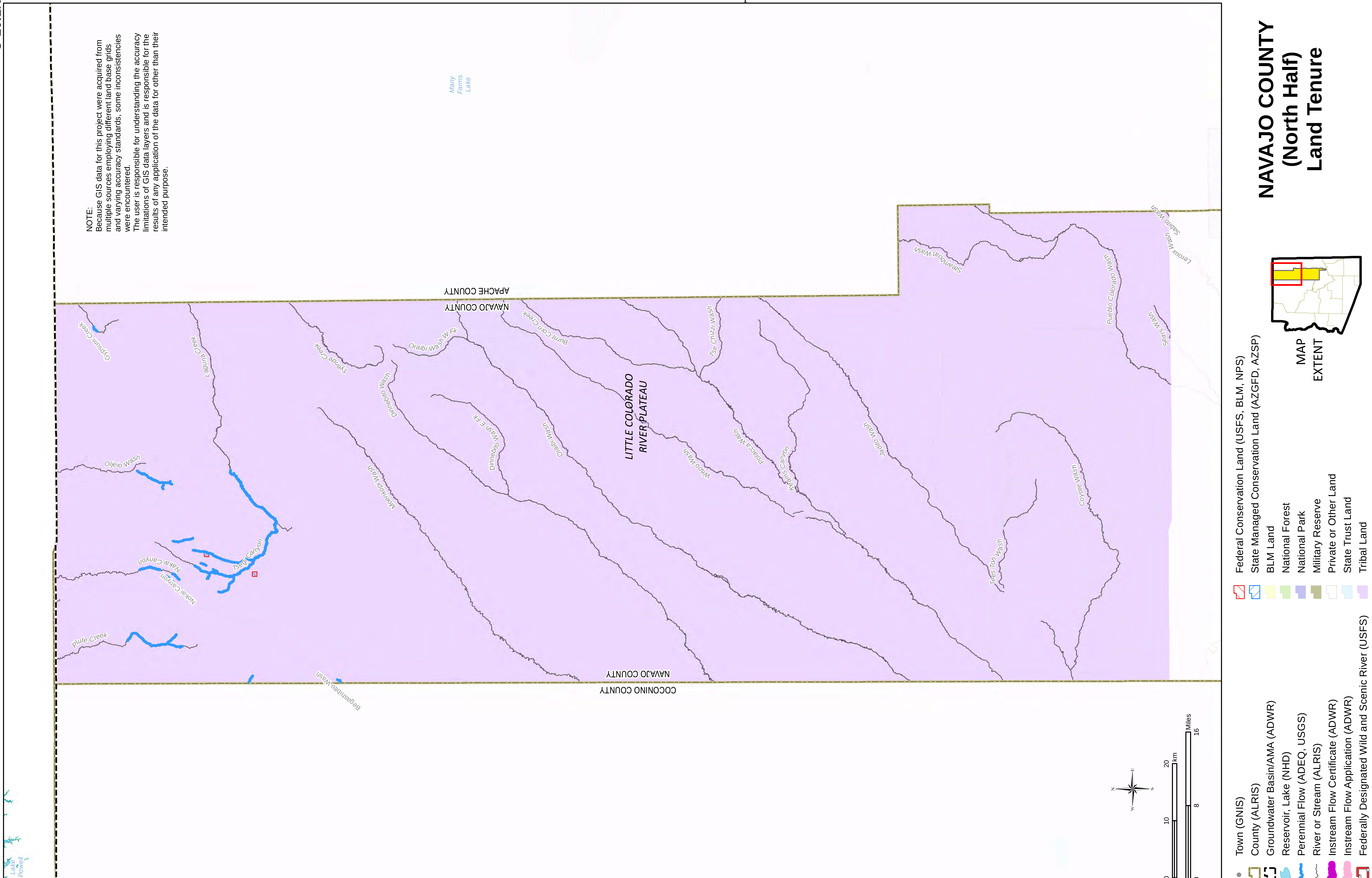
C-10.1N


NAVAJO COUNTY
(North Half)
Land Tenure
MAP EXTENT
NOTE:
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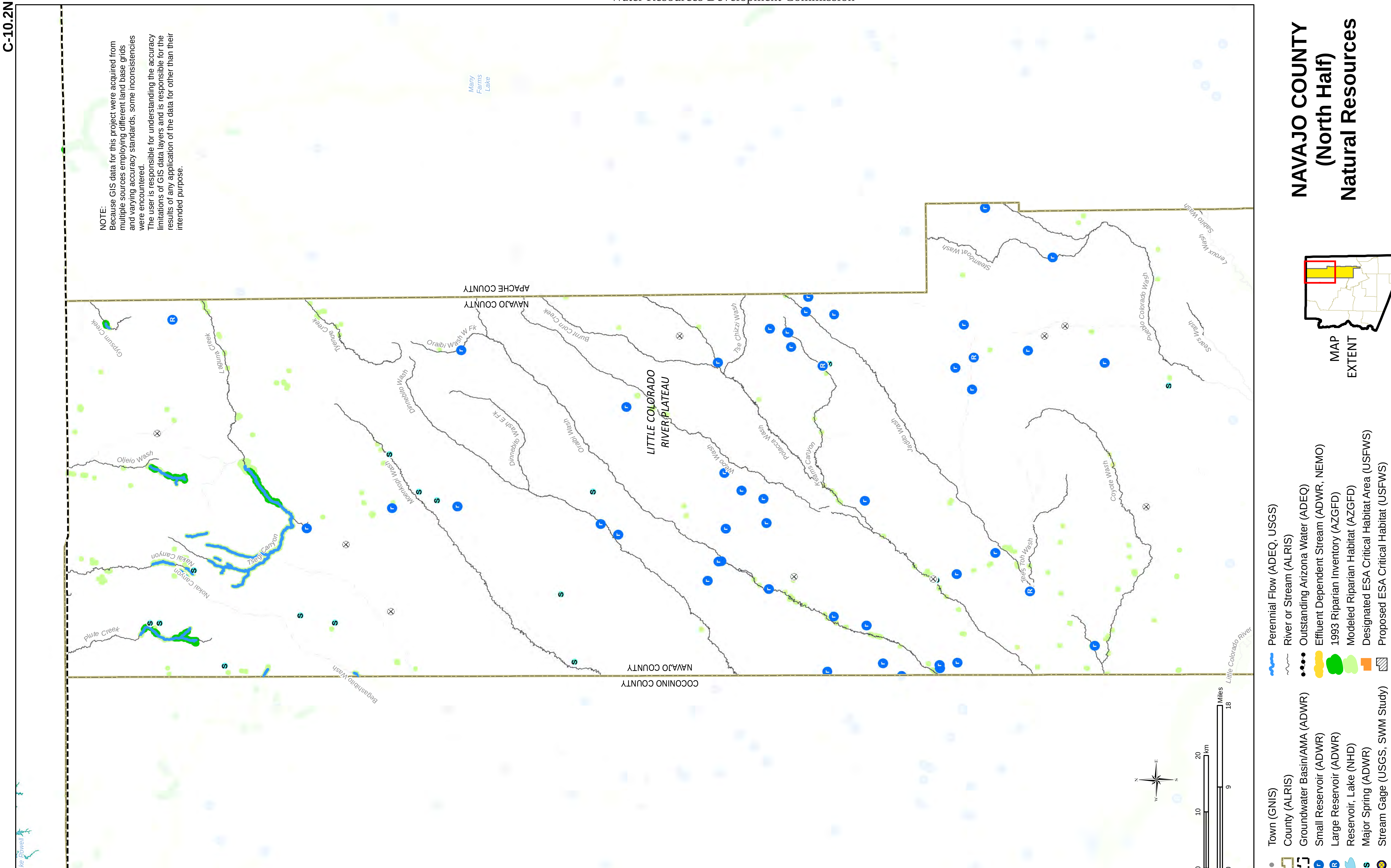
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation Land (AZGFD, AZSP)
BLM Land
National Forest
National Park
Military Reserve
Private or Other Land
State Trust Land
Tribal Land
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Reservoir, Lake (NHD)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Instream Flow Certificate (ADWR)
Instream Flow Application (ADWR)
Federally Designated Wild and Scenic River (USFS)
APACHE COUNTY
NAVAJO COUNTY
COCONINO COUNTY
LITTLE COLORADO RIVER PLATEAU
Many Farms Lake
Lake Powell
Gypsum Creek
Laguna Creek
Tyende Creek
Oraibi Wash W Fk
Burnt Corn Creek
Tse Chizzi Wash
Steamboat Wash
Sabito Wash
Leroux Wash
Pueblo Colorado Wash
Sands Wash
Dinnebito Wash
Wash E Fk
Oraibi Wash
Wepo Wash
Polacca Wash
Keams Canyon
Jeddito Wash
Coyote Wash
Tees Toh Wash
Moenkopi Wash
Oljeto Wash
Tsegi Canyon
Nakai Canyon
Nokai Canyon
Piute Creek
Begashibito Wash
0 10 20 km
0 8 16 Miles


C-10.2N
NAVAJO COUNTY
(North Half)
Natural Resources
MAP EXTENT
NOTE:
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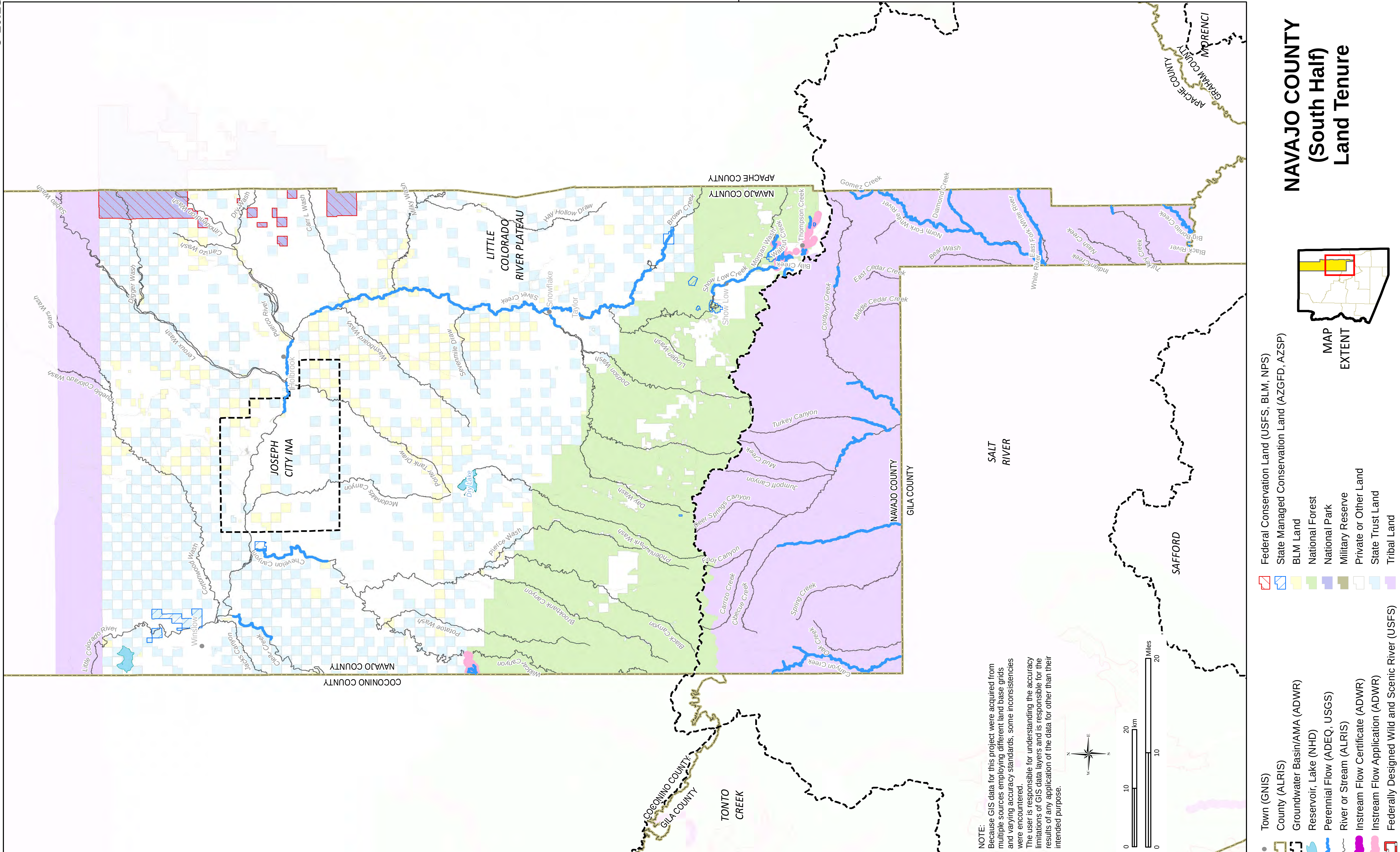
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Small Reservoir (ADWR)
Large Reservoir (ADWR)
Reservoir, Lake (NHD)
Major Spring (ADWR)
Stream Gage (USGS, SWM Study)
Stream Gage (USGS)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Outstanding Arizona Water (ADEQ)
Effluent Dependent Stream (ADWR, NEMO)
1993 Riparian Inventory (AZGFD)
Modeled Riparian Habitat (AZGFD)
Designated ESA Critical Habitat Area (USFWS)
Proposed ESA Critical Habitat (USFWS)
km
Miles
APACHE COUNTY
NAVAJO COUNTY
COCONINO COUNTY
LITTLE COLORADO RIVER PLATEAU
Many Farms Lake
Lake Powell
Little Colorado River
Gypsum Creek
Laguna Creek
Oljeto Wash
Tsegi Canyon
Nakai Canyon
Piute Creek
Begashibito Wash
Moenkopi Wash
Dinnebito Wash
Oraibi Wash
Oraibi Wash W Fk
Burnt Corn Creek
Tse Chizzi Wash
Polacca Wash
Wepo Wash
Jeddito Wash
Keams Canyon
Steamboat Wash
Pueblo Colorado Wash
Sabito Wash
Leroux Wash
Sears Wash
Coyote Wash
Tees Toh Wash


NAVAJO COUNTY
(South Half)
Land Tenure
MAP EXTENT
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Reservoir, Lake (NHD)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Instream Flow Certificate (ADWR)
Instream Flow Application (ADWR)
Federally Designed Wild and Scenic River (USFS)
Federal Conservation Land (USFS, BLM, NPS)
State Managed Conservation Land (AZGFD, AZSP)
BLM Land
National Forest
National Park
Military Reserve
Private or Other Land
State Trust Land
Tribal Land
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.
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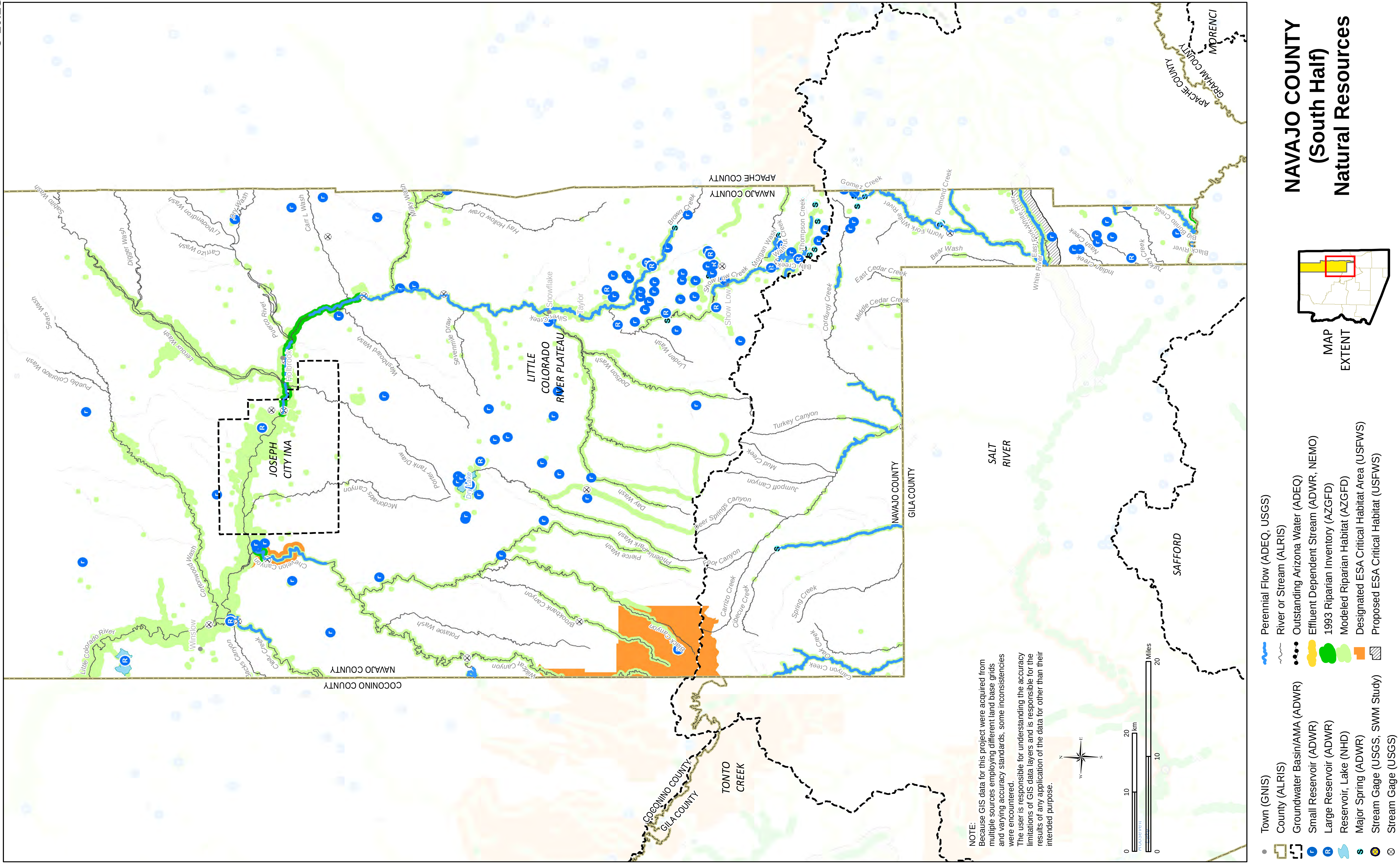
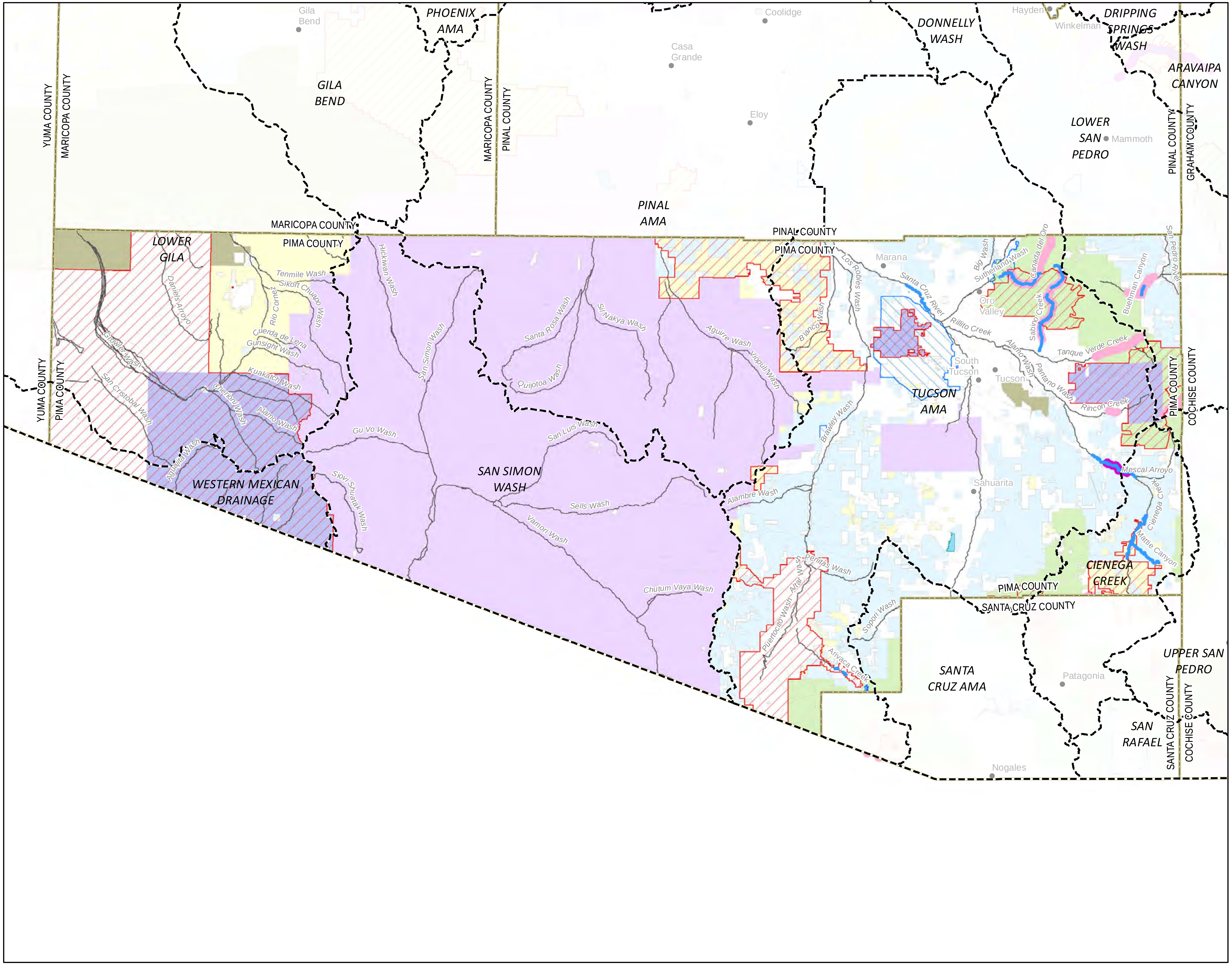
Miles
km
LITTLE COLORADO RIVER PLATEAU
JOSEPH CITY INA
SALT RIVER
SAFFORD
TONTO CREEK
MORENCI
NAVAJO COUNTY
APACHE COUNTY
COCONINO COUNTY
GILA COUNTY
GRAHAM COUNTY
Holbrook
Winslow
Snowflake
Taylor
Show Low

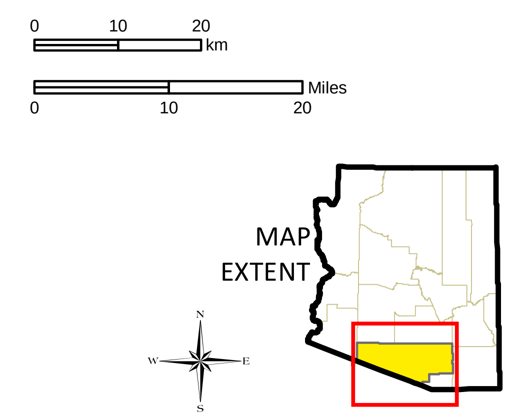
C-10.2S


NAVAJO COUNTY
(South Half)
Natural Resources
MAP EXTENT
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Small Reservoir (ADWR)
Large Reservoir (ADWR)
Reservoir, Lake (NHD)
Major Spring (ADWR)
Stream Gage (USGS, SWM Study)
Stream Gage (USGS)
Perennial Flow (ADEQ, USGS)
River or Stream (ALRIS)
Outstanding Arizona Water (ADEQ)
Effluent Dependent Stream (ADWR, NEMO)
1993 Riparian Inventory (AZGFD)
Modeled Riparian Habitat (AZGFD)
Designated ESA Critical Habitat Area (USFWS)
Proposed ESA Critical Habitat (USFWS)
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
km
LITTLE COLORADO RIVER PLATEAU
JOSEPH CITY INA
SALT RIVER
SAFFORD
TONTO CREEK
MORENCI
NAVAJO COUNTY
APACHE COUNTY
COCONINO COUNTY
GILA COUNTY
GRAHAM COUNTY
Holbrook
Winslow
Show Low
Snowflake
Taylor
Little Colorado River
Chevelon Canyon
Silver Creek
Black River
White River

PIMA COUNTY
Land Tenure



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Reservoir, Lake (NHD)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Instream Flow Certificate (ADWR)
- Instream Flow Application (ADWR)
- Federally Designated Wild and Scenic River (USFS)
- Federal Conservation Land (USFS, BLM, NPS)
- State Managed Conservation Land (AZGFD, AZSP)
- BLM Land
- National Forest
- National Park
- Military Reserve
- Private or Other Land
- State Trust Land
- Tribal Land



NOTE:
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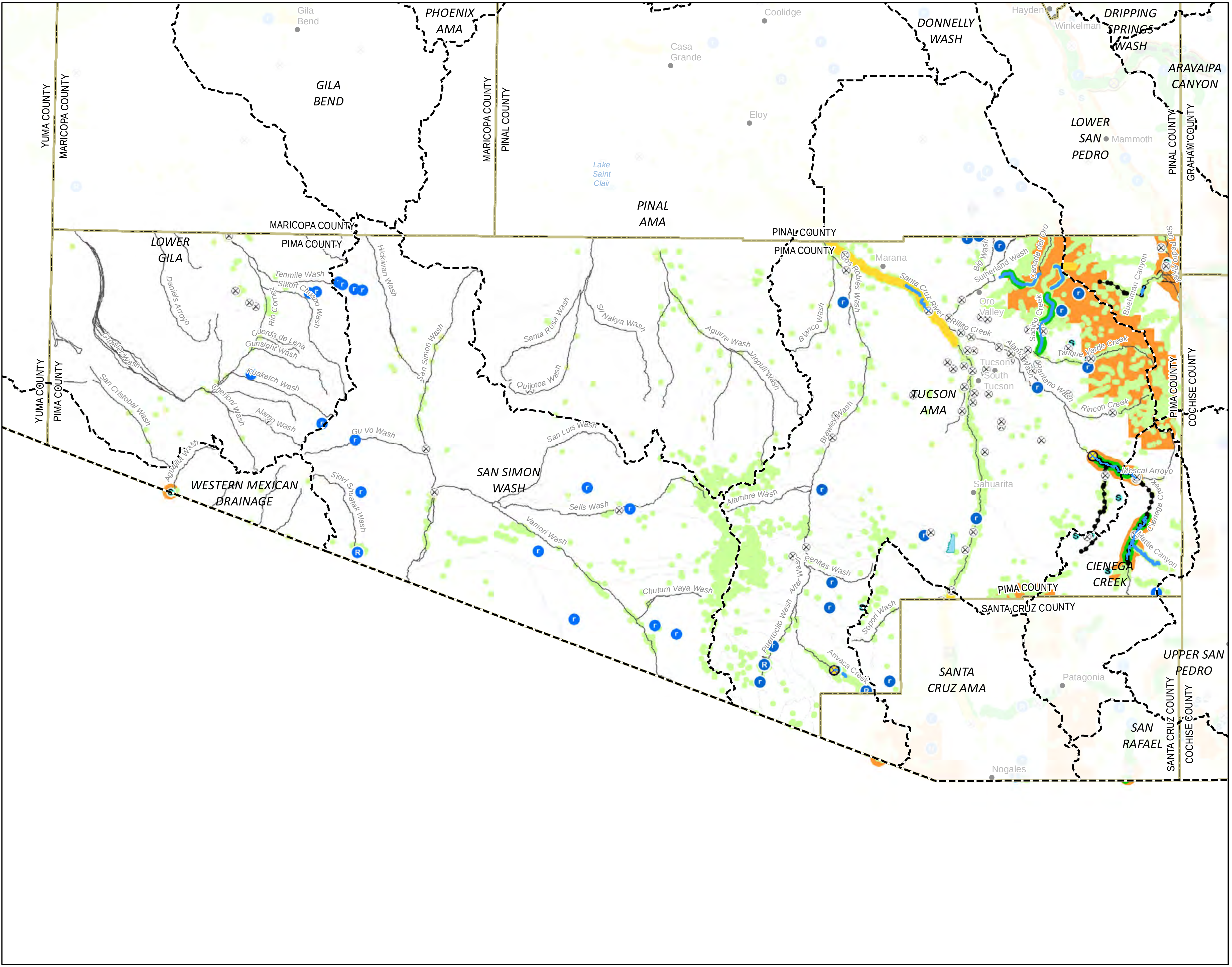
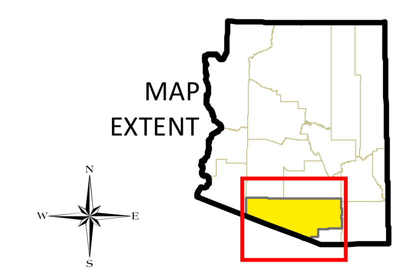
PIMA COUNTY
Natural Resources



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Small Reservoir (ADWR)
- Large Reservoir (ADWR)
- Reservoir, Lake (NHD)
- Major Spring (ADWR, Pima County)
- Stream Gage (USGS, SWM Study)
- Stream Gage (USGS)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
- Outstanding Arizona Water (ADEQ)
- Effluent Dependent Stream (ADWR, NEMO)
- 1993 Riparian Inventory (AZGFD)
- Modeled Riparian Habitat (AZGFD)
- Designated ESA Critical Habitat Area (USFWS)
- Proposed ESA Critical Habitat (USFWS)

0 10 20 km

0 10 20 Miles



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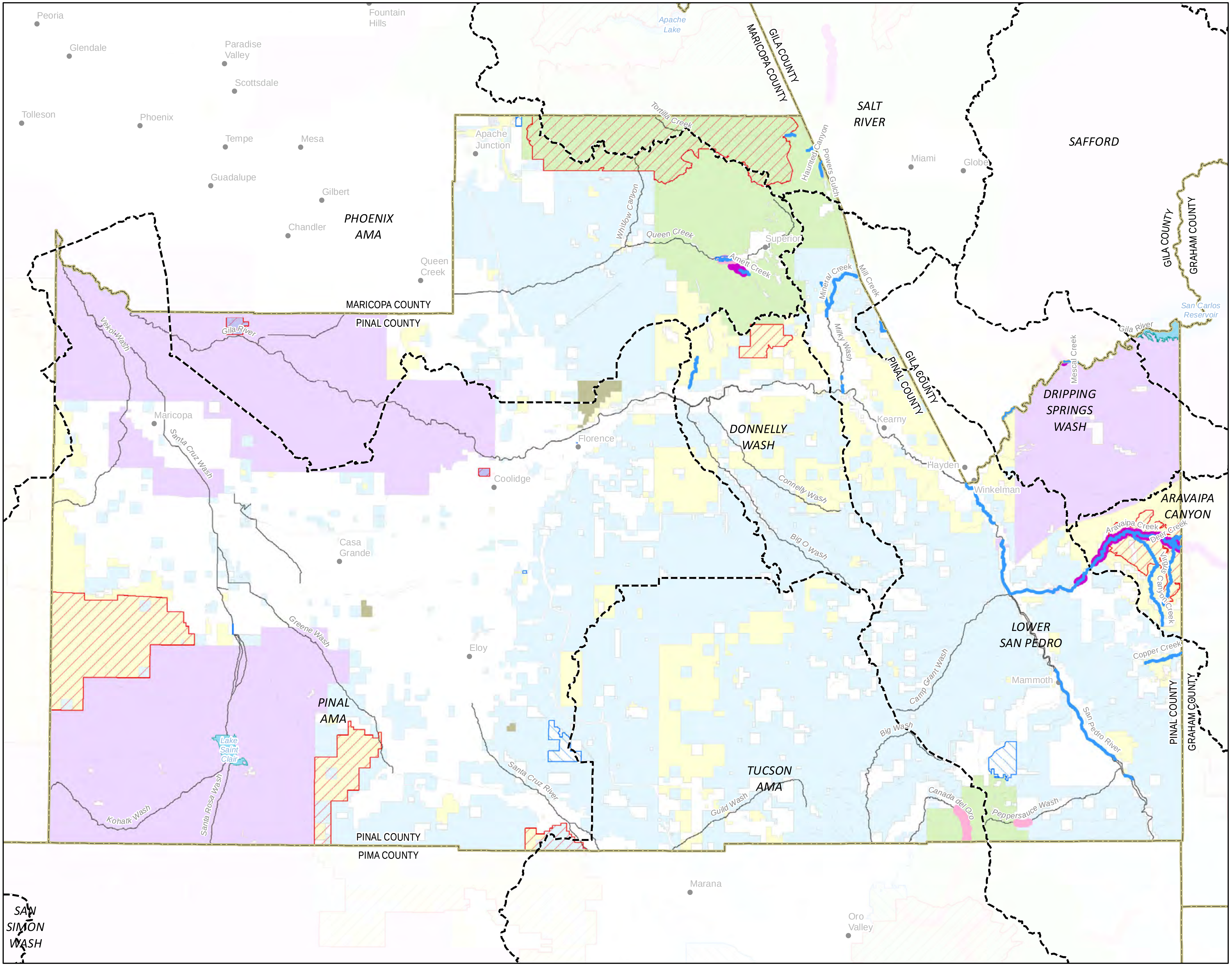
PINAL COUNTY
Land Tenure



- Town (GNIS)
- County (ALRIS)
- Groundwater Basin/AMA (ADWR)
- Reservoir, Lake (NHD)
- Perennial Flow (ADEQ, USGS)
- River or Stream (ALRIS)
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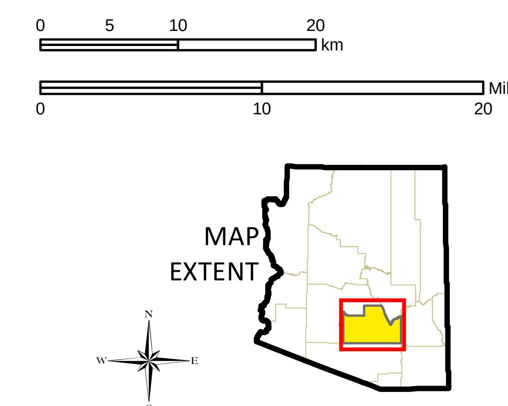
- Tribal Land



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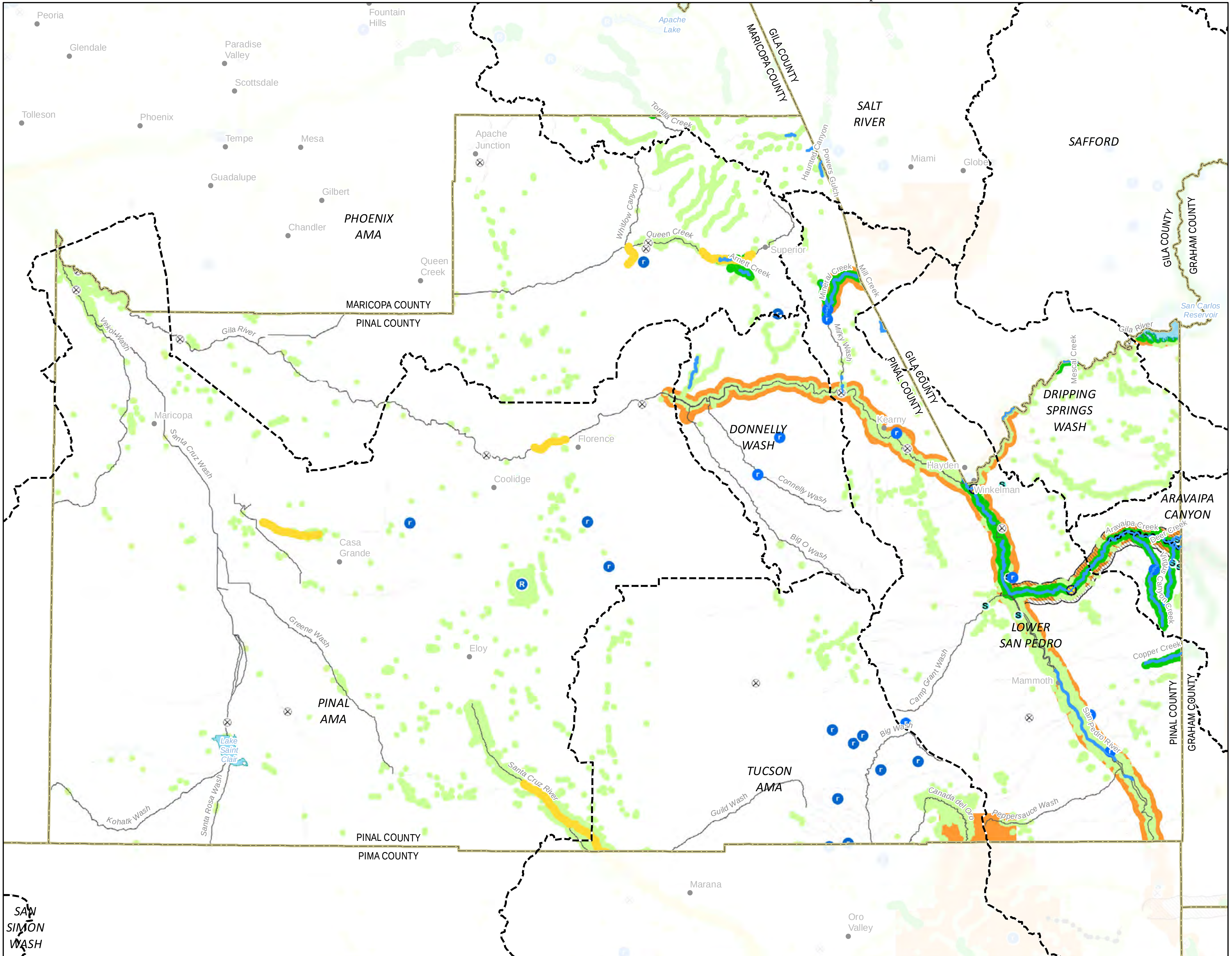
PINAL COUNTY Natural Resources



- Town (GNIS)
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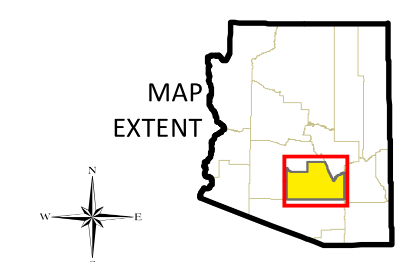

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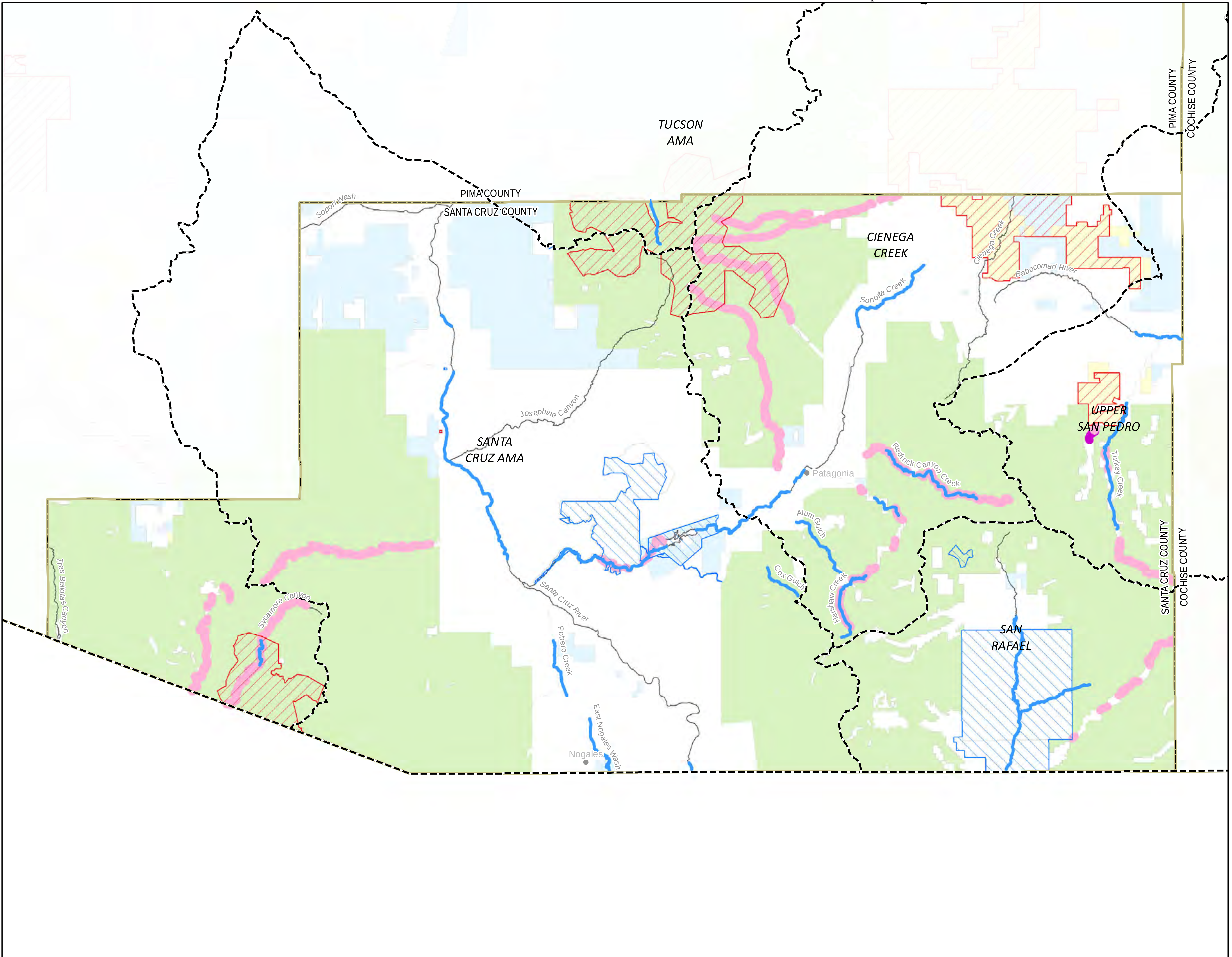
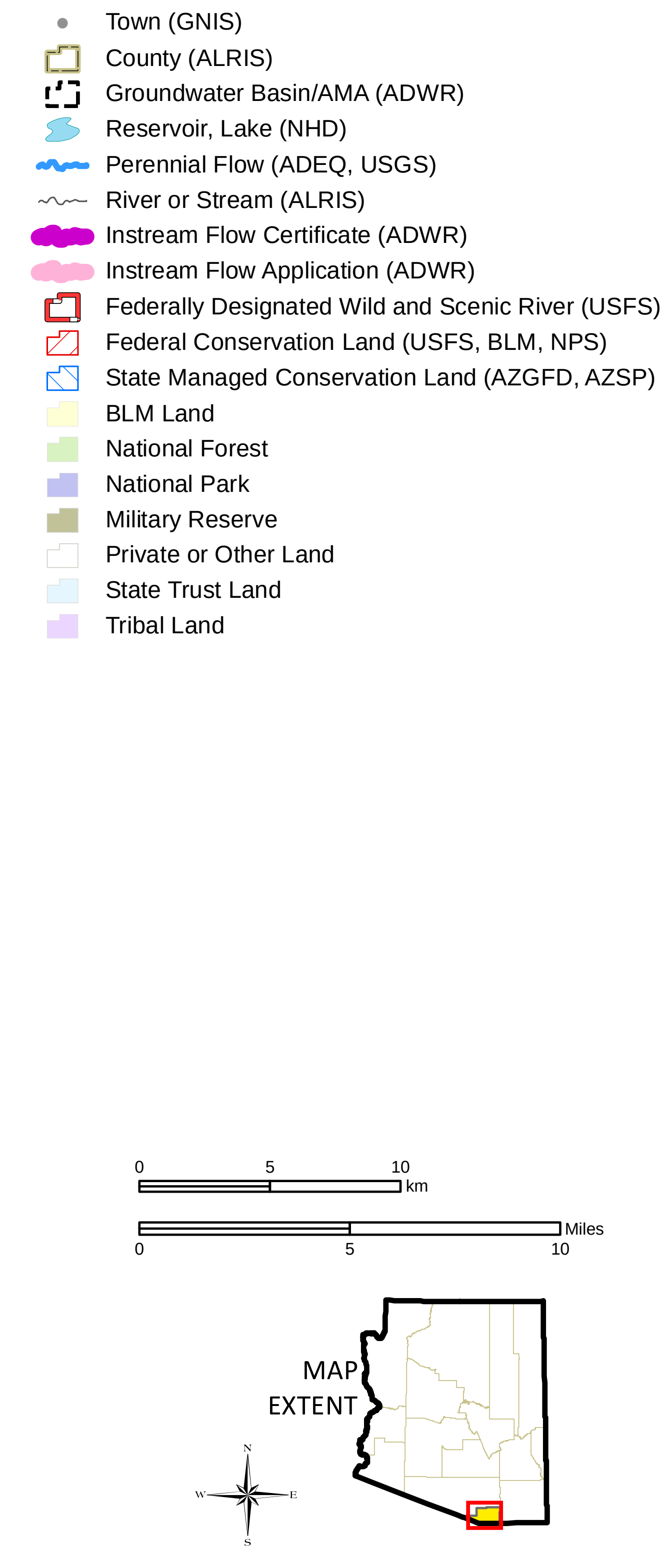
SANTA CRUZ COUNTY
Land Tenure





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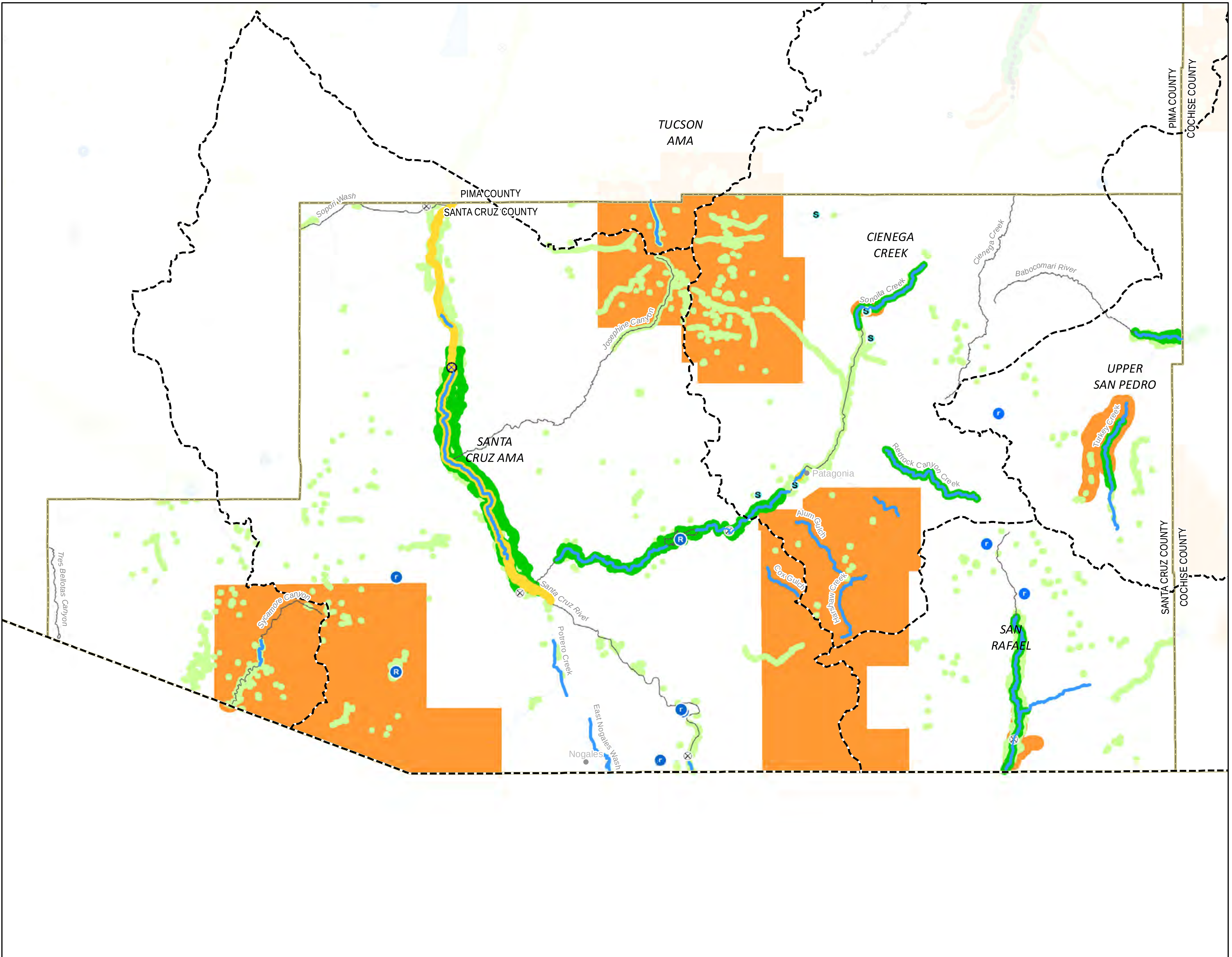
SANTA CRUZ COUNTY
Natural Resources



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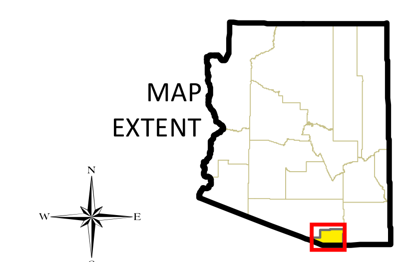

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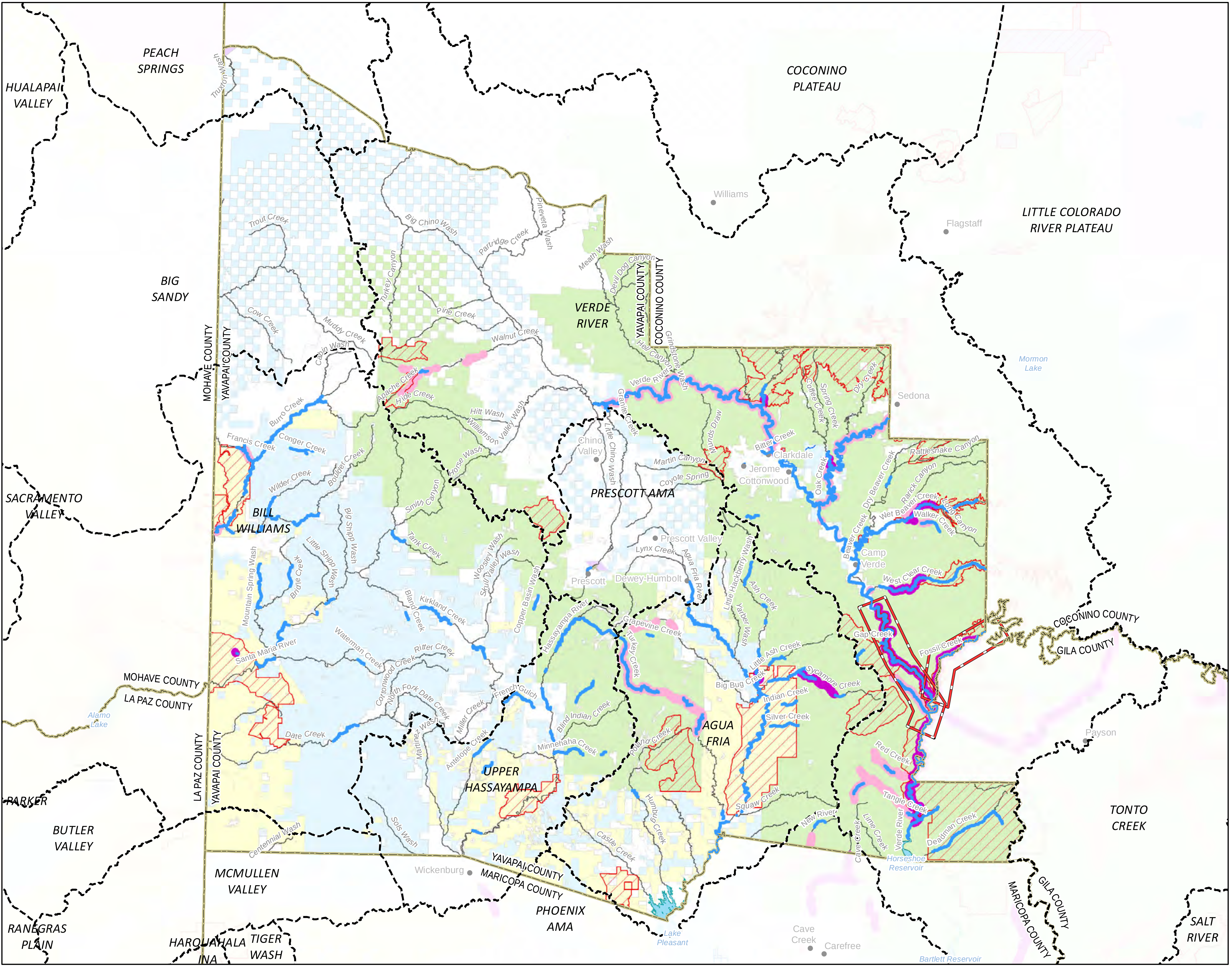
YAVAPAI COUNTY
Land Tenure



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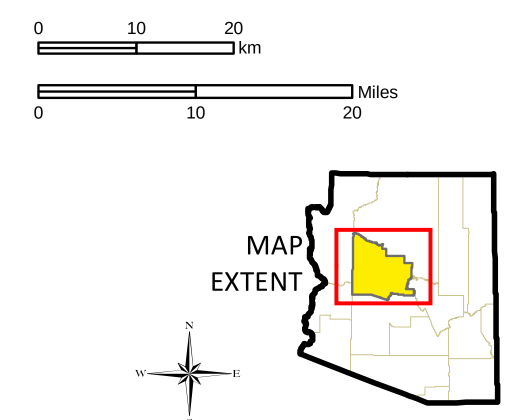

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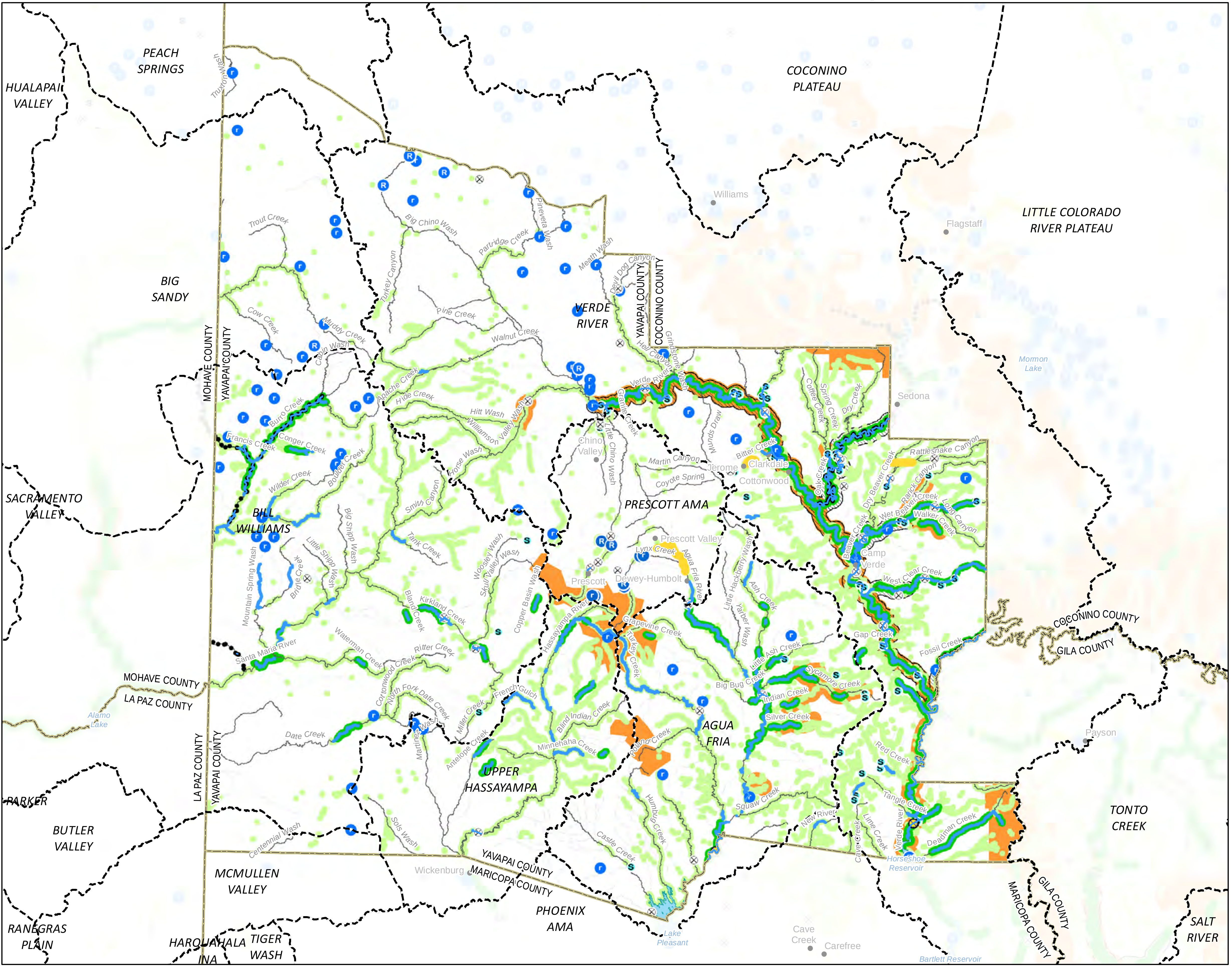
YAVAPAI COUNTY
Natural Resources



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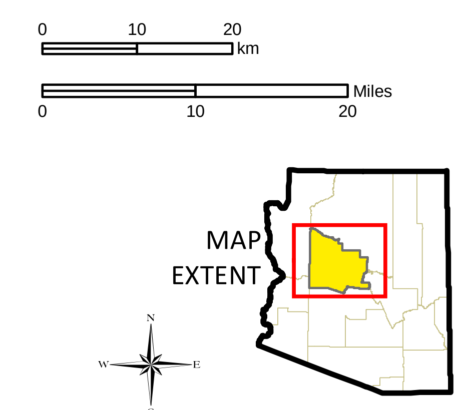

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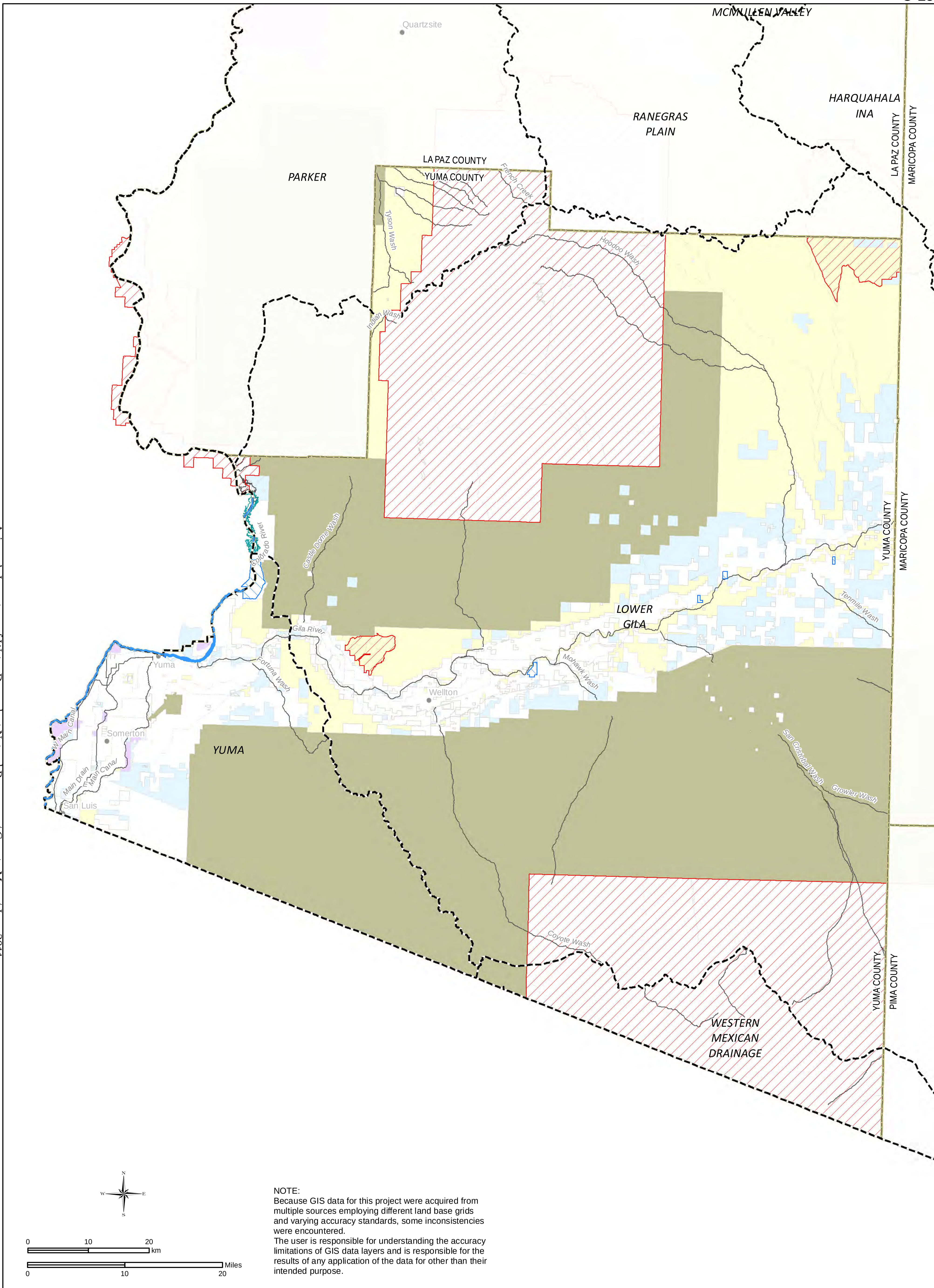

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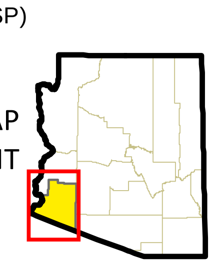
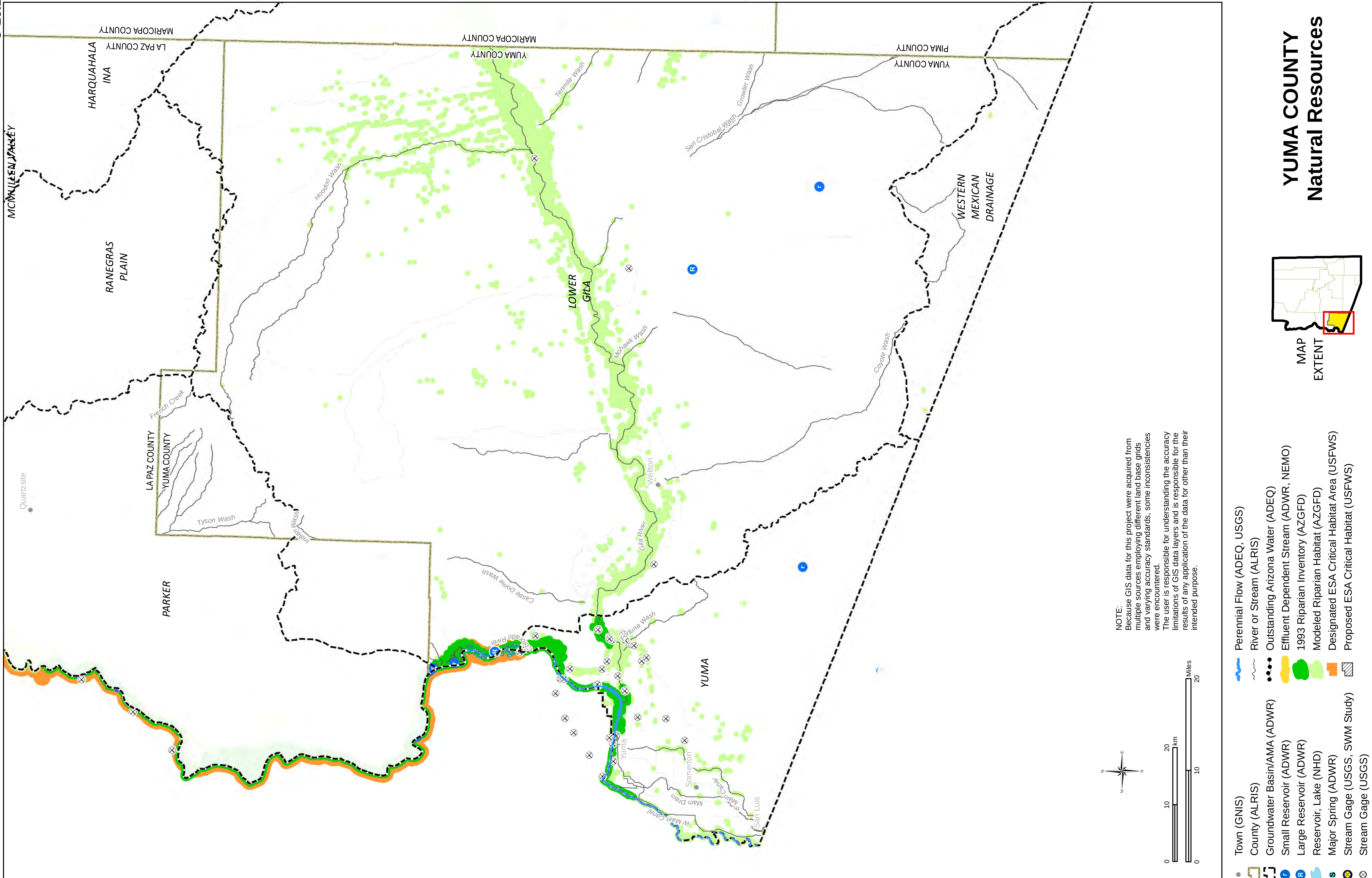


YUMA COUNTY Land Tenure

C-15.2


YUMA COUNTY
Natural Resources
MAP EXTENT
Town (GNIS)
County (ALRIS)
Groundwater Basin/AMA (ADWR)
Small Reservoir (ADWR)
Large Reservoir (ADWR)
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0 10 20 km
0 10 20 Miles
MARICOPA COUNTY
LA PAZ COUNTY
YUMA COUNTY
PIMA COUNTY
HARQUAHALA INA
MCMULLEN VALLEY
RANEGRAS PLAIN
PARKER
LOWER GILA
WESTERN MEXICAN DRAINAGE
YUMA
Quartzsite
Wellton
Yuma
Somerton
San Luis
Tenmile Wash
Growler Wash
San Cristobal Wash
Hoodoo Wash
Mohawk Wash
Coyote Wash
French Creek
Tyson Wash
Indian Wash
Castle Dome Wash
Gila River
Fortuna Wash
Colorado River
Main Drain
W Main Canal
E Main Canal

Water Resources Development Commission
Population Working Group

Working Group Chair:
Karen Collins, Salt River Project

July 13, 2011

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SUMMARY OF FINDINGS & RECOMMENDATIONS

OVERVIEW

In 2010, the Arizona Legislature passed H.B. 2661, which created the Water Resources Development Commission (WRDC) for the purpose of assessing the current and future water needs of Arizona. This paper provides a more detailed description of the methods and assumptions used by the Water Resources Development Commission's Population Working Group to project Arizona's future population by county and groundwater basin to the year 2110.

OBJECTIVE

The Population Committee's objective was to develop a set of projected population scenarios by county and groundwater basin for 25, 50 and 100 years into the future.

METHODS

Baseline Data Use for Projections:

1. U.S. Census Bureau national population projections for the years 2000 to 2100 (U.S. Census Bureau, 2000).
    a. This publication includes various projection scenarios. The Population Committee used data from the Lowest Migration Series, Middle Migration Series and Highest Migration Series (found in Table A) in developing three population projection scenarios for Arizona. (http://www.census.gov/population/www/projections/downloadablefiles.html)

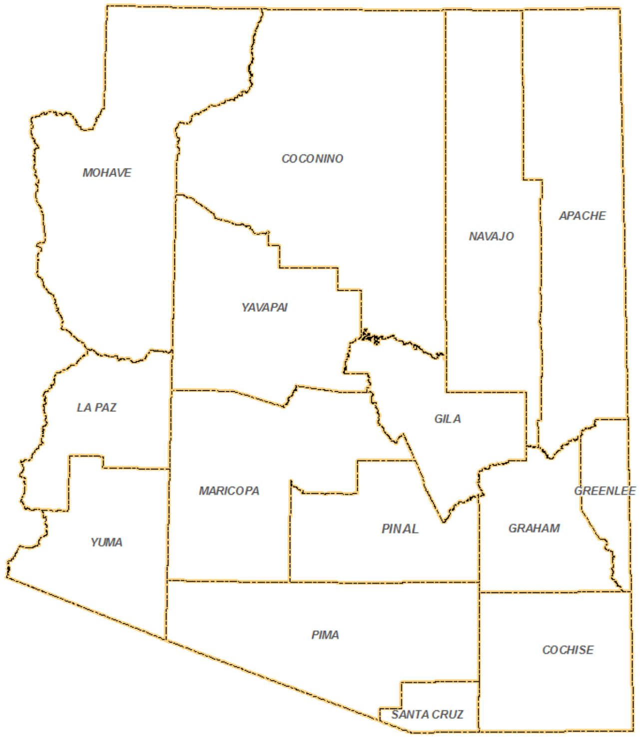
2. Population projections from the year 2006 to the year 2055 published by the Arizona Department of Economic Security (DES) in 2006, the Maricopa Association of Governments (MAG) in 2007, and Gila, Pima and Pinal Counties or their association of governments circa 2006, which appear collectively on the Arizona Department of Commerce (Commerce) website (Commerce, Circa 2006), Arizona Department of Economic Security, Research Administration, Population Statistics Unit. (2006, March 31). Arizona Population Projections 2006 - 2055. Retrieved September 24, 2010, from Arizona Commerce Authority Web Site: www.azcommerce.com

   a. were also used as the basis for projecting population to the year 2110. (Note that after the 2006 projections were prepared by the Department of Economic Security, the Population Statistics Unit of that agency was moved to the Department of Commerce.)

3. State Land 2010 Ownership Layer (http://www.land.state.az.us/alris/layers.html)
4. ESRI scripts Calc Demographics
5. Incorporate Cities layer (2009)
6. MPA layer (mpa2007_mc.shp)
7. US Census CCD CDP Layers (http://www.land.state.az.us/alris/layers.html)
8. ADWR Basin Layer

APPROACH

1. Adjust published DES population projections to account for economic downturn
2. Project Arizona's population to the year 2110
3. Calculate each county's population to the year 2110
4. Calculate each sub-county's population to the year 2110
5. Calculate each sub-county's population by basin within the county
6. Apply these ratios to state and county projections
   a. This will provide population by total county, sub-county, and county remainder (total county - sub-county = county remainder)
7. Dissect basins into associated counties
8. Dissect sub-county geographies into basins within each county
9. If a sub-county is split into two or more basins, calculate the sub-county's geographical ratio within each basin
10. Remove sub-county geographies and unavailable land areas from each county
11. Calculate new area for remaining available land within each county
12. Calculate new area for remaining available land within each basin/basin part in remaining available land within each county
13. Calculate the ratio of remaining available land within each basin/basin part to total remaining available land within each county
14. Apply sub-county projections to its associated basin ratio within each county
15. Apply county remainder projections to its associated basin remainder ratio within each county
16. Exceptions for counties that provide their own specific basin ratio to apply to the county projection



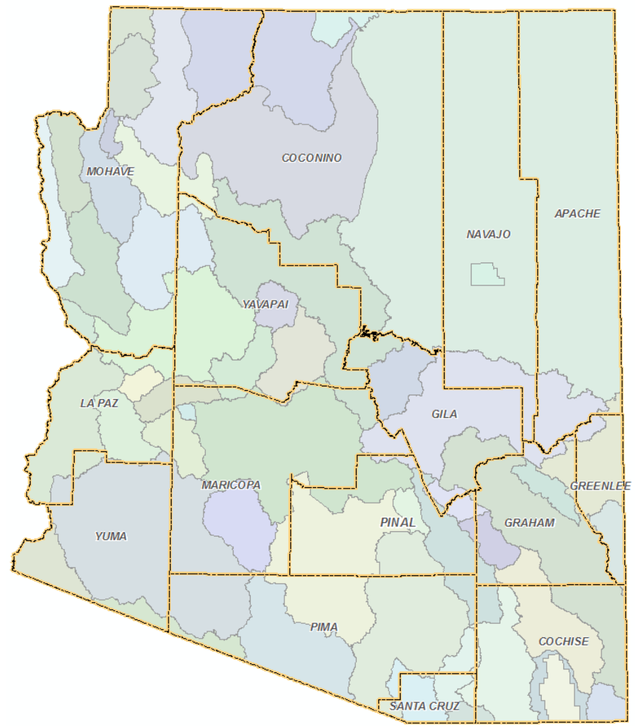


Figure 1: Arizona Counties

Figure 2: Arizona Groundwater Basins

Adjustment for Economic Downturn

State demographers from the Arizona Department of Commerce, as part of the Population Committee, adjusted the published DES population projections for the years 2010 to 2012 as a way to address the economic downturn that occurred in Arizona after the DES population projections were published. An overriding assumption that growth in the state was 0.5% in 2010, 0.7% in 2011 and 1.5% in 2012 resulted in a reduction of 595,700 people per year after 2012 which was subtracted from the published DES projections for the period of 2013 to 2055 (See Appendix 1.)

Calculation of Arizona State Population to 2110

The proportion of the adjusted DES state population projection to the U.S. Census national population projection (Mid-Series) was calculated through the end of the DES projection period to 2055. The proportion of Arizona's state population to the U.S. Census national population projection Mid-Series in the year 2055 was then applied to the U.S. Census national population projection period of 2056 to 2100 to get a new projection period for Arizona's state population. The Population Committee recognizes that this assumes Arizona's proportion of the national population will remain unchanged after the year 2055.

The U.S. Census national population projection was extended to the year 2110 by using the calculated rate of growth per year from 2050 to 2100 and carrying this forward to 2110. Arizona's state population was then calculated from 2101 through 2110 using the same methodology described above.

This process was then used to project Arizona's population as it relates to the national projection for the U.S. Census Lowest-Migration (Low-Series) and High-Migration Series (See Appendix 1 for details). The result of this methodology is shown in Table 1 below, where Arizona's population is 8,383,314 in the Low-Series scenario; 18,322,751 in the Mid-Series scenario, and 39,661,922 in the High-Series scenario in the year 2110.

Table 1: State Total Population
2010, 2035, 2060, 2110

Year	2010	2035	2060	2110
State, Mid-Series	6,628,757	10,453,870	13,252,013	18,322,751
State, Low-Series	6,589,080	8,909,230	9,318,236	8,383,314
State, High-Series	6,685,863	12,899,009	20,574,451	39,661,922

Calculation of County Population to 2110

The proportion of each county's population to the total state population was calculated using the published (not adjusted for economic downturn) DES state population projections for the years 2006 to 2055. Maricopa County's population projections were adjusted from the published MAG projections. This adjustment was necessary due to a discrepancy discovered between the published DES population for the state as a whole and the sum of the published county population projections and the MAG population projections. The MAG projections were adjusted to equal the remainder of the DES state population after all other counties were subtracted. This increased the MAG projections by 72,980 people by the end of the original projection period of 2030 (See Appendix 2; table 1, column AM).

Similar to the methodology used to calculate Arizona's proportion of the national population, each county proportion to the total state population in 2055 was held constant and used for the new projection period of 2056 to 2110 (See Appendix 2; County_Percent_State_Total, and Population_WRDC.mdb; table Cty_Percent_of_State for details). Tables 2a, 2b and 2c show the results of this calculation for the Mid-Series, Low-Series and High-Series projections:

Table 2a: County Population – Mid-Series 2010, 2035, 2060, 2110

County	2010	2035	2060	2110
Apache	74,082	91,244	105,989	146,545
Cochise	138,296	184,479	217,775	301,103
Coconino	133,959	170,790	201,624	278,773
Gila	54,704	68,234	80,030	110,652
Graham	35,456	43,654	50,325	69,582
Greenlee	7,774	7,991	9,285	12,838
La Paz	21,432	27,488	31,471	43,514
Maricopa	3,993,865	6,269,032	7,871,942	10,884,054
Mohave	209,705	331,521	414,724	573,414
Navajo	116,643	163,942	197,230	272,698
Pima	1,013,965	1,436,009	1,758,846	2,431,850
Pinal	345,261	916,691	1,407,673	1,946,304
Santa Cruz	47,548	70,943	87,166	120,519
Yavapai	228,856	354,682	430,025	594,569
Yuma	207,211	317,173	387,908	536,337
STATE	**6,628,757**	**10,453,870**	**13,252,013**	**18,322,751**

Table 2b: County Population – Low-Series 2010, 2035, 2060, 2110

County	2010	2035	2060	2110
Apache	73,639	77,762	74,527	67,050
Cochise	137,468	157,221	153,129	137,766
Coconino	133,157	145,554	141,773	127,549

Gila	54,376	58,152	56,274	50,627
Graham	35,244	37,204	35,387	31,836
Greenlee	7,727	6,810	6,529	5,874
La Paz	21,304	23,426	22,129	19,909
Maricopa	3,969,960	5,342,734	5,535,205	4,979,844
Mohave	208,449	282,536	291,616	262,358
Navajo	115,945	139,718	138,683	124,769
Pima	1,007,896	1,223,828	1,236,744	1,112,658
Pinal	343,194	781,243	989,814	890,504
Santa Cruz	47,264	60,461	61,291	55,142
Yavapai	227,487	302,274	302,375	272,037
Yuma	205,971	270,308	272,760	245,394
STATE	**6,589,080**	**8,909,230**	**9,318,236**	**8,383,314**

Table 2c: County Population – High-Series

2010, 2035, 2060, 2110

County	2010	2035	2060	2110
Apache	74,720	112,585	164,554	317,215
Cochise	139,487	227,628	338,106	651,777
Coconino	135,113	210,737	313,031	603,439
Gila	55,175	84,194	124,250	239,521
Graham	35,762	53,865	78,133	150,619
Greenlee	7,841	9,860	14,415	27,789
La Paz	21,617	33,917	48,861	94,191

Maricopa	4,028,272	7,735,346	12,221,606	23,559,919
Mohave	211,511	409,062	643,881	1,241,227
Navajo	117,648	202,288	306,210	590,289
Pima	1,022,700	1,771,889	2,730,702	5,264,048
Pinal	348,235	1,131,103	2,185,487	4,213,022
Santa Cruz	47,958	87,537	135,330	260,879
Yavapai	230,829	437,641	667,637	1,287,021
Yuma	208,996	391,359	602,248	1,160,969
STATE	**6,685,863**	**12,899,009**	**20,574,451**	**39,661,922**

Calculation of CCD Population to 2110

The proportion of each County Control Division's (CCD) population, which is the next largest geography after the county, to the total county population was calculated using the published (not adjusted for economic downturn) DES state population projections for the years 2006 to 2055.

The proportion of the CCD to the county total population in the year 2055 was held constant and used for the new projection period of 2056 to 2110. The results of these calculations can be found in Population_WRDC.mdb; table CCD_Percent_of_County.

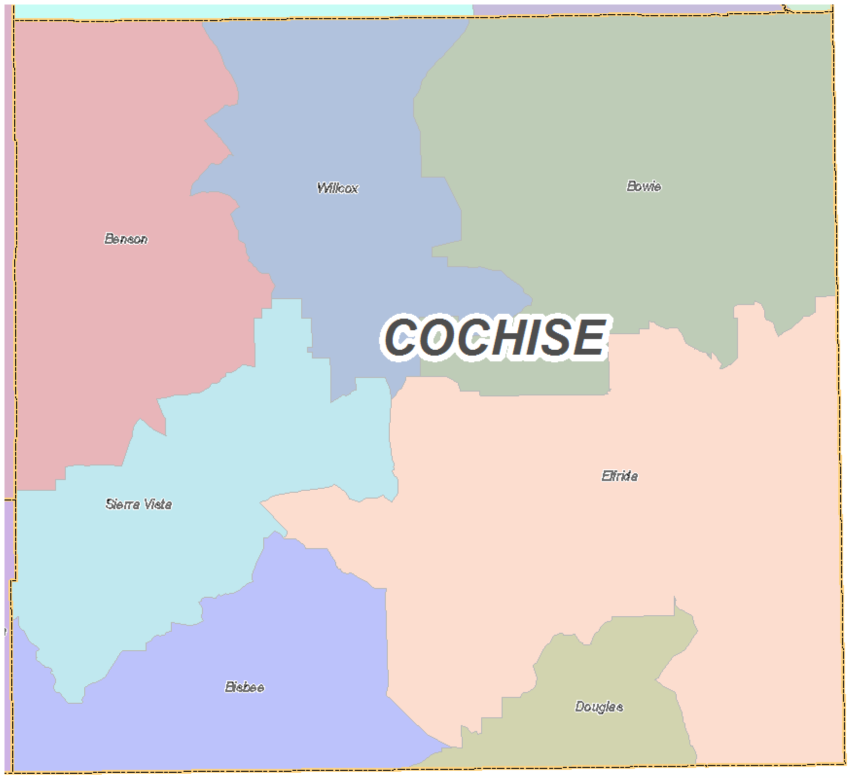


Figure 3: CCDs within Cochise County

Calculation of Municipal Planning Area and Incorporated Area Population to 2110

Four counties (Maricopa, Gila, Pima and Pinal) do not have published population projections available at the CCD level. Maricopa County projected population within Municipal Planning Areas (MPAs) and County Areas. Gila, Pima, and Pinal Counties projected population within Incorporated Areas and reservations or reservation parts. MPAs in Maricopa County, and Incorporated Areas in Gila, Pima and Pinal Counties, are the smallest geographies for which population projections are available within these counties. The same approach that was used for calculating the proportion of each CCD's population to the total county population was employed for calculating the proportion of each MPA or Incorporated Area's population; the proportion of the MPA or Incorporated Area to the county total was calculated for the extent of the published projection period (Maricopa County projections went to 2030, Gila, Pima and Pinal County projections went to 2055).

The proportion MPA or Incorporated Area to the county total population in the year 2055 was held constant and used for the new projection period of 2056 to 2110. The results of these calculations can be found in Population_WRDC.mdb; tables MPA_Percent_of_County and Other_Area_Percent_of_County.

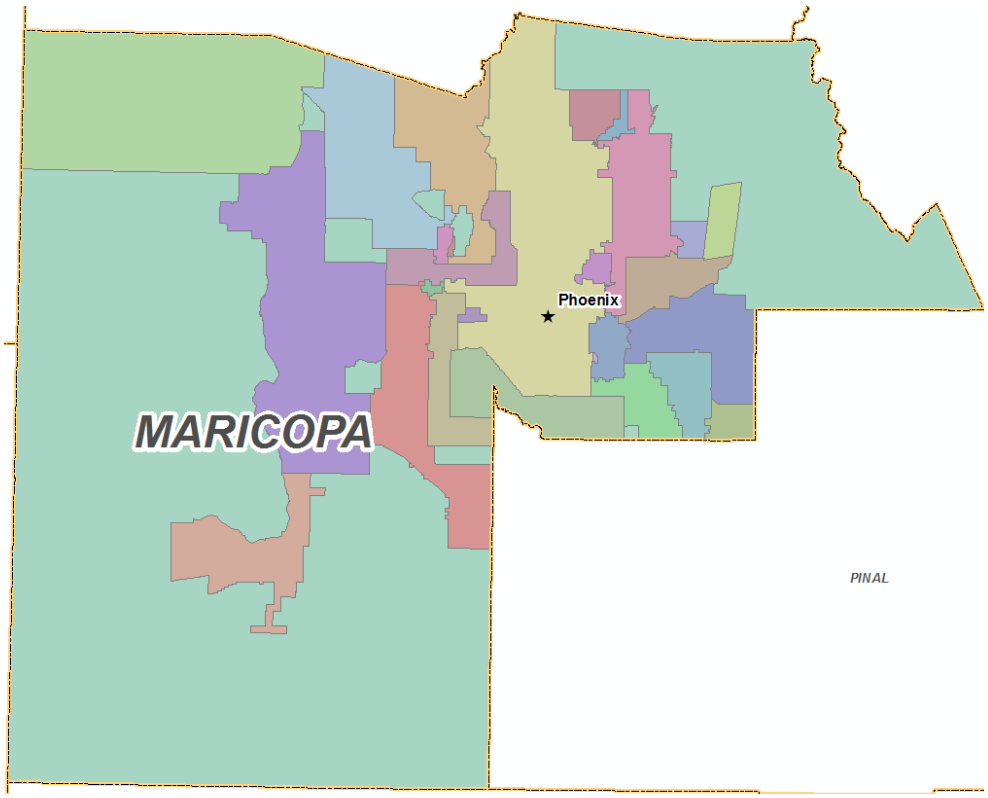


Figure 4: MPAs and County Areas within Maricopa County

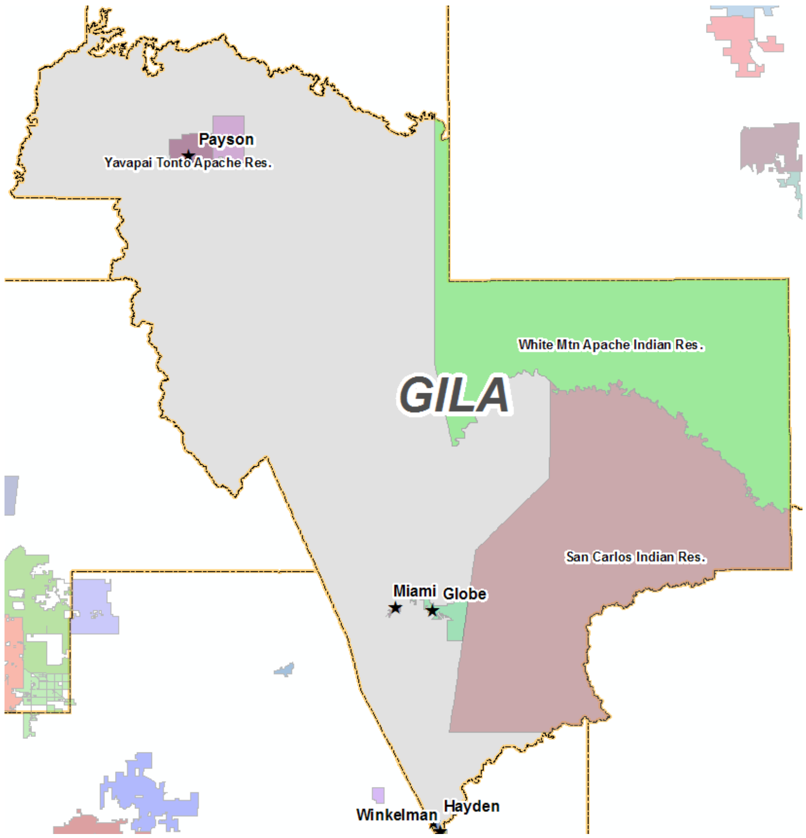


Figure 5: Incorporated Areas and Reservations within Gila County

Calculation of CDP Population to 2110

For counties other than Maricopa, Gila, Pima, and Pinal, DES made projections down to the Census Designated Place (CDP) level. CDPs are unincorporated population centers within a CCD and make up the smallest geography for which DES population projections are available. Calculations of population for CDPs to the year 2110 were done using the same methodology that was used for the state, county, CCD, MPA and Incorporated Areas. The proportion of the CDP to the CCD was calculated for the projection period of 2006 to 2055. The proportion of the CDP to the CCD in the year 2055 was held constant and used for the new projection period of 2056 to 2110. The results of these calculations can be found in Population_WRDC.mdb; table CDP_Percent_of_CCD.

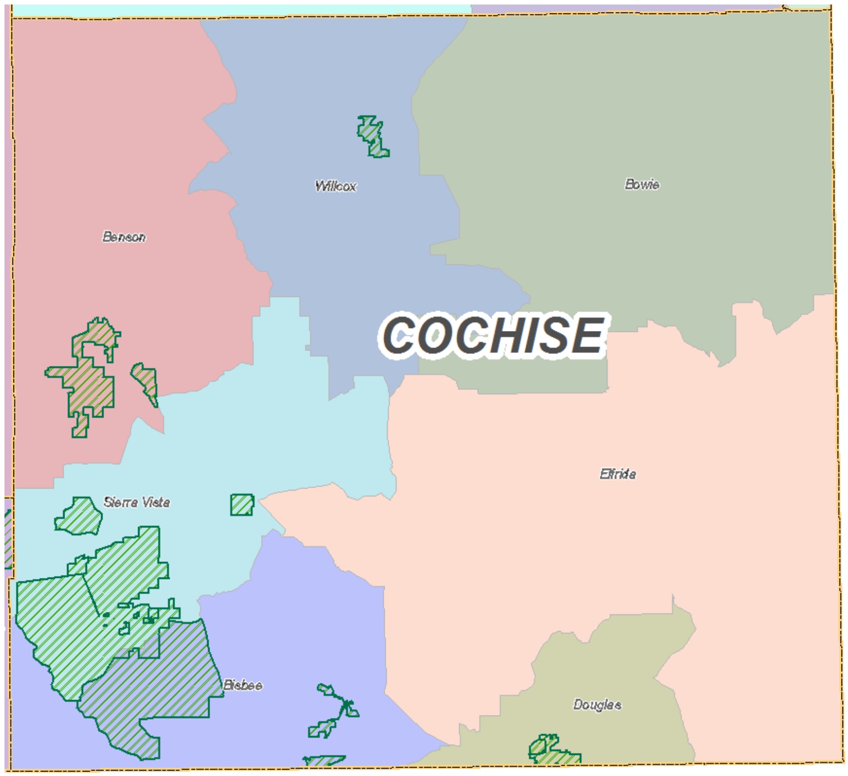


Figure 6: CDPs and CCDs within Cochise County

CCD and County Remainders

Any portion of the projected population within a CCD that does not contain a CDP is considered a CCD remainder; likewise, any portion of the projected population for a county that is not contained within an Incorporated Area is considered the county remainder. Within Maricopa County, areas outside of an MPA were categorized as County Areas in the published DES projection.

Calculation of CDP Population by Basin

After the population of each CDP was projected to the year 2110, CDP population projections were split between groundwater basin boundaries within each county. Many CDPs fell entirely within only one basin; however some CDPs straddled more than one basin. ADWR used an ESRI GIS script called Calculate Demographics (http://arcscripts.esri.com) to calculate the percent of each CDP's land area located within a basin or basins (area split method). This percent, which did not change from year to year, was then applied to the projected population for each CDP for each year to determine the population of each CDP within each basin (See Population_WRDC.mdb; table CDP_Percent_of_Basin).

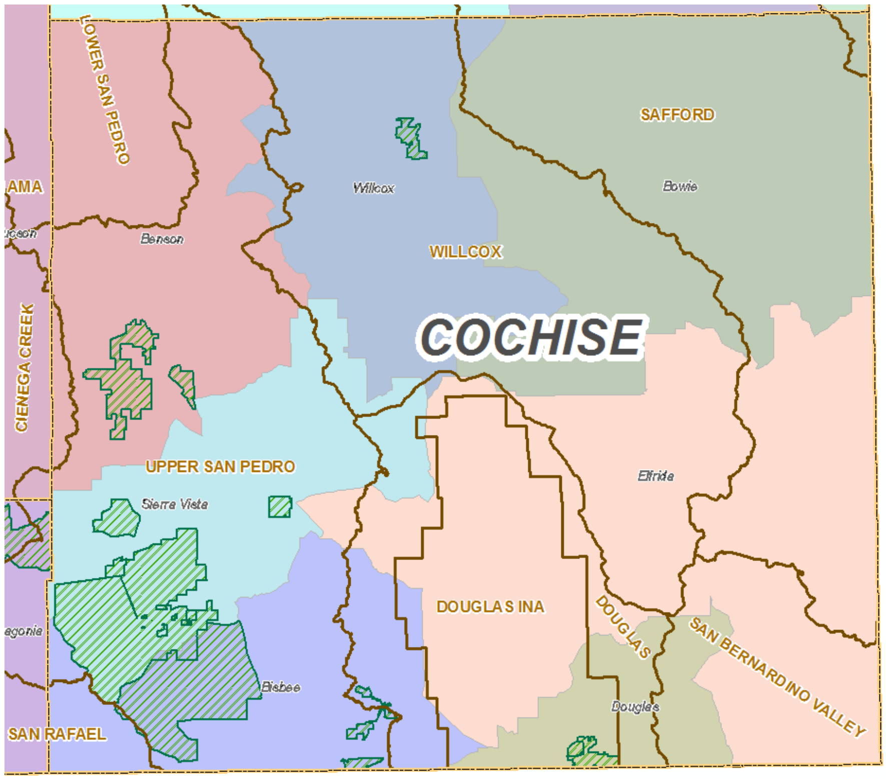


Figure 7: CDPs, CCDs and Groundwater Basins within Cochise County

Calculation of MPA Population by Basin

The methodology used to divide Maricopa County's MPA and County Area population projections into basin boundaries is similar to the methodology used to divide the CDP population projections into basin boundaries. The same ESRI script was used to calculate the percent of each MPA's land area within a basin or basins. This percent was then applied to the projected population of the MPA and County Area to determine the population of each MPA and County Area within each basin. Some exceptions were made to this methodology due to water provider service areas crossing basin boundaries. For example, some water service areas are located predominantly within the Phoenix AMA basin, but cross the Pinal AMA basin boundary. Because the water demand associated with this population is met with supplies from the Phoenix AMA, the population of the MPA within Pinal AMA was not distributed to Pinal AMA, but was kept 100% within the Phoenix AMA. The results of these calculations can be found in Population_WRDC.mdb; table MPA_Percent_of_Basin.

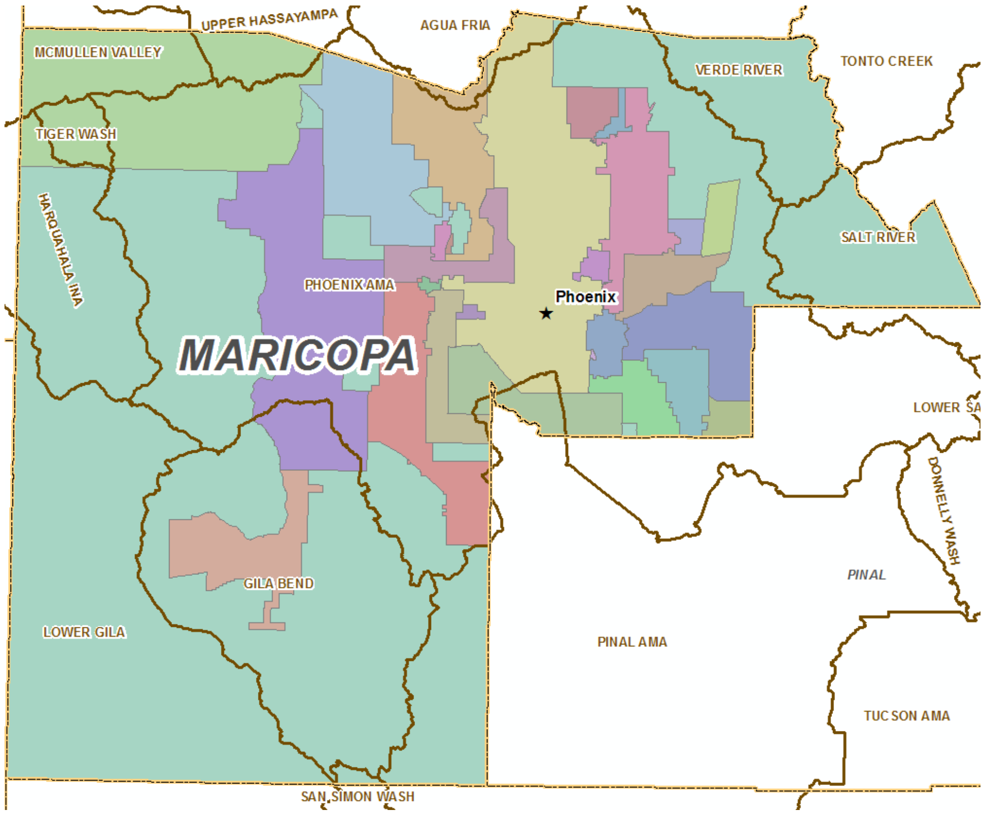


Figure 8: MPAs, County Remainders and Groundwater Basins within Maricopa County

Calculation of Incorporated Area Population by Basin

Population projections within incorporated areas of Gila, Pima and Pinal Counties were divided into groundwater basins using the same methodology that was used to divide the CDP population projections. The resulting percent distribution was then applied to the projected population within each incorporated area.

In addition to population projections by incorporated area, the published projections for both Gila and Pinal County include population by reservation or reservation part. In these counties, the projected population for the reservation or reservation part was divided into groundwater basins using the same methodology described above. This percent distribution was then applied to the projected population within each reservation or reservation part.

It is important to note that Gila and Pinal are the only two counties that include published population projections for specific Indian reservations and that all county projections were based on the published DES projection data for each county.

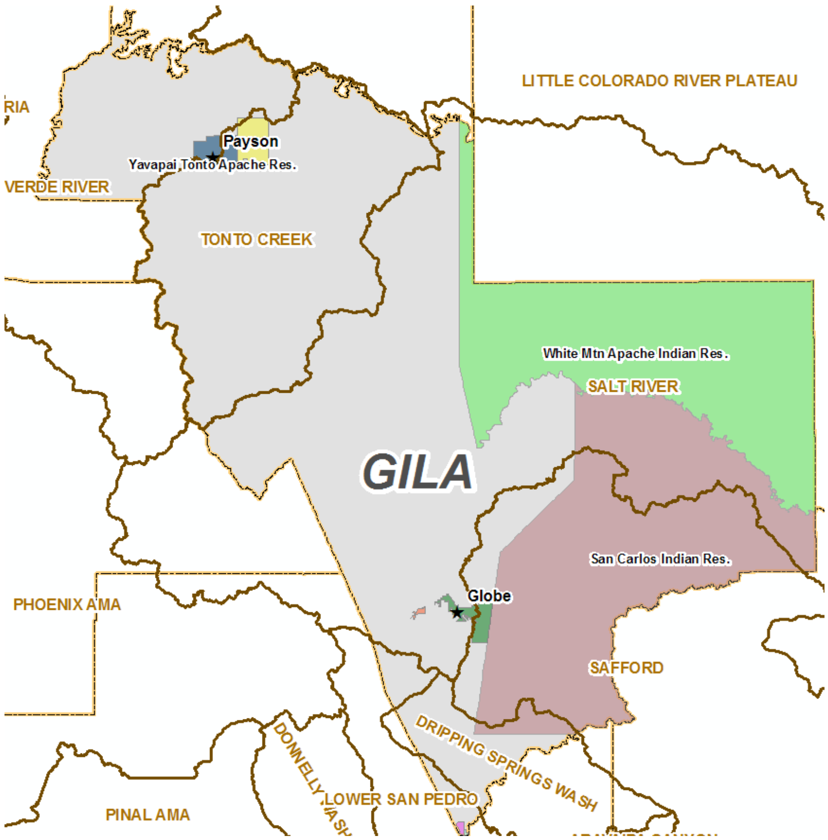


Figure 9: Incorporated Areas, Reservations and Groundwater Basins within Gila County

Calculation of CCD Remainder and County Remainder Population by Basin

The projected population for each CCD remainder and county remainder (CCD population – CDP population = CCD remainder population) (county population - Incorporated Area population = county remainder population) was divided between groundwater basin boundaries within each county using a slightly different approach to the CDP, MPA and Incorporated Area splits described above.

First, using GIS software, the CDP and Incorporated Area geographies were removed from each county. Next, using land ownership information published by the State Land Department, select land ownership types were removed from each county as follows:

> Bureau of Land Management, National Forests, Indian reservations*, state parks and recreational areas, Military bases, Federal Parks, Bureau of Recreation, Game and Fish, County Land, wildlife areas and refuges
>
> *For county projections that use CCDs, Indian reservations are included in the CCD populations, so the geographies for Indian reservations within these CCDs was not erased and was included as available land in the *area split method*.

A new geographical area was then calculated for each county and CCD; this became the geographical equivalent to the CCD remainder and county remainder. These new geographies were then divided between groundwater basin boundaries within each county and a ratio of each was calculated (*area split method*). This percent, which did not change from year to year, was then applied to the projected population for each CCD remainder or county remainder for each year to determine the population within each basin.

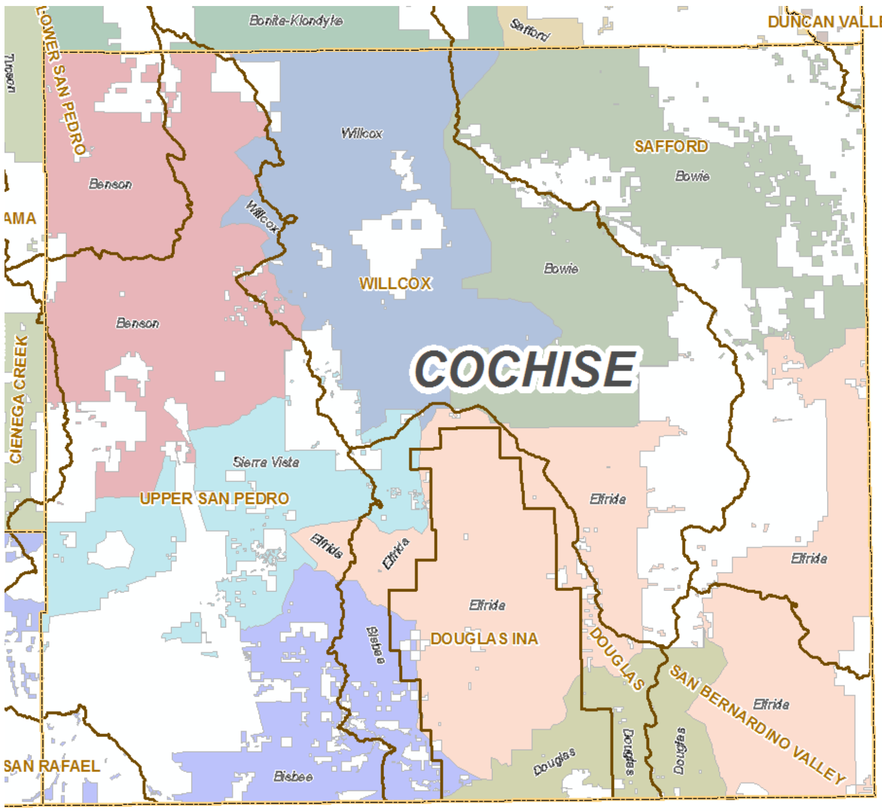


Figure 10: CCD Remainders and Basins within Cochise County

La Paz, Pima and Pinal County Exception

The Population Committee requested feedback from each county on how they would distribute the projected population remainders between basins within their county. The Committee received guidance from La Paz, Pima and Pinal County. The percent distribution of population within each basin for the CCD remainders and county remainders provided by La Paz and Pinal County do change over time (unlike the geographic distribution described in the previous sections). These figures are found in Appendix 3 and 4, and the results of these calculations, which are used in the final report, can be found in Population_WRDC.mdb; table Pinal_LaPaz_Percents.

In Pima County, the population within unincorporated areas is considered the county remainder. Pima County officials decided that the distribution of the unincorporated area population based on the 2000 U.S. Census block level population data gave a better result than distributing the unincorporated area. The proportion of the unincorporated area by basin can be found in Population_WRDC.mdb; table Inc_Area_Percent_of_Basin.

RESULTS

Most of the population calculations by county, CCD, CDP, MPA and Incorporated Area were done using queries within an Access database called Population_WRDC.mdb. For some calculations, queries were run through the year 2055 and then the query results were exported to Excel in order to quickly extend the 2055 proportion from 2056 to 2110. The results were then imported back into Access.

Queries for CDP, MPA and Incorporated Area by basin also contain fields for CCD (where applicable) and county which make it possible for the results to be viewed by county, CCD, MPA, CDP, Incorporated Area and basin.

Tables 3a, 3b and 3c below shows the results of the compilation query by basin:

Table 3a: Basin Population – Mid-Series
2010, 2035, 2060, 2110

BASIN_NAME	2010	2035	2060	2110
AGUA FRIA	147,501	215,989	270,217	373,613
ARAVAIPA CANYON	542	609	676	935
BIG SANDY	6,139	9,619	11,960	16,536
BILL WILLIAMS	18,801	23,339	26,647	36,976
BONITA CREEK	998	1,300	1,530	2,116
BUTLER VALLEY	0	0	0	0
CIENEGA CREEK	4,406	6,422	7,886	10,903
COCONINO PLATEAU	14,020	17,692	20,798	28,757
DETRITAL VALLEY	2,390	3,702	4,605	6,367
DONNELLY WASH	0	0	0	7,897
DOUGLAS	4,708	5,561	6,284	8,689

DOUGLAS INA	23,796	33,709	40,559	56,078
DRIPPING SPRINGS WASH	5,515	6,046	6,626	9,161
DUNCAN VALLEY	3,816	3,926	4,562	6,307
GILA BEND	29,729	107,998	135,612	187,503
GRAND WASH	172	319	415	574
HARQUAHALA INA	7,842	15,264	19,449	27,886
HUALAPAI VALLEY	38,342	59,180	73,538	101,677
JOSEPH CITY INA	647	760	858	1,186
KANAB PLATEAU	9,101	14,301	17,878	24,719
LAKE HAVASU	64,361	107,807	136,955	189,359
LAKE MOHAVE	61,773	91,293	112,009	154,868
LITTLE COLORADO PLATEAU	283,135	372,602	441,842	610,908
LOWER GILA	36,640	63,136	78,012	107,863
LOWER SAN PEDRO	16,553	23,349	36,277	50,158
MCMULLEN VALLEY	6,862	11,194	13,695	18,670
MEADVIEW	176	271	337	466
MORENCI	4,883	5,268	6,135	8,482
PARIA	209	242	274	379
PARKER	16,279	19,685	21,835	29,528
PEACH SPRINGS	4,904	7,287	8,956	12,384
PHOENIX AMA	3,873,900	6,079,298	7,640,570	10,540,458
PINAL AMA	234,814	672,112	1,065,750	1,457,753
PRESCOTT AMA	113,614	190,819	235,698	325,885
RANEGRAS PLAIN	557	834	1,035	1,232
SACRAMENTO VALLEY	23,047	37,460	47,215	65,281

SAFFORD	40,335	48,814	55,879	77,261
SALT RIVER	29,550	39,113	45,539	62,964
SAN BERNARDINO VALLEY	2,214	2,327	2,503	3,461
SAN RAFAEL	592	759	885	1,224
SAN SIMON WASH	7,415	11,484	14,444	19,971
SANTA CRUZ AMA	46,493	69,814	86,008	118,918
SHIVWITS PLATEAU	1,433	2,655	3,455	4,777
TIGER WASH	1,053	1,828	2,295	3,173
TONTO CREEK	19,522	27,074	33,475	46,284
TUCSON AMA	1,002,673	1,428,170	1,769,275	2,477,858
UPPER HASSAYAMPA	4,443	7,060	8,637	11,942
UPPER SAN PEDRO	91,178	122,806	145,434	201,083
VERDE RIVER	110,035	160,699	192,864	266,661
VIRGIN RIVER	362	671	874	1,208
WESTERN MEXICAN DRAINAGE	282	433	545	753
WILLCOX	12,812	15,557	17,770	24,569
YUMA	198,191	306,214	375,432	519,087
STATE	**6,628,757**	**10,453,870**	**13,252,013**	**18,322,751**

Table 3b: Basin Population – Low-Series
2010, 2035, 2060, 2110

BASIN_NAME	2010	2035	2060	2110
AGUA FRIA	146,618	184,075	190,005	170,941
ARAVAIPA CANYON	539	519	475	428
BIG SANDY	6,102	8,198	8,410	7,566
BILL WILLIAMS	18,688	19,891	18,737	16,918

BONITA CREEK	992	1,108	1,076	968
BUTLER VALLEY	0	0	0	0
CIENEGA CREEK	4,379	5,473	5,545	4,989
COCONINO PLATEAU	13,936	15,078	14,625	13,157
DETRITAL VALLEY	2,376	3,155	3,238	2,913
DONNELLY WASH	0	0	0	3,613
DOUGLAS	4,680	4,739	4,419	3,976
DOUGLAS INA	23,653	28,728	28,519	25,658
DRIPPING SPRINGS WASH	5,482	5,153	4,659	4,192
DUNCAN VALLEY	3,794	3,346	3,208	2,886
GILA BEND	29,551	92,041	95,357	85,789
GRAND WASH	171	272	292	263
HARQUAHALA INA	7,795	13,008	13,676	12,759
HUALAPAI VALLEY	38,112	50,436	51,709	46,521
JOSEPH CITY INA	643	648	603	543
KANAB PLATEAU	9,046	12,188	12,571	11,310
LAKE HAVASU	63,976	91,877	96,301	86,638
LAKE MOHAVE	61,403	77,804	78,760	70,858
LITTLE COLORADO PLATEAU	281,440	317,546	310,684	279,512
LOWER GILA	36,421	53,807	54,855	49,351
LOWER SAN PEDRO	16,454	19,899	25,508	22,949
MCMULLEN VALLEY	6,821	9,540	9,630	8,542
MEADVIEW	175	231	237	213
MORENCI	4,854	4,489	4,314	3,881
PARIA	208	207	193	174

PARKER	16,182	16,777	15,354	13,510
PEACH SPRINGS	4,874	6,210	6,298	5,666
PHOENIX AMA	3,850,713	5,181,034	5,372,514	4,822,637
PINAL AMA	233,408	572,802	749,389	666,974
PRESCOTT AMA	112,934	162,624	165,733	149,104
RANEGRAS PLAIN	554	710	728	564
SACRAMENTO VALLEY	22,909	31,925	33,200	29,869
SAFFORD	40,094	41,601	39,292	35,350
SALT RIVER	29,374	33,334	32,021	28,808
SAN BERNARDINO VALLEY	2,200	1,983	1,760	1,583
SAN RAFAEL	589	647	622	560
SAN SIMON WASH	7,370	9,787	10,156	9,137
SANTA CRUZ AMA	46,215	59,499	60,477	54,409
SHIVWITS PLATEAU	1,424	2,262	2,430	2,186
TIGER WASH	1,047	1,558	1,614	1,452
TONTO CREEK	19,406	23,074	23,538	21,177
TUCSON AMA	996,671	1,217,147	1,244,077	1,133,709
UPPER HASSAYAMPA	4,416	6,017	6,073	5,464
UPPER SAN PEDRO	90,632	104,661	102,263	92,003
VERDE RIVER	109,376	136,954	135,613	122,007
VIRGIN RIVER	360	572	615	553
WESTERN MEXICAN DRAINAGE	280	369	383	345
WILLCOX	12,735	13,258	12,495	11,241
YUMA	197,005	260,968	263,987	237,501
STATE	**6,589,080**	**8,909,230**	**9,318,235**	**8,383,314**

Table 3c: Basin Population – High-Series
2010, 2035, 2060, 2110

BASIN_NAME	2010	2035	2060	2110
AGUA FRIA	148,772	266,508	419,527	808,733
ARAVAIPA CANYON	547	751	1,050	2,024
BIG SANDY	6,192	11,869	18,568	35,795
BILL WILLIAMS	18,963	28,798	41,371	80,038
BONITA CREEK	1,007	1,604	2,376	4,579
BUTLER VALLEY	0	0	0	0
CIENEGA CREEK	4,444	7,924	12,243	23,601
COCONINO PLATEAU	14,141	21,830	32,291	62,248
DETRITAL VALLEY	2,411	4,568	7,150	13,783
DONNELLY WASH	0	0	0	17,095
DOUGLAS	4,749	6,862	9,757	18,809
DOUGLAS INA	24,001	41,594	62,970	121,389
DRIPPING SPRINGS WASH	5,563	7,460	10,287	19,830
DUNCAN VALLEY	3,849	4,845	7,082	13,653
GILA BEND	29,986	133,259	210,545	405,874
GRAND WASH	174	394	645	1,243
HARQUAHALA INA	7,910	18,834	30,196	60,362
HUALAPAI VALLEY	38,672	73,022	114,172	220,092
JOSEPH CITY INA	653	938	1,332	2,568
KANAB PLATEAU	9,179	17,646	27,757	53,508
LAKE HAVASU	64,915	133,022	212,629	409,892
LAKE MOHAVE	62,305	112,646	173,900	335,231
LITTLE COLORADO PLATEAU	285,574	459,752	685,983	1,322,389

LOWER GILA	36,956	77,903	121,118	233,483
LOWER SAN PEDRO	16,696	28,810	56,322	108,573
MCMULLEN VALLEY	6,921	13,812	21,262	40,414
MEADVIEW	177	335	523	1,008
MORENCI	4,926	6,500	9,524	18,360
PARIA	211	299	426	821
PARKER	16,419	24,289	33,901	63,916
PEACH SPRINGS	4,946	8,992	13,905	26,806
PHOENIX AMA	3,907,273	7,501,233	11,862,389	22,816,161
PINAL AMA	236,837	829,318	1,654,633	3,155,491
PRESCOTT AMA	114,592	235,451	365,934	705,420
RANEGRAS PLAIN	562	1,029	1,607	2,667
SACRAMENTO VALLEY	23,245	46,221	73,304	141,310
SAFFORD	40,683	60,232	86,756	167,241
SALT RIVER	29,805	48,261	70,702	136,294
SAN BERNARDINO VALLEY	2,233	2,871	3,886	7,491
SAN RAFAEL	597	936	1,374	2,649
SAN SIMON WASH	7,479	14,170	22,425	43,229
SANTA CRUZ AMA	46,893	86,143	133,532	257,414
SHIVWITS PLATEAU	1,445	3,276	5,365	10,341
TIGER WASH	1,062	2,255	3,563	6,868
TONTO CREEK	19,691	33,407	51,972	100,188
TUCSON AMA	1,011,311	1,762,216	2,746,893	5,363,638
UPPER HASSAYAMPA	4,481	8,711	13,410	25,850
UPPER SAN PEDRO	91,964	151,530	225,795	435,270

VERDE RIVER	110,983	198,286	299,432	577,222
VIRGIN RIVER	366	828	1,357	2,616
WESTERN MEXICAN DRAINAGE	284	534	846	1,630
WILLCOX	12,922	19,196	27,588	53,183
YUMA	199,898	377,837	582,878	1,123,630
STATE	**6,685,862**	**12,899,009**	**20,574,451**	**39,661,922**

Appendix 5 shows the results of a compilation query by County for the portions of basins located within each County.

How Uncertainty was Addressed

The Population Committee acknowledges that there is a level of uncertainty in projecting population 100 years into the future. Adding to this uncertainty is the use of outdated baseline data. The 2010 U.S. Census population numbers will not be available until early 2011; therefore, the Arizona's state demographers will not have an updated population projection until late summer/early fall 2012.

In an effort to address some of this uncertainty, the Population Committee agreed to create three projection scenarios: Low, Mid and High. The U.S. Census national population projection scenarios to the year 2100 was used in combination with the Population Committee's adjusted 2006 DES data to derive a set of three State projection scenarios.

Assumptions

During the development of the Population Committee's 100-year population projections, certain assumptions were made with regard to future population growth and related geographies. These assumptions include:

- The baseline data is accurate (U.S. Census and DES population projections)
- Arizona's ratio of the projected national population will remain constant from 2055-2100
- The proportion of population within each County, CCD, CDP, MPA and Incorporated Area to the total state's projected population will remain constant from 2055-2110
- Population growth will spread geographically based on land availability
- Land availability will remain as it is today
- State Trust Land will be available for future development
- The various geographical references used for the projections are accurate and will remain unchanged throughout the projection period

Other Population Distribution Methods and/or References Considered

In addition to the Area Split Method (dividing the population into county/basin based on current land use and availability (i.e. people go where there is available land) used to distribute population into groundwater basins, two other methods were considered by the WRDC Population Working Group. These methods included using data from the Arizona Water Atlas to determine population numbers by basin, and using data from the 2000 U.S. Census blocks to determine population numbers by basin. The Water Atlas and the U.S. Census methods are fairly similar to one another. Each look at the ratio of population within a groundwater basin using 2000 U.S. Census block data and apply this population ratio to any future projection (*population distribution method)* rather than evenly distributing projected population within available land area (*area split method*).

A pro/con list was created for each of the three population/basin methods and the Population Committee determined that dividing the population projections by basin using the *area split method* (based on land availability) was most logical for the purposes of the WRDC. This decision was partially based on the following:

- The land availability method could be applied consistently across the State and could be clearly documented for the WRDC
- Concern that if population growth was limited to the year 2000 U.S. Census geographies, some basins would exceed a maximum population density early in the projection period while others would remain unpopulated
- Members of the Committee could not readily reproduce or document the methodologies used for the population projections published in the Water Atlas and (not yet published) Basin Study. Furthermore, those projections were not done at a Census Designated Place (CDP), Incorporated Area and Municipal Planning Area (MPA) level (this level of detail was used to develop the Committee's baseline dataset), but were done on a basin level specific to each publication
- http://epa.gov/region9/nepa/huachuca/AppendicesGHIJKL02-01-07revision.pd

The differences between the *area split method* and the *population distribution method* of projecting population continued to be discussed after the Population Working Group formally selected the *area split method*. The leadership of the Water Supply & Demand Working Group requested a population projection series using the 2000 US Census Block method and the Population Working Group prepared this alternative distribution by basin analysis. The middle range projections given to the Water Supply & Demand Working Group using the *population distribution method* projection are in the Table 4.

Note: The Population Committee received basin distribution information from La Paz, Pima and Pinal Counties which was used to distribute the projected populations for those areas.

Table 4: Alternate 2000 Census Block Population Projection – Mid-Series
2010, 2035, 2060, 2110

BASIN_NAME	2010	2035	2060	2110

AGUA FRIA	11,144	16,671	20,036	27,703
ARAVAIPA CANYON	110	123	136	188
BIG SANDY	1,638	2,607	3,251	4,495
BILL WILLIAMS	5,496	6,858	7,850	10,987
BONITA CREEK	23	30	35	49
BUTLER VALLEY	0	0	0	0
CIENEGA CREEK	5,170	7,467	9,130	12,624
COCONINO PLATEAU	11,245	14,987	18,000	24,887
DETRITAL VALLEY	1,773	2,750	3,421	4,730
DONNELLY WASH	0	0	0	7,897
DOUGLAS + INA	30,871	41,635	49,327	68,201
DRIPPING SPRINGS WASH	217	245	272	375
DUNCAN VALLEY	3,559	3,659	4,252	5,879
GILA BEND	2,896	11,390	14,302	19,775
GRAND WASH	0	0	0	0
HARQUAHALA INA	799	1,491	2,155	3,974
HUALAPAI VALLEY	42,237	65,017	80,729	111,620
KANAB PLATEAU	8,017	12,553	15,675	21,674
LAKE HAVASU	64,797	108,522	137,859	190,609
LAKE MOHAVE	65,226	96,942	119,141	164,728
LITTLE COLORADO RIVER PLATEAU	285,867	375,183	444,449	614,513
LOWER GILA	12,470	16,685	19,850	27,446
LOWER SAN PEDRO	13,921	19,984	32,360	44,742
MCMULLEN VALLEY	4,866	7,741	9,362	12,679

MEADVIEW	1,084	1,674	2,079	2,875
MORENCI	4,553	4,724	5,477	7,572
PARIA	582	673	762	1,053
PARKER	16,809	20,438	22,722	30,753
PEACH SPRINGS	2,205	3,146	3,799	5,253
PHOENIX AMA	4,073,039	6,443,884	8,096,058	11,170,234
PINAL AMA	234,486	674,968	1,071,653	1,465,914
PRESCOTT AMA	130,392	211,763	259,600	358,933
RANEGRAS PLAIN	739	1,096	1,346	1,662
SACRAMENTO VALLEY	22,125	36,116	45,574	63,012
SAFFORD	40,125	48,905	56,139	77,261
SALT RIVER	28,822	33,400	37,506	51,856
SAN BERNARDINO VALLEY	92	96	104	143
SAN RAFAEL	149	183	211	291
SAN SIMON WASH	6,904	10,603	13,337	18,441
SANTA CRUZ AMA	45,914	68,887	84,828	117,287
SHIVWITS PLATEAU	7	13	16	23
TIGER WASH	0	0	0	0
TONTO CREEK	14,131	19,473	24,202	33,463
TUCSON AMA	1,004,446	1,430,910	1,772,729	2,482,634
UPPER HASSAYAMPA	12,914	21,270	26,335	36,412
UPPER SAN PEDRO	92,348	124,419	147,360	203,746
VERDE RIVER	108,577	1654,999	185,477	256,448
VIRGIN RIVER	2,672	4,950	6,444	8,909
WESTERN MEXICAN DRAINAGE	26	40	50	69

WILLCOX	13,722	16,738	19,153	26,482
YUMA	199,551	307,963	377,462	521,894
STATE	**6,628,757**	**10,453,870**	**13,252,013**	**18,322,751**

Data Issues and Limitations

The WRDC Population Committee was faced with several limitations during the development of the population projections. In addition to these limitations, concerns and additional data sources were brought to the group by working group members and other interested parties. Due to the November 30, 2010 deadline for completing the population projections, these limitations, concerns and additional data sources were not accounted for in the development of these projections; however, it is important to note that they were given consideration and may be important factors in any future work. The following is a list of limitations, concerns and additional data sources:

Limitations:

- Work was completed in approximately 6 weeks
- Limited number of staff completing the work
- Uncertainty in projecting population 100 years into the future
- Lack of up-to-date population projections for Arizona
- 2010 U.S. Census population numbers will not be available until early 2011
- Did not use the cohort-component model that is commonly used by professional demographers to project population growth patterns
- Differences between political and physical boundaries make distributing population by groundwater basin difficult

Concerns (aka Bin Items):

- Representatives from the Navajo Nation stated that the 2000 U.S. Census under represents the Navajo's population (John Leeper, representing the Navajo Nation, provided additional population information to the Committee: *Western Navajo Hopi Water Supply Study* by HDR, dated 2003)

    From: Norm DeWeaver [mailto:norm_deweaver@rocketmail.com]
    Sent: Friday, December 10, 2010 03:46 PM
    To: Collins Karen B
    Subject: "Bin" Item on Reservation Population Projections

    Fri, Dec 10th

    KAREN:

Great job with the presentation. The thoroughness with which you described the projection methodology was key to keeping the questions to a minimum.

Did want to raise a point regarding the "bin" item concerning the Census undercount of the population on the reservations.

There are two separate issues. One involves the undercount. The other relates to the rate of population growth in the projections.

Navajo and the other tribes consider the growth rates too low. In at least some cases the rates are inconsistent with past rates. In addition, as reservation housing and infrastructure conditions improve, more tribal members living off-reservation are likely to move back to reservation communities.

Would appreciate it if both points could be included when you draft the language for this "bin" item.

Thanks.
NORM

- The State Land Department is currently working on a study which is not in agreement with Pinal and La Paz County's projected population distribution by basin
- There are differences between the Committee's population projections and the Colorado River Basin Study's population projections (Perri Benemelis attended a Committee meeting and stated that she was comfortable with the variation in projected population and that the Basin Study and the WRDC Report are being developed for two different purposes.)
- The Bureau of Reclamation's Yavapai Highlands study includes projected population that may differ from the Committee's projections
- ADWR's AMA Assessments include projected population that may differ from the Committee's projections (Pam Nagel is a WRDC Population Committee member and also worked on the population projections used in ADWR's AMA Assessments.)
- Full participation from the Association of Governments, county planners, professional demographers and universities would be ideal
- Using updated 2010 U.S. Census data as a baseline for professional demographers to conduct population projections using a cohort-component method (accounts for age, sex, fertility, migration, etc.) (representatives from the Dept. of Commerce have indicated that a new set of population projections based on the 2010 U.S. Census data will be available for Arizona in 2012)
- 2010 revised population projection by CAAG (Pinal County) to 2040
- Yavapai County non-incorporated areas email from John Rasmussen dated 10-27-10
- Dean Trammel Tucson Water Plan and PAG analysis by water provider using TAZs email from Dean dated 10-26-10
- Indian Reservations population growth (no new official data since 2000 Census)

- MAG projections 2030, 2060?
- Rural/urban/Native American population projection breakdowns
- Census 2100 did it look at states?
- Are some counties facing some maximum population due to the limited availability of private land?
- Should the Population Working Group be working with an assumption of maximum density of population?
- How do we incorporate areas like Superstition Vistas?
- How soon will 2010 Census information be available for the Native American Reservations?
- Kevin Davidson from Mohave County email dated 11-29-10, "With this assumption [area split method] the Mohave North CCDs become a bit problematic with the Grand Wash and Shivwits Plateau basins having more growth than the Virgin River basin. Note this for the "bin." I can make the same argument for the Bill Williams being over-represented and Lake Havasu being under-represented in the Kingman South CCD. For the Kingman North CCD, the Detrital Valley population projection is most likely under-allocated while the estimate for Peach Springs basin is generally too aggressive for growth. Note these for the "bin" as well."

MEMBERS OF THE POPULATION WORKING GROUP

Name	Affiliation
Jason Baran	Arizona Municipal Water User's Association
Phil Bashaw	Arizona Farm Bureau
Perri Benemelis	Arizona Department of Water Resources
Patrick Bray	Arizona Cattle Feeders' Association
Tom Buschatzke	City of Phoenix
Jorge Canaca	Arizona Game & Fish Department
Luana Capponi	State Land
Jim Chang	Arizona Department of Commerce
Karen Collins	Salt River Project
Kevin Davidson	Mohave County
Rebecca Davidson	Salt River Project
Norm DeWeaver	Inter-Tribal Council of AZ
Santiago Garcia	U.S. Bureau of Reclamation
Maureen George	Law offices of Maureen George
Angela Gotto	Central Arizona Association of Governments
Laura Grignano	Arizona Department of Water Resources
Thomas Homan	Gila County
John Hunt	Department of Agriculture
David Iwanski	City of Goodyear
Jeff Johnson	Town of Taylor
Robert Kirk	Navajo Nation
Jim Klinker	Arizona Farm Bureau
John Leeper	Navajo Nation
Michael Liberti	City of Tucson
Colleen McVey	La Paz County
Adam Miller	City of Phoenix
Sharon Morris	Arizona Department of Water Resources
John Munderloh	Town of Prescott Valley
Shawn Murray	City of Mesa
Pam Nagel	Arizona Department of Water Resources
Karen Nally	representing Hohokam Irrigation & Drainage District and Central Arizona Irrigation & Drainage District
Steve Olson	Arizona Municipal Water Users Association
David Plane	University of Arizona
John Rasmussen	Yavapai County
Steve Rossi	City of Phoenix
Bill Schooling	Arizona Department of Commerce
Jerry Stabley	Pinal County
Dean Trammel	Tucson Water
Dianne Yunker	Arizona Department of Water Resources

Water Resources Development Commission Water Supply and Demand Working Group Report

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August 1, 2011

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INTRODUCTION

In 2010, the Arizona Legislature passed H.B. 2661, which created the Water Resources Development Commission (WRDC) for the purpose of assessing the current and future water needs of Arizona. The Water Supply and Demand (WS&D) Working Group of the WRDC has been tasked with the development of a statewide water needs assessment that identifies, by county, present water demands and supply. Water demand data was available to the Working Group by groundwater basin. In order to meet the purpose of H.B. 2661, all demand and supply data was analyzed on the basis of groundwater basins and then associated with the county(s) that geographically coincide with the basin(s). Present water demands are projected into the future at intervals of 25, 50, and 100 years and compared to present supply to identify future unmet demands. Appendix 1 of this report provides separate maps of the counties in Arizona and the groundwater basins located within each county. Unmet water demands are identified separately for each target year. This assessment includes the identification and legal and technical evaluation of sources of supply to satisfy the future unmet demands.

OBJECTIVES

The Water Resources Development Commission assigned the following tasks to the WS&D Work Group:

Objective 1

Compile and consider projected water needs of each county and groundwater basin over the study period.

1. Develop water demand assumptions based on forecasted growth for the study period.
    a. Provide municipal demand projection based on population growth
        i. Water provider v. domestic well demand
        ii. Changes in demand rate
    b. Prepare industrial demand assumptions
        i. Develop economic development/growth methodologies with county/other economic development experts; review existing development plans and strategies with appropriate staff
        ii. Incorporate economic projections that predict growth and location of power and mining industry/development
        iii. Develop demand assumptions based on current or new technology
        iv. Develop methodology to predict sand and gravel and industrial golf course demand based on population and other approach
    c. Prepare agricultural demand assumptions
        i. Incorporate studies and expert opinions; conduct trend analysis to forecast demand
    d. Prepare summary of findings and recommendations including needed studies and research by February 28, 2011.

Objective 2

Identify and quantify water supplies currently available in each county and groundwater basin.

1. Use the Arizona Water Atlas as the baseline condition for currently available water supplies at the groundwater basin level.
    a. Develop an approach to display basin data on a county basis
2. Identify how drought and climate change are/are not currently factored into water supply available planning
3. Incorporate Blue Ribbon Panel effluent reuse/recycle availability findings into available water supply portfolio
4. Prepare summary of findings and recommendations including needed studies and research by November 30, 2010

Objective 3

Compare current and future water supplies and demand to identify unmet demands. (With Environmental Committee)

1. Compare forecasted water demand to baseline water supply to determine whether supplies are sufficient to meet current and additional demand.
    a. Identify available supplies; and how these are defined basin by basin
    b. Identify current and/or future gaps between water demand and supply (unmet demand) during the study periods
    c. Identify unmet demands by sector over the study period
2. Prepare summary of findings and recommendations including needed studies and research by February 28, 2011

Objective 4

Identify potential water supplies that could be used to meet additional demands over the study period.

1. Identify additional supplies such as conservation, reuse, alternative technologies, desalination and other strategies such as agricultural land fallowing or retirement and to what extent these supplies could meet additional demand over the study period
2. Identify basins where water supplies may be available from outside the basin and what volumes are necessary to meet additional demands
3. Identify potential water supplies out of the region that could be imported to the region to meet additional demands
4. Prepare summary of findings and recommendations including needed studies and research by May 31, 2011

Objective 5

Identify any legal or technical issues associated with the use of those supplies (in conjunction with Objective 4)

1. For those basins where additional water supplies are available, evaluate the legal and/or technical issues

with accessing these supplies within the basin

2. For those basins where additional supplies are not available, evaluate the legal and/or technical issues with accessing additional supplies available with the region but outside the basin

3. For those basins where additional supplies are not available and no other regional supply exists, evaluate the legal and/or technical issues associated with importing water supplies into the region

4. Prepare summary of findings and recommendations including needed studies and research by May 31, 2011.

METHODS

In order to meet the objectives outlined above, four subcommittees and one special working group to the Water Supply and Demand Working Group were formed:

Municipal subcommittee	(Objective 1.1.a)
Industrial subcommittee	(Objective 1.1.b)
Agricultural subcommittee	(Objective 1.1.c)
Tribal special working group	(Tribal perspective on Objectives 1, 2 & 4)
Water Supply subcommittee	(Objectives 2, 4 & 5)

In addition to the four subcommittees formed by the WS&D Working Group, the Inter Tribal Council of Arizona (ITCA) suggested an additional effort be undertaken to present Tribal water demands and supplies and volunteered to lead the effort. Tribal water claims had not been clearly identified in the objectives and represent an important portion of the State of Arizona's water budget that should be identified. Accordingly, the Inter Tribal Council served as the Tribal liaison for the Working Group and for the purposes of this report, also worked with the representatives of the Navajo Nation (not an ITCA member). The background of Tribal water rights is discussed in "The Future of Water Resources in Arizona: A Tribal Report" provided by John Lewis, Ray Benally and Norm DeWeaver and located in Appendix 6.

Volunteers from the initial WS&D Working Group served as chairs of the four subcommittees. The subcommittees established their own meeting schedules and had access to Arizona Department of Water Resources (ADWR) data and supporting staff. Agendas and meeting notes were posted on the ADWR website and a File Transfer Protocol (FTP/InfoShare) site was established for data and reports to be accessed by the subcommittee and working group members. Membership and participation on the working group and subcommittees was open to all interested stakeholders. Summaries of findings, including all assumptions, for each of the objectives addressed by the subcommittee are attached to this report as Appendix 1 – County Basin Maps: Currently Developed and Adjusted Supplies Vs. Projected Demands, Appendix 2 – WRDC Agricultural Subcommittee Report, Appendix 3 – WRDC Industrial Demand Subcommittee Report, Appendix 4 – WRDC Municipal Demand Subcommittee Report, Appendix 5 – WRDC Water Supply Subcommittee Report, and Appendix 6 – WRDC Tribal Working Group Report. Reference material provided to the subcommittees and utilized by the working groups include the ADWR Arizona Water Atlas, ADWR AMA Assessments, ADWR 2008 Hydrologic Data and Draft Recommendations Related to the Review of 100-Year Physical Availability Depth Criteria for Demonstrating Adequate water Supplies and the Central Arizona Water Demand Model

RESULTS

Objectives 1 and 2: Identify Water Demands and Supplies

Numerous tables were built to bring together the information presented by the subcommittees to meet the first two objectives. Objectives 1 and 2 are addressed together due to the associated tables representing both demand and supply information. Table 1. Baseline Supply and Demand identifies the baseline water demands provided by ADWR to the subcommittees and the water sources that were used to meet those demands. Water sources include groundwater, instate surface water, effluent, and Colorado River water. The currently available groundwater and instate surface water supply is assumed to be equal to the baseline groundwater and instate surface water demands, respectively. Although existing wells may have capacities in excess of baseline groundwater demand, this conservative supply estimate is the best assumption based on the given level of data. Total Colorado River supply is equal to Arizona's Colorado River apportionment and is distributed into basins based on entitlements. And finally, effluent supply is equal to the amount of effluent currently generated.

Tables 2 through 5 identify demand projections for each basin by sector for the years 2035, 2060, 2110 (census split [CS] population method) and 2110 (area split [AS] population method). The difference between the CS population method (referred to as population distribution method in the Population Working Group Report) and the AS method is the AS method assumes population growth will go to available land and the CS method uses U.S. Census blocks keeping the same population ratios for growth. The WS&D Working Group chose to look at the AS method only for 2110 due to what appeared to be high population growth rates in unlikely areas of the State for the shorter target years (2035 and 2060). A Statewide summary of projected changes in water demands for 2035, 2060 and 2110 (CS and AS) are shown by percentage and Acre-Feet for each sector in Table 6. The industrial subcommittee generated high and low demand projection estimates for industrial users while the municipal and agricultural subcommittees generate a single estimate for projection years.

To avoid redundancy, tables provided in the Supply Subcommittee Report are not duplicated in this section of the Working Group Report. Table 7. Baseline Supply for Projection Purposes indicates the amount of water supply currently developed and/or available through entitlements to meet the current water demand. The Supply Subcommittee was charged with projecting water supplies available for future use, taking into account climate change and/or drought. These assumptions are taken into account in the tables that show the projected available water supplies for 2035, 2060, 2110 (CS) and 2110(AS) located in the Supply Subcommittee Report. Determination of Colorado River water supply available to contractors for the target years was more complex. To begin with, ADWR provided the subcommittee a listing of water entitlements based on diversions for Colorado River water users. All Colorado River main stem demands reported in the Arizona Water Atlas were based on water diversions. Therefore, all supply is reported as diversions. Assumptions used to calculate Colorado River water supply can be found in the Supply Subcommittee Report. Water supplies in this report that take into account drought and climate change are referred to as "adjusted water supplies."

In general, there are several variables, including growth patterns, economic conditions, technological advances and climate and weather patterns that, to one degree or another, affect water supply and demand regardless of the water using sector that is examined. While the supply projections reflect a general assumption of the future affects of climate change on future water supplies, any review of the supply and demand figures presented in this report should be cautious because there was no real attempt to independently evaluate these variables and their influence on future water supplies and demands. The supply figures are also confounded by the lack of data. For example, figures for groundwater in storage for some groundwater basins are more accurate than the groundwater in storage data for other basins simply because there have been more measurements in some basins than others.

Municipal and Industrial Demand

Demands for Municipal and Industrial water are projected to grow in nearly all of the groundwater basins in the future (See WRDC Municipal Demand Subcommittee Report and 5/27/11 rev WRDC Industrial Demand Subcommittee Report). Each of the basins with Colorado River entitlements has an increase in municipal and industrial use in the future. Development of Arizona State Trust Land was not considered separately by the Population Working Group for determining population projections. The State Land Department identified their concern that some population projections may be low. The Population Working Group identified the issue as a "bin item" due to the added layer of complexity and short time frame they faced to complete their report. The issue is not addressed in this report.

Agricultural Demand

In general, non-Tribal demands for agricultural water use are assumed to remain constant into the future (with the exception of the Yuma and Lower Gila groundwater basins and the Phoenix, Pinal and Tucson AMAs which are expected to decline – see WRDC Agriculture Demand Subcommittee Report in Appendix 2).

Tribal Demand and Supply

In this analysis, Tribal supply is only available to meet Tribal demands. Colorado River Tribal entitlements in each of the basins will only be available as supply on the reservation and may not be converted to supply to meet non-Tribal future unmet demands unless tribal consent is obtained.

Environmental Demand

Environmental demands were evaluated by the Environmental Committee. The goal of the environmental demand analysis was to capture a "snapshot in time" only. There was not an attempt to make a projection of environmental demand. Details of the evaluation can be found in the report from the Environmental Working Group titled "Arizona's Inventory of Water-Dependent Natural Resources".

Three wildlife refuges hold Colorado River entitlements. The Havasu National Wildlife Refuge, located in the Lake Mohave, Lake Havasu and Sacramento Basins has a diversion entitlement of 41,839 AF, the Imperial National Wildlife Refuge 28,000 AF (Lower Gila Basin and Parker Basins) and the Cibola National Wildlife Refuge 34,500 AF (Parker Basin). Although historically not fully utilized, this water is not available for other cultural uses. Entitlements for the refuges are set aside through Secretarial Order and are not available for transfer. Any entitlements not used by the refuges are available to CAP as an unused apportionment. For the purposes of identifying available water supplies, diversion entitlements are assumed to be fully utilized by the three wildlife refuges.

Categories of environmental sensitivity have been identified by the Environmental Committee for each basin and are indicated in Table 8. Water-Dependent Natural Resource Index for the Water Resource Development Commission. The table refers to additional work products found in the Environmental Committee Report.

Table 1. Baseline Supply and Demand

Version 6-17-11

	BASIN NAME	Baseline Demands: AGRICULTURE	MUNICIPAL	INDUSTRIAL: Dairy	Feedlots	Other Industrial	Mining	Rock Products	Power Plants	Turf	TOTAL	Baseline Demand Water Sources[1]: Instate: GW (c. 2006)	Instate SW (c. 2006)	Effluent (Used c. 2006)	Total Instate Supply	Colorado River/ CAP Diversions	TOTAL	Supply - Demand
Instate Water Supplies Only	AGUA FRIA	1,800	1,800	0	0	0	0	2	0	0	3,602	3,602	0	0	3,602	NA	3,602	0
	ARAVAIPA CANYON	1,000	14	0	0	0	0	0	0	0	1,014	514	500	0	1,014	NA	1,014	0
	BIG SANDY	0	271	0	0	0	14,717	40	0	0	15,028	15,028	0	0	15,028	NA	15,028	0
	BONITA CREEK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0
	BUTLER VALLEY	14,500	3	0	0	0	0	0	0	0	14,503	14,503	0	0	14,503	NA	14,503	0
	CIENEGA CREEK	500	600	0	0	0	0	1	0	0	1,101	1,101	0	0	1,101	NA	1,101	0
	COCONINO PLATEAU	0	1,173	0	0	0	0	0	0	0	1,173	500	400	273	1,173	NA	1,173	0
	DONNELLY WASH	0	19	0	0	0	0	0	0	0	19	19	0	0	19	NA	19	0
	DOUGLAS	48,000	5,300	0	0	0	0	0	0	0	53,300	53,300	0	0	53,300	NA	53,300	0
	DRIPPING SPRINGS WASH	0	11	0	0	0	0	0	0	0	11	11	0	0	11	NA	11	0
	DUNCAN VALLEY	17,100	550	93	0	0	0	0	0	211	17,954	8,054	9,900	0	17,954	NA	17,954	0
	GILA BEND	351,500	750	173	0	0	0	0	5,400	0	357,823	295,323	62,500	0	357,823	NA	357,823	0
	GRAND WASH	0	2	0	0	0	0	0	0	0	2	2	0	0	2	NA	2	0
	HUALAPAI VALLEY	0	9,100	0	0	0	0	9	0	0	9,109	9,109	0	0	9,109	NA	9,109	0
	LOWER SAN PEDRO	3,700	2,745	0	0	0	17,544	423	0	211	24,622	23,677	800	145	24,622	NA	24,622	0
	MCMULLEN VALLEY	71,000	500	0	0	0	0	0	0	0	71,500	71,500	0	0	71,500	NA	71,500	0
	MEADVIEW	0	145	0	0	0	0	0	0	0	145	145	0	0	145	NA	145	0
	MORENCI	0	2,200	0	0	0	8,109	0	0	75	10,384	9,126	1,258	0	10,384	NA	10,384	0
	PARIA	0	120	0	0	0	0	0	0	0	120	120	0	0	120	NA	120	0
	PEACH SPRINGS	0	350	0	0	0	0	1	0	0	351	351	0	0	351	NA	351	0
	PRESCOTT AMA	2,847	17,554	0	0	567	0	126	0	793	21,887	17,679	1,674	2,534	21,887	NA	21,887	0
	RANEGRAS PLAIN	29,000	350	0	0	0	0	0	0	0	29,350	29,350	0	0	29,350	NA	29,350	0
	SACRAMENTO VALLEY	0	2,300	76	0	0	90	0	1,300	0	3,765	3,765	0	0	3,765	NA	3,765	0
	SAFFORD	169,600	7,300	0	0	0	44	192	0	423	177,558	87,958	89,100	500	177,558	NA	177,558	0
	SALT RIVER	6,900	4,250	0	0	0	15,448	395	0	211	27,204	12,611	14,593	0	27,204	NA	27,204	0
	SAN BERNARDINO VALLEY	0	19	0	0	0	0	0	0	0	19	19	0	0	19	NA	19	0
	SAN RAFAEL	0	22	0	0	0	0	0	0	0	22	22	0	0	22	NA	22	0
	SAN SIMON WASH	500	1,000	0	0	0	0	0	0	0	1,500	1,500	0	0	1,500	NA	1,500	0
	SANTA CRUZ AMA	10,704	8,502	0	0	98	0	195	0	1,482	20,980	20,980	0	0	20,980	NA	20,980	0
	SHIVWITS PLATEAU	0	2	0	0	0	0	0	0	0	2	2	0	0	2	NA	2	0
	TIGER WASH	0	2	0	0	0	0	0	0	0	2	2	0	0	2	NA	2	0
	TONTO CREEK	1,500	2,700	0	0	0	0	0	0	0	4,200	3,000	1,000	200	4,200	NA	4,200	0
	UPPER HASSAYAMPA	0	2,500	786	0	0	0	0	0	0	3,286	3,286	0	0	3,286	NA	3,286	0
	UPPER SAN PEDRO	8,800	18,480	42	0	288	0	75	0	1,552	29,237	23,957	4,450	830	29,237	NA	29,237	0
	VERDE RIVER	23,700	16,560	0	0	0	0	1,180	0	3,087	44,527	28,549	15,194	784	44,527	NA	44,527	0
	VIRGIN RIVER	1,000	423	0	0	0	0	0	0	882	2,305	1,585	720	0	2,305	NA	2,305	0
	WESTERN MEXICAN DRAINAGE	0	6	0	0	0	0	0	0	0	6	6	0	0	6	NA	6	0
	WILLCOX	166,000	3,161	584	130	0	0	0	6,200	0	176,075	175,714	150	211	176,075	NA	176,075	0

	Basins Which Receive Part of their Supply from the Colorado River or CAP	Baseline Demands Cont.: AGRICULTURE Cont.	MUNICIPAL	INDUSTRIAL: Dairy	Feedlots	Other Industrial	Mining	Rock Products	Power Plants	Turf	TOTAL	Baseline Demand Water Sources[1] Cont.: Instate: GW (c. 2006)	Instate SW (c. 2006)	Effluent (Used c. 2006)	Total Instate Supply	Colorado River/ CAP Diversions	TOTAL	Supply - Demand Cont.
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	39,250	42,800	20	539	11,766	1,201	331	63,200	1,716	160,823	95,813	16,109	14,900	**126,822**	34,001	**160,823**	0
Instate + CR Lower Mainstem	BILL WILLIAMS	2,700	1,250	0	0	0	200	0	0	0	4,150	3,251	500	200	**3,951**	199	**4,150**	0
	DETRITAL VALLEY	0	309	0	0	0	0	0	0	0	309	159	72	0	**231**	78	**309**	0
	KANAB PLATEAU	1,100	2,500	27	0	0	0	0	0	0	3,627	2,799	800	0	**3,599**	28	**3,627**	0
	LAKE HAVASU	0	16,070	0	0	0	0	60	0	0	16,130	47	0	2,433	**2,480**	13,650	**16,130**	0
	LAKE MOHAVE	20,890	21,920	0	0	0	0	77	4,000	882	47,769	2,007	0	715	2,722	45,046	47,768	0
	Lake Mohave (Tribal Ag)	68,110									68,110	0	0	0	0	68,110	68,110	0
	LOWER GILA	499,000	2,020	246	3,421	0	0	0	0	0	504,687	110,296	320	0	**110,616**	394,071	**504,687**	0
	PARKER	21,942	4,520	0	0	0	0	0	0	0	26,462	1,787	0	1,116	**2,903**	23,559	**26,462**	0
	Parker (Tribal Ag)	621,454									621,454	0	0	0	0	621,454	**621,454**	0
	YUMA	804,766	44,960	0	0	1,178	0	238	658	441	852,241	108,570	1,041	460	**110,071**	742,170	**852,241**	0
	Yuma (Tribal Ag)	6,234									6,234	0	0	0	0	6,234	**6,234**	0
Instate + CAP	HARQUAHALA INA	135,500	128	0	0	0	0	0	1,107	0	136,735	66,178	0	0	**66,178**	70,557	**136,735**	0

	Major Active Management Areas (AMAs)	Non-Tribal Ag	Tribal Ag	MUNICIPAL	Dairy	Feedlots	Other Industrial	Mining	Rock Products	Power Plants	Turf	TOTAL	GW (c. 2006)	Instate SW (c. 2006)	Effluent (Used c. 2006)	Total Instate Supply	CAP	TOTAL	Supply -Demand
Instate + CAP	PHOENIX AMA	730,025	217,779	1,060,995	10,080	58	10,624	0	10,401	69,585	60,632	2,170,179	673,754	842,773	168,331	**1,684,858**	485,321	**2,170,179**	0
	PINAL AMA	819,894	152,140	30,485	8,400	3,033	1,229	0	1,199	96	6,286	1,022,762	431,290	100,734	4,614	**536,638**	486,124	**1,022,762**	0
	TUCSON AMA	87,755	10,635	185,769	110	0	4,181	34,905	3,807	2,656	8,249	338,067	216,997	588	14,336	**231,921**	106,146	**338,067**	0
	STATEWIDE	**5,168,825**		**1,524,510**	**20,637**	**7,182**	**29,932**	**92,256**	**18,750**	**154,202**	**87,132**	**7,103,425**	**2,628,917**	**1,165,176**	**212,583**	**4,006,675**	**3,096,749**	**7,103,425**	**0**

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. Baseline Demand Water Sources are derived from the Arizona Water Atlas (outside AMAs) and AMA Assessments with some adjustments made for basins receiving Colorado River Water to reflect estimated diversions resulting in corresponding reductions in groundwater and instate surface water quantities used. **Recharged CAP not included as a cultural water demand.**

Table 2. 2035 Demand Projections

	BASIN NAME	AGRICULTURE	MUNICIPAL	Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
		2035 Demand Projections		INDUSTRIAL												
Instate Water Supplies Only	AGUA FRIA	1,800	2,888	0	0	0	0	0	83	200	0	0	0	0	**4,772**	**4,888**
	ARAVAIPA CANYON	1,000	12	0	0	0	0	0	1	1	0	0	0	0	**1,013**	**1,014**
	BIG SANDY	0	496	0	0	0	0	0	13	31	0	0	0	0	**509**	**528**
	BONITA CREEK	0	5	0	0	0	0	0	0	0	0	0	0	0	**5**	**5**
	BUTLER VALLEY	14,500	0	0	0	0	0	0	0	0	0	0	0	0	**14,500**	**14,500**
	CIENEGA CREEK	500	918	0	0	0	300	500	37	89	0	0	0	0	**1,755**	**2,007**
	COCONINO PLATEAU	0	1,521	0	0	0	0	0	75	179	0	0	0	0	**1,596**	**1,701**
	DONNELLY WASH	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
	DOUGLAS	48,000	7,633	0	0	0	0	0	208	498	1	2	0	211	**55,841**	**56,344**
	DRIPPING SPRINGS WASH	0	14	0	0	0	0	0	1	3	0	0	0	0	**16**	**17**
	DUNCAN VALLEY	17,100	546	93	0	0	0	0	18	44	0	0	211	211	**17,969**	**17,994**
	GILA BEND	351,500	1,332	5,281	0	0	0	0	57	136	19,102	26,147	0	0	**377,271**	**384,396**
	GRAND WASH	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
	HUALAPAI VALLEY	0	14,595	0	0	0	0	0	324	778	0	0	0	211	**14,919**	**15,584**
	LOWER SAN PEDRO	3,700	2,937	0	0	0	14,000	30,000	100	239	0	0	211	211	**20,948**	**37,087**
	MCMULLEN VALLEY	71,000	970	0	0	0	0	0	39	93	0	0	0	0	**72,008**	**72,062**
	MEADVIEW	0	243	0	0	0	0	0	8	20	0	0	0	0	**251**	**263**
	MORENCI	0	2,051	0	0	0	12,000	48,000	24	57	0	0	75	75	**14,150**	**50,183**
	PARIA	0	148	0	0	0	0	0	3	8	9,332	12,832	0	0	**9,483**	**12,988**
	PEACH SPRINGS	0	494	0	0	0	300	300	16	38	0	0	0	0	**810**	**832**
	PRESCOTT AMA	1,329	32,994	0	0	567	0	0	1,056	2,535	16	22	902	1,032	**36,863**	**38,478**
	RANEGRAS PLAIN	29,000	392	0	0	0	0	0	5	13	0	0	0	0	**29,398**	**29,405**
	SACRAMENTO VALLEY	0	7,403	76	0	0	8,000	12,000	180	432	4,346	5,944	0	211	**20,005**	**26,067**
	SAFFORD	169,600	7,914	0	0	0	5,000	27,000	244	585	0	0	423	423	**183,181**	**205,523**
	SALT RIVER	6,900	4,762	0	0	0	27,000	43,000	167	400	420	577	211	211	**39,460**	**55,850**
	SAN BERNARDINO VALLEY	0	25	0	0	0	0	0	0	1	0	0	0	0	**25**	**26**
	SAN RAFAEL	0	25	0	0	0	0	0	1	2	0	0	0	0	**26**	**28**
	SAN SIMON WASH	500	1,489	0	0	0	0	0	53	127	0	0	0	0	**2,042**	**2,116**
	SANTA CRUZ AMA	11,233	12,347	0	0	98	0	0	344	824	38	52	1,482	1,781	**25,541**	**26,336**
	SHIVWITS PLATEAU	0	2	0	0	0	0	0	0	0	0	0	0	0	**2**	**2**
	TIGER WASH	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
	TONTO CREEK	1,500	5,821	0	0	0	0	0	97	233	0	0	0	211	**7,418**	**7,765**
	UPPER HASSAYAMPA	0	4,659	786	0	0	0	0	106	255	0	0	0	0	**5,551**	**5,699**
	UPPER SAN PEDRO	8,800	26,226	42	0	288	2,000	12,000	620	1,489	0	0	1,552	1,675	**39,528**	**50,520**
	VERDE RIVER	23,700	25,190	0	0	0	1,000	4,000	773	1,855	0	0	3,087	3,530	**53,750**	**58,275**
	VIRGIN RIVER	1,000	798	0	0	0	0	0	25	59	0	0	882	882	**2,705**	**2,740**
	WESTERN MEXICAN DRAINAGE	0	6	0	0	0	0	0	0	0	0	0	0	0	**6**	**7**
	WILLCOX	166,000	3,816	584	130	0	300	300	83	200	6,656	9,152	0	0	**177,569**	**180,182**

	Basins Which Receive Part of their Supply from the Colorado River or CAP	AGRICULTURE	MUNICIPAL	Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
		2035 Demands Projections		INDUSTRIAL												
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	39,250	58,523	20	539	11,766	1,500	1,500	1,871	4,490	103,034	141,672	1,716	1,806	**218,219**	**259,566**
Instate + CR Lower Mainstem	BILL WILLIAMS	2,700	1,564	0	0	0	10,000	30,000	34	82	0	0	0	0	**14,298**	**34,346**
	DETRITAL VALLEY	0	397	0	0	0	0	0	14	33	0	0	0	0	**410**	**430**
	KANAB PLATEAU	1,100	3,885	27	0	0	0	0	63	150	0	0	0	0	**5,075**	**5,163**
	LAKE HAVASU	0	31,036	0	0	0	0	0	541	1,299	0	0	0	211	**31,577**	**32,545**
	LAKE MOHAVE	20,890	36,384	0	0	0	0	0	483	1,160	14,097	19,383	882	1,050	**72,736**	**78,867**
	Lake Mohave (Tribal Ag)	68,110													**68,110**	**68,110**
	LOWER GILA	481,535	2,676	5,281	6,781	0	0	18,000	83	200	1,313	1,642	0	0	**497,669**	**516,115**
	PARKER	21,942	5,391	0	0	0	300	300	102	245	5,563	6,979	0	211	**33,298**	**35,067**
	Parker (Tribal Ag)	621,454													**621,454**	**621,454**
	YUMA	776,599	76,244	0	0	1,178	0	0	1,536	3,686	2,061	2,784	476	545	**858,095**	**861,037**
	Yuma (Tribal Ag)	6,234													**6,234**	**6,234**
Instate + CAP	HARQUAHALA INA	135,500	245	0	0	0	0	0	7	18	918	1,147	0	0	**136,670**	**136,910**

	Major Active Management Areas (AMAs)	Non-Tribal Ag	Tribal Ag	MUNICIPAL	Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
Instate + CAP	PHOENIX AMA	307,926	525,228	1,876,700	0	58	34,476	15,000	25,000	32,135	77,125	126,752	174,283	67,147	76,843	**2,985,423**	**3,097,639**
	PINAL AMA	590,540	194,616	151,212	18,480	3,033	3,847	4,000	18,000	3,366	8,078	4,135	5,686	12,658	14,486	**985,887**	**1,007,978**
	TUCSON AMA	66,242	20,412	278,695	0	0	2,501	39,000	74,000	7,136	17,126	2,913	4,005	8,249	9,414	**425,148**	**472,395**
	STATEWIDE	**4,808,940**		**2,693,625**	**30,670**	**10,541**	**54,721**	**139,700**	**343,900**	**52,133**	**125,119**	**300,696**	**412,309**	**100,164**	**115,441**	**8,191,191**	**8,595,266**

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet.
Generally speaking 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users or as determined by the Arizona-Nevada Shortage Agreement.
3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.
4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use.
It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAPs contract with the Secretary.
Increased values in future years correspond to decreased values in the Yuma and Lower Gila Basins based on a projected 7% decrease in non-Indian agriculture demand.
6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.
Note: In a Normal Year (Lake Mead Elevation between 1,075 And 1,145), AZ CU Entitlements = 2.8MAF, AZ use =2.8MAF, Balance available equals zero.
In a First Tier Shortage Year (Lake Mead Elevation between 1,050 and 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available equals zero. Arizona will always use its full apportionment.

Table 3. 2060 Demand Projections

2060 Demand Projections — Instate Water Supplies Only

Basin Name	Agriculture	Municipal	Industrial: Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
AGUA FRIA	1,800	3,471	0	0	0	0	0	100	240	0	0	0	0	**5,371**	**5,511**
ARAVAIPA CANYON	1,000	14	0	0	0	0	0	1	2	0	0	0	0	**1,014**	**1,015**
BIG SANDY	0	619	0	0	0	0	0	16	39	0	0	0	0	**635**	**658**
BONITA CREEK	0	6	0	0	0	0	0	0	0	0	0	0	0	**6**	**6**
BUTLER VALLEY	14,500	0	0	0	0	0	0	0	0	0	0	0	0	**14,500**	**14,500**
CIENEGA CREEK	500	1,123	0	0	0	300	500	46	109	0	0	0	0	**1,968**	**2,232**
COCONINO PLATEAU	0	1,827	0	0	0	0	0	90	215	0	0	0	0	**1,917**	**2,043**
DONNELLY WASH	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
DOUGLAS	48,000	9,043	0	0	0	0	0	246	590	2	3	0	211	**57,291**	**57,847**
DRIPPING SPRINGS WASH	0	16	0	0	0	0	0	1	3	0	0	0	0	**17**	**19**
DUNCAN VALLEY	17,100	635	93	0	0	0	0	21	51	0	0	211	211	**18,060**	**18,090**
GILA BEND	351,500	1,672	13,814	0	0	0	0	71	171	23,435	33,434	0	0	**390,492**	**400,591**
GRAND WASH	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
HUALAPAI VALLEY	0	18,122	0	0	0	0	0	403	966	0	0	0	211	**18,524**	**19,299**
LOWER SAN PEDRO	3,700	4,756	0	0	0	14,000	30,000	161	387	0	0	343	211	**22,961**	**39,054**
MCMULLEN VALLEY	71,000	1,173	0	0	0	0	0	47	112	0	0	0	0	**72,220**	**72,285**
MEADVIEW	0	302	0	0	0	0	0	10	25	0	0	0	0	**312**	**326**
MORENCI	0	2,378	0	0	0	12,000	48,000	27	66	0	0	75	75	**14,481**	**50,519**
PARIA	0	167	0	0	0	0	0	4	9	11,171	16,091	0	0	**11,342**	**16,267**
PEACH SPRINGS		597	0	0	0	300	300	19	45	0	0	0	0	**916**	**942**
PRESCOTT AMA	1,329	40,447	0	0	567	0	0	1,295	3,107	19	28	1,105	1,103	**44,762**	**46,581**
RANEGRAS PLAIN	29,000	482	0	0	0	0	0	7	16	0	0	0	0	**29,488**	**29,498**
SACRAMENTO VALLEY	0	9,342	76	0	0	8,000	12,000	227	545	5,351	7,623	0	211	**22,996**	**29,797**
SAFFORD	169,600	9,085	0	0	0	5,000	27,000	280	672	0	0	423	423	**184,388**	**206,780**
SALT RIVER	6,900	5,347	0	0	0	27,000	43,000	187	449	502	723	211	211	**40,148**	**56,630**
SAN BERNARDINO VALLEY	0	27	0	0	0	0	0	1	1	0	0	0	0	**27**	**28**
SAN RAFAEL	0	29	0	0	0	0	0	1	3	0	0	0	0	**30**	**32**
SAN SIMON WASH	500	1,873	0	0	0	0	0	67	160	0	0	0	0	**2,440**	**2,533**
SANTA CRUZ AMA	11,233	15,204	0	0	98	0	0	423	1,015	46	66	1,917	1,914	**28,921**	**29,530**
SHIVWITS PLATEAU	0	3	0	0	0	0	0	0	0	0	0	0	0	**3**	**3**
TIGER WASH	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
TONTO CREEK	1,500	7,235	0	0	0	0	0	121	290	0	0	0	211	**8,856**	**9,236**
UPPER HASSAYAMPA	0	5,768	786	0	0	0	0	131	315	0	0	0	0	**6,685**	**6,869**
UPPER SAN PEDRO	8,800	31,062	42	0	288	2,000	12,000	735	1,764	0	0	1,734	1,731	**44,660**	**55,686**
VERDE RIVER	23,700	30,143	0	0	0	1,000	4,000	925	2,220	0	0	3,691	3,686	**59,459**	**63,748**
VIRGIN RIVER	1,000	1,039	0	0	0	0	0	32	77	0	0	882	882	**2,953**	**2,998**
WESTERN MEXICAN DRAINAGE	0	8	0	0	0	0	0	0	1	0	0	0	0	**8**	**8**
WILLCOX	166,000	4,366	584	130	0	300	300	96	229	7,967	11,476	0	0	**179,443**	**183,085**

2060 Demand Projections — Basins Which Receive Part of their Supply from the Colorado River or CAP

Supply	Basin Name	Agriculture	Municipal	Industrial: Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	39,250	69,327	20	539	11,766	1,500	1,500	2,216	5,319	123,332	177,657	1,870	1,867	**249,821**	**307,246**
Instate + CR Lower Mainstem	BILL WILLIAMS	2,700	1,790	0	0	0	10,000	30,000	39	94	0	0	0	0	**14,529**	**34,584**
	DETRITAL VALLEY	0	494	0	0	0	0	0	17	41	0	0	0	0	**511**	**534**
	KANAB PLATEAU	1,100	4,852	27	0	0	0	0	78	188	0	0	0	0	**6,057**	**6,166**
	LAKE HAVASU	0	39,425	0	0	0	0	0	687	1,650	0	0	0	211	**40,113**	**41,286**
	LAKE MOHAVE	20,890	44,715	0	0	0	0	0	594	1,426	16,874	24,307	1,128	1,126	**84,201**	**92,464**
	Lake Mohave (Tribal Ag)	68,110													**68,110**	**68,110**
	LOWER GILA	464,070	3,184	13,814	6,781	0	0	18,000	99	238	2,364	2,955	0	0	**490,312**	**509,041**
	PARKER	21,942	5,993	0	0	0	300	300	113	272	9,894	12,412	0	211	**38,242**	**41,130**
	Parker (Tribal Ag)	621,454													**621,454**	**621,454**
	YUMA	748,432	93,451	0	0	1,178	0	0	1,882	4,518	2,705	3,761	584	583	**848,232**	**851,923**
	Yuma (Tribal Ag)	6,234													**6,234**	**6,234**
	HARQUAHALA INA	135,500	354	0	0	0	0	0	11	26	1,652	2,065	0	0	**137,516**	**137,944**

Supply	Major Active Management Areas (AMAs)	Non-Tribal Ag	Tribal Ag	MUNICIPAL	Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
Instate + CAP	PHOENIX AMA	147,045	525,228	2,357,875	0	58	34,476	15,000	25,000	40,375	96,899	151,841	218,724	84,364	84,234	**3,356,261**	**3,489,538**
	PINAL AMA	418,152	194,616	240,081	8,000	3,033	3,847	4,000	18,000	5,344	12,826	4,954	7,136	20,097	20,066	**902,124**	**925,757**
	TUCSON AMA	56,723	20,412	345,271	0	0	2,501	39,000	74,000	8,840	21,217	3,489	5,026	10,191	10,175	**486,427**	**535,325**
	STATEWIDE	**4,420,519**		**3,414,190**	**37,256**	**10,541**	**54,721**	**139,700**	**343,900**	**66,087**	**158,609**	**365,598**	**523,486**	**128,826**	**129,765**	**8,637,438**	**9,092,987**

GW = groundwater
CR = Mainstem Colorado River
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet.
Generally speaking 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users or as determined by the Arizona-Nevada Shortage Agreement.
3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAMGW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAMGW Supply < Baseline (c. 2006), the GW Supply = CAMGW Supply.
4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use.
It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.
Increased values in future years correspond to decreased values in the Yuma and Lower Gila Basins based on a projected 7% decrease in non-Indian agriculture demand.
6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.
Note: In a Normal Year (Lake Mead Elevation between 1,075 And 1,145), AZ CU Entitlements = 2.8MAF, AZ use =2.8MAF, Balance available equals zero.
In a First Tier Shortage Year (Lake Mead Elevation between 1,050 and 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available equals zero. Arizona will always use its full apportionment.

Table 4. 2110 Demand Projections (CS)

	BASIN NAME	AGRICULTURE	MUNICIPAL	Dairy (Industrial)	Feedlots (Industrial)	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
Instate Water Supplies Only	AGUA FRIA	1,800	4,800	0	0	0	0	0	138	332	0	0	0	0	**6,738**	**6,931**
	ARAVAIPA CANYON	1,000	19	0	0	0	0	0	1	2	0	0	0	0	**1,020**	**1,021**
	BIG SANDY	0	856	0	0	0	0	0	22	54	0	0	0	0	**879**	**910**
	BONITA CREEK	0	8	0	0	0	0	0	0	1	0	0	0	0	**8**	**8**
	BUTLER VALLEY	14,500	0	0	0	0	0	0	0	0	0	0	0	0	**14,500**	**14,500**
	CIENEGA CREEK	500	1,552	0	0	0	300	500	63	151	0	0	0	0	**2,415**	**2,703**
	COCONINO PLATEAU	0	2,526	0	0	0	0	0	124	298	0	0	0	0	**2,651**	**2,824**
	DONNELLY WASH	0	811	0	0	0	0	0	39	95	0	0	0	0	**850**	**906**
	DOUGLAS	48,000	12,503	0	0	0	0	0	340	816	2	3	0	211	**60,845**	**61,533**
	DRIPPING SPRINGS WASH	0	22	0	0	0	0	0	2	4	0	0	0	0	**24**	**27**
	DUNCAN VALLEY	17,100	878	93	0	0	0	0	29	70	0	0	211	211	**18,311**	**18,352**
	GILA BEND	351,500	2,312	23,782	0	0	0	0	99	237	26,910	40,743	0	0	**404,603**	**418,574**
	GRAND WASH	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
	HUALAPAI VALLEY	0	25,056	0	0	0	0	0	557	1,336	0	0	0	211	**25,612**	**26,603**
	LOWER SAN PEDRO	3,700	6,576	0	0	0	14,000	30,000	223	535	0	0	343	211	**24,843**	**41,023**
	MCMULLEN VALLEY	71,000	1,588	0	0	0	0	0	63	152	0	0	0	0	**72,652**	**72,740**
	MEADVIEW	0	417	0	0	0	0	0	14	34	0	0	0	0	**431**	**451**
	MORENCI	0	3,288	0	0	0	12,000	48,000	38	91	0	0	75	75	**15,401**	**51,454**
	PARIA	0	231	0	0	0	0	0	5	13	12,665	19,484	0	0	**12,901**	**19,728**
	PEACH SPRINGS	0	825	0	0	0	300	300	26	63	0	0	0	0	**1,151**	**1,188**
	PRESCOTT AMA	1,329	55,923	0	0	567	0	0	1,790	4,296	22	33	1,105	1,314	**60,736**	**63,463**
	RANEGRAS PLAIN	29,000	595	0	0	0	0	0	8	20	0	0	0	0	**29,603**	**29,615**
	SACRAMENTO VALLEY	0	12,917	76	0	0	8,000	12,000	314	754	6,155	9,298	0	450	**27,462**	**35,495**
	SAFFORD	169,600	12,561	0	0	0	5,000	27,000	387	929	0	0	423	423	**187,971**	**210,513**
	SALT RIVER	6,900	7,394	0	0	0	27,000	43,000	259	621	569	876	211	211	**42,332**	**59,001**
	SAN BERNARDINO VALLEY	0	37	0	0	0	0	0	1	2	0	0	0	0	**38**	**39**
	SAN RAFAEL	0	41	0	0	0	0	0	1	3	0	0	0	0	**42**	**44**
	SAN SIMON WASH	500	2,590	0	0	0	0	0	92	221	0	0	0	0	**3,182**	**3,311**
	SANTA CRUZ AMA	11,233	21,022	0	0	98	0	0	585	1,404	52	80	1,917	2,280	**34,906**	**36,116**
	SHIVWITS PLATEAU	0	4	0	0	0	0	0	0	0	0	0	0	0	**4**	**4**
	TIGER WASH	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0**
	TONTO CREEK	1,500	10,003	0	0	0	0	0	167	401	0	0	0	211	**11,670**	**12,115**
	UPPER HASSAYAMPA	0	7,975	786	0	0	0	0	182	436	0	0	0	0	**8,943**	**9,197**
	UPPER SAN PEDRO	8,800	42,947	42	0	288	2,000	12,000	1,016	2,439	0	0	1,734	2,062	**56,827**	**68,577**
	VERDE RIVER	23,700	41,677	0	0	0	1,000	4,000	1,279	3,069	0	0	3,691	4,390	**71,347**	**76,836**
	VIRGIN RIVER	1,000	1,437	0	0	0	0	0	44	107	0	0	882	882	**3,363**	**3,426**
	WESTERN MEXICAN DRAINAGE	0	11	0	0	0	0	0	0	1	0	0	0	0	**11**	**12**
	WILLCOX	166,000	6,037	584	130	0	300	300	132	317	9,033	13,896	0	0	**182,216**	**187,264**

2110 Demand Projections

	Basins Which Receive Part of their Supply from the Colorado River or CAP	AGRICULTURE	MUNICIPAL	Dairy (Industrial)	Feedlots (Industrial)	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	39,250	95,854	20	539	11,766	0	0	3,065	7,355	139,831	215,112	1,870	2,225	**292,195**	**372,121**
Instate + CR Lower Mainstem	BILL WILLIAMS	2,700	2,505	0	0	0	10,000	30,000	55	131	0	0	0	0	**15,260**	**35,337**
	DETRITAL VALLEY	0	682	0	0	0	0	0	24	57	0	0	0	0	**706**	**739**
	KANAB PLATEAU	1,100	6,708	27	0	0	0	0	108	259	0	0	0	0	**7,943**	**8,095**
	LAKE HAVASU	0	54,511	0	0	0	0	0	951	2,281	0	0	292	450	**55,754**	**57,242**
	LAKE MOHAVE	20,890	61,825	0	0	0	0	0	821	1,972	19,131	29,431	1,128	1,341	**103,795**	**115,459**
	Lake Mohave (Tribal Ag)	68,110													**68,110**	**68,110**
	LOWER GILA	464,070	4,402	23,782	6,781	0	0	18,000	137	328	3,152	3,940	0	0	**502,324**	**521,304**
	PARKER	21,942	8,111	0	0	0	300	300	153	368	13,144	16,508	0	211	**43,651**	**47,440**
	Parker (Tribal Ag)	621,454													**621,454**	**621,454**
	YUMA	748,432	129,209	0	0	1,178	0	0	2,603	6,246	3,209	4,663	584	695	**885,215**	**890,423**
	Yuma (Tribal Ag)	6,234													**6,234**	**6,234**
Instate + CAP	HARQUAHALA INA	135,500	652	0	0	0	0	0	20	48	2,202	2,753	0	0	**138,374**	**138,953**

	Major Active Management Areas (AMAs)	Non-Tribal Ag	Tribal Ag	MUNICIPAL	Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
Instate + CAP	PHOENIX AMA	147,045	525,228	3,253,190	0	58	34,476	15,000	25,000	55,705	133,693	172,992	266,126	75,927	100,127	**4,279,621**	**4,484,942**
	PINAL AMA	418,152	194,616	328,407	0	3,033	3,847	4,000	18,000	7,310	17,545	5,644	8,682	18,087	23,648	**983,096**	**1,015,930**
	TUCSON AMA	56,723	20,412	483,537	0	0	2,501	39,000	74,000	12,381	29,714	3,975	6,115	8,560	12,277	**627,088**	**685,279**
	STATEWIDE	**4,420,519**		**4,717,032**	**49,192**	**10,541**	**54,721**	**138,200**	**342,400**	**91,374**	**219,299**	**418,688**	**637,743**	**117,040**	**154,115**	**10,017,308**	**10,605,563**

GW = groundwater
CR = Mainstem Colorado River
CAP = Central Arizona Project
Instate SW = Other Surface water
Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet.
Generally speaking 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users or as determined by the Arizona-Nevada Shortage Agreement.
3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAMGW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAMGW Supply < Baseline (c. 2006), the GW Supply = CAMGW Supply.
4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use.
It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.
Increased values in future years correspond to decreased values in the Yuma and Lower Gila Basins based on a projected 7% decrease in non-Indian agriculture demand.
6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.
Note: In a Normal Year (Lake Mead Elevation between 1,075 And 1,145), AZ CU Entitlements = 2.8MAF, AZ use =2.8MAF, Balance available equals zero.
In a First Tier Shortage Year (Lake Mead Elevation between 1,050 and 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available equals zero. Arizona will always use its full apportionment.

Table 5. 2110 Demand Projections (AS)

2110 (Area Split) Demand Projections

	BASIN NAME	AGRICULTURE	MUNICIPAL	INDUSTRIAL Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
Instate Water Supplies Only	AGUA FRIA	1,800	64,732	0	0	0	0	0	1,863	4,472	0	0	7,109	0	**75,504**	**71,004**
	ARAVAIPA CANYON	1,000	93	0	0	0	0	0	5	11	0	0	0	0	**1,098**	**1,105**
	BIG SANDY	0	3,149	0	0	0	0	0	82	198	0	0	0	0	**3,232**	**3,347**
	BONITA CREEK	0	332	0	0	0	0	0	11	25	0	0	0	0	**342**	**357**
	BUTLER VALLEY	14,500	0	0	0	0	0	0	0	0	0	0	0	0	**14,500**	**14,500**
	CIENEGA CREEK	500	1,341	0	0	0	300	500	54	130	0	0	0	0	**2,195**	**2,471**
	COCONINO PLATEAU	0	2,919	0	0	0	0	0	143	344	0	0	0	0	**3,063**	**3,264**
	DONNELLY WASH	0	811	0	0	0	0	0	39	95	0	0	0	0	**850**	**906**
	DOUGLAS	48,000	11,873	0	0	0	0	0	323	775	2	3	0	211	**60,198**	**60,862**
	DRIPPING SPRINGS WASH	0	542	0	0	0	0	0	46	110	0	0	0	0	**587**	**651**
	DUNCAN VALLEY	17,100	942	93	0	0	0	0	31	75	0	0	211	211	**18,377**	**18,421**
	GILA BEND	351,500	21,922	23,782	0	0	0	0	935	2,244	26,910	40,743	3,706	0	**428,755**	**440,191**
	GRAND WASH	0	77	0	0	0	0	0	3	7	0	0	0	0	**79**	**83**
	HUALAPAI VALLEY	0	22,824	0	0	0	0	0	507	1,217	0	0	0	211	**23,331**	**24,252**
	LOWER SAN PEDRO	3,700	7,372	0	0	0	14,000	30,000	250	600	0	0	343	450	**25,666**	**42,123**
	MCMULLEN VALLEY	71,000	2,339	0	0	0	0	0	93	223	0	0	0	0	**73,432**	**73,562**
	MEADVIEW	0	68	0	0	0	0	0	2	6	0	0	0	0	**70**	**73**
	MORENCI	0	3,683	0	0	0	12,000	48,000	42	102	0	0	75	75	**15,801**	**51,860**
	PARIA	0	83	0	0	0	0	0	2	5	12,665	19,484	0	0	**12,750**	**19,572**
	PEACH SPRINGS	0	1,945	0	0	0	300	300	62	148	0	0	0	0	**2,307**	**2,394**
	PRESCOTT AMA	1,329	50,774	0	0	567	0	0	1,625	3,900	22	33	1,105	1,193	**55,423**	**57,797**
	RANEGRAS PLAIN	29,000	441	0	0	0	0	0	6	15	0	0	0	0	**29,447**	**29,456**
	SACRAMENTO VALLEY	0	13,382	76	0	0	8,000	12,000	326	781	6,155	9,298	0	450	**27,938**	**35,987**
	SAFFORD	169,600	12,503	0	0	0	5,000	27,000	385	925	0	0	423	423	**187,911**	**210,451**
	SALT RIVER	6,900	8,977	0	0	0	27,000	43,000	314	754	569	876	211	211	**43,971**	**60,718**
	SAN BERNARDINO VALLEY	0	889	0	0	0	0	0	17	41	0	0	0	0	**906**	**930**
	SAN RAFAEL	0	170	0	0	0	0	0	6	15	0	0	0	0	**176**	**185**
	SAN SIMON WASH	500	2,805	0	0	0	0	0	100	239	0	0	0	0	**3,405**	**3,544**
	SANTA CRUZ AMA	11,233	21,314	0	0	98	0	0	593	1,423	52	80	1,917	2,311	**35,207**	**36,460**
	SHIVWITS PLATEAU	0	796	0	0	0	0	0	24	57	0	0	0	0	**820**	**853**
	TIGER WASH	0	1,269	0	0	0	0	0	16	38	0	0	0	0	**1,285**	**1,307**
	TONTO CREEK	1,500	13,836	0	0	0	0	0	231	554	0	0	0	450	**15,567**	**16,340**
	UPPER HASSAYAMPA	0	2,616	786	0	0	0	0	60	143	0	0	0	0	**3,461**	**3,545**
	UPPER SAN PEDRO	8,800	42,386	42	0	288	2,000	12,000	1,003	2,407	0	0	1,734	2,035	**56,252**	**67,957**
	VERDE RIVER	23,700	43,336	0	0	0	1,000	4,000	1,330	3,192	0	0	3,691	4,565	**73,058**	**78,793**
	VIRGIN RIVER	1,000	195	0	0	0	0	0	6	14	0	0	882	882	**2,083**	**2,091**
	WESTERN MEXICAN DRAINAGE	0	119	0	0	0	0	0	4	9	0	0	0	0	**123**	**128**
	WILLCOX	166,000	5,601	584	130	0	300	300	123	294	9,033	13,896	0	0	**181,770**	**186,805**

2110 (Area Split) Demand Projections

	Basins Which Receive Part of their Supply from the Colorado River or CAP	AGRICULTURE	MUNICIPAL	INDUSTRIAL Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	39,250	95,477	20	539	11,766	0	0	3,052	7,326	139,831	215,112	1,870	2,219	**291,806**	**371,709**
Instate + CR Lower Mainstem	BILL WILLIAMS	2,700	8,431	0	0	0	10,000	30,000	184	443	0	0	225	0	**21,541**	**41,574**
	DETRITAL VALLEY	0	919	0	0	0	0	0	32	76	0	0	0	0	**950**	**995**
	KANAB PLATEAU	1,100	7,651	27	0	0	0	0	123	296	0	0	0	0	**8,901**	**9,074**
	LAKE HAVASU	0	54,153	0	0	0	0	0	944	2,266	0	0	292	450	**55,390**	**56,870**
	LAKE MOHAVE	20,890	58,124	0	0	0	0	0	772	1,854	19,131	29,431	1,128	1,261	**100,045**	**111,560**
	Lake Mohave (Tribal Ag)	68,110													**68,110**	**68,110**
	LOWER GILA	464,070	17,301	23,782	6,781	0	0	18,000	538	1,291	3,152	3,940	1,577	0	**517,200**	**535,164**
	PARKER	21,942	7,788	0	0	0	300	300	147	353	13,144	16,508	0	211	**43,321**	**47,102**
	Parker (Tribal Ag)	621,454													**621,454**	**621,454**
	YUMA	748,432	128,514	0	0	1,178	0	0	2,589	6,213	3,209	4,663	584	691	**884,506**	**889,691**
	Yuma (Tribal Ag)	6,234													**6,234**	**6,234**
	HARQUAHALA INA	135,500	4,576	0	0	0	0	0	139	334	2,202	2,753	225	0	**142,642**	**143,163**

	Major Active Management Areas (AMAs)	Non-Tribal Ag	Tribal Ag	MUNICIPAL	Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
Instate + CAP	PHOENIX AMA	147,045	525,228	3,069,776	0	58	34,476	15,000	25,000	52,565	126,155	172,992	266,126	61,454	97,650	**4,078,593**	**4,291,514**
	PINAL AMA	418,152	194,616	326,579	0	3,033	3,847	4,000	18,000	7,270	17,447	5,644	8,682	18,087	25,702	**981,227**	**1,016,058**
	TUCSON AMA	56,723	20,412	482,607	0	0	2,501	39,000	74,000	12,357	29,657	3,975	6,115	10,191	12,253	**627,766**	**684,268**

	AGRICULTURE	MUNICIPAL	Dairy	Feedlots	Other Industrial	Mining Low	Mining High	Rock Products Low	Rock Products High	Power Plants Low	Power Plants High	Turf Low	Turf High	TOTAL Low	TOTAL High
STATEWIDE	**4,420,519**	**4,630,352**	**49,192**	**10,541**	**54,721**	**138,200**	**342,400**	**91,374**	**219,299**	**418,688**	**637,743**	**117,040**	**154,116**	**9,930,628**	**10,518,883**

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6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.
Note: In a Normal Year (Lake Mead Elevation between 1,075 And 1,145), AZ CU Entitlements = 2.8MAF, AZ use =2.8MAF, Balance available equals zero.
In a First Tier Shortage Year (Lake Mead Elevation between 1,050 and 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available equals zero. Arizona will always use its full apportionment.

Table 6. Changes in Projected Water Demands

Version 6-17-11

Sector	Sub Sector	2035 low[3]	2035 high[3]	2060 low[3]	2060 high[3]	2110 Census low[3]	2110 Census high[3]	2110 Area Split low[3]	2110 Area Split high[3]
Change in Percentage Statewide Cultural Water Demands Baseline to Projection Year									
Statewide Demands (Percents)									
AGRICULTURE		-7%	-7%	-14%	-14%	-14%	-14%	-14%	-14%
MUNICIPAL		77%	77%	124%	124%	209%	209%	204%	204%
INDUSTRIAL	Dairy	49%	49%	81%	81%	138%	138%	138%	138%
	Feedlots	47%	47%	47%	47%	47%	47%	47%	47%
	Other Industrial	83%	83%	83%	83%	83%	83%	83%	83%
	Mining	51%	273%	51%	273%	50%	271%	50%	271%
	Rock Products	178%	567%	252%	746%	387%	1070%	387%	1070%
	Power Plants	95%	167%	137%	239%	172%	314%	172%	314%
	Turf	15%	32%	48%	49%	34%	77%	34%	77%
	TOTAL DEMANDS	15%	21%	22%	28%	41%	49%	40%	48%
Change in Percentage Statewide Currently Developed and Adjusted Baseline Water Supply to Projection Year									
Instate	Groundwater	-3%	-1%	-7%	-1%	-3%	1%	-4%	1%
	Instate Surface Water	-18%	-18%	-22%	-22%	-22%	-22%	-22%	-22%
	Effluent	137%	137%	137%	137%	137%	137%	137%	137%
Colorado River/CAP Diversions[1]	Normal Year[9a]	16%	16%	15%	15%	15%	15%	15%	15%
	Shortage Year[9b]	5%	5%	5%	5%	5%	5%	5%	5%
TOTAL SUPPLY	Normal Year[9a]	7%	8%	4%	7%	6%	7%	5%	7%
	Shortage Year[9b]	2%	3%	0%	2%	1%	3%	1%	3%

1. Diversions of Colorado River Water indicate an increase in projected future years, however, there would be a corresponding increase in return flow and the same consumptive use (2.8MAF in a normal year and 2.48MAF in a first tier shortage year).

Sector	Sub Sector	2035 low[3]	2035 high[3]	2060 low[3]	2060 high[3]	2110 Census low[3]	2110 Census high[3]	2110 Area Split low[3]	2110 Area Split high[3]
Change in Quantities (Acre-Feet) Statewide Cultural Water Demands Baseline to Projection Year									
Statewide Demands (Percents)									
AGRICULTURE		-359,884	-359,884	-748,305	-748,305	-748,305	-748,305	-748,305	-748,305
MUNICIPAL		1,169,115	1,169,115	1,889,680	1,889,680	3,192,522	3,192,522	3,105,842	3,105,842
INDUSTRIAL	Dairy	10,033	10,033	16,619	16,619	28,555	28,555	28,555	28,555
	Feedlots	3,359	3,359	3,359	3,359	3,359	3,359	3,359	3,359
	Other Industrial	24,789	24,789	24,789	24,789	24,789	24,789	24,789	24,789
	Mining	47,444	251,644	47,444	251,644	45,944	250,144	45,944	250,144
	Rock Products	33,383	106,368	47,337	139,859	72,624	200,548	72,624	200,548
	Power Plants	146,494	258,107	211,396	369,284	264,486	483,541	264,486	483,541
	Turf	13,032	28,309	41,694	42,633	29,909	66,984	29,909	66,984
	TOTAL DEMANDS	1,087,766	1,491,841	1,534,013	1,989,562	2,913,883	3,502,138	2,827,203	3,415,458
Change in Quantities (Acre-Feet) Statewide Currently Developed and Asjusted Baseline Cultural Water Supplies to Projection Year									
Instate	Groundwater	-87,353	-20,738	-189,047	-16,595	-91,300	20,991	-108,281	20,798
	Instate Surface Water	-207,690	-207,690	-258,084	-258,084	-258,084	-258,084	-258,084	-258,084
	Effluent	291,853	291,853	291,853	291,853	291,853	291,853	291,853	291,853
Colorado River/CAP Diversions	Normal Year[9a]	482,541	482,541	464,722	464,722	464,722	464,722	464,722	464,722
	Shortage Year[9b]	162,314	162,314	144,533	144,533	144,533	144,533	144,533	144,533
TOTAL SUPPLY	Normal Year[9a]	479,352	545,966	309,444	481,897	407,191	519,483	390,210	519,289
	Shortage Year[9b]	159,124	225,739	-10,745	161,708	87,002	199,294	70,021	199,100

	Baseline	2035 low	2035 high	2060 low	2060 high	2110 Census low	2110 Census high	2110 Area Split low	2110 Area Split high
Projected Sector Demand Totals (acre feet)									
AGRICULTURE	5,168,825	4,808,940	4,808,940	4,420,519	4,420,519	4,420,519	4,420,519	4,420,519	4,420,519
MUNICIPAL	1,524,510	2,693,625	2,693,625	3,414,190	3,414,190	4,717,032	4,717,032	4,630,352	4,630,352
Industrial	410,090	688,625	1,092,701	802,729	1,258,278	879,757	1,468,012	879,757	1,468,012
Total	**7,103,425**	**8,191,191**	**8,595,266**	**8,637,438**	**9,092,987**	**10,017,308**	**10,605,563**	**9,930,628**	**10,518,883**
Projected Sector Demand (percents)									
AGRICULTURE	73%	59%	56%	51%	49%	44%	42%	45%	42%
MUNICIPAL	21%	33%	31%	40%	38%	47%	44%	47%	44%
Industrial	6%	8%	13%	9%	14%	9%	14%	9%	14%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 7. Baseline Supply for Projection Purposes

	BASIN NAME	Baseline Supply for Projection Purposes[1]					
		Instate					
		GW (c. 2006)	Instate SW (2001-2006 Average Diversions)	Effluent (Generated c. 2006)	Total Instate Supply	Colorado River/CAP	Total Supply
Instate Water Supplies Only	AGUA FRIA	3,602	0	30	3,632	NA	3,632
	ARAVAIPA CANYON	514	500	0	1,014	NA	1,014
	BIG SANDY	15,028	0	0	15,028	NA	15,028
	BONITA CREEK	0	0	0	0	NA	0
	BUTLER VALLEY	14,503	0	0	14,503	NA	14,503
	CIENEGA CREEK	1,101	0	100	1,201	NA	1,201
	COCONINO PLATEAU	500	358	1,700	2,558	NA	2,558
	DONNELLY WASH	19	0	0	19	NA	19
	DOUGLAS	53,300	0	1,400	54,700	NA	54,700
	DRIPPING SPRINGS WASH	11	0	0	11	NA	11
	DUNCAN VALLEY	8,054	9,900	50	18,004	NA	18,004
	GILA BEND	295,323	55,417	800	351,540	NA	351,540
	GRAND WASH	2	0	0	2	NA	2
	HUALAPAI VALLEY	9,109	0	1,800	10,909	NA	10,909
	LOWER SAN PEDRO	23,677	833	700	25,211	NA	25,211
	MCMULLEN VALLEY	71,500	0	0	71,500	NA	71,500
	MEADVIEW	145	0	0	145	NA	145
	MORENCI	9,126	1,627	200	10,953	NA	10,953
	PARIA	120	0	0	120	NA	120
	PEACH SPRINGS	351	0	100	451	NA	451
	PRESCOTT AMA	17,679	2,067	6,900	26,645	NA	26,645
	RANEGRAS PLAIN	29,350	0	0	29,350	NA	29,350
	SACRAMENTO VALLEY	3,765	0	300	4,065	NA	4,065
	SAFFORD	87,958	74,183	2,600	164,741	NA	164,741
	SALT RIVER	12,611	12,011	2,600	27,222	NA	27,222
	SAN BERNARDINO VALLEY	19	0	0	19	NA	19
	SAN RAFAEL	22	0	0	22	NA	22
	SAN SIMON WASH	1,500	0	400	1,900	NA	1,900
	SANTA CRUZ AMA	20,980	0	16,311	37,291	NA	37,291
	SHIVWITS PLATEAU	2	0	0	2	NA	2
	TIGER WASH	2	0	0	2	NA	2
	TONTO CREEK	3,000	1,000	500	4,500	NA	4,500
	UPPER HASSAYAMPA	3,286	0	600	3,886	NA	3,886
	UPPER SAN PEDRO	23,957	4,450	5,300	33,707	NA	33,707
	VERDE RIVER	28,549	16,494	6,200	51,243	NA	51,243
	VIRGIN RIVER	1,585	1,618	10	3,213	NA	3,213
	WESTERN MEXICAN DRAINAGE	6	0	0	6	NA	6
	WILLCOX	175,714	150	500	176,364	NA	176,364

Basins Which Receive Part of their Supply from the Colorado River or CAP		Baseline Supply for Projection Purposes											
		Instate				Colorado River/CAP Diversions		Total Supply		Colorado River Expected Return Flow		Colorado River Consumptive Use	
		GW (c. 2006)	Instate SW (2001-2006 Average Diversions)	Effluent (Generated c. 2006)	Total Instate Supply	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	95,813	14,717	36,100	146,630	51,782	51,782	198,412	198,412	1,782	1,782	50,000	50,000
Instate + CR Lower Mainstem	BILL WILLIAMS	3,251	500	200	3,951	654	464	4,604	4,415	237	0	417	299
	DETRITAL VALLEY	159	50	0	209	150	150	359	359	0	0	150	150
	KANAB PLATEAU	2,799	800	500	4,099	70	50	4,169	4,149	25	0	45	32
	LAKE HAVASU	47	0	3,400	3,447	37,010	26,528	40,457	29,975	13,578	0	23,432	16,796
	LAKE MOHAVE	2,007	0	3,100	5,107	72,242	51,887	77,349	56,995	24,553	89	47,689	34,285
	Lake Mohave (Tribal Ag)	0	0	0	0	103,535	103,535	103,535	103,535	47,570	47,570	55,965	55,965
	LOWER GILA	110,296	473	300	111,070	400,825	400,617	511,894	511,687	140,045	139,790	260,780	260,645
	PARKER	1,787	0	2,100	3,887	36,581	26,992	40,468	30,879	9,799	348	26,782	19,378
	Parker (Tribal Ag)	0	0	0	0	666,680	665,468	666,680	665,468	290,025	288,164	376,655	375,971
	YUMA	108,570	973	13,500	123,042	806,498	803,175	929,540	926,217	325,095	320,786	481,403	479,086
	Yuma (Tribal Ag)	0	0	0	0	17,197	17,197	17,197	17,197	4,793	4,793	12,404	12,404
	HARQUAHALA INA	66,178	0	0	66,178	0	0	66,178	66,178	0	0	0	0
Instate + CAP	Major Active Management Areas (AMAs)	GW (c. 2006)	Instate SW (2001-2006 Average Diversions)	Effluent (Generated c. 2006)	Total Instate Supply	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]
	PHOENIX AMA	673,755	727,402	315,000	1,693,083	895,395	703,579	2,588,479	2,396,662	0	0	895,395	703,579
	PINAL AMA	431,290	73,830	6,900	506,639	166,269	116,073	672,908	622,712	0	0	166,269	116,073
	TUCSON AMA	216,996	506	74,235	291,721	220,106	188,519	511,827	480,240	0	0	220,106	188,519
Central Arizona Project (CAP) Supply Range[4,5]						1,281,770 to 1,403,887	1,008,170 to 1,128,998	1,281,770 to 1,403,887	1,008,170 to 1,128,998	0	0	1,281,770 to 1,403,887	1,008,170 to 1,128,998
Colorado Mainstem Environmental (Not Available For Cultural Supply)						104,339	104,339	0	0	61,409	61,409	42,930	42,930
CAP System Loss = -5% of Diversion (Not Available For Supply)						67,462	53,062	0	0	0	0	67,462	53,062
STATEWIDE		**2,628,917**	**999,860**	**504,436**	**4,104,742**	**3,768,911**	**3,434,245**	**7,701,852**	**7,381,586**	**918,911**	**864,732**	**2,850,000**	**2,530,000**

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. The Baseline Supply for Projection Purposes represents currently developed supplies that are available today and throughout the study period to meet both baseline and, if applicable, future demand.
This value will be adjusted in the future scenarios to simulate reductions in water supply due to climate change and other stressors.
2. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
3. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet.
Generally speaking 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users or as determined by the Arizona-Nevada Shortage Agreement.
4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversi
It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAPs contract with the Secretary.
Increased values in future yars correspond to decreased values in the Yuma and Lower Gila Basins based on a projected 7% decrease in non-Indian agriculture demand.
Note: In a Normal Year (Lake Mead Elevation between 1,075 And 1,145), AZ CU Entitlements = 2.8MAF, AZ use =2.8MAF, Balance available equals zero.
In a First Tier Shortage Year (Lake Mead Elevation between 1,050 and 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available equals zero. Arizona will always use its full apportionment.
Generally speaking 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users or as determined by the Arizona-Nevada Shortage Agreement.

Table 8. Water-Dependent Natural Resource Index

Water-Dependent Natural Resource Index for the Water Resource Development Commission

BASINS	Perennial Water (Instate)	Basin Includes Colorado River	Major Springs	Waters in Federal/State Conservation Lands	Current GW-SW Connection*	Effluent Dependent Stream Reach	ESA Critical Habitat Designated	ESA Species Observed	Instream Flow Certificate	Audubon Important Bird Area	Water Based Recreation Opportunity	ADEQ Outstanding Arizona Water	Federal Wild and Scenic Designation
AGUA FRIA	▨		■	■	■		■	■	■	■	■		
ARAVAIPA CANYON	▨		■	■	■		■	■	■	■	■	■	
BIG SANDY	■		■		■		■	■			■		
BILL WILLIAMS	▨	■	■	■	■		■	■	■	■	■	■	
BONITA CREEK	■		■	■	■			■			■	■	
BUTLER VALLEY													
CIENEGA CREEK	▨		■	■	■	■	■	■	■	■	■	■	
COCONINO PLATEAU	■	■	■	■	■	■	■	■		■	■		
DETRITAL VALLEY		■		■	■		■				■		
DONNELLY WASH	■				■		■	■			■		
DOUGLAS	■			■	■			■	■		■		
DRIPPING SPRINGS WASH	■		■	■	■		■	■	■		■		
DUNCAN VALLEY	■		■	■	■		■	■			■		
GILA BEND						■		■			■		
GRAND WASH		■	■	■	■		■	■			■		
HARQUAHALA INA													
HUALAPAI VALLEY		■	■	■	■		■	■			■		
KANAB PLATEAU	■	■	■	■	■	■	■	■		■	■		
LAKE HAVASU		■		■	■		■	■			■		
LAKE MOHAVE		■	■	■	■		■	■			■		
LITTLE COLORADO RIVER PLATEAU	■	■	■	■	■	■	■	■		■	■	■	
LOWER GILA		■		■	■		■	■		■	■		
LOWER SAN PEDRO	▨		■	■	■	■	■	■	■	■	■	■	
MCMULLEN VALLEY													
MEADVIEW		■	■	■	■		■	■			■		
MORENCI	■		■	■	■		■	■		■	■	■	
PARIA	■	■		■	■					■	■		
PARKER	■	■		■	■		■	■			■		
PEACH SPRINGS	■	■	■	■	■		■	■			■		
PHOENIX AMA	■		■	■	■	■		■	■	■	■		
PINAL AMA						■		■			■		
PRESCOTT AMA	■		■	■	■	■	■	■		■	■		
RANEGRAS PLAIN													
SACRAMENTO VALLEY		■	■	■	■		■	■			■		
SAFFORD	▨		■	■	■	■	■	■		■	■	■	
SALT RIVER	▨		■	■	■	■	■	■	■	■	■	■	
SAN BERNARDINO VALLEY	■			■	■		■	■			■		
SAN RAFAEL	■			■	■		■	■		■	■		
SAN SIMON WASH								■			■		
SANTA CRUZ AMA	▨		■	■	■	■	■	■		■	■		
SHIVWITS PLATEAU	■	■	■	■	■		■	■			■		
TIGER WASH													
TONTO CREEK	▨		■	■	■		■	■	■	■	■		
TUCSON AMA	▨		■	■	■	■	■	■		■	■		
UPPER HASSAYAMPA	■				■		■	■	■		■		
UPPER SAN PEDRO	▨		■	■	■	■	■	■	■	■	■		
VERDE RIVER	▨		■	■	■	■	■	■	■	■	■	■	■
VIRGIN RIVER	■		■	■	■		■	■			■		
WESTERN MEXICAN DRAINAGE			■	■			■	■					
WILLCOX	■		■	■	■		■	■		■	■		
YUMA		■			■			■		■	■		

▨ Hatched cells represent perennial streams within groundwater basins where current flow volumes that support water-dependent natural resources have been estimated.

This table depicts major water-dependent natural resources cataloged by the Environmental Workgroup of the WRDC. It is not meant to be a comprehensive assessment of *all* important water-dependent natural resources, and some potentially important features are not represented here. Rather, this information is meant to be used as a starting point for identifying important water-dependent natural resources in Arizona's counties and groundwater basins. For a more detailed description of known resources in each groundwater basin, please review the Maps, Basin Descriptions and

*Brown DE, Carmony NB, Turner RM. 1981. Drainage map of Arizona showing perennial streams and some important wetlands. Arizona Game and Fish Department, Phoenix.

*Anning, D.W. and Konieczki, A.D. 2005. Classification of hydrogeologic areas and hydrogeologic flow systems in the Basin and Range Physiographic Province, Southwestern United States. USGS Professional Paper 1702. 37 pp.

Objective 3: Compare Current and Future Water Supplies and Demand to Identify Unmet Demands (With Environmental Committee)

In order to establish unmet demands for the next 25 (2035), 50 (2060), and 100 (2110) years, future demands were subtracted from the baseline available supply. Notwithstanding the caveat regarding the term "currently developed supplies" previously identified, all unmet demands represent water supply that will need to be developed in order to meet demand.

The **future water demand** (projected for 2035, 2060 and 2110) was compiled for each groundwater basin by adding the individual projected demands from the following sectors:

- Agricultural (including both tribal and non-tribal in most basins)
- Municipal
- Tribal Agricultural users of main stem Colorado River water in Lake Mohave, Parker and Yuma basins and CAP in the Phoenix, Pinal and Tucson AMAs (per Central Arizona Water Demand Model – WRDC Scenarios)
- Tribal Industrial in AMAs only (per Central Arizona Water Demand Model - WRDC Scenarios)
- Industrial – hard rock mining (low and high demand)
- Industrial - rock products (low and high demand)
- Industrial - power plants (low and high demand)
- Industrial – turf (low and high demand)
- Industrial – dairy
- Industrial – feedlots
- Industrial – other

The future water supply (projected for 2035, 2060 and 2110) was compiled for each groundwater basin by adding the individual **currently developed and adjusted supplies** from the following sources:

- Groundwater
- Instate surface water
- Upper Basin Colorado River apportionment
- Lower Basin Colorado River apportionment
- Central Arizona Project
- Effluent

The projected future unmet water demand for each basin was calculated as the difference between the **currently available and adjusted supply** and the **projected future demand** (Equation 1).

Unmet Demand = (Currently Available and Adjusted Supply - Projected Future Demand)   (Equation 1)

When future demands are projected to be greater than currently available and adjusted supplies, a deficit (negative) supply or "unmet" demand condition is projected. Multiple projected unmet demand scenarios were developed to account for the high and low range of industrial demand projections, normal supply and shortage conditions on the Colorado River and instate river systems due to potential drought and/or climate change and the two potential future population distributions (census split, and area split) for the year 2110.

Results of Projected Unmet Demand Analysis

The projected future unmet demand analyses for each basin for the years 2035, 2060 and 2110 for each sector are summarized in Table 9. Currently Developed Adjusted Supplies Vs. Projected Demands. The results show that the total statewide unmet demand (which included positive differences for some basins) is projected to range from a potential low of -608,000 AF/Yr in 2035 to a potential high of -3,303,000 AF/Yr in 2110. A negative "unmet demand" number indicates the existence of unmet demand (rather than the absence of any such demand). Table 10. Adjusted Currently Developed Supplies Vs. Projected Demand shows the projected unmet demands by basin for each of the target periods (2035, 2060 and 2110). Tables 11, 12, 13, and 14 summarize the unmet demands by basin and show the results quantitatively and as a percentage of projected demand. The higher the percentage, the greater the portion of demand is unmet for the target period of time in the identified basin. The analysis indicates that approximately 77% and 82% of the projected unmet demand for 2035 (low demand) and 2110 (low demand, CS) would occur in AMAs with the remaining 23% and 18% of the projected unmet demand for those years occurring in non-AMA areas. Projected unmet demands are greatest in the Phoenix AMA and Pinal AMA for all target years. It is noted, however, that the percent of unmet demand in a basin, versus the raw number, must be considered in any analysis of unmet demand and is a more significant factor of the extent of the problem in any given basin.

In addition to the tables provided in this section, Figures 1 through 12 show graphically the unmet demand by basin for the target years. These are categorized by instate basins, basins that receive Colorado River water and AMAs and INAs that may receive Central Arizona Project water.

Table 9. Currently Developed Adjusted Supplies Vs. Projected Demands

Statewide Cultural Water Demands (acre-feet)[1]

Sector	Sub Sector	Baseline			2035 low[3]	2035 high[3]	2060 low[3]	2060 high[3]	2110 Census low[3]	2110 Census high[3]	2110 Area Split low[3]	2110 Area Split high[3]
AGRICULTURE[2]		5,168,825			4,808,940	4,808,940	4,420,519	4,420,519	4,420,519	4,420,519	4,420,519	4,420,519
MUNICIPAL		1,524,510			2,693,625	2,693,625	3,414,190	3,414,190	4,717,032	4,717,032	4,630,352	4,630,352
INDUSTRIAL	Dairy	20,637			30,670	30,670	37,256	37,256	49,192	49,192	49,192	49,192
	Feedlots	7,182			10,541	10,541	10,541	10,541	10,541	10,541	10,541	10,541
	Other Industrial	29,932			54,721	54,721	54,721	54,721	54,721	54,721	54,721	54,721
	Mining	92,256			139,700	343,900	139,700	343,900	138,200	342,400	138,200	342,400
	Rock Products	18,750			52,133	125,119	66,087	158,609	91,374	219,299	91,374	219,299
	Power Plants	154,202			300,696	412,309	365,598	523,486	418,688	637,743	418,688	637,743
	Turf	87,132			100,164	115,441	128,826	129,765	117,040	154,115	117,040	154,116
TOTAL DEMANDS		**7,103,425**			**8,191,191**	**8,595,266**	**8,637,438**	**9,092,987**	**10,017,308**	**10,605,563**	**9,930,628**	**10,518,883**

Statewide Currently Developed Adjusted Supplies (acre-feet)

		Baseline Demand Water Sources[4]		Currently Developed & Adjusted Water Supplies	2035 low[3]	2035 high[3]	2060 low[3]	2060 high[3]	2110 Census low[3]	2110 Census high[3]	2110 Area Split low[3]	2110 Area Split high[3]
Instate	Groundwater (C. 2006)[5]	2,628,917	Instate	Groundwater (C. 2006 or CAM Values)	2,541,563	2,608,178	2,439,869	2,612,322	2,537,616	2,649,908	2,520,635	2,649,714
	Instate SW (c. 2006)[6]	1,165,176		Instate SW (2001-2006 Average With Reductions/CAM)	957,486	957,486	907,092	907,092	907,092	907,092	907,092	907,092
	Effluent (c. 2006 Used)[7]	212,583		Effluent (Generated c.2006)	504,436	504,436	504,436	504,436	504,436	504,436	504,436	504,436
	Total Instate Supply	4,006,675		Total Instate Supply	low[3]	high[3]	low[3]	high[3]	low[3]	high[3]	low[3]	high[3]
					4,003,485	**4,070,100**	**3,851,397**	**4,023,850**	**3,949,144**	**4,061,436**	**3,932,163**	**4,061,242**
Colorado River/CAP[8,9]	Mainstem Basin Diversions	1,948,602	Mainstem Basin Diversions To Meet Cultural Demands	Normal Year[9a]	2,151,388	2,151,388	2,109,553	2,109,553	2,109,553	2,109,553	2,109,553	2,109,553
				Shortage Year[9b]	2,106,120	2,106,120	2,064,394	2,064,394	2,064,394	2,064,394	2,064,394	2,064,394
	CAP	1,148,148	Central Arizona Project (CAP) Supply Range[10,11]	Normal Year[9a]	1,281,770 to 1,427,903	1,281,770 to 1,427,903	1,281,770 to 1,451,918	1,281,770 to 1,451,918	1,281,770 to 1,451,918	1,281,770 to 1,451,918	1,281,770 to 1,451,918	1,281,770 to 1,451,918
				Shortage Year[9b]	1,008,170 to 1,152,943	1,008,170 to 1,152,943	1,008,170 to 1,176,889	1,008,170 to 1,176,889	1,008,170 to 1,176,889	1,008,170 to 1,176,889	1,008,170 to 1,176,889	1,008,170 to 1,176,889
	Diversions (c. 2006)[8]	**3,096,749**	Total Diversion Supplies For Cultural Demand Projections	Normal Year[9a]	**3,579,291**	**3,579,291**	**3,561,471**	**3,561,471**	**3,561,471**	**3,561,471**	**3,561,471**	**3,561,471**
				Shortage Year[9b]	**3,259,063**	**3,259,063**	**3,241,282**	**3,241,282**	**3,241,282**	**3,241,282**	**3,241,282**	**3,241,282**
			Environmental (Not Avilable For Cultural Supply)	Normal Year[9a]	104,339	104,339	104,339	104,339	104,339	104,339	104,339	104,339
				Shortage Year[9b]	104,339	104,339	104,339	104,339	104,339	104,339	104,339	104,339
			CAP System Loss = -5% of Diversion (Not Avilable For Supply)	Normal Year[9a]	67,462	67,462	67,462	67,462	67,462	67,462	67,462	67,462
				Shortage Year[9b]	53,062	53,062	53,062	53,062	53,062	53,062	53,062	53,062
			Total Return Flow	Normal Year[9a]	903,591	903,591	888,271	888,271	888,271	888,271	888,271	888,271
				Shortage Year[9b]	888,964	888,964	873,683	873,683	873,683	873,683	873,683	873,683
			Total Consumptive Use	Normal Year[9a]	2,847,500	2,847,500	2,845,000	2,845,000	2,845,000	2,845,000	2,845,000	2,845,000
				Shortage Year[9b]	2,527,500	2,527,500	2,525,000	2,525,000	2,525,000	2,525,000	2,525,000	2,525,000
					low[3]	high[3]	low[3]	high[3]	low[3]	high[3]	low[3]	high[3]
TOTAL SUPPLIES (Instate + CR)		7,103,425		Normal Year[9a]	**7,582,776**	**7,649,391**	**7,412,868**	**7,585,321**	**7,510,616**	**7,622,907**	**7,493,634**	**7,622,714**
				Shortage Year[9b]	**7,262,549**	**7,329,163**	**7,092,679**	**7,265,132**	**7,190,426**	**7,302,718**	**7,173,445**	**7,302,524**

Currently Developed & Adjusted Supplies - Projected Demands[12]

				Year	2035		2060		2110 Census		2110 Area Split	
TOTAL SUPPLY - DEMAND		0		Demands	low[3]	high[3]	low[3]	high[3]	low[3]	high[3]	low[3]	high[3]
				Normal Year[9a]	**-608,415**	**-945,875**	**-1,224,570**	**-1,507,666**	**-2,506,693**	**-2,982,656**	**-2,436,994**	**-2,896,170**
				Shortage Year[9b]	**-928,642**	**-1,266,103**	**-1,544,759**	**-1,827,855**	**-2,826,882**	**-3,302,845**	**-2,757,183**	**-3,216,359**

Notes

1. Cultural water demands include agriculture, municipal and industrial uses. Not included are environmental and artificial recharge.

2. Statewide total Includes both tribal and non-tribal agriculture. The CAM shows an increase in tribal agriculture in the Phoenix, Pinal and Tucson AMAs.

3. The Mining, Rock Products, Power Plants and Turf Industrial sub-sectors submitted high and low projection scenarios to account for uncertainty and volatility in those industries. Both are presented here with corresponding total demands and 'supply - demand' values. Within the Phoenix, Pinal and Tucson AMAs, the CAM predicted corresponding low and high groundwater and effluent supplies, however, CAM values were only used when less than baseline supplies because additional infrastructure will be needed to fully utilize them.

4. Baseline Demand Water Sources are derived from the Arizona Water Atlas (outside AMAs) and AMA Assessments some adjustments made for basins receiving Colorado River Water to reflect estimated diversions resulting in corresponding reductions in groundwater and instate surface water quantities used. Basin totals from the original sources were maintained, sometimes resulting in the inability to fully quantify the Colorado River portion. The data is circa 2006, however, since the Municipal baseline year was 2005 instead, these values come from both 2005 and 2006.

5. Groundwater supplies used to meet baseline demands correspond with reported groundwater use from the Atlas and AMA assessments (with reductions in some basins for Colorado River use). The value is slightly different than what was used as the 'available' baseline groundwater supply, which is from 2006, because the municipal sector baseline year was 2005. Future year groundwater supplies for most basins = 'available' baseline supply (developed supply). In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If Central AZ Model (CAM) GW Supply was > Baseline (c. 2006), the GW Supply = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.

6. Instate surface water supplies used to meet baseline demands correspond with reported surface water use from the Atlas and AMA assessments (with reductions in some basins for Colorado River use). The 'Baseline Supply for Projection Purposes' surface water supply comes from the 2001-2006 average in-state use. Future surface water supplies were calculated by applying a 5% reduction in 2035 and another 5% in 2060, flat-lined thereafter. The Phoenix, Pinal and Tucson AMA instate surface water supplies came from the CAM results-which were very similar to previous values.

7. Effluent supplies used to meet baseline demands correspond with reported information in the Atlas and AMA assessments. The Baseline Supply for Projection Purposes effluent supply is the total currently generated, much of it not used for current demands. Future year effluent supplies are expected to increase and are addressed in the unmet demand analysis. Values shown here are flat-lined.

8. Colorado River Mainstem supplies used to meet baseline demands correspond with reported diversion information from the USBOR and ADWR Colorado River Management, which was later parsed into groundwater basins for use by the WRDC Supply and Demand Committee.

CAP supplies used to meet baseline demands correspond with reported use within the AMAs and the CAP delivered use in the Harquahala INA. Recharged CAP water not included. Approximately 350,000 acre feet of CAP water was recharged in 2006. Please see Table 10. 2006 CAP Summary for more information.

9. The Baseline Supply for Projection Purposes of the Colorado River Mainstem and CAP Diversions are based on a calculation of diversions and return flow to obtain full on-river buildout and the consumptive use entitlement for municipal and industrial uses. Since agriculture projections along the mainstem were either held constant or reduced, previous use of 'full-buildout' diversion entitlements changed to 2001-2005 average diversions, unless those exceeded entitlements. Remaining consumptive use volume = water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.

9a. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.

9b. The first degree shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet. Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.

10. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use. It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.

11. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary. Increased values in future years correspond to decreased values in the Yuma and Lower Gila Basins based on a projected 7% decrease in non-Indian agriculture demand.

12. Negative Results of the Supply - Demand reflects the volume of additional water required to meet projected demands above what is currently available, with anticipated reduced availability of surface water. Sources of additional water are explored in the **Unmet Demand Analysis.**

Table 10. Adjusted Currently Developed Supplies Vs. Projected Demand

	BASIN NAME	Baseline Supply & Demand	2035 Demands TOTAL Low	2035 Demands TOTAL High	2035 Total Supply	2035 Supply - Demand: Instate Supply - Low Demand	2035 Supply - Demand: Instate Supply - High Demand	2060 Demands TOTAL Low	2060 Demands TOTAL High	2060 Total Supply	2060 Supply - Demand: Instate Supply - Low Demand	2060 Supply - Demand: Instate Supply - High Demand
Instate Water Supplies Only	AGUA FRIA	3,602	4,772	4,888	3,632	-1,140	-1,256	5,371	5,511	3,632	-1,739	-1,879
	ARAVAIPA CANYON	1,014	1,013	1,014	989	-24	-25	1,014	1,015	964	-50	-51
	BIG SANDY	15,028	509	528	15,028	14,519	14,500	635	658	15,028	14,393	14,370
	BONITA CREEK	0	5	5	0	-5	-5	6	6	0	-6	-6
	BUTLER VALLEY	14,503	14,500	14,500	14,503	3	3	14,500	14,500	14,503	3	3
	CIENEGA CREEK	1,101	1,755	2,007	1,201	-554	-806	1,968	2,232	1,201	-767	-1,031
	COCONINO PLATEAU	1,173	1,596	1,701	2,540	944	840	1,917	2,043	2,523	605	480
	DONNELLY WASH	19	0	0	19	19	19	0	0	19	19	19
	DOUGLAS	53,300	55,841	56,344	54,700	-1,141	-1,644	57,291	57,847	54,700	-2,591	-3,147
	DRIPPING SPRINGS WASH	11	16	17	11	-5	-6	17	19	11	-6	-8
	DUNCAN VALLEY	17,954	17,969	17,994	17,509	-460	-486	18,060	18,090	17,014	-1,047	-1,076
	GILA BEND	357,823	377,271	384,396	348,769	-28,503	-35,627	390,492	400,591	345,998	-44,495	-54,593
	GRAND WASH	2	0	0	2	2	2	0	0	2	2	2
	HUALAPAI VALLEY	9,109	14,919	15,584	10,909	-4,010	-4,675	18,524	19,299	10,909	-7,615	-8,390
	LOWER SAN PEDRO	24,622	20,948	37,087	25,169	4,221	-11,918	22,961	39,054	25,127	2,167	-13,927
	MCMULLEN VALLEY	71,500	72,008	72,062	71,500	-508	-562	72,220	72,285	71,500	-720	-785
	MEADVIEW	145	251	263	145	-106	-118	312	326	145	-167	-181
	MORENCI	10,384	14,150	50,183	10,871	-3,279	-39,312	14,481	50,519	10,790	-3,691	-39,729
	PARIA	120	9,483	12,988	120	-9,363	-12,868	11,342	16,267	120	-11,222	-16,147
	PEACH SPRINGS	351	810	832	451	-359	-381	916	942	451	-465	-491
	PRESCOTT AMA	21,887	36,863	38,478	26,542	-10,321	-11,936	44,762	46,581	26,438	-18,323	-20,143
	RANEGRAS PLAIN	29,350	29,398	29,405	29,350	-48	-55	29,488	29,498	29,350	-138	-148
	SACRAMENTO VALLEY	3,765	20,005	26,067	4,065	-15,940	-22,001	22,996	29,797	4,065	-18,931	-25,732
	SAFFORD	177,558	183,181	205,523	161,032	-22,149	-44,490	184,388	206,780	157,323	-27,065	-49,457
	SALT RIVER	27,204	39,460	55,850	26,621	-12,838	-29,229	40,148	56,630	26,021	-14,127	-30,610
	SAN BERNARDINO VALLEY	19	25	26	19	-6	-7	27	28	19	-8	-9
	SAN RAFAEL	22	26	28	22	-4	-6	30	32	22	-8	-10
	SAN SIMON WASH	1,500	2,042	2,116	1,900	-142	-216	2,440	2,533	1,900	-540	-633
	SANTA CRUZ AMA	20,980	25,541	26,336	37,291	11,750	10,956	28,921	29,530	37,291	8,371	7,761
	SHIVWITS PLATEAU	2	2	2	2	0	0	3	3	2	-1	-1
	TIGER WASH	2	0	0	2	2	2	0	0	2	2	2
	TONTO CREEK	4,200	7,418	7,765	4,450	-2,968	-3,315	8,856	9,236	4,400	-4,456	-4,836
	UPPER HASSAYAMPA	3,286	5,551	5,699	3,886	-1,664	-1,813	6,685	6,869	3,886	-2,799	-2,983
	UPPER SAN PEDRO	29,237	39,528	50,520	33,484	-6,044	-17,036	44,660	55,686	33,262	-11,398	-22,425
	VERDE RIVER	44,527	53,750	58,275	50,418	-3,332	-7,857	59,459	63,748	49,593	-9,866	-14,155
	VIRGIN RIVER	2,305	2,705	2,740	3,132	427	393	2,953	2,998	3,052	98	53
	WESTERN MEXICAN DRAINAGE	6	6	7	6	0	-1	8	8	6	-2	-2
	WILLCOX	176,075	177,569	180,182	176,357	-1,213	-3,825	179,443	183,085	176,349	-3,094	-6,736

	Basins Which Receive Part of their Supply from the Colorado River or CAP	Baseline Supply & Demand	2035 TOTAL Low	2035 TOTAL High	2035 Total Supply: Normal Year[1]	2035 Total Supply: Shortage Year[2]	2035 Supply - Demand Cont.[4] Instate + Normal Diversions of CR Supply: -Low Demands	Instate + Normal Diversions of CR Supply: -High Demands	Instate + Shortage Diversions of CR Supply: -Low Demands	Instate + Shortage Diversions of CR Supply: -High Demands	2060 TOTAL Low	2060 TOTAL High	2060 Total Supply: Normal Year[1]	2060 Total Supply: Shortage Year[2]	2060 Supply - Demand Cont.[4] Instate + Normal Diversions of CR Supply: -Low Demands	Instate + Normal Diversions of CR Supply: -High Demands	Instate + Shortage Diversions of CR Supply: -Low Demands	Instate + Shortage Diversions of CR Supply: -High Demands
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	160,823	218,219	259,566	195,087	195,087	-23,132	-64,479	-23,132	-64,479	249,821	307,246	191,762	191,762	-58,059	-115,484	-58,059	-115,484
Instate + CR Lower Mainstem	BILL WILLIAMS	4,150	14,298	34,346	4,579	4,390	-9,718	-29,766	-9,908	-29,956	14,529	34,584	4,554	4,365	-9,975	-30,029	-10,164	-30,219
	DETRITAL VALLEY	309	410	430	357	357	-54	-73	-54	-73	511	534	354	354	-156	-180	-156	-180
	KANAB PLATEAU	3,627	5,075	5,163	4,129	4,109	-946	-1,033	-966	-1,053	6,057	6,166	4,089	4,069	-1,968	-2,077	-1,988	-2,097
	LAKE HAVASU	16,130	31,577	32,545	40,457	29,975	8,880	7,912	-1,602	-2,570	40,113	41,286	40,457	29,975	344	-829	-10,138	-11,311
	LAKE MOHAVE	47,769	72,736	78,867	77,349	56,995	4,613	-1,518	-15,742	-21,873	84,201	92,464	77,349	56,995	-6,852	-15,115	-27,207	-35,470
	Lake Mohave (Tribal Ag)	68,110	68,110	68,110	103,535	103,535	35,425	35,425	35,425	35,425	68,110	68,110	103,535	103,535	35,425	35,425	35,425	35,425
	LOWER GILA	504,687	497,669	516,115	497,868	497,660	198	-18,247	-9	-18,455	490,312	509,041	483,841	483,633	-6,471	-25,201	-6,679	-25,408
	PARKER	26,462	33,298	35,067	40,468	30,879	7,170	5,401	-2,419	-4,189	38,242	41,130	40,468	30,879	2,225	-662	-7,364	-10,251
	Parker (Tribal Ag)	621,454	621,454	621,454	666,680	665,468	45,226	45,226	44,014	44,014	621,454	621,454	666,680	665,468	45,226	45,226	44,014	44,014
	YUMA	852,241	858,095	861,037	904,249	901,035	46,154	43,212	42,940	39,998	848,232	851,923	878,958	875,852	30,725	27,035	27,620	23,929
	Yuma (Tribal Ag)	6,234	6,234	6,234	17,197	17,197	10,963	10,963	10,963	10,963	6,234	6,234	17,197	17,197	10,963	10,963	10,963	10,963
Instate + CAP	HARQUAHALA INA	136,735	136,670	136,910	66,178	66,178	-70,492	-70,732	-70,492	-70,732	137,516	137,944	66,178	66,178	-71,338	-71,766	-71,338	-71,766

	Major Active Management Areas (AMAs)	Baseline Supply & Demand	2035 TOTAL Low	2035 TOTAL High	2035 Normal Year Low	2035 Normal Year High	2035 Shortage Year Low	2035 Shortage Year High	2035 Normal -Low Demands	2035 Normal -High Demands	2035 Shortage -Low Demands	2035 Shortage -High Demands	2060 TOTAL Low	2060 TOTAL High	2060 Normal Year Low	2060 Normal Year High	2060 Shortage Year Low	2060 Shortage Year High	2060 Normal -Low Demands	2060 Normal -High Demands	2060 Shortage -Low Demands	2060 Shortage -High Demands
Instate + CAP	PHOENIX AMA	2,170,179	2,985,423	3,097,639	2,557,931	2,586,512	2,366,114	2,394,695	-427,491	-511,128	-619,308	-702,944	3,356,261	3,489,538	2,416,455	2,549,545	2,224,638	2,357,729	-939,806	-939,993	-1,131,623	-1,131,810
	PINAL AMA	1,022,762	985,887	1,007,978	670,902	670,902	620,706	620,706	-314,985	-337,076	-365,181	-387,272	902,124	925,757	667,405	667,405	617,209	617,209	-234,719	-258,352	-284,915	-308,548
	TUCSON AMA	338,067	425,148	472,395	453,030	491,064	421,442	459,477	27,882	18,669	-3,705	-12,918	486,427	535,325	455,821	495,184	424,234	463,596	-30,606	-40,141	-62,193	-71,729
	Central Arizona Project (CAP) Supply Range[5,6]				1,281,770 to 1,427,903	1,281,770 to 1,427,903	1,008,170 to 1,152,943	1,008,170 to 1,152,943											1,281,770 to 1,451,918	1,281,770 to 1,451,918	1,008,170 to 1,176,889	1,008,170 to 1,176,889
	STATEWIDE	7,103,425	8,191,191	8,595,266	7,582,776	7,649,391	7,262,549	7,329,163	-608,415	-945,875	-928,642	-1,266,103	8,637,438	9,092,987	7,412,868	7,585,321	7,092,679	7,265,132	-1,224,570	-1,507,666	-1,544,759	-1,827,855

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
2. The first degree shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet.
Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.
3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.
4. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.
5. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use.
It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
6. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.
Increased values in future years correspond to decreased values in the Yuma and Lower Gila Basins based on a projected 7% decrease in non-Indian agriculture demand.

Table 10. Adjusted Currently Developed Supplies vs. Projected Demand (Continued)

	BASIN NAME	Baseline Supply & Demand	2110 Demands TOTAL Low	2110 Demands TOTAL High	2110 Total Supply	2110 Supply - Demand: Instate Supply - Low Demand	2110 Supply - Demand: Instate Supply - High Demand	2110 Area Split TOTAL Low	2110 Area Split TOTAL High	2110 Area Split Total Supply	2110 (Area Split) Supply - Demand: Instate Supply - Low Demand	2110 (Area Split) Supply - Demand: Instate Supply - High Demand
Instate Water Supplies Only	AGUA FRIA	3,602	6,738	6,931	3,632	-3,106	-3,299	75,504	71,004	3,632	-71,872	-67,372
	ARAVAIPA CANYON	1,014	1,020	1,021	964	-56	-57	1,098	1,105	964	-134	-141
	BIG SANDY	15,028	879	910	15,028	14,149	14,118	3,232	3,347	15,028	11,796	11,681
	BONITA CREEK	0	8	8	0	-8	-8	342	357	0	-342	-357
	BUTLER VALLEY	14,503	14,500	14,500	14,503	3	3	14,500	14,500	14,503	3	3
	CIENEGA CREEK	1,101	2,415	2,703	1,201	-1,214	-1,502	2,195	2,471	1,201	-994	-1,270
	COCONINO PLATEAU	1,173	2,651	2,824	2,523	-128	-302	3,063	3,264	2,523	-540	-741
	DONNELLY WASH	19	850	906	19	-831	-887	850	906	19	-831	-887
	DOUGLAS	53,300	60,845	61,533	54,700	-6,145	-6,833	60,198	60,862	54,700	-5,498	-6,162
	DRIPPING SPRINGS WASH	11	24	27	11	-13	-16	587	651	11	-576	-640
	DUNCAN VALLEY	17,954	18,311	18,352	17,014	-1,298	-1,339	18,377	18,421	17,014	-1,364	-1,408
	GILA BEND	357,823	404,603	418,574	345,998	-58,605	-72,576	428,755	440,191	345,998	-82,757	-94,193
	GRAND WASH	2	0	0	2	2	2	79	83	2	-77	-81
	HUALAPAI VALLEY	9,109	25,612	26,603	10,909	-14,703	-15,694	23,331	24,252	10,909	-12,422	-13,343
	LOWER SAN PEDRO	24,622	24,843	41,023	25,127	285	-15,895	25,666	42,123	25,127	-538	-16,995
	MCMULLEN VALLEY	71,500	72,652	72,740	71,500	-1,152	-1,240	73,432	73,562	71,500	-1,932	-2,062
	MEADVIEW	145	431	451	145	-286	-306	70	73	145	75	72
	MORENCI	10,384	15,401	51,454	10,790	-4,611	-40,664	15,801	51,860	10,790	-5,011	-41,070
	PARIA	120	12,901	19,728	120	-12,781	-19,608	12,750	19,572	120	-12,630	-19,452
	PEACH SPRINGS	351	1,151	1,188	451	-700	-737	2,307	2,394	451	-1,856	-1,942
	PRESCOTT AMA	21,887	60,736	63,463	26,438	-34,298	-37,024	55,423	57,797	26,438	-28,984	-31,359
	RANEGRAS PLAIN	29,350	29,603	29,615	29,350	-253	-265	29,447	29,456	29,350	-97	-106
	SACRAMENTO VALLEY	3,765	27,462	35,495	4,065	-23,396	-31,429	27,938	35,987	4,065	-23,873	-31,922
	SAFFORD	177,558	187,971	210,513	157,323	-30,648	-53,190	187,911	210,451	157,323	-30,588	-53,127
	SALT RIVER	27,204	42,332	59,001	26,021	-16,311	-32,980	43,971	60,718	26,021	-17,951	-34,697
	SAN BERNARDINO VALLEY	19	38	39	19	-19	-20	906	930	19	-887	-911
	SAN RAFAEL	22	42	44	22	-20	-22	176	185	22	-154	-163
	SAN SIMON WASH	1,500	3,182	3,311	1,900	-1,282	-1,411	3,405	3,544	1,900	-1,505	-1,644
	SANTA CRUZ AMA	20,980	34,906	36,116	37,291	2,385	1,175	35,207	36,460	37,291	2,084	831
	SHIVWITS PLATEAU	2	4	4	2	-2	-2	820	853	2	-818	-851
	TIGER WASH	2	0	0	2	2	2	1,285	1,307	2	-1,283	-1,305
	TONTO CREEK	4,200	11,670	12,115	4,400	-7,270	-7,715	15,567	16,340	4,400	-11,167	-11,940
	UPPER HASSAYAMPA	3,286	8,943	9,197	3,886	-5,056	-5,311	3,461	3,545	3,886	425	342
	UPPER SAN PEDRO	29,237	56,827	68,577	33,262	-23,565	-35,316	56,252	67,957	33,262	-22,991	-34,696
	VERDE RIVER	44,527	71,347	76,836	49,593	-21,754	-27,243	73,058	78,793	49,593	-23,465	-29,200
	VIRGIN RIVER	2,305	3,363	3,426	3,052	-312	-374	2,083	2,091	3,052	969	960
	WESTERN MEXICAN DRAINAGE	6	11	12	6	-5	-6	123	128	6	-117	-122
	WILLCOX	176,075	182,216	187,264	176,349	-5,867	-10,915	181,770	186,805	176,349	-5,421	-10,456

	Basins Which Receive Part of their Supply from the Colorado River or CAP	Baseline Supply & Demand	TOTAL Low	TOTAL High	Total Supply: Normal Year[1]		Total Supply: Shortage Year[2]		2110 Supply - Demand Cont.[4] Instate + Normal Diversions of CR Supply: -Low Demands	Instate + Normal Diversions of CR Supply: -High Demands	Instate + Shortage Diversions of CR Supply: -Low Demands	Instate + Shortage Diversions of CR Supply: -High Demands	TOTAL Low	TOTAL High	Total Supply: Normal Year[1]		Total Supply: Shortage Year[2]		2110 Supply - Demand Cont.[4] Instate + Normal Diversions of CR Supply: -Low Demands	Instate + Normal Diversions of CR Supply: -High Demands	Instate + Shortage Diversions of CR Supply: -Low Demands	Instate + Shortage Diversions of CR Supply: -High Demands
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	160,823	292,195	372,121	191,762		191,762		-100,433	-180,359	-100,433	-180,359	291,806	371,709	191,762		191,762		-100,044	-179,947	-100,044	-179,947
Instate + CR Lower Mainstem	BILL WILLIAMS	4,150	15,260	35,337	4,554		4,365		-10,705	-30,782	-10,895	-30,972	21,541	41,574	4,554		4,365		-16,986	-37,019	-17,176	-37,209
	DETRITAL VALLEY	309	706	739	354		354		-352	-385	-352	-385	950	995	354		354		-596	-641	-596	-641
	KANAB PLATEAU	3,627	7,943	8,095	4,089		4,069		-3,854	-4,006	-3,874	-4,025	8,901	9,074	4,089		4,069		-4,812	-4,985	-4,832	-5,005
	LAKE HAVASU	16,130	55,754	57,242	40,457		29,975		-15,296	-16,785	-25,778	-27,267	55,390	56,870	40,457		29,975		-14,933	-16,413	-25,415	-26,895
	LAKE MOHAVE	47,769	103,795	115,459	77,349		56,995		-26,447	-38,110	-46,801	-58,464	100,045	111,560	77,349		56,995		-22,697	-34,211	-43,051	-54,565
	Lake Mohave (Tribal Ag)	68,110	68,110	68,110	103,535		103,535		35,425	35,425	35,425	35,425	68,110	68,110	103,535		103,535		35,425	35,425	35,425	35,425
	LOWER GILA	504,687	502,324	521,304	483,841		483,633		-18,483	-37,463	-18,691	-37,670	517,200	535,164	483,841		483,633		-33,360	-51,324	-33,567	-51,531
	PARKER	26,462	43,651	47,440	40,468		30,879		-3,183	-6,973	-12,772	-16,562	43,321	47,102	40,468		30,879		-2,854	-6,635	-12,443	-16,224
	Parker (Tribal Ag)	621,454	621,454	621,454	666,680		665,468		45,226	45,226	44,014	44,014	621,454	621,454	666,680		665,468		45,226	45,226	44,014	44,014
	YUMA	852,241	885,215	890,423	878,958		875,852		-6,257	-11,465	-9,362	-14,571	884,506	889,691	878,958		875,852		-5,548	-10,733	-8,654	-13,839
	Yuma (Tribal Ag)	6,234	6,234	6,234	17,197		17,197		10,963	10,963	10,963	10,963	6,234	6,234	17,197		17,197		10,963	10,963	10,963	10,963
Instate + CAP	HARQUAHALA INA	136,735	138,374	138,953	66,178		66,178		-72,196	-72,775	-72,196	-72,775	142,642	143,163	66,178		66,178		-76,464	-76,985	-76,464	-76,985
	Major Active Management Areas (AMAs)	Baseline Supply & Demand	TOTAL Low	TOTAL High	Low	High	Low	High	-Low Demands	-High Demands	-Low Demands	-High Demands	TOTAL Low	TOTAL High	Low	High	Low	High	-Low Demands	-High Demands	-Low Demands	-High Demands
	PHOENIX AMA	2,170,179	4,279,621	4,484,942	2,484,097	2,549,545	2,292,280	2,357,729	-1,795,524	-1,935,397	-1,987,341	-2,127,214	4,078,593	4,291,514	2,465,951	2,549,545	2,274,134	2,357,729	-1,612,642	-1,741,968	-1,804,459	-1,933,785
	PINAL AMA	1,022,762	983,096	1,015,930	667,405	667,405	617,209	617,209	-315,691	-348,525	-365,887	-398,721	981,227	1,016,058	667,405	667,405	617,209	617,209	-313,822	-348,653	-364,018	-398,849
	TUCSON AMA	338,067	627,088	685,279	485,926	532,769	454,339	501,182	-141,162	-152,509	-172,749	-184,097	627,766	684,268	487,092	532,576	455,504	500,988	-140,674	-151,692	-172,262	-183,279
	Central Arizona Project (CAP) Supply Range[5,6]				1,281,770 to 1,451,918	1,281,770 to 1,451,918	1,008,170 to 1,176,889	1,008,170 to 1,176,889							1,281,770 to 1,451,918	1,281,770 to 1,451,918	1,008,170 to 1,176,889	1,008,170 to 1,176,889				
	STATEWIDE	7,103,425	10,017,308	10,605,563	7,510,616	7,622,907	7,190,426	7,302,718	-2,506,693	-2,982,656	-2,826,882	-3,302,845	9,930,628	10,518,883	7,493,634	7,622,714	7,173,445	7,302,524	-2,436,994	-2,896,170	-2,757,183	-3,216,359

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. Normal Colorado River Supply A1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
2. The first degree shortage of Colo2. The first degree shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet.
Of that 90% is reduced from the CA Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.
3. In the AMAs, a low and high grou3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.
4. Positive values for (supply – den4. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.
5. The first CAP value in the range 5. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use.
It is divided into the Phoenix, Pinal It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
6. The second CAP value in the rar6. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.
Increased values in future years cor Increased values in future years correspond to decreased values in the Yuma and Lower Gila Basins based on a projected 7% decrease in non-Indian agriculture demand.

Table 11. Currently Developed Adjusted Supplies Vs. 2035 Projected Demands

	BASIN NAME	2035 Supply - Demand		Percentage of Projected Demand Unmet With Currently Developed & Adjusted Supplies	
		Instate Supply - Low Demand	Instate Supply - High Demand	Instate Supply - Low Demand	Instate Supply - High Demand
Instate Water Supplies Only	AGUA FRIA	-1,140	-1,256	24%	26%
	ARAVAIPA CANYON	-24	-25	2%	2%
	BIG SANDY	14,519	14,500	None	None
	BONITA CREEK	-5	-5	100%	100%
	BUTLER VALLEY	3	3	None	None
	CIENEGA CREEK	-554	-806	32%	40%
	COCONINO PLATEAU	944	840	None	None
	DONNELLY WASH	19	19	None	None
	DOUGLAS	-1,141	-1,644	2%	3%
	DRIPPING SPRINGS WASH	-5	-6	30%	37%
	DUNCAN VALLEY	-460	-486	3%	3%
	GILA BEND	-28,503	-35,627	8%	9%
	GRAND WASH	2	2	None	None
	HUALAPAI VALLEY	-4,010	-4,675	27%	30%
	LOWER SAN PEDRO	4,221	-11,918	None	32%
	MCMULLEN VALLEY	-508	-562	0.71%	0.78%
	MEADVIEW	-106	-118	42%	45%
	MORENCI	-3,279	-39,312	23%	78%
	PARIA	-9,363	-12,868	99%	99%
	PEACH SPRINGS	-359	-381	44%	46%
	PRESCOTT AMA	-10,321	-11,936	28%	31%
	RANEGRAS PLAIN	-48	-55	0.16%	0.19%
	SACRAMENTO VALLEY	-15,940	-22,001	80%	84%
	SAFFORD	-22,149	-44,490	12%	22%
	SALT RIVER	-12,838	-29,229	33%	52%
	SAN BERNARDINO VALLEY	-6	-7	25%	27%
	SAN RAFAEL	-4	-6	17%	21%
	SAN SIMON WASH	-142	-216	7%	10%
	SANTA CRUZ AMA	11,750	10,956	None	None
	SHIVWITS PLATEAU	0	0	7%	11%
	TIGER WASH	2	2	None	None
	TONTO CREEK	-2,968	-3,315	40%	43%
	UPPER HASSAYAMPA	-1,664	-1,813	30%	32%
	UPPER SAN PEDRO	-6,044	-17,036	15%	34%
	VERDE RIVER	-3,332	-7,857	6%	13%
	VIRGIN RIVER	427	393	None	None
	WESTERN MEXICAN DRAINAGE	0	-1	7%	11%
	WILLCOX	-1,213	-3,825	1%	2%

Basins Which Receive Part of their Supply from the Colorado River or CAP		2035 Supply - Demand Cont.[6]				Percentage Cont.			
		Instate + Normal Diversions of CR Supply		Instate + Shortage Diversions of CR Supply		Instate + Normal Diversions of CR Supply		Instate + Shortage Diversions of CR Supply	
		-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	-23,132	-64,479	-23,132	-64,479	11%	25%	11%	25%
Instate + CR Lower Mainstem	BILL WILLIAMS	-9,718	-29,766	-9,908	-29,956	68%	87%	69%	87%
	DETRITAL VALLEY	-54	-73	-54	-73	13%	17%	13%	17%
	KANAB PLATEAU	-946	-1,033	-966	-1,053	19%	20%	19%	20%
	LAKE HAVASU	8,880	7,912	-1,602	-2,570	None	None	5%	8%
	LAKE MOHAVE	4,613	-1,518	-15,742	-21,873	None	2%	22%	28%
	Lake Mohave (Tribal Ag)	35,425	35,425	35,425	35,425	None	None	None	None
	LOWER GILA	198	-18,247	-9	-18,455	None	4%	0.002%	4%
	PARKER	7,170	5,401	-2,419	-4,189	None	None	7%	12%
	Parker (Tribal Ag)	45,226	45,226	44,014	44,014	None	None	None	None
	YUMA	46,154	43,212	42,940	39,998	None	None	None	None
	Yuma (Tribal Ag)	10,963	10,963	10,963	10,963	None	None	None	None
Instate + CAP	HARQUAHALA INA	-70,492	-70,732	-70,492	-70,732	52%	52%	52%	52%
	Major Active Management Areas (AMAs)	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands
	PHOENIX AMA	-427,491	-511,128	-619,308	-702,944	14%	17%	21%	24%
	PINAL AMA	-314,985	-337,076	-365,181	-387,272	32%	33%	37%	38%
	TUCSON AMA	27,882	18,669	-3,705	-12,918	None	4%	1%	11%
	STATEWIDE	-608,415	-945,875	-928,642	-1,266,103	7%	12%	11%	16%

GW = groundwater

CR = Mainstem Colorado River Water

CAP = Central Arizona Project

Instate SW = Other Surface Water

Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.

2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet. Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.

3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.

4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use.
It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.

5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.
Increased values in future years correspond to decreased values in the Yuma and Lower Gila basins based on a projected 7% decrease in non-Indian agriculture demand.

6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.

Note: In a Normal Year (Lake Mead Elevation = 1,075 to 1,145), AZ CU Entitlements = 2.8MAF, AZ use = 2.8MAF, Balance available = zero.

In a First Tier Shortage Year (Lake Mead Elevation = 1,050 to 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available = zero. Arizona will always use its full apportionment.

Table 12. Currently Developed Adjusted Supplies Vs. 2060 Projected Demands

	BASIN NAME	2060 Supply - Demand		Percentage of Projected Demand Unmet With Currently Developed & Adjusted Supplies	
		Instate Supply - Low Demand	Instate Supply - High Demand	Instate Supply - Low Demand	Instate Supply - High Demand
Instate Water Supplies Only	AGUA FRIA	-1,739	-1,879	32%	34%
	ARAVAIPA CANYON	-50	-51	5%	5%
	BIG SANDY	14,393	14,370	None	None
	BONITA CREEK	-6	-6	100%	100%
	BUTLER VALLEY	3	3	None	None
	CIENEGA CREEK	-767	-1,031	39%	46%
	COCONINO PLATEAU	605	480	None	None
	DONNELLY WASH	19	19	None	None
	DOUGLAS	-2,591	-3,147	5%	5%
	DRIPPING SPRINGS WASH	-6	-8	37%	43%
	DUNCAN VALLEY	-1,047	-1,076	6%	6%
	GILA BEND	-44,495	-54,593	11%	14%
	GRAND WASH	2	2	None	None
	HUALAPAI VALLEY	-7,615	-8,390	41%	43%
	LOWER SAN PEDRO	2,167	-13,927	None	36%
	MCMULLEN VALLEY	-720	-785	1.00%	1.09%
	MEADVIEW	-167	-181	54%	56%
	MORENCI	-3,691	-39,729	25%	79%
	PARIA	-11,222	-16,147	99%	99%
	PEACH SPRINGS	-465	-491	51%	52%
	PRESCOTT AMA	-18,323	-20,143	41%	43%
	RANEGRAS PLAIN	-138	-148	0.47%	0.50%
	SACRAMENTO VALLEY	-18,931	-25,732	82%	86%
	SAFFORD	-27,065	-49,457	15%	24%
	SALT RIVER	-14,127	-30,610	35%	54%
	SAN BERNARDINO VALLEY	-8	-9	30%	32%
	SAN RAFAEL	-8	-10	28%	31%
	SAN SIMON WASH	-540	-633	22%	25%
	SANTA CRUZ AMA	8,371	7,761	None	None
	SHIVWITS PLATEAU	-1	-1	29%	31%
	TIGER WASH	2	2	None	None
	TONTO CREEK	-4,456	-4,836	50%	52%
	UPPER HASSAYAMPA	-2,799	-2,983	42%	43%
	UPPER SAN PEDRO	-11,398	-22,425	26%	40%
	VERDE RIVER	-9,866	-14,155	17%	22%
	VIRGIN RIVER	98	53	None	None
	WESTERN MEXICAN DRAINAGE	-2	-2	26%	29%
	WILLCOX	-3,094	-6,736	2%	4%

Basins Which Receive Part of their Supply from the Colorado River or CAP		2060 Supply - Demand Cont.[6]				Percentage Cont.			
		Instate + Normal Diversions of CR Supply		Instate + Shortage Diversions of CR Supply		Instate + Normal Diversions of CR Supply		Instate + Shortage Diversions of CR Supply	
		-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	-58,059	-115,484	-58,059	-115,484	23%	38%	23%	38%
Instate + CR Lower Mainstem	BILL WILLIAMS	-9,975	-30,029	-10,164	-30,219	69%	87%	70%	87%
	DETRITAL VALLEY	-156	-180	-156	-180	31%	34%	31%	34%
	KANAB PLATEAU	-1,968	-2,077	-1,988	-2,097	32%	34%	33%	34%
	LAKE HAVASU	344	-829	-10,138	-11,311	None	2%	25%	27%
	LAKE MOHAVE	-6,852	-15,115	-27,207	-35,470	8%	16%	32%	38%
	Lake Mohave (Tribal Ag)	35,425	35,425	35,425	35,425	None	None	None	None
	LOWER GILA	-6,471	-25,201	-6,679	-25,408	1.32%	5%	1.362%	5%
	PARKER	2,225	-662	-7,364	-10,251	None	2%	19%	25%
	Parker (Tribal Ag)	45,226	45,226	44,014	44,014	None	None	None	None
	YUMA	30,725	27,035	27,620	23,929	None	None	None	None
	Yuma (Tribal Ag)	10,963	10,963	10,963	10,963	None	None	None	None
Instate + CAP	HARQUAHALA INA	-71,338	-71,766	-71,338	-71,766	52%	52%	52%	52%
	Major Active Management Areas (AMAs)	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands
	PHOENIX AMA	-939,806	-939,993	-1,131,623	-1,131,810	28%	31%	34%	36%
	PINAL AMA	-234,719	-258,352	-284,915	-308,548	26%	28%	32%	33%
	TUCSON AMA	-30,606	-40,141	-62,193	-71,729	6%	15%	13%	21%
	STATEWIDE	**-1,224,570**	**-1,507,666**	**-1,544,759**	**-1,827,855**	**14%**	**18%**	**18%**	**22%**

GW = groundwater

CR = Mainstem Colorado River Water

CAP = Central Arizona Project

Instate SW = Other Surface Water

Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.

2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet.
Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.

3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.

4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use.
It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.

5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.
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Note: In a Normal Year (Lake Mead Elevation = 1,075 to 1,145), AZ CU Entitlements = 2.8MAF, AZ use = 2.8MAF, Balance available = zero.

In a First Tier Shortage Year (Lake Mead Elevation = 1,050 to 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available = zero. Arizona will always use its full apportionment.

Table 13. Currently Developed Adjusted Supplies Vs. 2110 (CS) Projected Demands

	BASIN NAME	2110 Supply - Demand		Percentage of Projected Demand Unmet With Currently Developed & Adjusted Supplies	
		Instate Supply - Low Demand	Instate Supply - High Demand	Instate Supply - Low Demand	Instate Supply - High Demand
Instate Water Supplies Only	AGUA FRIA	-3,106	-3,299	46%	48%
	ARAVAIPA CANYON	-56	-57	5%	6%
	BIG SANDY	14,149	14,118	None	None
	BONITA CREEK	-8	-8	100%	100%
	BUTLER VALLEY	3	3	None	None
	CIENEGA CREEK	-1,214	-1,502	50%	56%
	COCONINO PLATEAU	-128	-302	5%	11%
	DONNELLY WASH	-831	-887	98%	98%
	DOUGLAS	-6,145	-6,833	10%	11%
	DRIPPING SPRINGS WASH	-13	-16	54%	59%
	DUNCAN VALLEY	-1,298	-1,339	7%	7%
	GILA BEND	-58,605	-72,576	14%	17%
	GRAND WASH	2	2	None	None
	HUALAPAI VALLEY	-14,703	-15,694	57%	59%
	LOWER SAN PEDRO	285	-15,895	None	39%
	MCMULLEN VALLEY	-1,152	-1,240	1.59%	1.70%
	MEADVIEW	-286	-306	66%	68%
	MORENCI	-4,611	-40,664	30%	79%
	PARIA	-12,781	-19,608	99%	99%
	PEACH SPRINGS	-700	-737	61%	62%
	PRESCOTT AMA	-34,298	-37,024	56%	58%
	RANEGRAS PLAIN	-253	-265	0.85%	0.89%
	SACRAMENTO VALLEY	-23,396	-31,429	85%	89%
	SAFFORD	-30,648	-53,190	16%	25%
	SALT RIVER	-16,311	-32,980	39%	56%
	SAN BERNARDINO VALLEY	-19	-20	49%	51%
	SAN RAFAEL	-20	-22	48%	50%
	SAN SIMON WASH	-1,282	-1,411	40%	43%
	SANTA CRUZ AMA	2,385	1,175	None	None
	SHIVWITS PLATEAU	-2	-2	48%	50%
	TIGER WASH	2	2	None	None
	TONTO CREEK	-7,270	-7,715	62%	64%
	UPPER HASSAYAMPA	-5,056	-5,311	57%	58%
	UPPER SAN PEDRO	-23,565	-35,316	41%	51%
	VERDE RIVER	-21,754	-27,243	30%	35%
	VIRGIN RIVER	-312	-374	9%	11%
	WESTERN MEXICAN DRAINAGE	-5	-6	47%	49%
	WILLCOX	-5,867	-10,915	3%	6%

Basins Which Receive Part of their Supply from the Colorado River or CAP		2110 Supply - Demand Cont.[6]				Percentage Cont.			
		Instate + Normal Diversions of CR Supply		Instate + Shortage Diversions of CR Supply		Instate + Normal Diversions of CR Supply		Instate + Shortage Diversions of CR Supply	
		-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	-100,433	-180,359	-100,433	-180,359	34%	48%	34%	48%
Instate + CR Lower Mainstem	BILL WILLIAMS	-10,705	-30,782	-10,895	-30,972	70%	87%	71%	88%
	DETRITAL VALLEY	-352	-385	-352	-385	50%	52%	50%	52%
	KANAB PLATEAU	-3,854	-4,006	-3,874	-4,025	49%	49%	49%	50%
	LAKE HAVASU	-15,296	-16,785	-25,778	-27,267	27%	29%	46%	48%
	LAKE MOHAVE	-26,447	-38,110	-46,801	-58,464	25%	33%	45%	51%
	Lake Mohave (Tribal Ag)	35,425	35,425	35,425	35,425	None	None	None	None
	LOWER GILA	-18,483	-37,463	-18,691	-37,670	3.68%	7%	3.721%	7%
	PARKER	-3,183	-6,973	-12,772	-16,562	7%	15%	29%	35%
	Parker (Tribal Ag)	45,226	45,226	44,014	44,014	None	None	None	None
	YUMA	-6,257	-11,465	-9,362	-14,571	1%	1%	1%	2%
	Yuma (Tribal Ag)	10,963	10,963	10,963	10,963	None	None	None	None
Instate + CAP	HARQUAHALA INA	-72,196	-72,775	-72,196	-72,775	52%	52%	52%	52%
	Major Active Management Areas (AMAs)	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands
	PHOENIX AMA	-1,795,524	-1,935,397	-1,987,341	-2,127,214	42%	45%	46%	49%
	PINAL AMA	-315,691	-348,525	-365,887	-398,721	32%	34%	37%	39%
	TUCSON AMA	-141,162	-152,509	-172,749	-184,097	23%	29%	28%	34%
	STATEWIDE	**-2,506,693**	**-2,982,656**	**-2,826,882**	**-3,302,845**	**25%**	**29%**	**28%**	**32%**

GW = groundwater

CR = Mainstem Colorado River Water

CAP = Central Arizona Project

Instate SW = Other Surface Water

Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.

2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet.

Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.

3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.

4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use.

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5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.

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6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.

Note: In a Normal Year (Lake Mead Elevation = 1,075 to 1,145), AZ CU Entitlements = 2.8MAF, AZ use = 2.8MAF, Balance available = zero.

In a First Tier Shortage Year (Lake Mead Elevation = 1,050 to 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available = zero. Arizona will always use its full apportionment.

Table 14. Currently Developed Adjusted Supplies Vs. 2110 (AS) Projected Demands

	BASIN NAME	2110 (Area Split) Supply - Demand		Percentage of Projected Demand Unmet With Currently Developed & Adjusted Supplies	
		Instate Supply - Low Demand	Instate Supply - High Demand	Instate Supply - Low Demand	Instate Supply - High Demand
Instate Water Supplies Only	AGUA FRIA	-71,872	-67,372	95%	95%
	ARAVAIPA CANYON	-134	-141	12%	13%
	BIG SANDY	11,796	11,681	None	None
	BONITA CREEK	-342	-357	100%	100%
	BUTLER VALLEY	3	3	None	-0.02%
	CIENEGA CREEK	-994	-1,270	45%	51%
	COCONINO PLATEAU	-540	-741	18%	23%
	DONNELLY WASH	-831	-887	98%	98%
	DOUGLAS	-5,498	-6,162	9%	10%
	DRIPPING SPRINGS WASH	-576	-640	98%	98%
	DUNCAN VALLEY	-1,364	-1,408	7%	8%
	GILA BEND	-82,757	-94,193	19%	21%
	GRAND WASH	-77	-81	97%	98%
	HUALAPAI VALLEY	-12,422	-13,343	53%	55%
	LOWER SAN PEDRO	-538	-16,995	2%	40%
	MCMULLEN VALLEY	-1,932	-2,062	2.63%	2.80%
	MEADVIEW	75	72	None	None
	MORENCI	-5,011	-41,070	32%	79%
	PARIA	-12,630	-19,452	99%	99%
	PEACH SPRINGS	-1,856	-1,942	80%	81%
	PRESCOTT AMA	-28,984	-31,359	52%	54%
	RANEGRAS PLAIN	-97	-106	None	None
	SACRAMENTO VALLEY	-23,873	-31,922	85%	89%
	SAFFORD	-30,588	-53,127	16%	25%
	SALT RIVER	-17,951	-34,697	41%	57%
	SAN BERNARDINO VALLEY	-887	-911	98%	98%
	SAN RAFAEL	-154	-163	88%	88%
	SAN SIMON WASH	-1,505	-1,644	44%	46%
	SANTA CRUZ AMA	2,084	831	None	None
	SHIVWITS PLATEAU	-818	-851	100%	100%
	TIGER WASH	-1,283	-1,305	100%	100%
	TONTO CREEK	-11,167	-11,940	72%	73%
	UPPER HASSAYAMPA	425	342	None	None
	UPPER SAN PEDRO	-22,991	-34,696	41%	51%
	VERDE RIVER	-23,465	-29,200	32%	37%
	VIRGIN RIVER	969	960	None	None
	WESTERN MEXICAN DRAINAGE	-117	-122	95%	95%
	WILLCOX	-5,421	-10,456	3%	6%

Basins Which Receive Part of their Supply from the Colorado River or CAP		2110 Supply - Demand Cont.[6]				Percentage Cont.			
		Instate + Normal Diversions of CR Supply		Instate + Shortage Diversions of CR Supply		Instate + Normal Diversions of CR Supply		Instate + Shortage Diversions of CR Supply	
		-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	-100,044	-179,947	-100,044	-179,947	34%	48%	34%	48%
Instate + CR Lower Mainstem	BILL WILLIAMS	-16,986	-37,019	-17,176	-37,209	79%	89%	80%	90%
	DETRITAL VALLEY	-596	-641	-596	-641	63%	64%	63%	64%
	KANAB PLATEAU	-4,812	-4,985	-4,832	-5,005	54%	55%	54%	55%
	LAKE HAVASU	-14,933	-16,413	-25,415	-26,895	27%	29%	46%	47%
	LAKE MOHAVE	-22,697	-34,211	-43,051	-54,565	23%	31%	43%	49%
	Lake Mohave (Tribal Ag)	35,425	35,425	35,425	35,425	None	None	None	None
	LOWER GILA	-33,360	-51,324	-33,567	-51,531	6.45%	10%	6.490%	10%
	PARKER	-2,854	-6,635	-12,443	-16,224	7%	14%	29%	34%
	Parker (Tribal Ag)	45,226	45,226	44,014	44,014	None	None	None	None
	YUMA	-5,548	-10,733	-8,654	-13,839	1%	1%	1%	2%
	Yuma (Tribal Ag)	10,963	10,963	10,963	10,963	None	None	None	None
Instate + CAP	HARQUAHALA INA	-76,464	-76,985	-76,464	-76,985	54%	54%	54%	54%
	Major Active Management Areas (AMAs)	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands	-Low Demands	-High Demands
	PHOENIX AMA	-1,612,642	-1,741,968	-1,804,459	-1,933,785	40%	43%	44%	47%
	PINAL AMA	-313,822	-348,653	-364,018	-398,849	32%	34%	37%	39%
	TUCSON AMA	-140,674	-151,692	-172,262	-183,279	22%	29%	27%	33%
	STATEWIDE	**-2,436,994**	**-2,896,170**	**-2,757,183**	**-3,216,359**	**25%**	**29%**	**28%**	**32%**

GW = groundwater

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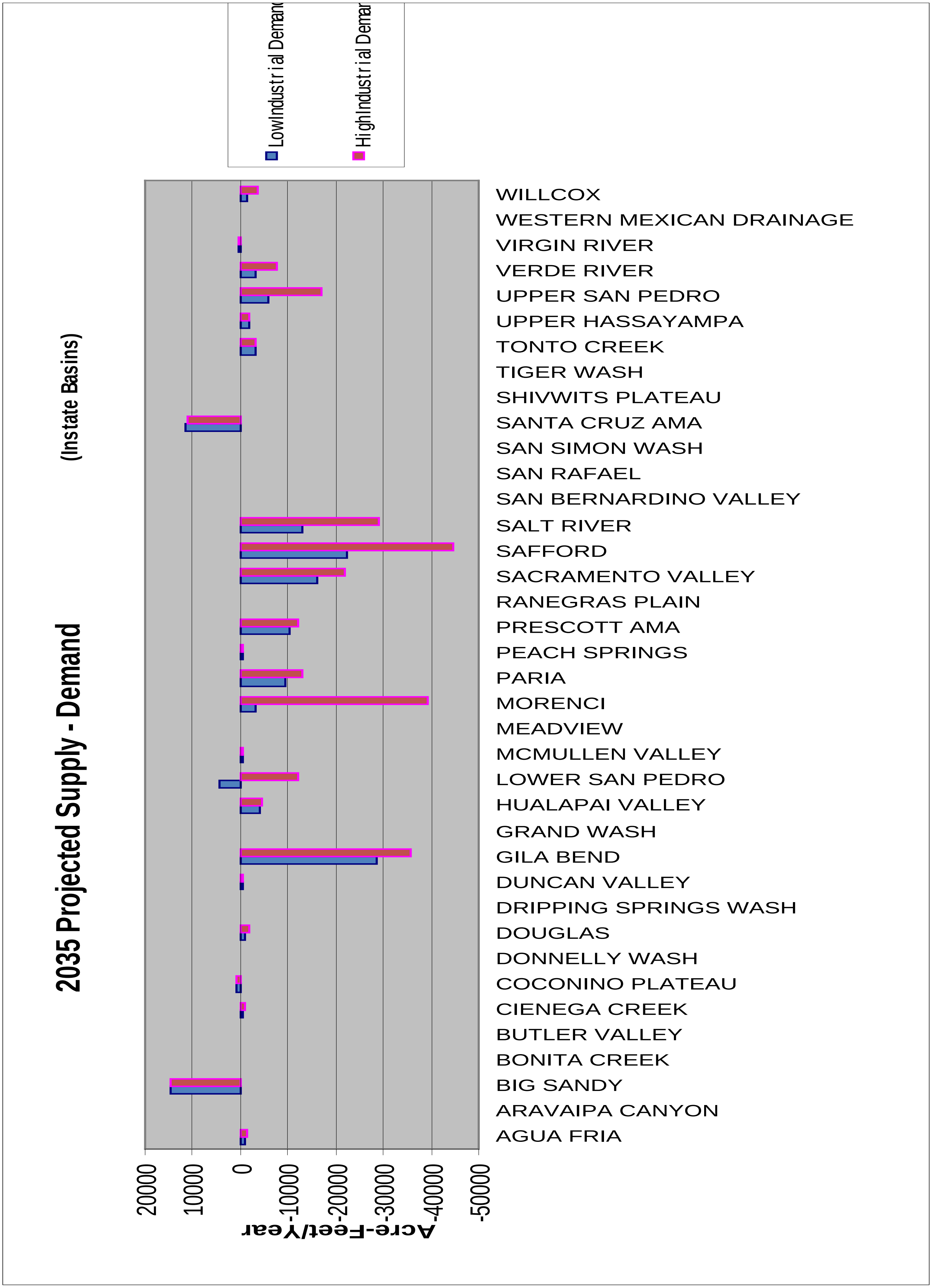


Figure 1. 2035 Projected Unmet Demand for Instate Basins

Figure 2. 2060 Projected Unmet Demand for Instate Basins

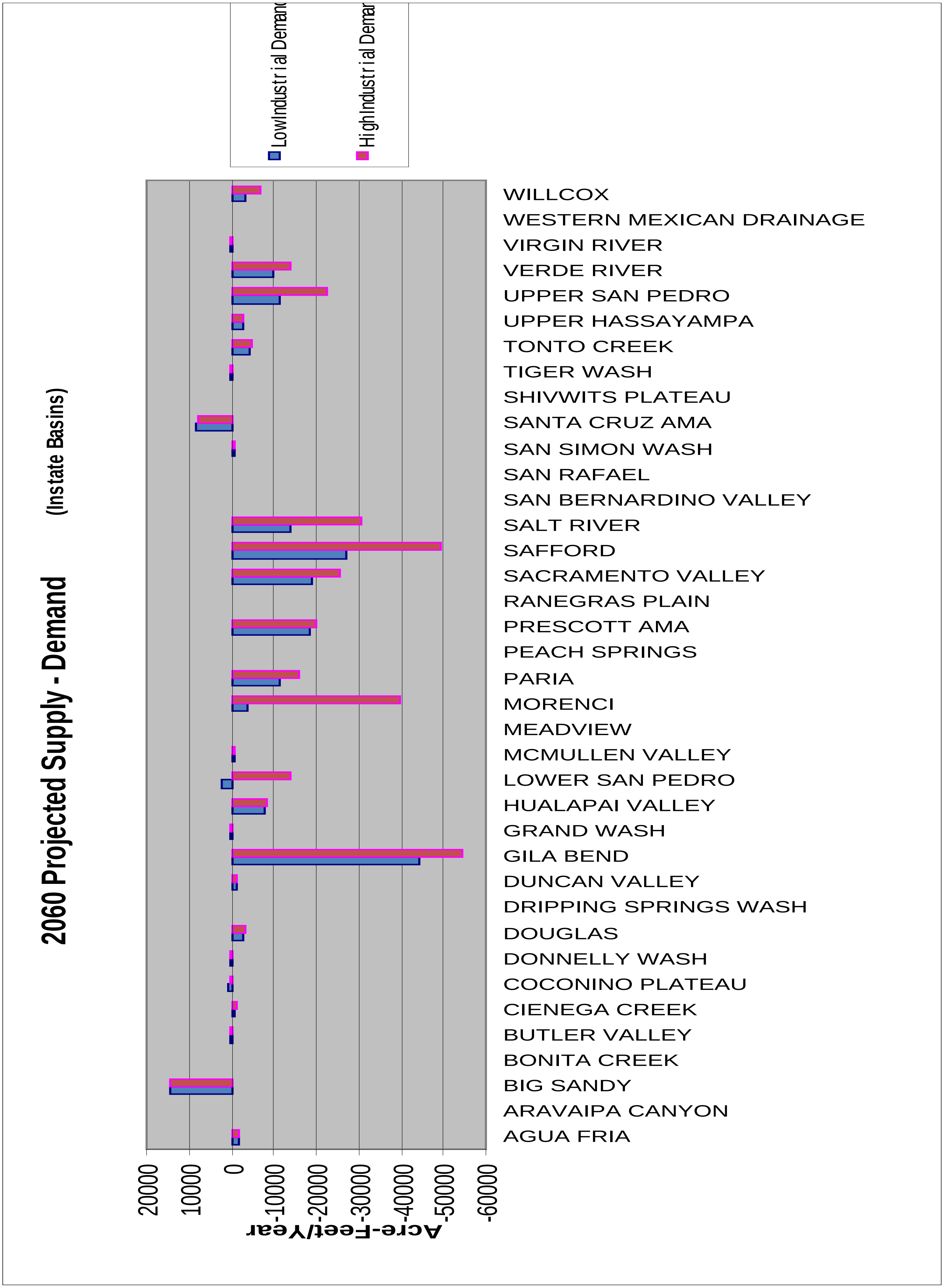


Figure 3. 2110 (CS) Projected Unmet Demand for Instate Basins

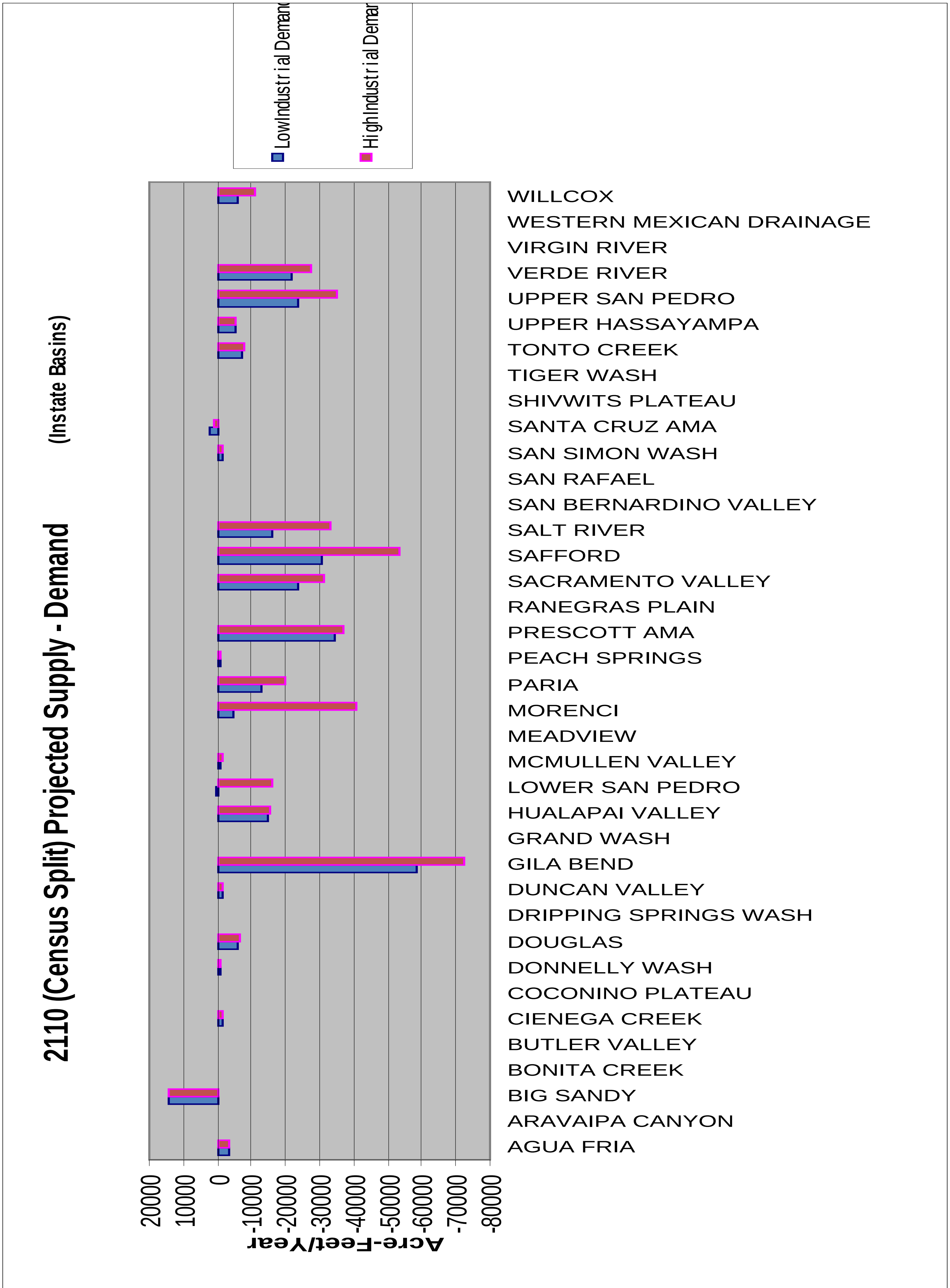


Figure 4. 2110 (AS) Projected Unmet Demand for Instate Basins

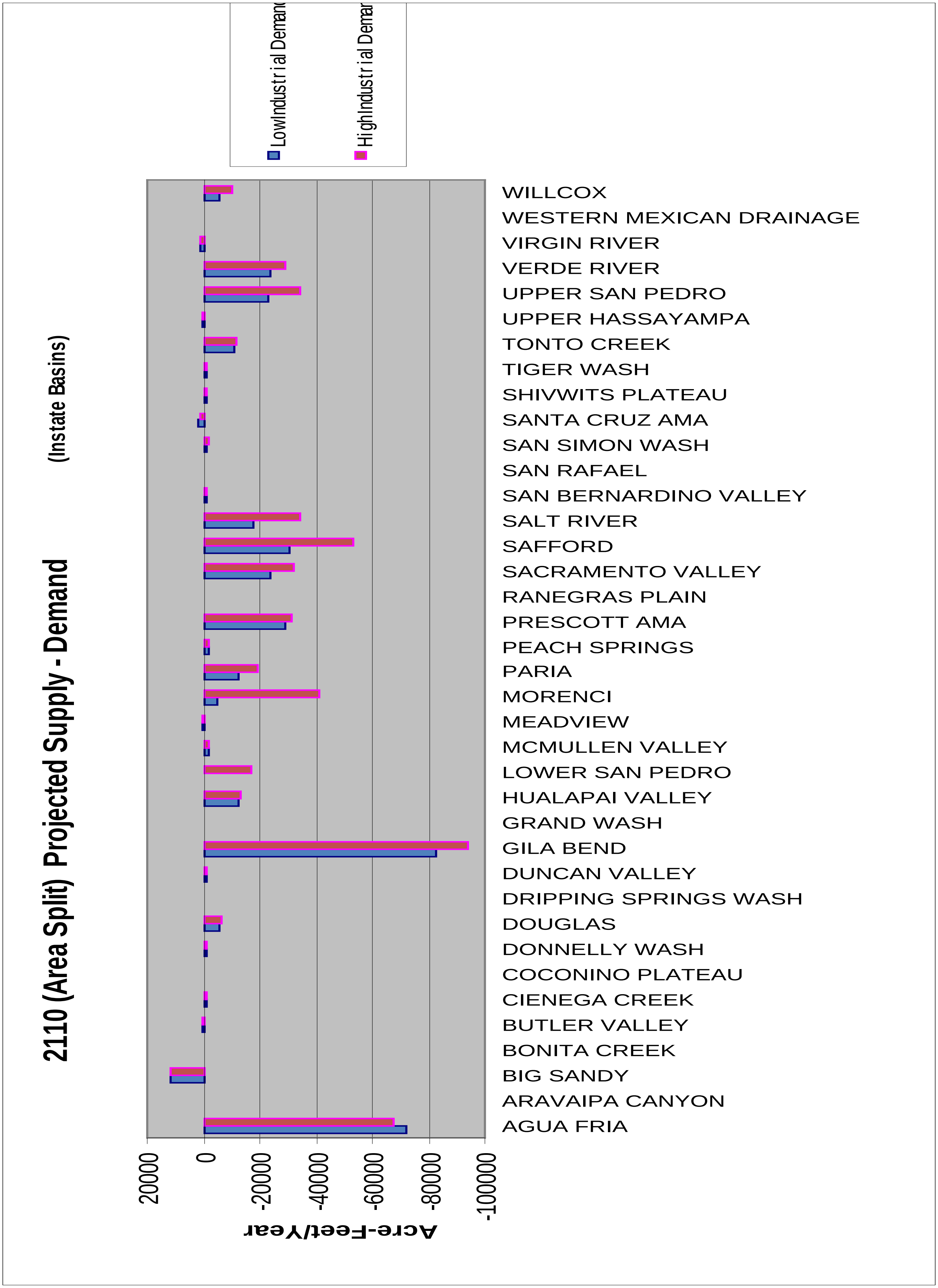
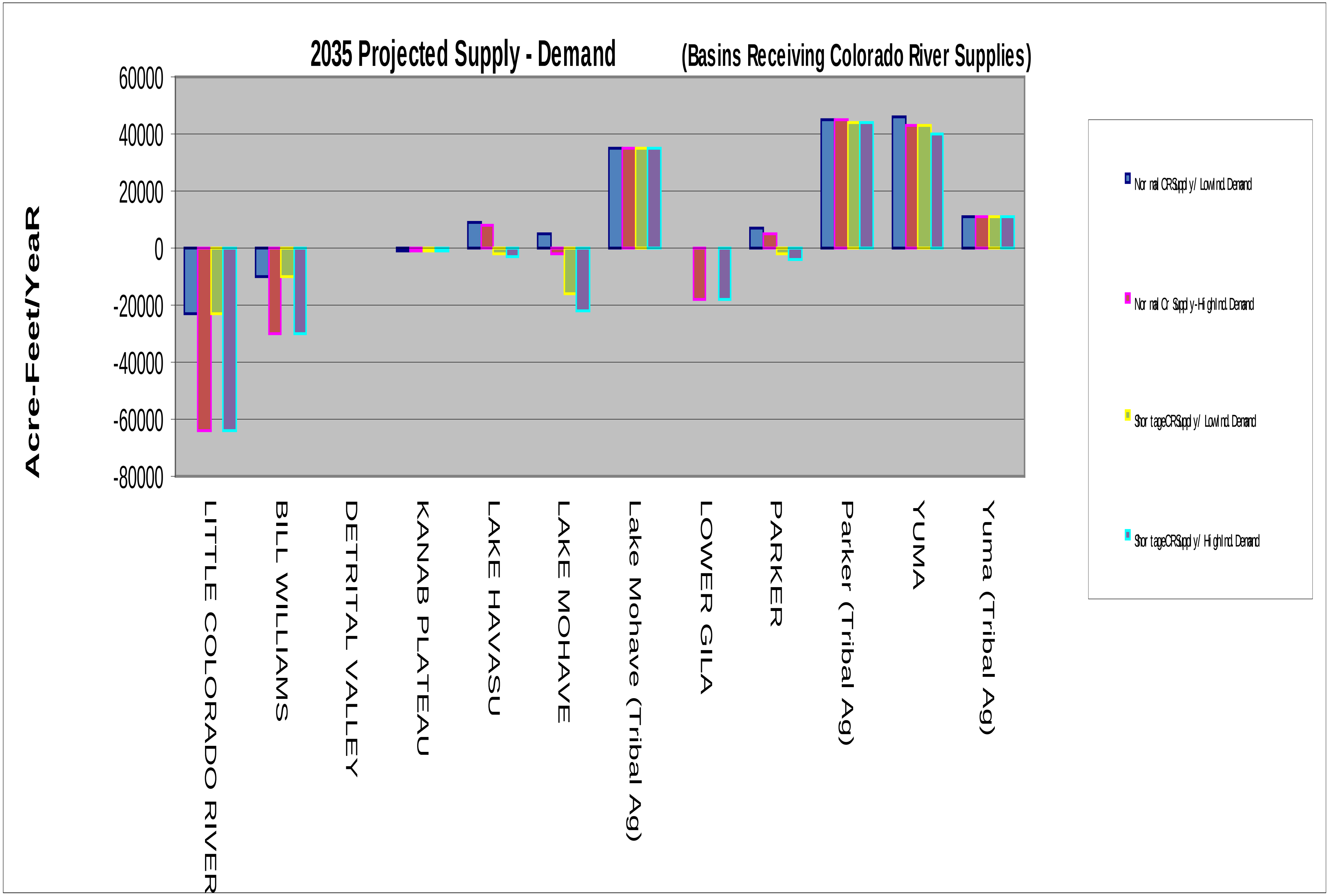
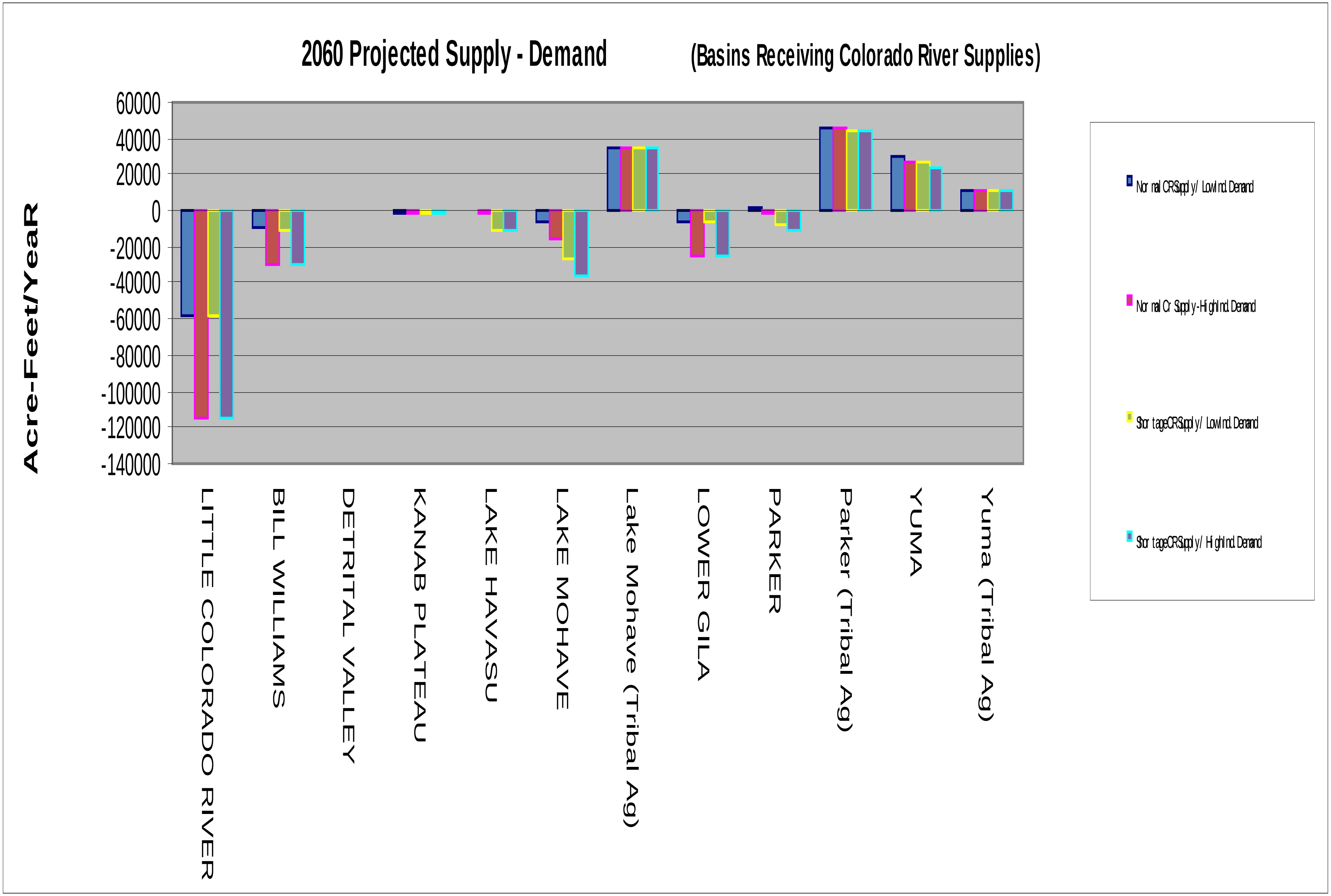


Figure 5. 2035 Projected Unmet Demand for Basins Receiving Colorado River Water



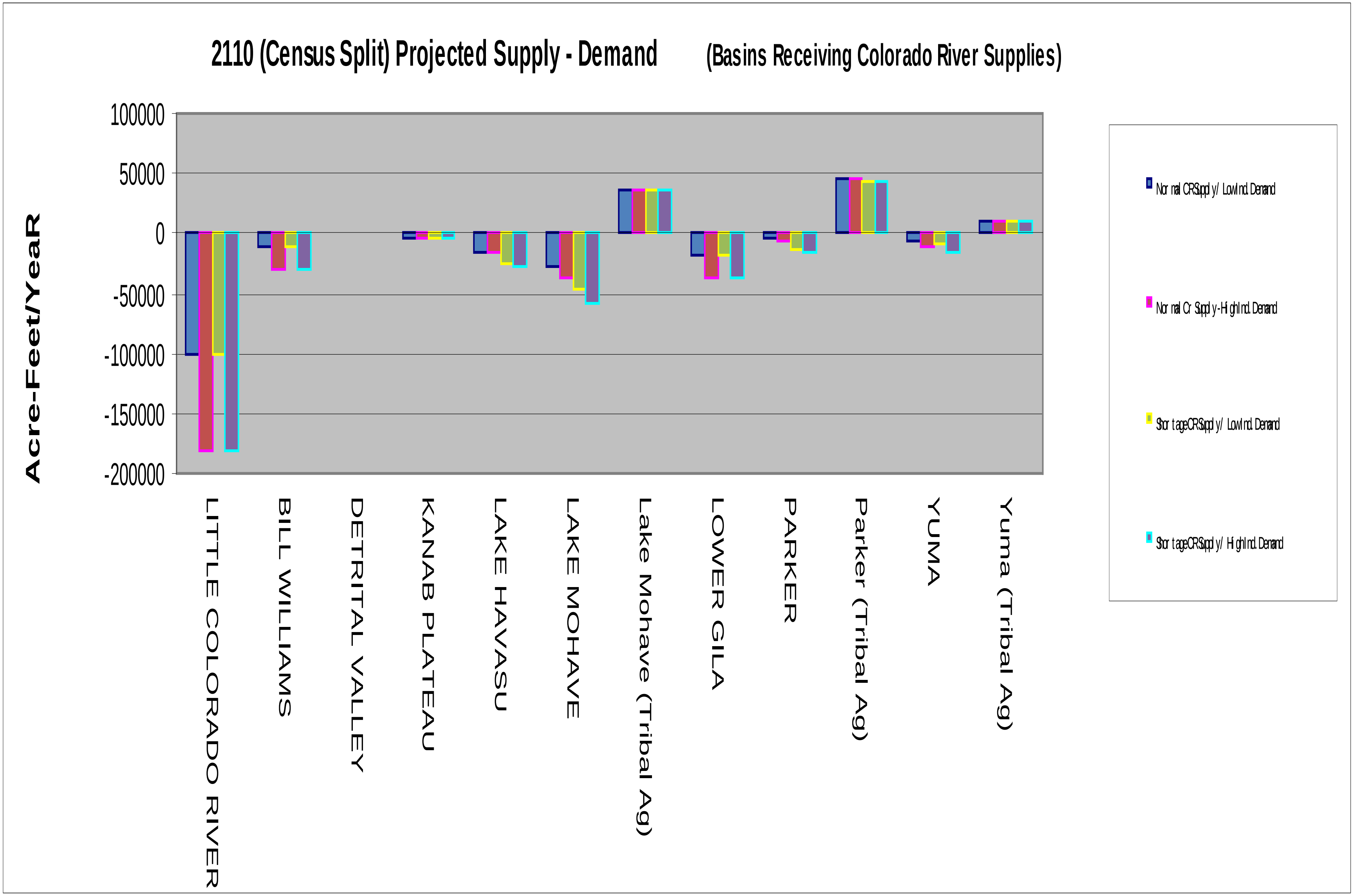
Note: Total supplies for basins receiving Colorado River water may also include groundwater, instate surface water and effluent. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or potentially by other Colorado River water users within the state. No water would be left unused in the basin. Projected Tribal Sector Surpluses Are Reserved For Tribal Uses.

Figure 6. 2060 Projected Unmet Demand for Basins Receiving Colorado River Water



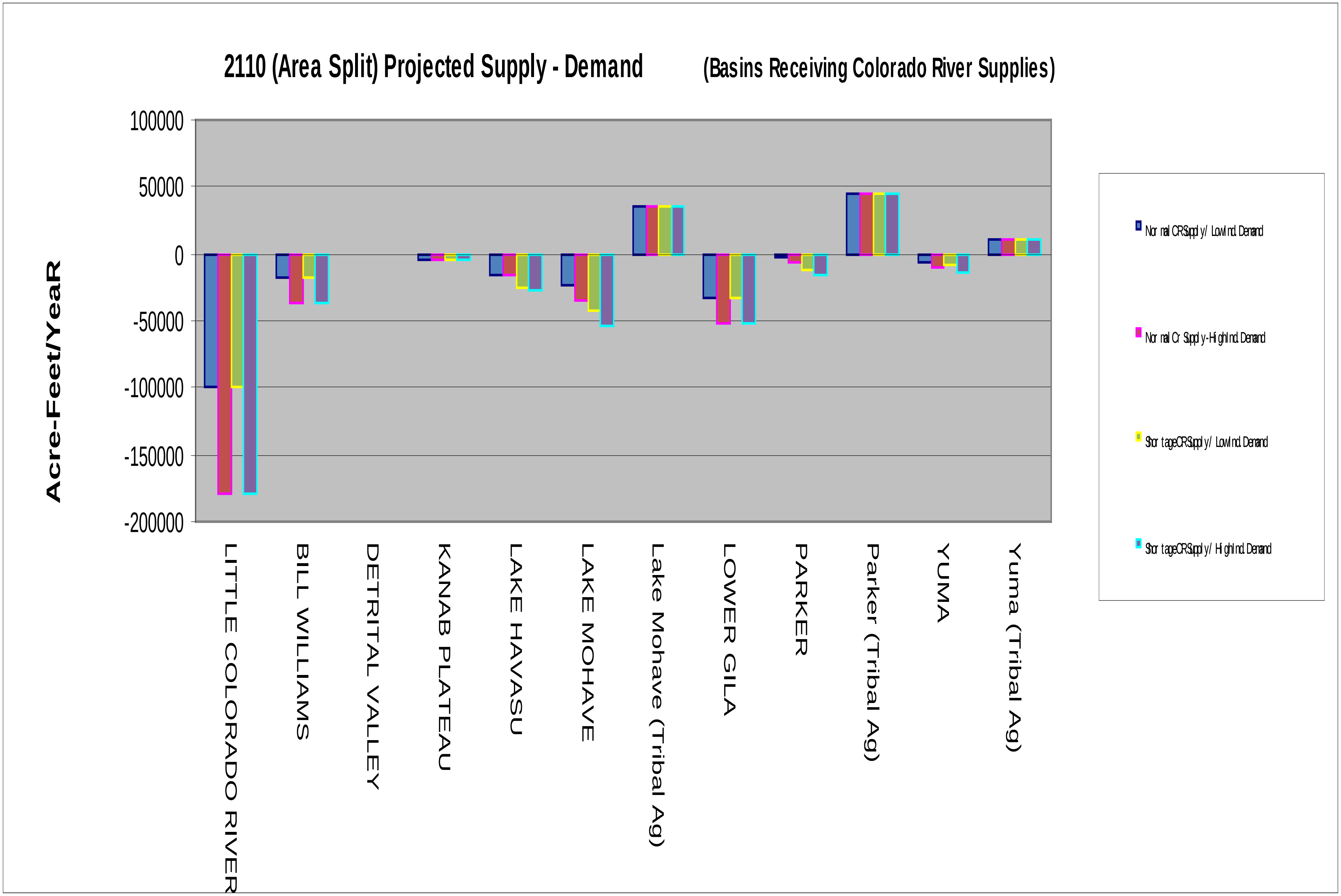
Note: Total supplies for basins receiving Colorado River water may also include groundwater, instate surface water and effluent. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or potentially by other Colorado River water users within the state. No water would be left unused in the basin. Projected Tribal Sector Surpluses Are Reserved For Tribal Uses.

Figure 7. 2110 (CS) Projected Unmet Demand for Basins Receiving Colorado River Water



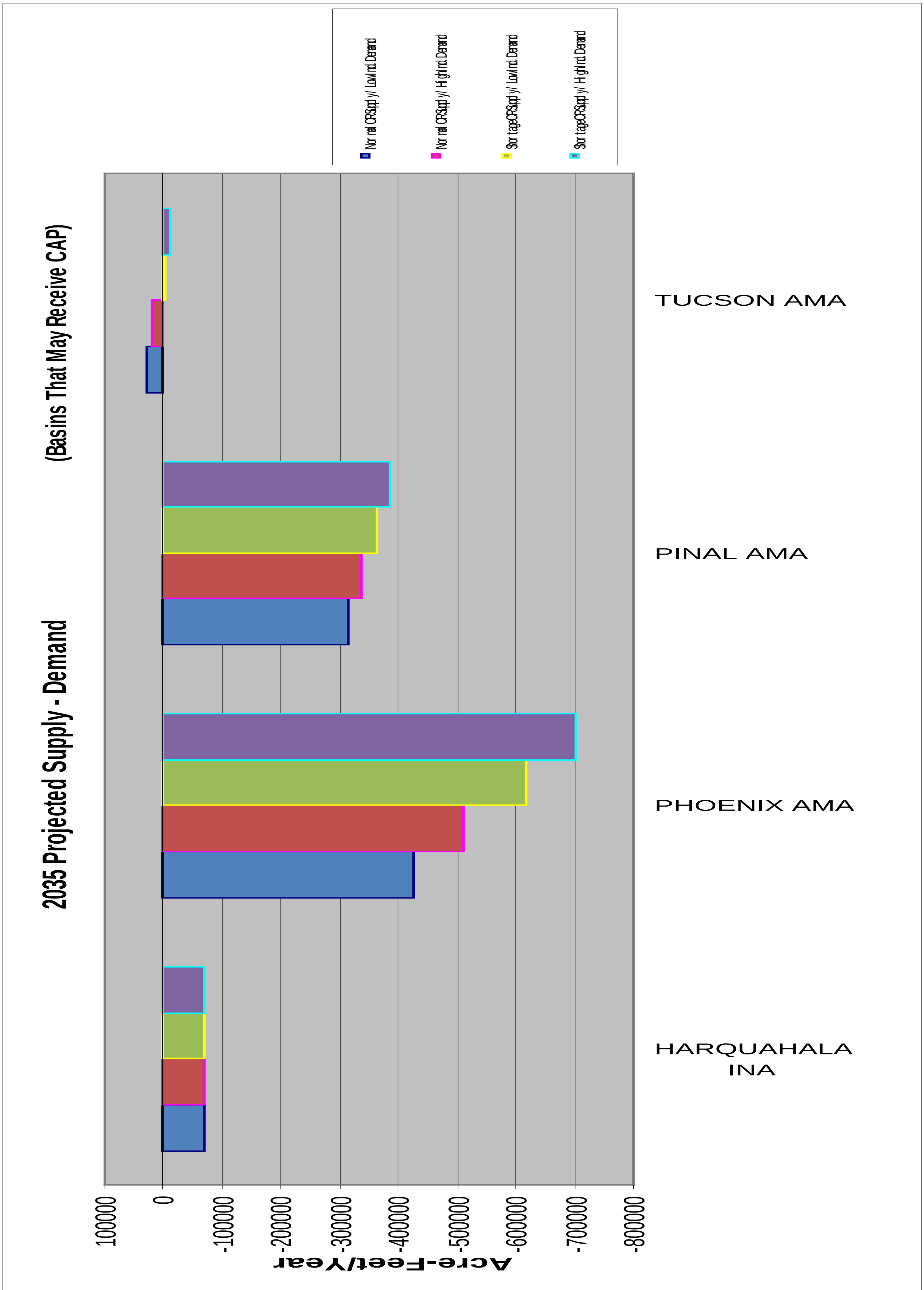
Note: Total supplies for basins receiving Colorado River water may also include groundwater, instate surface water and effluent. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or potentially by other Colorado River water users within the state. No water would be left unused in the basin. Projected Tribal Sector Surpluses Are Reserved For Tribal Uses.

Figure 8. 2110 (AS) Projected Unmet Demand for Basins Receiving Colorado River Water



Note: Total supplies for basins receiving Colorado River water may also include groundwater, instate surface water and effluent. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or potentially by other Colorado River water users within the state. No water would be left unused in the basin. Projected Tribal Sector Surpluses Are Reserved For Tribal Uses.

Figure 9. 2035 Projected Unmet Demand for AMAs or INAs that May Receive CAP Water



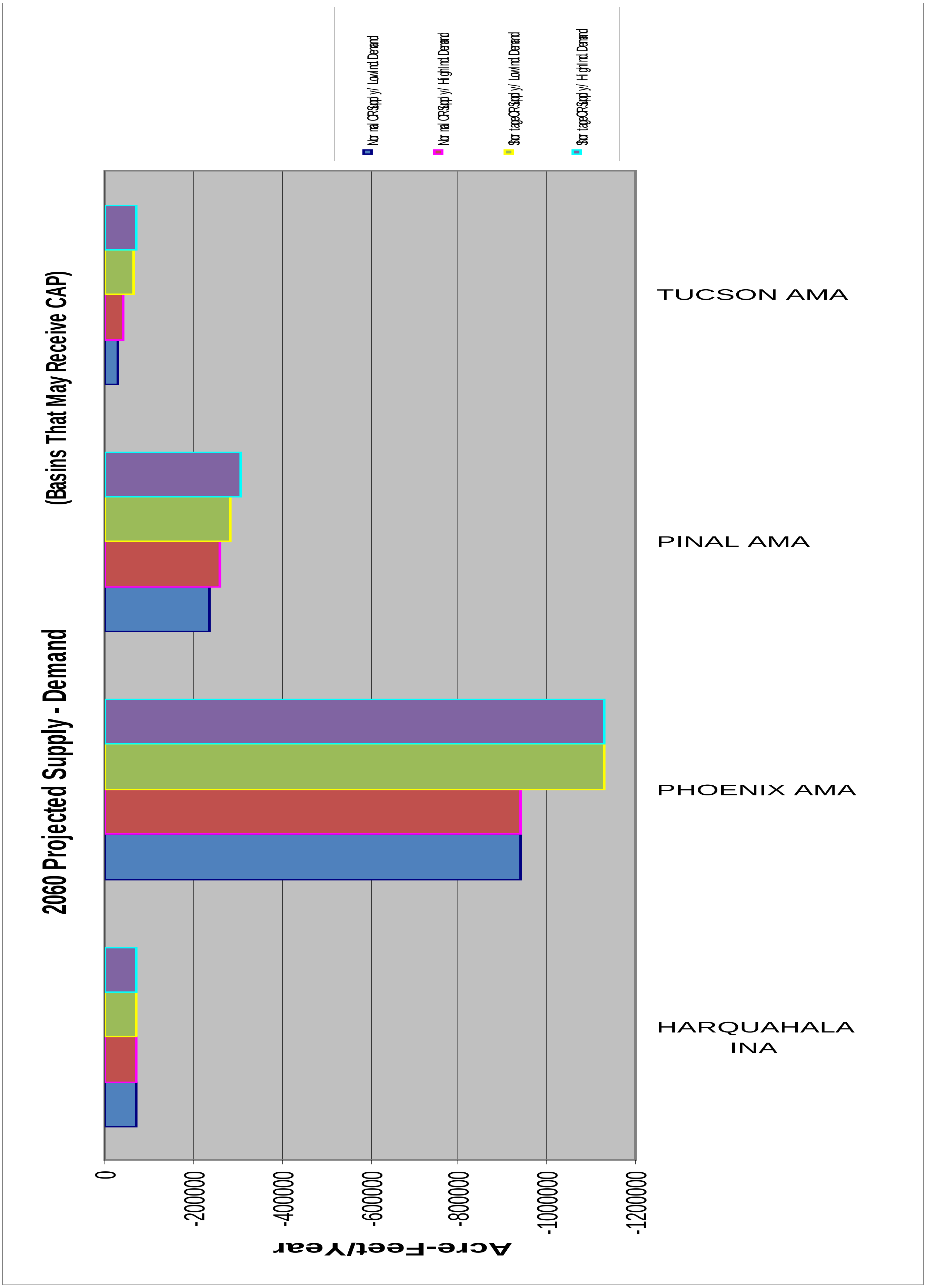


Figure 10. 2060 Projected Unmet Demand for AMAs or INAs that May Receive CAP Water

Figure 11. 2110 (CS) Projected Unmet Demand for AMAs or INAs that May Receive CAP Water

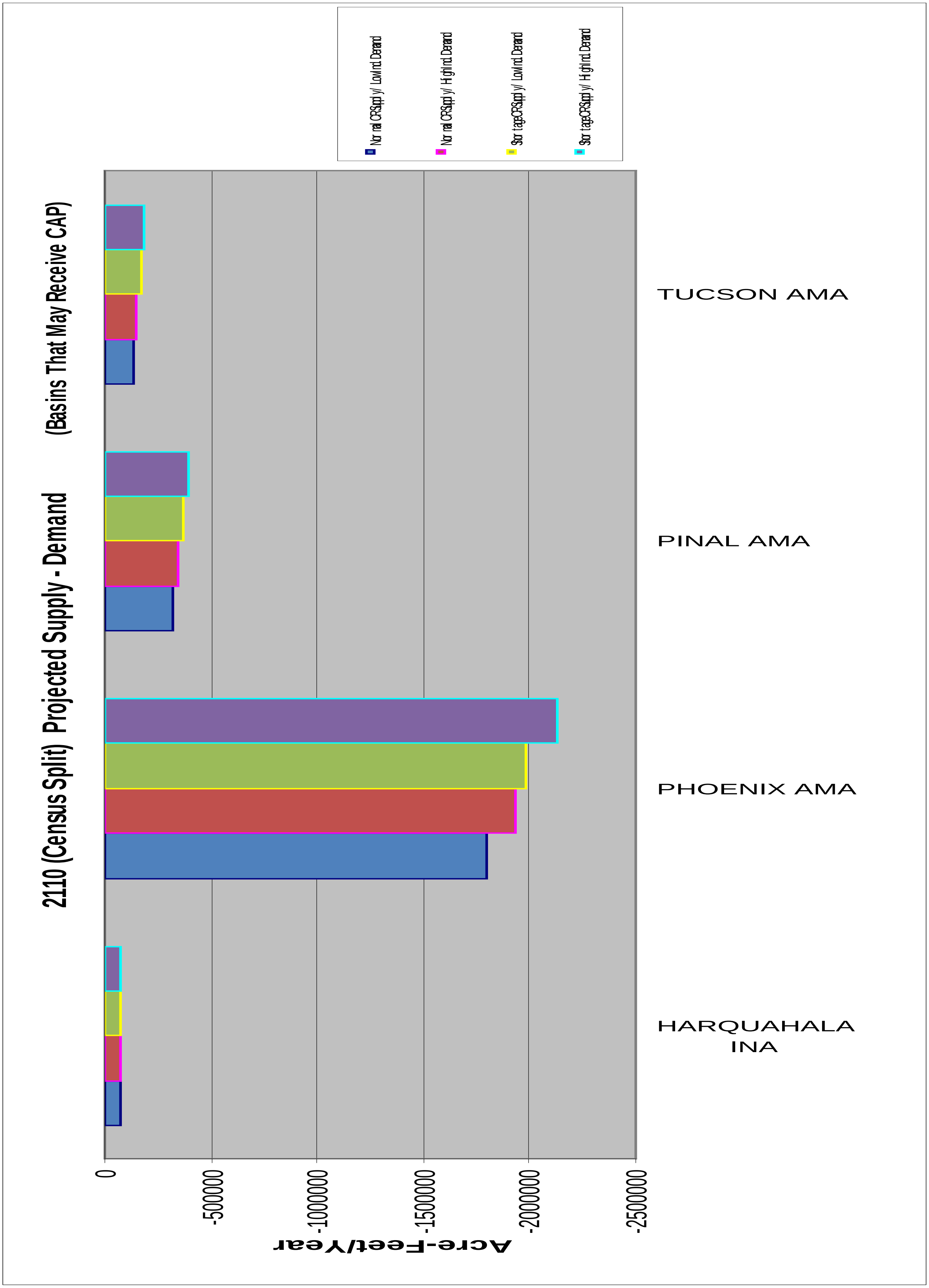
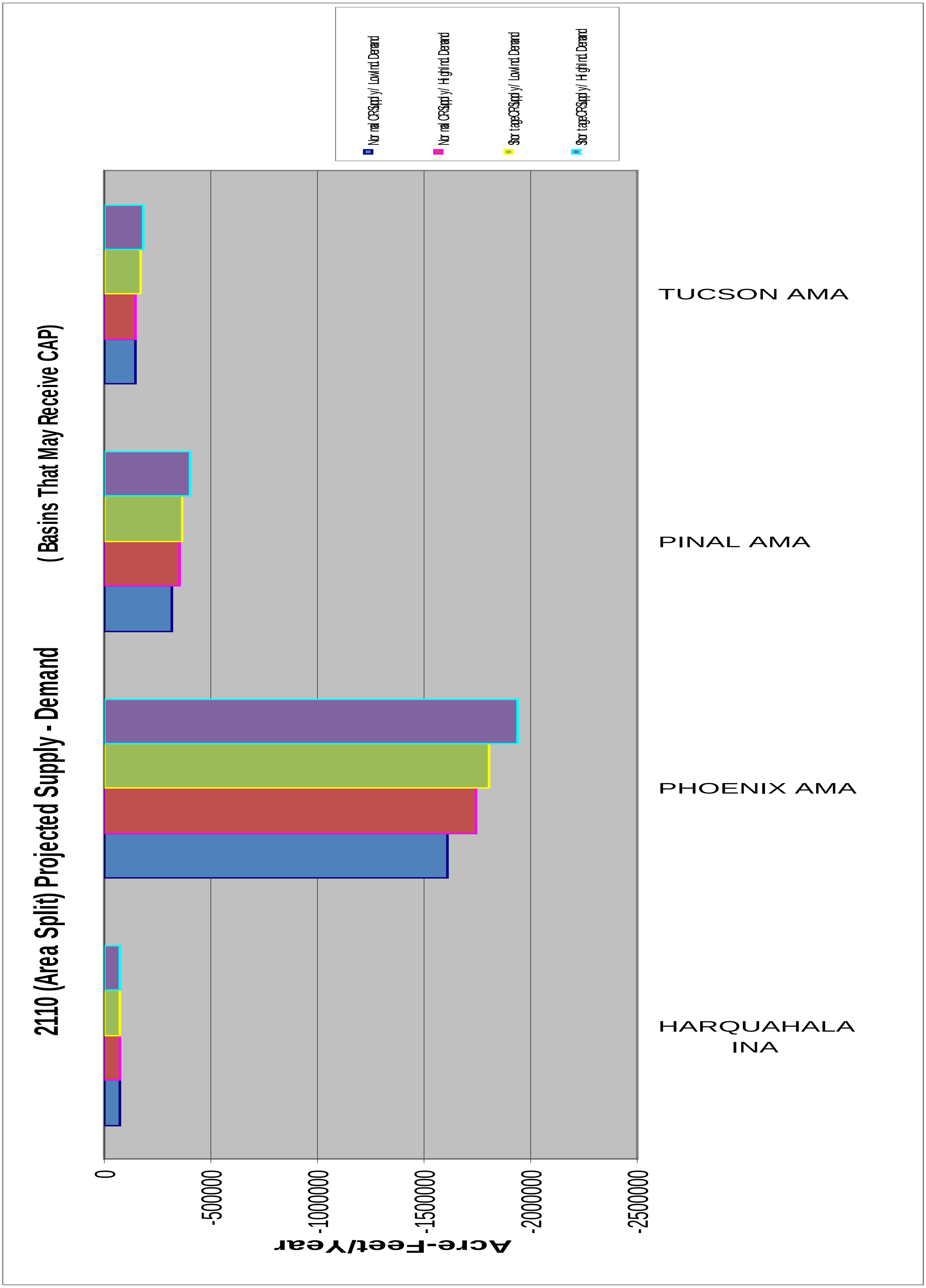


Figure 12. 2110 (AS) Projected Unmet Demand for AMAs or INAs that May Receive CAP Water



Objective 4: Identification of Potential Water Supplies to Meet Unmet Demands

The projections of future unmet demand were used to identify groundwater basins that will eventually require the development of additional water supplies to meet projected future water demands. Water supplies that were evaluated as potential sources of additional water to meet future unmet demands included: groundwater, surface water (instate rivers, Colorado River), CAP, effluent and other miscellaneous supplies. Groundwater management programs such as water conservation were also considered as means to mitigate unmet demands that would not require development of additional water resources.

Water Conservation and the identification of potential additional water supplies that may be developed to offset projected unmet demands

Water Conservation

Conservation of water supplies is perhaps one of the most simple, yet potentially effective methods to help offset future unmet water demands. In AMAs conservation methods and goals exist for all major water use sectors, including the municipal, industrial and agricultural sectors. Outside AMAs many water providers and agricultural and industrial users practice conservation methods, both to conserve the available water supply and to gain the cost benefits that may be achieved by reducing water consumption. It is assumed that conservation in all water use sectors will be an ever-increasing practice in future years, and one capable of generating reductions in future water use for all groundwater basins in the state.

Renewable and Non-Renewable Supplies

Whenever possible, it is important to promote the use and development of renewable water supplies, such as surface water or effluent. Following this goal will help sustain existing groundwater uses and reserves for longer periods of time and better preserve this limited, non-renewable resource for times of drought or other water shortage and provide a more reliable water supply for future generations.

Supporting the use and development of renewable supplies is an important goal. However, as a practical matter it may be found that the development of sufficient additional renewable water supplies in any given basin may be difficult or unlikely due to limited physical availability of renewable supplies, or due to other practical, legal, environmental or economic factors.

Since future decisions on developing additional water supplies will involve many complex issues and considerations, it was beyond the scope of this study to specifically recommend the development of one potential source of additional supply over another. However, it is believed that the analysis will help identify those basins where the development of renewable resources is a potentially viable option.

Potential Additional Water Supplies

The projections of future unmet demand were used to identify groundwater basins that will eventually require the development of additional water supplies to meet projected future water demands. Water supplies that were evaluated as potential sources of additional water to meet future unmet demands included: groundwater, surface water (instate rivers, Colorado River), CAP, effluent and other miscellaneous supplies.

Potential Hydrologic, Technical, Legal and Other Issues Related to Developing Additional Water Supplies

Although additional sources of water supply are potentially available for any given groundwater basin, there are various hydrologic, technical, legal, environmental and economic issues related to developing such supplies that may limit their practical feasibility or actual development. Potential additional supplies, issues related to developing additional supplies and potential infrastructure requirements are listed for each basin for 2035, 2060 and 2110 in Tables 18 through 21.

Groundwater

Water in aquifer storage is generally referred to as groundwater. However, under Arizona law, water in aquifer storage that is closely associated with certain surface water features may be legally classified as surface water, subflow, Colorado River water, etc. Based on the available data and estimates, no attempt was made to subdivide the total estimated volume of water in aquifer storage into separate legally defined classes of water. With the possible exception of the Colorado River main stem basins, most water in aquifer storage in the state is generally and legally classified as groundwater.

Based on available estimates of groundwater in storage, natural recharge and current rates of groundwater consumption it appears that pumping additional groundwater to supply part, or all of the projected unmet demand for many basins would be a potential option. However, estimates of groundwater storage and natural recharge vary significantly in reliability due to existing data limitations, methods of analysis and underlying assumptions. It should not be assumed that these estimates are alone sufficient to project the future long-term sustainability of groundwater supplies in any basin, or portion of a basin. The cost to develop additional groundwater supplies may also be prohibitive when determining if future long-term groundwater supplies are feasible.

During its review of currently available water supplies the WRDC Supply committee reviewed recent groundwater level change trends (from the late 1980s/mid 1990's to the mid/late 2000's) to assist in making qualitative assessments of each basin's current overdraft status. Basins with sparse, or no water level data available could not be evaluated for this qualitative indicator of overdraft.

Most basins showed predominant trends of either rising or falling water levels. For example, many of the predominantly agricultural basins of west-central and southeastern Arizona showed extensive water level declines over the last 15 to 20 years (see Table 15. Hydrogeologic and

Cultural Characteristics of Arizona Groundwater Basins). The observed water level declines in these basins are clear indicators that current levels of groundwater pumping are causing aquifer overdraft. In many parts of the Phoenix, Pinal and Tucson AMAs water levels have been rising over the last 15 to 20 years. Water level rises in these areas are mainly attributed to overall reductions in groundwater pumping, and the introduction and use of large volumes of CAP water for direct use and recharge.

The evaluation of currently available groundwater supplies also included a comparison of the current rate of groundwater consumption in each basin to the basin's estimated natural recharge and aquifer storage. The estimates of water in aquifer storage and natural recharge were taken from data compiled in the Arizona Water Atlas that were originally presented in various hydrologic reports prepared by United States Geological Survey (USGS), the Arizona Department of Water Resources (ADWR) and other researchers. Low-end estimates were used for analysis when more than one storage or recharge estimate was available for a given basin. Original aquifer storage estimates for each basin were reduced (adjusted) by 20 percent to reflect hydrologic, practical and other limitations on the actual volume of water that may be produced from a basin. For the most part, the estimates of water in aquifer storage were available only to depths of 1,000 to 1,200 feet below land surface.

The results of the analysis indicated that, for most basins, the current rates of groundwater consumption are probably sustainable for at least 100 years (for the purposes of this report, 100 years is regarded as "long-term"). However, it should be noted that basins where groundwater use was estimated to be sustainable for 100 years may still be in overdraft (withdrawals exceed recharge over time), and therefore the depth to water and the total volume of aquifer storage may still decrease over those 100 years.

The analysis also revealed that some basins that are currently experiencing significant overdraft have relatively large groundwater consumption rates compared to estimated groundwater storage and natural recharge. The long-term sustainability of the groundwater supply for these basins is uncertain as conditions of ongoing water level decline and reductions in storage are not generally considered "sustainable."

The qualitative analysis of the long-term sustainability of current groundwater consumption was based on the underlying assumption that current water supply and demand conditions would remain unchanged into the future (thus assuming all currently available instate surface, CAP and Colorado River water supplies would remain available and undiminished for potential future direct use or recharge). Since this assumption may be unrealistic in the future for some basins that currently rely heavily on such renewable resources, the analysis may significantly overestimate the long-term sustainability of current rates of groundwater consumption.

Table 15. Hydrogeologic and Cultural Characteristics of Arizona Groundwater Basins

	Basin	Sub-basin	Basin Area (Sq. Miles)	SELECT CHARACTERISTICS OF ARIZONA GROUNDWATER BASINS Major Aquifers[1]
Instate Water Supplies Only	AGUA FRIA	none	1,263	Basin Fill, Sedimentary Rock
	ARAVAIPA CANYON	none	517	Recent Stream Alluvium, Basin Fill
	BIG SANDY	Fort Rock Wikiup	1,988	Recent Stream Alluvium, Basin Fill, Sedimentary Rock (R-Aquifer)
	BONITA CREEK	none	457	Recent Stream Alluvium, Basin Fill, Volcanic Rock
	BUTLER VALLEY	none	288	Basin Fill
	CIENEGA CREEK	none	606	Recent Stream Alluvium, Basin Fill
	COCONINO PLATEAU	none	5,812	Basin Fill, Volcanic Rock, Sedimentary Rock (Moenkopi, Chinle, R, & C aquifers)
	DONNELLY WASH	none	293	Basin Fill
	DOUGLAS	Douglas Douglas INA	949	Basin Fill with locally Inter-bedded Volcanic Rock
	DRIPPING SPRINGS WASH	none	378	Recent Stream Alluvium, Sedimentary Rock (Gila Conglomerate)
	DUNCAN VALLEY	none	550	Recent Stream Alluvium, Sedimentary Rock (Gila Conglomerate)
	GILA BEND	none	1,284	Basin Fill
	GRAND WASH	none	959	Recent Stream Alluvium, Basin Fill, Volcanic & Sedimentary Rock
	HUALAPAI VALLEY	none	1,212	Basin Fill, Volcanic & Sedimentary Rock
	LOWER SAN PEDRO	Camp Grant Wash Mammoth	1,624	Recent Stream Alluvium, Basin Fill
	MCMULLEN VALLEY	none	649	Basin Fill
	MEADVIEW	none	190	Sedimentary Rock (Muddy Creek)
	MORENCI	none	1,599	Recent Stream Alluvium, Volcanic Rock
	PARIA	none	408	Sedimentary Rock (N- aquifer)
	PEACH SPRINGS	none	1,409	Basin Fill, Sedimantary Rock (R-Aquifer)
	PRESCOTT AMA	Little Chino Valley Upper Agua Fria	485	Basin Fill, Igneous (Volcanic mainly) & Metamorphic Rock
	RANEGRAS PLAIN	none	912	Basin Fill
	SACRAMENTO VALLEY	none	1,587	Basin Fill & Volcanic Rock
	SAFFORD	Gila Valley San Carlos Valley San Simon Valley	4,747	Recent Stream Alluvium & Basin Fill
	SALT RIVER	Black River Salt River Canyon Salt River Lakes White River	5,232	Recent Stream Alluvium, Volcanic Rocks, & Sedimantary Rock (R, C aquifers & Gila Conglomerate)
	SAN BERNARDINO VALLEY	none	387	Recent Stream Alluvium & Volcanic Rock
	SAN RAFAEL	none	229	Recent Stream Alluvium & Basin Fill
	SAN SIMON WASH	none	2,284	Basin Fill
	SANTA CRUZ AMA	none	716	Recent Stream Alluvium, Basin Fill
	SHIVWITS PLATEAU	none	1,821	Recent Stream Alluvium
	TIGER WASH	none	74	Basin Fill
	TONTO CREEK	none	955	Basin Fill, Sedimantary Rock (R & C aquifers)
	UPPER HASSAYAMPA	none	787	Basin Fill
	UPPER SAN PEDRO	Allen Flat Sierra Vista	1,825	Recent Stream Alluvium, Basin Fill
	VERDE RIVER	Big Chino Verde Valley Verde Canyon	5,661	Recent Stream Alluvium, Basin Fill Inter-bedded with Volcanic Rock, Sedimentary Rock (Verde Formation, R & C aquifers), Igneous & Metamorphic Rock
	VIRGIN RIVER	none	434	Recent Stream Alluvium, Basin Fill, Sedimentary Rock (Muddy Creek Formation)
	WESTERN MEXICAN DRAINAGE	none	610	Basin Fill
	WILLCOX	none	1,911	Recent Stream Alluvium & Basin Fill
		Instate Subtotals	**53,092**	
Basins Which Receive Part of Supply from the Colorado River or CAP		**Sub-basin**	**Basin Area (Sq. Miles)**	**Major Aquifers[1]**
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	none	26,700	Recent Stream Alluvium, Volcanic Rock (Lakeside-Pinetop Aquifer) and Sedimentary rock (Bidahochi Formation, C,D,N, Springerville, and White Mountain Aquifers)
Instate + CR Lower Mainstem	BILL WILLIAMS	Burro Creek Alamo Reservoir Clara Peak Skull Valley Santa Maria	3,350	Recent Stream Alluvium, Basin Fill and Volcanic Rocks
	DETRITAL VALLEY	none	892	Recent Stream Alluvium, Basin Fill, Sedimentary and Volcanic Rocks
	KANAB PLATEAU	none	4,247	Recent Stream Alluvium and Sedimentary Rock
	LAKE HAVASU	none	252	Basin Fill
	LAKE MOHAVE	none	980	Recent Stream Alluvium
	LOWER GILA	Childs Valley Dendora Valley Wellton - Mohawk	7,309	Recent Stream Alluvium, Basin Fill
	PARKER	Cibola Valley Colorado River Indian Reservation La Posa Plains	2,229	Recent Stream Alluvium, Sedimentary Rock (Bouse Formation)
	YUMA	none	792	Basin Fill
Instate + CAP	HARQUAHALA INA	none	766	Basin Fill
	PHOENIX AMA	Carefree East Salt River Fountain Hills Hassayampa Lake Pleasant Rainbow Valley West Salt River	5,646	Recent Alluvium, Basin Fill with locally inter-bedded volcanics, sedimentary rocks (Red Unit and conglomerate)
	PINAL AMA	Aguirre Valley Eloy Maricopa-Stanfield Santa Rosa Vekol Valley	4,000	Recent Stream Alluvium, Basin Fill
	TUCSON AMA	Avra Valley Upper Santa Cruz	3,866	Recent Stream Alluvium and Basin Fill (Fort Lowell Formation and Tinaja Beds)
		Colorado River + CAP Basin Subtotals	**61,029**	
		Statewide Totals	**114,121**	

Table 15. Hydrogeologic and Cultural Characteristics of Arizona Groundwater Basins (Continued)

SELECT CHARACTERISTICS OF ARIZONA GROUNDWATER BASINS

Recent Water Level Change Trends and Depth-to-Water in Wells Measured in Basin [2,3]

	Basin	Sub-basin	Basin Area (Sq. Miles)	Measurement Period (Beginning Year - Ending Year)	Total Number of Wells Measured	Number of Wells Measured In Basin Showing Rising Water Levels	Number of Wells Measured In Basin Showing Declining Water Levels	Number of Wells Measured In Basin Showing No Change In Water Level or Flowing Conditions	Mean Annual Positive Change Rate for Wells Showing Rises (Ft/Yr)	Mean Annual Negative Change Rate for Wells Showing Declines (Ft/Yr)	Overall Mean Water Level Change In Basin Over Measurement Period (Feet)	Minimum Measured DTW For Ending Year (Feet - BLS)	Maximum Measured DTW for Ending Year (Feet -BLS)	Mean DTW for Ending Year (Feet - BLS)
Instate Water Supplies Only	AGUA FRIA	none	1,263	1991 - 2008	6	3	3	0	0.1	-0.1	0.2	21	120	55
	ARAVAIPA CANYON	none	517	1990 - 2007	2	0	2	0	NA	-0.1	-2.5	38	54	46
	BIG SANDY	Fort Rock	1,988	1995 - 2008	6	2	4	0	0.2	-0.4	-2.5	7	686	214
		Wikiup		1995 - 2008	37	21	16	0	0.4	-0.4	0.5	4	523	70
	BONITA CREEK	none	457	NA	0	0	0	0	NA	NA	NA	NA	NA	NA
	BUTLER VALLEY	none	288	1990 - 2008	20	0	20	0	NA	-1.0	-18.5	88	515	247
	CIENEGA CREEK	none	606	1987 - 2005	54	19	33	2	0.2	-0.3	-1.7	2	405	113
	COCONINO PLATEAU	none	5,812	1994 - 2009	2	0	2	0	NA	-0.5	-8.7	95	274	185
	DONNELLY WASH	none	293	NA	0	0	0	0	NA	NA	NA	NA	NA	NA
	DOUGLAS	Douglas	949	1990 - 2004	272	31	240	1	0.4	-1.2	-16.4	17	347	162
		Douglas INA		1990 - 2009	13	2	11	0	0.4	-1.3	-20.0	67	358	165
	DRIPPING SPRINGS WASH	none	378	1990 - 2009	2	0	2	0	NA	-0.4	-7.5	90	100	95
	DUNCAN VALLEY	none	550	1990 - 2007	7	2	5	0	0.1	-0.2	-1.8	23	194	76
	GILA BEND	none	1,284	1993 - 2008	124	8	116	0	2.1	-4.3	-58.8	3	645	221
	GRAND WASH	none	959	1991 - 2009	2	2	0	0	1.2	NA	23.1	10	508	259
	HUALAPAI VALLEY	none	1,212	1991 - 2006	46	26	20	0	0.4	-0.9	-2.9	24	925	459
	LOWER SAN PEDRO	Camp Grant Wash	1,624	1994 - 2006	17	3	14	0	0.2	-0.9	-9.5	9	319	72
		Mammoth		1994 - 2006	112	57	55	0	0.6	-0.6	0.2	5	606	94
	MCMULLEN VALLEY	none	649	1989 - 2004	84	4	80	0	0.3	-2.2	-34.2	122	700	474
	MEADVIEW	none	190	1995 - 2006	8	1	7	0	<0.1	-1.1	-11.0	397	494	439
	MORENCI	none	1,599	1990 - 2007	1	0	1	0	NA	-0.1	-10.0	16	16	16
	PARIA	none	408	1991 - 2007	5	0	5	0	NA	-1.2	-19.9	111	519	322
	PEACH SPRINGS	none	1,409	1995 - 2009	2	1	1	0	0.4	-0.1	2.1	146	825	486
	PRESCOTT AMA	Little Chino Valley	485	1994 - 2010	35	4	31	0	0.1	-1.4	-19.2	15	435	214
		Upper Agua Fria		1994 - 2009	20	6	14	0	0.2	-1.4	-16.1	44	652	245
	RANEGRAS PLAIN	none	912	1988 - 2004	89	20	69	0	0.3	-0.9	-11.7	44	482	231
	SACRAMENTO VALLEY	none	1,587	1990 - 2006	82	60	20	2	0.8	-0.1	8.3	<1	1229	241
	SAFFORD	Gila Valley	4,747	1990 - 2008	14	6	7	1	0.4	-0.2	1.3	24	631	105
		San Carlos Valley		1992 - 2007	1	0	0	1	NA	NA	NA	722	722	722
		San Simon Valley		1987 - 2007	286	85	201	0	0.4	-1.2	-15.7	2	537	178
	SALT RIVER	Black River	5,232	NA	0	0	0	0	NA	NA	NA	NA	NA	NA
		Salt River Canyon		1991 - 2007	1	0	1	0	NA	-0.3	-4.3	20	20	20
		Salt River Lakes		1991 - 2003	15	0	15	0	NA	-2.2	-30.2	46	82	68
		White River		NA	0	0	0	0	NA	NA	NA	NA	NA	NA
	SAN BERNARDINO VALLEY	none	387	1990 - 2007	24	6	17	1	0.1	-0.4	-4.2	<1	464	74
	SAN RAFAEL	none	229	1987 - 2008	6	2	4	0	0.1	-0.4	-5.2	7	209	75
	SAN SIMON WASH	none	2,284	1989 - 2004	1	1	0	0	0.3	NA	4.9	6	6	6
	SANTA CRUZ AMA	none	716	1987 - 2010	48	6	42	0	0.0	-0.5	-9.6	6	255	78
	SHIVWITS PLATEAU	none	1,821	1992 - 2005	1	0	0	1	NA	NA	NA	959	959	959
	TIGER WASH	none	74	1993 - 2007	3	3	0	0	0.3	NA	4.1	21	217	94
	TONTO CREEK	none	955	1990 - 2008	9	5	3	1	0.4	-0.4	1.2	4	82	38
	UPPER HASSAYAMPA	none	787	1990 - 2008	5	4	1	0	0.1	-0.4	0.1	15	817	356
	UPPER SAN PEDRO	Allen Flat	1,825	1990 - 2006	7	1	6	0	0.5	-0.4	-4.7	7	373	141
		Sierra Vista		1990 - 2007	379	111	244	24	0.3	-0.5	-4.1	<1	611	116
	VERDE RIVER	Big Chino	5,661	1992 - 2009	60	43	16	1	0.4	-0.2	3.8	<1	694	132
		Verde Valley		1994 - 2009	174	33	138	3	0.6	-1.2	-13.1	<1	883	183
		Verde Canyon		1990 - 2009	7	1	6	0	0.8	-2.4	-41.1	85	318	173
	VIRGIN RIVER	none	434	1990 - 2009	3	2	1	0	0.3	-0.1	3.4	46	313	168
	WESTERN MEXICAN DRAINAGE	none	610	1991 - 2004	5	1	4	0	0.4	-0.5	-4.2	28	99	74
	WILLCOX	none	1,911	1990 - 2005	587	27	560	0	0.7	-2.0	-32.1	3	730	211
		Instate Subtotals	53,092		2,684	609	2,037	38						

Recent Water Level Change Trends and Depth-to-Water in Wells Measured in Basin [2,3]

	Basins Which Receive Part of Supply from the Colorado River or CAP	Sub-basin	Basin Area (Sq. Miles)	Measurement Period (Beginning Year - Ending Year)	Total Number of Wells Measured	Number of Wells Measured In Basin Showing Rising Water Levels	Number of Wells Measured In Basin Showing Declining Water Levels	Number of Wells Measured In Basin Showing No Change In Water Level or Flowing Conditions	Mean Annual Positive Change Rate for Wells Showing Rises (Ft/Yr)	Mean Annual Negative Change Rate for Wells Showing Declines (Ft/Yr)	Overall Mean Water Level Change In Basin Over Measurement Period (Feet)	Minimum Measured DTW For Ending Year (Feet - BLS)	Maximum Measured DTW for Ending Year (Feet -BLS)	Mean DTW for Ending Year (Feet - BLS)
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	none	26,700	1991 - 2004	64	12	51	1	0.8	-1.4	-14.5	12	1241	230
Instate + CR Lower Mainstem	BILL WILLIAMS	Burro Creek	3,350	NA	0	0	0	0	NA	NA	NA	NA	NA	NA
		Alamo Reservoir		1991 - 2009	3	2	1	0	0.1	-0.2	0.2	51	640	276
		Clara Peak		1991 - 2008	1	1	0	0	0.3	NA	5.4	22	22	22
		Skull Valley		1991 - 2009	7	3	4	0	0.3	-1.3	-11.1	37	248	150
		Santa Maria		1991 - 2009	5	2	3	0	0.2	-0.1	0.2	19	91	55
	DETRITAL VALLEY	none	892	1995 - 2006	15	10	5	0	0.2	-0.8	-1.4	7	773	354
	KANAB PLATEAU	none	4,247	1992 - 2009	2	1	1	0	<0.1	<-0.1	0.4	484	611	548
	LAKE HAVASU	none	252	1991 - 2009	1	1	0	0	1.3	NA	25.3	28	28	28
	LAKE MOHAVE	none	980	1991 - 2009	2	1	1	0	1.2	-0.1	10.0	346	427	387
	LOWER GILA	Childs Valley	7,309	1992 - 2007	1	1	0	0	0.9	NA	14.2	676	676	676
		Dendora Valley		1992 - 2009	1	0	1	0	NA	-1.7	-30.4	96	96	96
		Wellton - Mohawk		1992 - 2007	20	9	11	0	0.3	-0.4	-1.1	12	383	141
	PARKER	Cibola Valley	2,229	NA	0	0	0	0	NA	NA	NA	NA	NA	NA
		Colorado River Indian Reservation		1991 - 2010	1	0	1	0	NA	>-0.1	-0.1	78	78	78
		La Posa Plains		1992 - 2009	3	0	3	0	NA	-0.9	-17.1	66	510	238
	YUMA	none	792	1992 - 2009	4	0	4	0	NA	-0.4	-7.0	16	121	56
Instate + CAP	HARQUAHALA INA	none	766	1993 - 2009	27	18	9	0	1.4	-1.1	9.9	28	607	342
	PHOENIX AMA	Carefree	5,646	1991 - 2009	1	1	0	0	2.7	NA	50.6	94	94	94
		East Salt River		1991 - 2009	172	149	23	0	4.6	-1.1	69.6	13	855	217
		Fountain Hills		1991 - 2009	7	4	3	0	0.4	-2.1	-12.7	13	663	194
		Hassayampa		1991 - 2009	35	18	17	0	0.9	-0.2	6.8	24	658	234
		Lake Pleasant		1991 - 2009	3	2	1	0	0.6	-0.4	4.9	27	275	169
		Rainbow Valley		1991 - 2008	22	8	14	0	0.7	-0.6	-1.4	256	582	370
		West Salt River		1991 - 2009	273	111	162	0	1.7	-1.0	1.9	16	525	182
	PINAL AMA	Aguirre Valley	4,000	1993 - 2007	1	0	1	0	NA	-0.8	-11.9	273	273	273
		Eloy		1993 - 2008	490	314	175	1	1.3	-1.8	3.5	32	619	195
		Maricopa-Stanfield		1993 - 2008	174	140	33	1	3.4	-1.0	38.9	52	674	314
		Santa Rosa		NA	0	0	0	0	NA	NA	NA	NA	NA	NA
		Vekol Valley		1993 - 2007	12	3	9	0	0.1	-0.1	-0.8	213	529	351
	TUCSON AMA	Avra Valley	3,866	1994 - 2010	131	98	33	0	1.9	-1.0	18.0	5	745	300
		Upper Santa Cruz		1994 - 2010	529	78	450	1	1.2	-1.7	-19.8	7	620	215
	Colorado River + CAP Basin Subtotals		61,029		2,007	987	1,016	4						
		Statewide Totals	114,121		4,691	1,596	3,053	42						

Table 15. Hydrogeologic and Cultural Characteristics of Arizona Groundwater Basins (Continued)

	Basin	Sub-basin	Basin Area (Sq. Miles)	SELECT CHARACTERISTICS OF ARIZONA GROUNDWATER BASINS — Aquifer: Estimated Natural Recharge [4] (AF/Yr)	2006 Baseline Groundwater Demand [5] (AF/Yr)	Estimated Natural Recharge - 2006 Baseline GW Demand[6] (AF/Yr)	Predominant Current/Recent Trend of Basinwide WL Declines?[7]	Pumping Centers or Areas Within Basin That Show Locally Significant Current/Recent WL Decline?	Adjusted Estimated Volume of Water in Aquifer Storage [8,9] (AF)	If Baseline Supply/Demand Conditions Continue, Is Baseline GW Demand Estimated to Be Sustainable For at Least 100 Years? [10]	Documented Land Subsidence? [11]
Instate Water Supplies Only	AGUA FRIA	none	1,263	9,000	3,602	5,398	NA	N	480,000	Y	
	ARAVAIPA CANYON	none	517	7,000	514	6,486	NA	?	4,000,000	Y	
	BIG SANDY	Fort Rock	1,988				NA	?		Y	
		Wikiup		22,000	15,028	6,972	N	N	7,600,000		
	BONITA CREEK	none	457	9,000	0	9,000	NA	NA	800,000	Y	
	BUTLER VALLEY	none	288	1,000	14,503	-13,503	Y	Y	1,600,000	?	
	CIENEGA CREEK	none	606	8,500	1,101	7,399	Y	?	4,080,000	Y	
	COCONINO PLATEAU	none	5,812	NA	500	NA	NA	?	2,400,000	Y	
	DONNELLY WASH	none	293	3,000	19	2,981	NA	NA	112,000	Y	
	DOUGLAS	Douglas	949				Y	Y		?	Y
		Douglas INA		15,500	53,300	-37,800	Y	Y	16,640,000		
	DRIPPING SPRINGS WASH	none	378	3,000	11	2,989	NA	?	120,000	Y	
	DUNCAN VALLEY	none	550	6,000	8,054	-2,054	N	N	7,200,000	Y	
	GILA BEND	none	1,284	10,000	295,323	-285,323	Y	Y	13,600,000	N	Y
	GRAND WASH	none	959	NA	2	NA	NA	N	NA	Y	
	HUALAPAI VALLEY	none	1,212	2,000	9,109	-7,109	Y	Y	2,400,000	?	
	LOWER SAN PEDRO	Camp Grant Wash	1,624				Y	Y		Y	
		Mammoth		24,000	23,677	323	N	Y	8,800,000		
	MCMULLEN VALLEY	none	649	1,000	71,500	-70,500	Y	Y	11,200,000	?	Y
	MEADVIEW	none	190	4,000	145	3,855	Y	Y	800,000	Y	
	MORENCI	none	1,599	15,000	9,126	5,874	NA	N	2,400,000	Y	
	PARIA	none	408	NA	120	NA	?	Y	12,000,000	Y	
	PEACH SPRINGS	none	1,409	NA	351	NA	N	N	800,000	Y	
	PRESCOTT AMA	Little Chino Valley	485				Y	Y		?	
		Upper Agua Fria		8,200	17,679	-9,479	Y	Y	2,400,000		
	RANEGRAS PLAIN	none	912	1,000	29,350	-28,350	Y	Y	7,200,000	?	Y
	SACRAMENTO VALLEY	none	1,587	1,000	3,765	-2,765	?	Y	2,880,000	Y	
	SAFFORD	Gila Valley	4,747				N	N		Y,?	Y
		San Carlos Valley					NA	N			
		San Simon Valley		105,000	87,958	17,042	Y	Y	21,600,000		
	SALT RIVER	Black River	5,232				NA	NA		Y,?	
		Salt River Canyon					NA	NA			
		Salt River Lakes					?	Y			
		White River		178,000	12,611	165,389	NA	NA	6,960,000		
	SAN BERNARDINO VALLEY	none	387	9,000	19	8,981	Y	N	1,280,000	Y	
	SAN RAFAEL	none	229	5,000	22	4,978	Y	Y	3,200,000	Y	
	SAN SIMON WASH	none	2,284	11,000	1,500	9,500	NA	NA	5,360,000	Y	
	SANTA CRUZ AMA	none	716	50,800	20,980	29,820	Y	Y	128,000	Y	
	SHIVWITS PLATEAU	none	1,821	NA	2	NA	NA	NA	NA	Y	
	TIGER WASH	none	74	1,000	2	998	N	N	560,000	Y	
	TONTO CREEK	none	955	17,000	3,000	14,000	N	N	1,600,000	Y	
	UPPER HASSAYAMPA	none	787	8,000	3,286	4,714	N	N	800,000	Y	
	UPPER SAN PEDRO	Allen Flat	1,825				Y	Y		Y	
		Sierra Vista		35,800	23,957	11,843	Y	Y	15,840,000		
	VERDE RIVER	Big Chino	5,661				N	Y		Y	
		Verde Valley					Y	Y			
		Verde Canyon		107,000	28,549	78,452	?	Y	10,400,000		
	VIRGIN RIVER	none	434	30,000	1,585	28,415	N	N	1,360,000	Y	
	WESTERN MEXICAN DRAINAGE	none	610	1,000	6	994	N	Y	2,400,000	Y	
	WILLCOX	none	1,911	15,000	175,714	-160,714	Y	Y	33,600,000	?	Y
		Instate Subtotals	**53,092**	**723,800**	**915,970**				**214,600,000**		

	Basins Which Receive Part of Supply from the Colorado River or CAP	Sub-basin	Basin Area (Sq. Miles)	Aquifer: Estimated Natural Recharge [4] (AF/Yr)	2006 Baseline Groundwater Demand [5] (AF/Yr)	Estimated Natural Recharge - 2006 Baseline GW Demand[6] (AF/Yr)	Predominant Current/Recent Trend of Basinwide WL Declines?[7]	Pumping Centers or Areas Within Basin That Show Locally Significant Current/Recent WL Decline?	Adjusted Estimated Volume of Water in Aquifer Storage [8,9] (AF)	If Baseline Supply/Demand Conditions Continue, Is Baseline GW Demand Estimated to Be Sustainable For at Least 100 Years? [10]	Documented Land Subsidence? [11]
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	none	26,700	344,600	95,813	248,787	Y	Y	763,200,000	Y	
Instate + CR Lower Mainstem	BILL WILLIAMS	Burro Creek	3,350				NA	NA			
		Alamo Reservoir					NA	NA			
		Clara Peak					NA	NA			
		Skull Valley					?	Y			
		Santa Maria		32,000	3,251	28,749	N	N	8,000,000	Y	
	DETRITAL VALLEY	none	892	1,000	159	841	N	N	800,000	Y	
	KANAB PLATEAU	none	4,247	NA	2,799	NA	NA	NA	NA	?	
	LAKE HAVASU	none	252	35,000	47	34,953	NA	NA	800,000	Y	
	LAKE MOHAVE	none	980	183,000	2,007	180,993	NA	NA	960,000	Y	
	LOWER GILA	Childs Valley	7,309				NA	NA			
		Dendora Valley					NA	NA			
		Wellton - Mohawk		9,000	110,296	-101,296	N	N	80,000,000	?	
	PARKER	Cibola Valley	2,229				NA	NA			
		Colorado River Indian Reservation					NA	NA			
		La Posa Plains		241,000	1,787	239,213	N	Y	11,200,000	Y	
	YUMA	none	792	213,000	108,570	104,430	NA	Y	27,200,000	Y	
Instate + CAP	HARQUAHALA INA	none	766	1,000	66,178	-65,178	N	Y	10,400,000	?	Y
	PHOENIX AMA	Carefree	5,646				NA	NA			
		East Salt River					N	Y			
		Fountain Hills					N	Y			
		Hassayampa					N	N			
		Lake Pleasant					NA	NA			
		Rainbow Valley					Y	Y			
		West Salt River		172,300	673,754	-501,454	?	Y	64,320,000	Y	Y
	PINAL AMA	Aguirre Valley	4,000				NA	NA			
		Eloy					N	Y			
		Maricopa-Stanfield					N	Y			
		Santa Rosa					N	N			
		Vekol Valley		96,300	431,290	-334,990	Y	N	28,160,000	Y	Y
	TUCSON AMA	Avra Valley	3,866				?	Y			
		Upper Santa Cruz		99,100	216,997	-117,897	Y	Y	48,800,000	Y	Y
		Colorado River + CAP Basin Subtotals	**61,029**	**1,427,300**	**1,712,948**				**1,043,840,000**		
		Statewide Totals	**114,121**	**2,151,100**	**2,628,918**				**1,258,440,000**		

Table 15. Hydrogeologic and Cultural Characteristics of Arizona Groundwater Basins (Continued)

SELECT CHARACTERISTICS OF ARIZONA GROUNDWATER BASINS

	Basin	Sub-basin	Basin Area (Sq. Miles)	Effluent [12]: 2006 Baseline Effluent Directly Used (AF/Yr)	Effluent [12]: 2006 Baseline Effluent Generated (AF/Yr)	Effluent [12]: Basin Includes Effluent Dependent Stream Reach?	River & Streams [13]: Instate Perennial Stream Miles[14]	River & Streams [13]: Current GW/SW Connection? (h=historic connection; may not currently exist)[15]	River & Streams [13]: Reach Length of CR Bordering or Within Basin[14] (Miles)	River & Streams [13]: Waters in Fed/State Conservation Lands?	River & Streams [13]: Basin Includes Instream Flow Certificate(s)?	Springs [16]: Number of Major (>10GPM)	Springs [16]: Estimated Annual Discharge of Major (AF/Yr)	Springs [16]: Number of Minor (<10GPM)	Springs [16]: Estimated Annual Discharge of Minor (AF/Yr)	Environmental / Recreation [17]: ESA Critical Habitat Designation?	Environmental / Recreation [17]: ESA Species Observed?	Environmental / Recreation [17]: Audubon Important Bird Area?	Environmental / Recreation [17]: Water Based Recreational Opportunity?	Environmental / Recreation [17]: ADEQ Outstanding Arizona Water?	Environmental / Recreation [17]: Federal Wild and Scenic Designation?	Tribal [18]: Tribal Lands In Basin	Tribal [18]: Estimated % of Tribe(s) Total Water Use within Basin	Tribal [18]: Area of Tribal Lands in Basin (Sq. Miles)	Tribal [18]: Ratio Tribal Land / Total Basin Area
Instate Water Supplies Only	AGUA FRIA	none	1,263	0	30		108	Y		Y	Y	5	22	14	2	Y	Y	Y	Y						
	ARAVAIPA CANYON	none	517	0	0		50	Y		Y	Y	7	16	18	10	Y	Y	Y	Y	Y		San Carlos Apache	0%	6	0.01
	BIG SANDY	Fort Rock Wikiup	1,988	0	0		49	Y Y				6	16	11	8	Y	Y		Y			Hualapai	0%	4	<0.01
	BONITA CREEK	none	457	0	0		14	Y		Y		1	32	4	13		Y		Y	Y		San Carlos Apache	0%	404	0.88
	BUTLER VALLEY	none	288	0	0		0	N																	
	CIENEGA CREEK	none	606	0	100	Y	46	Y		Y	Y	8	694	2	6	Y	Y	Y	Y	Y					
	COCONINO PLATEAU	none	5,812	273	1,700	Y	44	Y	153	Y		29	163,882	28	13	Y	Y	Y	Y			Havasupai Hualapai Navajo	100% 0% 7%	275 739 1,177	0.05 0.13 0.20
	DONNELLY WASH	none	293	0	0		3	Y(h)								Y	Y		Y						
	DOUGLAS	Douglas Douglas INA	949	0	1,400		2	Y N (h)		Y	Y			6	6		Y		Y						
	DRIPPING SPRINGS WASH	none	378	0	0		7	Y (?)		Y	Y	2	323			Y	Y		Y			San Carlos Apache	0%	224	0.59
	DUNCAN VALLEY	none	550	0	50		26	Y		Y		2	48	1	10	Y	Y		Y						
	GILA BEND	none	1,284	0	800	Y	0	N (h)								Y			Y			Gila Bend Tohono O'odham	100% 0%	16 36	0.01 0.03
	GRAND WASH	none	959	0	0		0	Y	4	Y		6	121	9	2	Y	Y		Y						
	HUALAPAI VALLEY	none	1,212	0	1,800		0	Y	21	Y		3	40	19	11	Y	Y		Y			Hualapai	0%	12	0.01
	LOWER SAN PEDRO	Camp Grant Wash Mammoth	1,624	145	700	Y	77	Y Y		Y	Y	12	3,115	30	142	Y	Y	Y	Y	Y		San Carlos Apache	0%	23	0.01
	MCMULLEN VALLEY	none	649	0	0		0	N																	
	MEADVIEW	none	190	0	0		0	Y	7	Y		6	450	2	12	Y	Y		Y			Hualapai	0%	3	0.01
	MORENCI	none	1,599	0	200		355	Y		Y		9	968	8	32	Y	Y	Y	Y	Y		San Carlos Apache	0%	357	0.22
	PARIA	none	408	0	0		7	Y	19	Y								Y	Y						
	PEACH SPRINGS	none	1,409	0	100		<1	Y	14	Y		14	9,409	5	29	Y	Y		Y			Hualapai	100%	845	0.60
	PRESCOTT AMA	Little Chino Valley Upper Agua Fria	485	2,534	6,900	Y	5	Y Y		Y		1	1,410	9	46	Y	Y	Y	Y			Yavapai-Prescott	100%	2	<0.01
	RANEGRAS PLAIN	none	912	0	0		0	N																	
	SACRAMENTO VALLEY	none	1,587	0	300		0	Y	5	Y		12	418	45	210	Y	Y		Y						
	SAFFORD	Gila Valley San Carlos Valley San Simon Valley	4,747	500	2,600	Y	157	Y Y N		Y		23	7,966	31	108	Y	Y	Y	Y	Y		San Carlos Apache	100%	1,408	0.30
	SALT RIVER	Black River Salt River Canyon Salt River Lakes White River	5,232	0	2,600	Y	1,187	? Y ? ?		Y	Y	26	28,555	2	11	Y	Y	Y	Y	Y		White Mountain Apache San Carlos Apache	100% 0%	2,627 484	0.50 0.09
	SAN BERNARDINO VALLEY	none	387	0	0		2	Y		Y				1	5	Y	Y		Y						
	SAN RAFAEL	none	229	0	0		14	Y		Y				1	2	Y	Y	Y	Y						
	SAN SIMON WASH	none	2,284	0	400		0	N									Y		Y			Tohono O'odham	0%	2,270	0.99
	SANTA CRUZ AMA	none	716	0	16,311	Y	32	Y		Y		2	673	1	6	Y	Y		Y						
	SHIVWITS PLATEAU	none	1,821	0	0		4	Y	57	Y		1	534	5	13	Y	Y		Y			Hualapai	0%	2	<0.01
	TIGER WASH	none	74	0	0		0	N																	
	TONTO CREEK	none	955	200	500		129	Y		Y	Y	10	4,543	7	50	Y	Y	Y	Y	Y		Tonto Apache	20%	<1	<0.01
	UPPER HASSAYAMPA	none	787	0	600		52	Y			Y					Y	Y		Y						
	UPPER SAN PEDRO	Allen Flat Sierra Vista	1,825	830	5,300	Y	101	Y Y		Y	Y	12	1,075	4	29	Y	Y	Y	Y	Y					
	VERDE RIVER	Big Chino Verde Valley Verde Canyon	5,661	784	6,200	Y	475	Y Y Y		Y	Y	90	97,214	95	1,585	Y	Y	Y	Y	Y	Y	Yavapai-Apache Tonto Apache	100% 80%	<1 <1	<0.01 <0.01
	VIRGIN RIVER	none	434	0	10		47	Y		Y		2	37,938			Y	Y		Y						
	WESTERN MEXICAN DRAINAGE	none	610	0	0		0	N		Y		1	45	2	8	Y	Y					Tohono O'odham	0%	1	<0.01
	WILLCOX	none	1,911	211	500		32	Y		Y						Y	Y	Y	Y						
		Instate Subtotals	**53,092**	**5,477**	**49,101**		**3,025**					**290**	**359,507**	**360**	**2,369**									**10,917**	

	Basins Which Receive Part of Supply from the Colorado River or CAP	Sub-basin	Basin Area (Sq. Miles)	Effluent [12]: 2006 Baseline Effluent Directly Used (AF/Yr)	Effluent [12]: 2006 Baseline Effluent Generated (AF/Yr)	Effluent [12]: Basin Includes Effluent Dependent Stream Reach?	River & Streams [13]: Instate Perennial Stream Miles[14]	River & Streams [13]: Current GW/SW Connection? (h=historic connection; may not currently exist)[15]	River & Streams [13]: Reach Length of CR Bordering or Within Basin[14] (Miles)	River & Streams [13]: Waters in Fed/State Conservation Lands?	River & Streams [13]: Basin Includes Instream Flow Certificate(s)?	Springs [16]: Number of Major (>10GPM)	Springs [16]: Estimated Annual Discharge of Major (AF/Yr)	Springs [16]: Number of Minor (<10GPM)	Springs [16]: Estimated Annual Discharge of Minor (AF/Yr)	Environmental / Recreation [17]: ESA Critical Habitat Designation?	Environmental / Recreation [17]: ESA Species Observed?	Environmental / Recreation [17]: Audubon Important Bird Area?	Environmental / Recreation [17]: Water Based Recreational Opportunity?	Environmental / Recreation [17]: ADEQ Outstanding Arizona Water?	Environmental / Recreation [17]: Federal Wild and Scenic Designation?	Tribal [18]: Tribal Lands In Basin	Tribal [18]: Estimated % of Tribe(s) Total Water Use within Basin	Tribal [18]: Area of Tribal Lands in Basin (Sq. Miles)	Tribal [18]: Ratio Tribal Land / Total Basin Area
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	none	26,700	14,900	36,100	Y	850	Y	34	Y		67	20,320	161	678	Y	Y	Y	Y	Y		White Mountain Apache Hopi Navajo San Juan Southern Paiute Zuni	0% 100% 93% 100% 100%	5 2,536 14,681 <1 18	<0.01 0.09 0.55 <0.01 <0.01
Instate + CR Lower Mainstem	BILL WILLIAMS	Burro Creek Alamo Reservoir Clara Peak Skull Valley Santa Maria	3,350	200	200		151	Y Y Y(h) Y Y	<1	Y	Y	6	29	13	15	Y	Y	Y	Y	Y					
	DETRITAL VALLEY	none	892	0	0		0	Y	27	Y		1	1,936	4	10	Y			Y						
	KANAB PLATEAU	none	4,247	0	500	Y	89	Y	49	Y		38	30,265	23	15	Y	Y	Y	Y			Hualapai Kaibab Navajo	0% 100% 0%	<1 189 <1	<0.01 0.04 <0.01
	LAKE HAVASU	none	252	2,433	3,400		0	Y	38	Y						Y	Y		Y						
	LAKE MOHAVE	none	980	715	3,100		0	Y	122	Y		10	1,344	2	10	Y	Y		Y			Fort Mojave	100%	37	0.04
	LOWER GILA	Childs Valley Dendora Valley Wellton - Mohawk	7,309	0	300		3	N (h) N (h) Y	11	Y						Y	Y	Y	Y			Tohono O'odham	0%	164	0.02
	PARKER	Cibola Valley Colorado River Indian Reservation La Posa Plains	2,229	1,116	2,100		3	Y Y Y	144	Y						Y	Y		Y			Colorado River	100%	391	0.18
	YUMA	none	792	460	13,500		0	Y	53								Y	Y	Y			Cocopah Fort Yuma	100% 100%	11 3	0.01 <0.01
Instate + CAP	HARQUAHALA INA	none	766	0	0		0	N																	
	PHOENIX AMA	Carefree East Salt River Fountain Hills Hassayampa Lake Pleasant Rainbow Valley West Salt River	5,646	168,331	315,000	Y	94	Y Y(h) Y Y Y N Y		Y	Y	2	242	4	16		Y	Y	Y			Fort McDowell Gila River Salt River Pima-Maricopa	100% 70% 100%	39 311 81	<0.01 0.06 0.01
	PINAL AMA	Aguirre Valley Eloy Maricopa-Stanfield Santa Rosa Vekol Valley	4,000	4,614	6,900	Y	0	N N(h) N(h) N N									Y		Y			Gila River Maricopa (Ak-Chin) Tohono O'odham	30% 100% 31%	277 33 1,802	0.07 <0.01 0.45
	TUCSON AMA	Avra Valley Upper Santa Cruz	3,866	14,336	74,235	Y	42	Y Y		Y		8	774	2	6	Y	Y	Y	Y			Pasqua Yaqui Tohono O'odham San Xavier	100% 69% 100%	1 111 59	<0.01 0.03 0.02
		Colorado River + CAP Basin Subtotals	**61,029**	**207,105**	**455,335**		**1,232**					**132**	**54,910**	**209**	**750**									**20,747**	
		Statewide Totals	**114,121**	**212,582**	**504,436**		**4,257**					**422**	**414,417**	**569**	**3,119**									**31,664**	

Table 15. Hydrogeologic and Cultural Characteristics of Arizona Groundwater Basins (Continued)

Footnotes:

[1] Major aquifer classifications from Arizona Water Atlas, Vol. 1, ADWR, 2010.

[2] Waterlevel data from ADWR-GWSI database

[3] Water Level Data for Some Basins With Few Measurements May Be Insufficent to Accurately Characterize Basin-wide or Local Water Level Change or Depth to Water Conditions

[4] Estimated Natural Recharge From Arizona Water Atlas Vols. 2-8. ADWR, 2007- 2010.

[5] 2006 Baseline GW Demand From ADWR Az Water Atlas and AMA Assessment Data and USGS data

[6] Negative Differences Between Estimated Natural Recharge and Baseline GW Withdrawals Are Not Necessarily Indicators of Groundwater Overdraft. Assessment of Overdraft for Any Basin Requires A Complete Evaluation of All GW Inflows and All GW Outflows.

[7] Basins with insufficient water level data to support basinwide water level trend analysis identified as NA.

[8] Estimated water in aquifer storage from compilations of independent estimates listed in the Arizona Water Atlas Vols. 2-8. ADWR, 2007- 2010. Original studies by USGS and/or ADWR usually estimate volume of water in aquifer storage to depths of 1,000 to 1,200 feet below land surface. Original estimates were reduced (adjusted) by 20 percent to reflect hydrologic, technical and practical limitations on theoretical withdrawals of all water from aquifer storage in a basin.

[9] Water in aquifer storage is generally referred to as groundwater. However, under Arizona law, water in aquifer storage that is closely associated with certain surface water features may also be legally referred to as surface water, subflow, Colorado River water, etc. Based on available data and estimates, no attempt was made to sub-divide the total estimated volume of water in aquifer storage into seperate legally defined classes of water. With the possible exception of the Colorado river mainstem basins, most water in aquifer storage in the state is generally and legally classified as groundwater.

[10] Estimates of potential 100 year gw sustainability assume that current water supply and demand conditions will continue unchanged into the future (assumes no reduction instate surface water, Colorado River water or CAP water supplies that may be directly used, or recharged by artifical or incidental processes). This assumption may be very unrealistic for some basins that directly use of recharge large volumes of surface water. Groundwater sustainability assessment was a qualitative assessment of current baseline GW withdrawals, estimated natural recharge, estimated adjusted gw in storage and current water level change trends.

[11] Land subsidence analysis from historic and current surveying data and INSAR data collected and analyzed by USGS and ADWR.

[12] Effluent data from Arizona Water Atlas Vols. 2-8. ADWR, 2007-2010.

[13] River and stream related information from various independent sources that are compiled in WRDC - Environmental Committee (WRDC Natural Resources Index Table with accompanying metadata).

[14] Perennial Instate and Colorado River stream miles based on GIS analysis of Brown DE, Carmony NB, Turner RM. 1981. Drainage map of Arizona showing perennial streams and some important wetlands. Arizona Game and Fish Department, Phoenix.

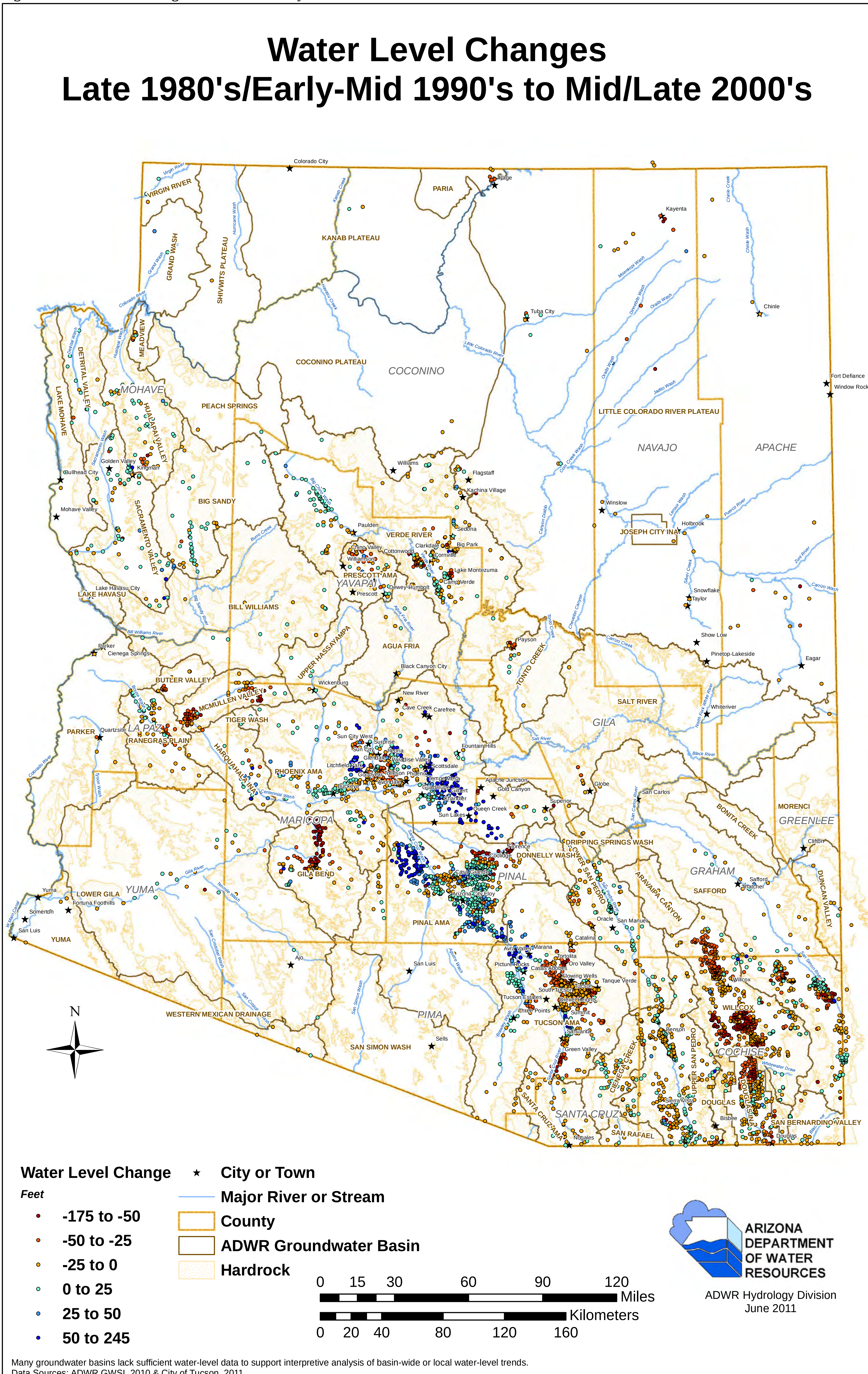
[15] Current GW/SW Connection based mainly on work of Anning, DW and Konieczki, 2005. Classification of hydrogeologic areas and hydrologic flow systems in the Basin and Range Physiographic Province, Southwest United States. USGS Professional Paper 1702. And Hart, RJ, and others, 2002. Generalized hydrogeology and groundwater budget for the Coconino aquifer, Little Colorado River Basin, and parts of the Verde and Salt River Basins, Arizona and new Mexico. USGS Water Resources Investigations report 02-4026. These data are summarized in WRDC - Environmental Committee (WRDC Natural Resources Index Table - metadata worksheet).

[16] Spring information from independent data and estimates compiled by WRDC Environmental Committee.

[17] Environmental and Recreation Data information from various independent sources that are compiled in WRDC - Environmental Committee (WRDC Natural Resources Index Table with accompanying metadata).

[18] Tribal data from ADWR Arizona Water Atlas data, and GIS analysis.

Figure 13. Water level changes Late 1980’s Early/Mid 1990’s to Mid/Late 2000’s



Basins that have uncertain long-term groundwater sustainability, based on current rates of consumption, are listed in Table 16. A complete listing for all basins is provided in Table 15. Hydrogeologic and Cultural Characteristics of Arizona Groundwater Basins. It should be noted that the available water level change data for some sub-basins or local areas within basins, such as the San Simon sub-basin of the Safford basin clearly indicate overdraft conditions. However, sub-basin specific groundwater storage and groundwater withdrawal data are unavailable. Therefore, it was not possible to evaluate the long-term sustainability of the baseline groundwater demand for such sub-basins or local areas. Based on the analysis it seems that plans to develop additional groundwater supplies in basins that already face long-term groundwater sustainability issues may be comparatively short-term solutions that will eventually fail to meet projected long-term water needs.

Basin	Sub-basin	2006 GW Demand (AF/Yr)	Estimated Natural Recharge (AF/Yr)	Adjusted GW Storage (AF)	Recent WL Neg. WL Change Rate (FT/Yr)
Butler Valley	none	14,500	1,000	2,000,000	-1.0
Douglas	Douglas	53,500	15,500	16,640,000	-1.2
	Douglas INA				-1.3
Gila Bend	none	295,300	10,000	13,600,000	-4.3
Harquahala	none	66,000	1,000	10,400,000	-1.1
Hualapai	none	8,800	2,000	2,400,000	-0.9
McMullen Valley	none	71,500	1,000	11,200,000	-2.2
Prescott AMA	Little Chino	20,300	8,200	2,400,000	-1.4
	Upper Agua Fria				-1.4
Ranegras Plain	none	29,350	1,000	7,200,000	-0.9
Willcox	none	175,000	15,000	33,600,000	-2.0

Table 16. Basins currently in overdraft that have long-term groundwater sustainability issues at baseline rates of groundwater consumption

Aquifer Productivity

Basins with a currently sustainable long-term groundwater supply still face other hydrologic and technical issues that may ultimately limit the actual volume of additional groundwater that can be produced. For example, in any basin groundwater production is directly related to aquifer transmissivity and storage properties. In many basins these properties vary substantially from location to location. Therefore, it isn't always possible to develop groundwater resources in the area where they may be needed to supply the current or projected water demand. Additionally, it is unrealistic to assume that sufficient wells could be drilled within a basin over any reasonable time-frame that would be capable of completely "draining" an aquifer, as some planned groundwater depletion scenarios might propose.

Groundwater Quality

Other hydrologic and technical issues related to the development of groundwater resources include degradation of water quality at increasing pumping depths. In many groundwater basins it is a well known fact that the quality of groundwater decreases with increasing depth in the aquifer. For most basins it is likely that increased treatment costs, particularly for municipal supplies, will be experienced as groundwater supplies are pumped from deeper depths in the aquifer system.

Land Subsidence

Land subsidence and earth fissures are potential problems that often accompany groundwater development and aquifer overdraft. Wide-spread, damaging land subsidence and earth fissuring has occurred in many groundwater basins of central and southern Arizona where historic groundwater pumping has caused the water table to decline by several hundred feet and irreversible aquifer compaction has occurred. Land subsidence has caused significant damage to land, structures, wells, flood control and water/wastewater infrastructure and permanent reductions in aquifer storage capacity.

Although land subsidence is generally regarded as a regional problem that is caused by the collective impacts of many wells, ADWR is charged with evaluating the potential for new, non-exempt wells that are proposed to pump in AMAs to cause unreasonable increasing damage to surrounding land and other water users due to projected water level decline and projected regional land subsidence. The potential for land subsidence or earth fissuring to endanger property or potential groundwater storage capacity is one of the three fundamental water management concerns that may be evaluated to determine if subsequent (new) active management areas are formed in the state. It is clear that land subsidence continues to be a major concern that could eventually impact groundwater development in certain areas of the state.

Groundwater/Surface Water Interaction

The development of additional groundwater supplies may also be limited in areas where pumping may impact perennial or intermittent surface water features such as: rivers, streams, springs or lakes. In such areas groundwater in the aquifer may be in direct hydraulic connection with the surface water system, and additional pumping may cause reduction in surface water flows that could be legally limited or prohibited due to their detrimental impact to surface water right holders.   Depletion of surface water resources may also damage the state and local economies (especially because of impacts to tourism, recreation, and property values) and/or may be otherwise culturally undesirable or unacceptable.

Along the main stem of the Colorado River any pumping that occurs within the area known as the Colorado River accounting surface is regulated under Federal law or rules. For instate basins that have perennial or intermittent rivers, streams or springs; the existence of numerous surface water rights may practically limit the actual locations and volumes of any additional groundwater supplies that may be developed.

A compilation of groundwater - surface water connection data is provided for all basins in Table 8. Water-Dependent Natural Resource Index for the Water Resource Development Commission provided by the Environmental Committee.

Environment

Since additional groundwater pumping may impact surface water resources and because such impacts to surface water often result in collateral impacts to environmental resources it is also possible that potential environmental impacts and concerns would be raised that could limit the development of additional groundwater supplies in environmentally sensitive and/or protected areas.

Tribal Rights and Claims

Many Indian Tribes have currently quantified their water rights through decrees, settlements or other processes. Some settlements include rights to groundwater. Other tribes have yet to quantify their water rights through settlements or litigation. All Tribes may claim a legal right to groundwater under their tribal lands. The use of groundwater from aquifers underlying tribal lands by non-Tribal users is restricted by these legal rights.

Legal Limits

The development of additional groundwater resources and location of new wells in Active Management Areas (AMAs) and within some areas covered by various legal agreements or settlements also carries varying levels of regulation and potential restriction. In AMAs, applicable groundwater withdrawal permits or groundwater rights must be obtained to withdraw groundwater. Additionally, well spacing and impact rules must be followed to receive authority to drill non-exempt wells in specific locations in AMAs. Outside AMAs, restrictions on well drilling (other than well construction) are few, but prospective well owners are advised that the location and pumping of their wells may eventually be evaluated as part of future adjudications proceedings that could ultimately impact the future use of their well.

Inter-Basin Transfer

Legal restrictions prohibiting the transportation of groundwater from one groundwater basin to another exist for most basins in the state. Except for a few limited situations, groundwater supplies that are developed in one basin cannot be transported to another basin.

Costs

The economic costs to drill and test wells and to pump, transport and potentially treat groundwater are significant considerations that may ultimately limit the uses and volume of additional groundwater that is produced in many groundwater basins. In 2008, the estimated cost to drill domestic wells in the Payson area was about $25,000 to $30,000 (ADWR, 2008). Recent costs to drill high capacity municipal wells in alluvial basins of central and southern Arizona were estimated at $600,000 to $800,000 (ADWR, 2008). Recent costs to drill four, 12-inch diameter municipal wells into deep, hard rock aquifers in the Flagstaff area were estimated to range from about $1.2 to $1.5 million per well (ADWR, 2008). Costs to drill 700-foot deep wells in the Showlow area that are capable of producing 300-500 gallons per minute (gpm) from the Coconino sandstone run from about $250,000 to $300,000 per well (ADWR, 2008). Costs to

drill, case, develop and install pumping equipment in a 3,000 to 4,000 foot water production well for the City of Williams are reported to have run in the $2 to $3 million range. The reported costs to pump this well which has a depth to water that exceeds 3,000 feet below land surface (BLS) along with the other City of Williams well at peak rates that produce a combined volume of several hundred gallons per minute is in the $24,000 to $28,000 per month range.

Pumping costs increase as the depth to water increases. Estimated pumping costs of groundwater are shown in Figure 14 for various pump (Ep) and pump motor (Em) efficiencies, and power rates currently available to groundwater pumpers in various areas throughout the state. For reference purposes, the current average statewide depth to water was about 200 feet BLS for the over 4,000 wells that are shown on Figure 13. Based on the current average depth to water for those wells, and assuming electrical costs will still be in the 4 to 10 cent per kilowatt-hour range (not necessarily a likely assumption), there would be about a 5-fold increase in pumping costs over today’s costs when pumping depths approach 1,000 BLS.

Based on the high costs to drill wells and to pump, transport and potentially treat groundwater it seems probable that economic considerations will have an increasing influence on the ultimate development of additional groundwater supplies in any basin, and potentially make groundwater too expensive for certain uses.

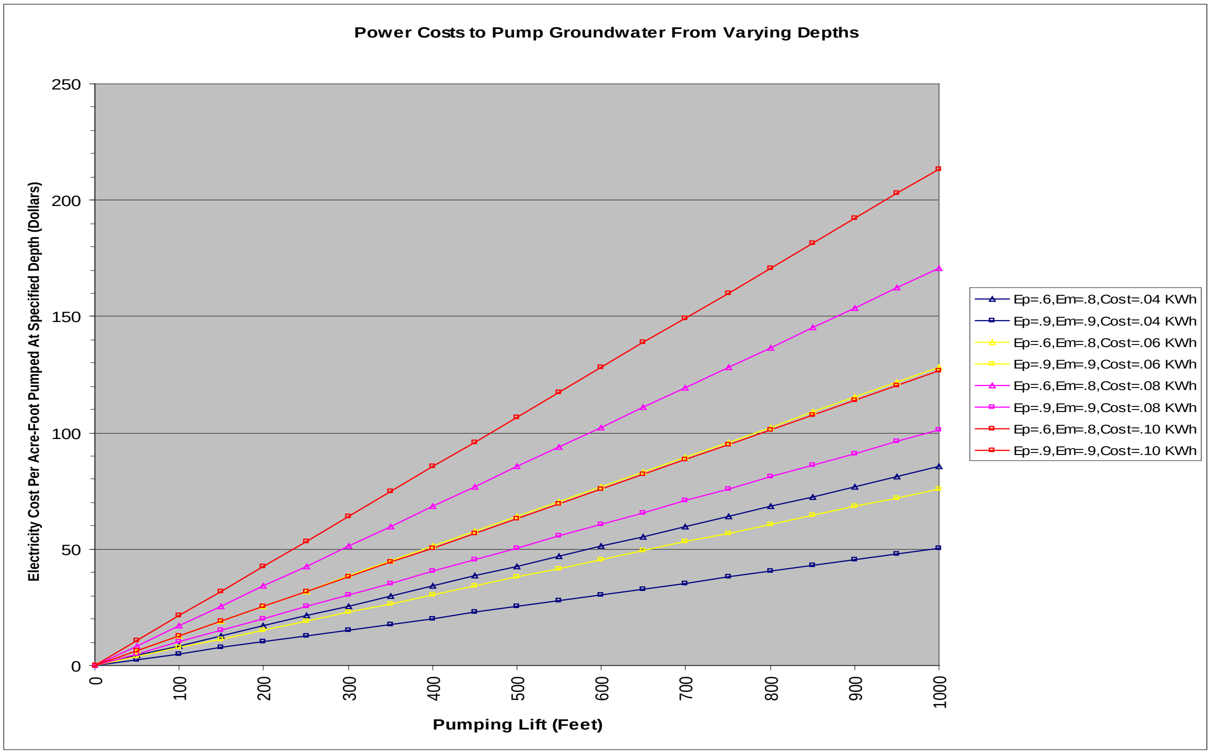


Figure 14. Estimated Cost to Pump Groundwater From Varying Depths

Surface Water

Climate Change

Current scientific research generally indicates that climate change may significantly reduce and/or change the future magnitude and timing of annual precipitation, surface water runoff and stream flow. There seems to be little doubt that such changes will eventually impact and diminish instate surface water, Colorado River, and CAP water supplies.

Physical Availability and Water Rights

<u>Instate Rivers and Streams</u>

The development of additional surface water supplies from the state's in-state river and stream systems is physically possible, but legally unlikely without the purchase of existing surface water rights that would have to be severed and transferred from the land to which it is appurtenant, which in and of itself poses a significant obstacle. There are existing surface water rights or claims to many of these flows, and it would generally be necessary to acquire existing rights in order to tap this potential source of supply. However, the acquisition of existing surface water rights may be difficult to justify due to uncertainties in the eventual outcomes of ongoing and/or potential future adjudications proceedings in the state and the legal limitations on severance and transfers of surface water rights. Perennial reaches of rivers and streams have been identified in many instate groundwater basins The physical availability of instate surface water could also be impacted by future groundwater pumping that may diminish surface flows.

Proposals to construct additional storage (new dams and/or reservoirs) have also been made. However, it is doubtful that many new dams could be built in the state, due to the lack of suitable dam sites, or due to environmental concerns and regulations or because the flow they might capture and divert would already be claimed by existing surface water right-holders. Increasing storage capacity of existing dams provides another option that carries with it similar concerns as new construction.

Colorado River

Arizona has to two allocations of Colorado River: an Upper Colorado River Basin (Upper Basin) apportionment of 50,000 acre-feet, and a Lower Colorado River Basin (Lower Basin) apportionment of 2.8 million acre-feet (MAF).

Arizona's Lower Basin apportionment is fully utilized by main stem users and the Central Arizona Project (which delivers water to Maricopa, Pinal, and Pima counties for municipal, industrial, agriculture, and Central Arizona Indian Tribes uses). Federal regulations allow the acquisition and transfer of main stem entitlements between a willing buyer and seller. But before the transfer can be completed, consultation is required with the Arizona Department of Water Resources (ADWR) and must meet the conditions of its transfer policy. Entitlements for certain main stem Indian Tribes and Federal reservations are not allowed to be transferred. Thus there is not any "new" Colorado River water that can be made available to meet unmet demands for Basins along the Colorado River or for areas served by the Central Arizona Project.

Arizona's Upper Basin apportionment of 50,000 acre-feet is not fully utilized at present but expected to in the near future. The Navajo Generating Station is the largest user, followed by the City of Page, and the Navajo Nation. Any changes in use or transfers are governed by Federal law and Arizona's State Water Code.

CAP

The volume of Colorado River water available for diversion to CAP off the mainstem is calculated as the remainder of Arizona's 2.8 MAF Lower Basin apportionment after subtracting mainstem uses. The CAP currently delivers about 1.6 MAF of Arizona's Lower Basin apportionment to Central Arizona. Over time, this amount is expected to decrease as the main stem contractors fully use their entitlements. All of the water diverted by CAP from the Colorado River is delivered to users through various forms of contracts with the Central Arizona Water Conservation District (CAWCD), the entity that operates the CAP delivery system.   Any exchanges or transfers of CAP water are governed by ADWR's CAP transfer policy and Federal regulations. There is a block of relinquished CAP agricultural priority water designated by the Arizona Water Settlements Act for re-allocation by ADWR for municipal and industrial use. The CAWCD has also undertaken an evaluation of acquiring additional water supplies above their current subcontracted amounts.

Tribal Rights and Claims

Many Indian Tribes have currently quantified their water rights through decrees, settlements or other processes. These currently quantified rights frequently involve mainstem Colorado River and in-state surface water. Other Tribes have yet to quantify their water rights through settlements or litigation. All tribes may claim a legal right to surface water flowing across or adjacent to their lands. The use of such surface water by non-Tribal users is restricted by these legal rights.

Surface Water Quality

Water quality is an important factor that must be considered when evaluating instate surface water, Colorado River or CAP water as potential additional water supplies. Any water supplies that may be potentially developed for municipal use would require treatment to existing Federal Safe Drinking Water Act (SDWA) and state standards. Increasingly stringent SDWA standards may affect the ability to treat water and raise treatment costs beyond the means of water users in some basins.

Environment

Since impacts to surface water resources often result in collateral impacts to environmental resources it is possible that potential environmental impacts and concerns would be raised that could limit the diversion of additional surface water supplies, or the sever and transfer of existing surface water flows that may help maintain or support environmentally sensitive and/or protected areas.

Costs

The costs to acquire surface water rights, and to build infrastructure such as dams, diversion works, canals, pipelines and water treatment plants are very high. Some of these costs will be detailed in the WRDC Finance committee report.

Effluent

The use of effluent to offset projected unmet demands is a very important option for many basins. Based on data developed from the Arizona Water Atlas and other sources there was about 503 KAF/yr of effluent generated in the state during the 2006 baseline period and about 212 KAF/yr of effluent that was directly used during that same time. The effluent numbers used in this report were questioned during the final writing of this report and a recommendation was made to review the numbers with the Sub-Regional Operating Group (SROG) that manages Phoenix's 91st Avenue wastewater treatment plant. Due to time constraints, this review was not made. In AMA's much of the difference between the volume of effluent generated and that which was directly used went to aquifer recharge, either in managed or constructed facilities. A substantial volume of effluent that is discharged into rivers and streams also helps support wildlife and riparian habitat and some may also be diverted by downstream users.

In the future more effluent will be used directly to meet projected unmet demands Additionally, in areas served by sewage systems, the volume of effluent generated will increase as populations grow. Therefore, basins with significant populations and sufficient sewage and wastewater treatment facilities will have significant additional "new" effluent supplies available to help offset projected unmet demands. In these areas "new " effluent will probably be much more useful to meet new demands than "old" effluent because many existing waste water treatment facilities are regional facilities, and do not have infrastructure that connects them to areas where effluent may be used directly. New treatment facilities would not have this constraint, because they could be sited locally, closer to the end users.

Costs

The costs to build and operate infrastructure such as sewers, pumping stations, pipelines and wastewater treatment plants are very high. Some of these costs will be detailed in the WRDC Finance committee report

Other Water Supplies

In the future the potential development of other sources of water may help meet projected unmet demands. Statewide, other potential sources of additional supply may be unavailable or insufficient in volume to significantly offset projected unmet demands. However, on the local and basin scale the development of other potential supplies will be important.

Potential sources of additional water supply include, but are not limited to:

- Currently Undevelopable or Under-utilized Sources of Groundwater
    - Brackish and/or Poor Quality Groundwater

  - o Mine drainage
  - o Agricultural drainage
- Desalination of ocean water
- Weather modification

Currently Undevelopable or Under-utilized Sources of Groundwater

Although groundwater has been identified as a generally available potential source of additional water in many basins there are some areas in the state where poor groundwater water quality makes it an essentially undevelopable resource to supply current uses. Likewise there are certain areas in the state where mining or agricultural activities require the pumping of water for drainage purposes, and the resource may be currently under-utilized. The following sections provide information on these currently undevelopable or under-utilized sources of water

Brackish and/or Poor Quality Groundwater

There are large volumes of brackish and poor quality groundwater located in certain parts of the state (Little Colorado River basin, Gila basin, Yuma Basin) that may eventually be developed. While this volume of water is included in the estimates of aquifer storage, it is generally not regarded as a currently practical resource to develop because of its comparatively high treatment costs. Although this resource has limited current uses it may be tapped sometime in the future as supplies diminish and/or treatment costs become a less significant component of the overall price of providing water.

Mine Drainage

This potential source of supply could provide additional water in areas where hard rock mining operations, and possibly sand and gravel mining operations exist and require dewatering. This potential source of supply would likely be limited to the known copper mining areas of central and southern Arizona. And to areas along stream channels where sand and gravel operations exist and pit flooding occurs. Water quality issues and potential groundwater/surface water impact issues could also limit the volume and suitable uses of this potential source of supply.

Agricultural Drainage

In AMAs, drainage water withdrawal permits may be obtained if it is determined that drainage of irrigated lands is necessary for a reasonable economic return from agricultural production in respect to those lands. End-use of water obtained under drainage permits may be allowed for certain non-irrigation, industrial or municipal purposes. In most areas outside AMAs the end-use of agricultural drainage water does not carry this same set of restrictions. However, in the Yuma basin and in other basins where Colorado River is used there are many laws, rules, agreements or treaties that may legally or practically impact the diversion or end-use of irrigation drainage water.

Desalination of Ocean Water

Desalination of ocean water is a possible method that may eventually bring additional water supplies to some Arizona basins. Possible locations for desalination plants include the Gulf of California and Pacific coast of California. In either situation it is unlikely that desalinated ocean water would actually be transported to instate Arizona groundwater basins. Instead, the desalinated water would be exchanged for Colorado River water that would have been used in California or Mexico. Suffice it to say, the costs of such activities would be high, the details complex and ultimate implementation may be far into the future. However, it is a potential long-term option to supplement water supplies that may eventually be available to some basins.

Weather Modification

Cloud seeding projects have occurred in various areas of Arizona in the past. However, no comprehensive assessment of the results of such studies was made in the preparation of this report. Therefore, the potential for cloud seeding to appreciably increase precipitation and to ultimately increase available water supplies in any groundwater basin is uncertain. Weather modification has been successfully employed in other states such as California, Utah, Montana, Wyoming, Colorado and others for more than 20 years in some cases. There are physical and meteorological limitations on the implementation of weather modifications, but in the states that have used it continuously, the average annual increase in precipitation has ranged from a low of about 3 percent to a high of as much as 20 percent with the variability due to the meteorological conditions present during the year.

Summary

The unmet demand analysis for 2035, 2060 and 2010 indicated that unmet demands may potentially range from -608,000 AF/Yr in 2035 to -3,303,000 AF/Yr. in 2110. The analysis indicated that approximately 77% and 82% of the projected unmet demand for 2035 and 2110 would occur in AMAs with the remaining 23% and 18% of the projected unmet demand for those years occurring in non-AMA areas. It is noted, however, that the percent of unmet demand in a basin, versus the raw number, must be considered in any analysis of unmet demand and is a more significant factor of the extent of the problem in any given basin.

Water conservation is seen as an extremely important activity that will help reduce projected future unmet demands. Likewise, whenever possible, the development and use of renewable supplies will help sustain existing groundwater uses and reserves for longer periods of time and better preserve this limited, non-renewable resource for times of drought or other water shortage and provide a more reliable future water supply.

However, since future decisions on developing additional water supplies will involve many complex issues and considerations, it was beyond the scope of this study to specifically recommend the development of one potential source of additional supply over another.

The projections of future unmet demand were used to identify groundwater basins that will eventually require the development of additional water supplies to meet projected future water demands. Water supplies that were evaluated as potential sources of additional water to meet future unmet demands included: groundwater, surface water (instate rivers, Colorado River), CAP, effluent and other miscellaneous supplies.

Additional sources of water supply are potentially available for any given groundwater basin, however there are various hydrologic, technical, legal, environmental and economic issues related to developing such supplies that may limit their practical feasibility or actual development. Table 17 provides a summary of potential additional supplies, issues that may limit their development and use, and general infrastructure requirements associated with developing additional water supplies.

The analysis of Arizona's current and future water supplies and demands has revealed several areas of data deficiency and/or analytical uncertainty that may impact the potential accuracy of the unmet demand analysis. Some major areas of data deficiency and/or analytical uncertainty include:

- Future population growth (magnitude and distribution) and associated water use
- Future levels of agricultural activity and associated water use

- Future levels of industrial activity and associated water use
- Limited hydrogeologic data (recharge estimates, basin storage, water level data)
- Limited water consumption data for some areas and some sectors
- Future impacts of climate change on water supplies and water demand
- Future outcomes of various on-going settlements and legal proceedings related to Tribal water rights and stream adjudications
- Future impacts of various state, Federal and international water negotiations and settlements
- Other

Potential Source of Supply	Potential Issues	Potential Infrastructure Requirements
Conservation	Costs	Lining or Relining Canals, Greywater systems, water use and monitoring equipment, water savings devices and equipment
Groundwater (Within Basin)	Available GW in Storage Current GW Basin Overdraft Aquifer heterogeneity/productivity Water Quality Land Subsidence and Earth Fissures GW/SW Impacts Colorado River Accounting Surface Impacts Environmental Tribal Rights and Claims Groundwater Right and Well Drilling Rules Costs to Drill Wells and to Pump, Treat and Transport Groundwater	Wells Pipelines Storage Facilities Treatment Facilities
Groundwater (Import)	Same as Above Plus Inter-basin GW Transfer Restrictions	Same as Above
Surface water (In-state)	Physical Availability of SW Physical Availability of New Dam and Reservoir Sites Costs to Construct and Operate New SW Diversion and Transport Infrastructure Water Quality Environmental Costs to Treat SW SW Rights (Acquisition) Tribal Rights and Claims	Dams Diversion Works Pipelines Canals Treatment Facilities
Surface water (Colorado River)	Physical Availability of CR Water Water Quality Costs to Treat CR Water Environmental Tribal Rights and Claims Colorado River Entitlements (Acquisition)	Diversion Works Pipelines Canals Treatment Facilities
CAP	Physical Availability of CAP Water Proximity to CAP Canal Tribal Rights and Claims Costs to Treat CAP Water Priorities in Times of Shortage	Diversion Works Pipelines Canals Treatment Facilities
Effluent	Water Quality Treatment and transport costs	Sewer systems Lift stations Pipelines WWTPs
Other Supplies:		
Mine Drainage	GW/SW Impacts Water Quality Treatment and transport costs	Same as for GW
Agricultural Drainage	GW/SW Impacts Water Quality Treatment and transport costs	Same as for GW
Desalination/Ocean Water	International and Interstate Water Transfer Issues Infrastructure and Treatment Costs Ownership of Water Availability of Electric Power	Desalination Plants Pipelines Brine Disposal Systems
Desalination/Brackish Water	Costs Federal Regulations Availability of Electric Power	Desalination Plants Pipelines Brine Disposal Systems
Weather Modification	Technical Feasibility Cost	?

Table 17. Additional Water Supplies That May Potentially Be Developed

Objective 5: Identification of Legal or Technical Issues Associated with the Uses of Potential Supplies

Legal and technical issues were identified for accessing groundwater, surface water and effluent.

Those associated with groundwater include:

- Decreasing physical availability or aquifer heterogeneity possibly limiting water well production
- Current or near term groundwater water quality issues
- Current or near term land subsidence
- Documented or potential groundwater pumping impacts on surface water
- Environmental issues
- Tribal rights or claims
- Some existing limits on well locations and withdrawals
- Complete or partial restrictions on importing or exporting groundwater
- Ownership of groundwater

Legal and technical issues associated with surface water include:

- Physical availability and water storage
- Surface water quality issues
- Water rights
- Environmental issues
- Tribal rights or claims

Legal and technical issues associated with the use of effluent are primarily dealing with environmental issues. However, environmental issues are not the only issues affecting the reuse of effluent. In its final report, the Governor's Blue Ribbon Panel on Water Sustainability made 18 recommendations and 63 additional sub-recommendations to promote reuse. Public education to increase awareness of the value of effluent, facilitating indirect potable reuse, and regulatory permitting inconsistencies are three examples cited by the Blue Ribbon Panel in this regard. Readers should refer to the Blue Ribbon Panel on Water Sustainability Final Report (ADWR/ADEQ/ACC, November 30, 2010) as a source for additional legal and technical issues associated with effluent use. Tables 18 through 21, Potential Additional Water Supplies, Technical and Legal Issues and Potential Infrastructure Needs Necessary to Develop and Deliver Additional Supplies to Fully or Partially Offset Projected Unmet Demands …(2035 through 2110) identify basins where technical and legal issues may exist.

Table 18. Potential Additional Water Supplies, Technical and Legal Issues and Potential Infrastructure Needs Necessary to Develop and Deliver Additional Supplies to Fully or Partially Offset projected Unmet Demands in 2035

Potential Additional Water Supplies, Technical and Legal Issues and Potential Infrastructure Needs Necessary to Develop and Deliver Additional Supplies to Fully or Partially Offset Projected Unment Demands in 2035

Note! Basins Highlighted in Light Blue had Insignificant or No Projected Unmet Demand in 2035

Column groups: 2035 Supply-Demand (Projected Unmet Demand) | Potential Sources of Additional Water Supplies Sufficient to Offset a Portion of Projected Unmet Demand | Potential Physical, Technical and Legal Issues Related to Acquiring, Developing and Delivering Additional Water Supplies to Offset Projected Unmet Demand [1] | Potential Infrastructure Needs to Develop and Deliver Additional Water Supplies (For New Construction or Expansion, Upgrade, or Replacement of Existing Infrastructure)[15]

	Basin	Instate Supply-Low Demand	Instate Supply-High Demand	Conservation	Groundwater: Within Basin or AMA[2]	Groundwater: Basin or AMA Currently Allowed Some GW Imports From Other Legally Specified Basins	Surface Water: Instate[3]	Surface Water: CR[4]	Surface Water: CAP[5]	Effluent[6]	Other[7]	Groundwater: Decreasing Aquifer Storage or Aquifer Heterogenity May Limit Actual Well Production In Some Areas	Groundwater: Current or Near-Term GW-WQ Issues May Limit Some Uses in Some Areas	Groundwater: Current or Near-Term Land Subsidence Concerns In Some Areas	Groundwater: Current GW/SW Connection (h=historic connection, may not currently exist)[8]	Groundwater: Environmental Issues[9]	Groundwater: Tribal Rights/Claims[10]	Groundwater: Some State Legal Limits or Restrictions on Well Locations and/or GW Withdrawals Exist[11]	Groundwater: Complete or Partial Restrictions On Import/Export Of Groundwater Exist	Surface Water: Physical Availability/Extra SW Storage[12]	Surface Water: SW-WQ Issues	Surface Water: Water Rights (Acquire or Transfer)	Surface Water: Environmental Issues[13]	Surface Water: Tribal Rights/Claims[10]	Effluent: Environmental Issues[14]	Other: ?	Infrastructure Groundwater: Wells & Pipelines	Infrastructure Groundwater: Water Treatment Plants or Disinfection Systems	Infrastructure Surface Water: Dams, Diversion Works, Canals, Wells & Pipelines	Infrastructure Surface Water: Water Treatment Plants	Infrastructure Effluent: WWTPs & Lift Stations	Infrastructure Other: ?
Instate Water Supplies Only	AGUA FRIA	-1140	-1256	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	ARAVAIPA CANYON	-24	-25	√	√		√				?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	BIG SANDY	14519	14500	√	√		√				?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	BONITA CREEK	-5	-5	√	√		√				?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	BUTLER VALLEY	3	3	√	?						?	√	√					√	√							?	?	?				
	CIENEGA CREEK	-554	-806	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	COCONINO PLATEAU	944	840	√	√	√	√	√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
	DONNELLY WASH	19	19	√	√		√				?	√	√		√(h)	√			√	√	√	√	√			?	√	√	√	√		
	DOUGLAS	-1141	-1644	√	?	√	√			√	?	√	√	√	√	√		√	√		√	√	√		√	?	?	?			√	
	DRIPPING SPRINGS WASH	-5	-6	√	√		√				?	√	√		√(?)	√	√		√	√	√	√	√	√		?	√	√	√	√		
	DUNCAN VALLEY	-460	-486	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	GILA BEND	-28503	-35627	√	?		√			√	?	√	√	√	(h)	√	√		√	√	√	√	√	√	√	?	?	?	√	√	√	
	GRAND WASH	2	2	√	√			√			?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	HUALAPAI VALLEY	-4010	-4675	√	?			√		√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	?	?	√	√	√	
	LOWER SAN PEDRO	4221	-11918	√	√		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	MCMULLEN VALLEY	-508	-562	√	?						?	√	√	√				√	√	√	√	√	√			?	?	?				
	MEADVIEW	-106	-118	√	√			√			?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	MORENCI	-3279	-39312	√	√		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	PARIA	-9363	-12868	√	√		√	√			?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	PEACH SPRINGS	-359	-381	√	√		√	√		√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	PRESCOTT AMA	-10321	-11936	√	?	√	√			√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	RANEGRAS PLAIN	-48	-55	√	?						?	√	√						√							?	?	?				
	SACRAMENTO VALLEY	-15940	-22001	√	√			√		√	?	√	√		√	√			√		√	√	√		√	?	√	√	√	√	√	
	SAFFORD	-22149	-44490	√	?		√			√	?	√	√	√	√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	SALT RIVER	-12838	-29229	√	?		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	?	?	√	√	√	
	SAN BERNARDINO VALLEY	-6	-7	√	√		√				?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	SAN RAFAEL	-4	-6	√	√		√				?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	SAN SIMON WASH	-142	-216	√	√					√	?	√	√				√		√						√	?	√	√			√	
	SANTA CRUZ AMA	11750	10956	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	SHIVWITS PLATEAU	0	0	√	√		√	√			?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	TIGER WASH	2	2	√	√						?	√	√						√							?	√	√				
	TONTO CREEK	-2968	-3315	√	√		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	UPPER HASSAYAMPA	-1664	-1813	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	UPPER SAN PEDRO	-6044	-17036	√	√	√	√			√	?	√	√		√	√		√	√	√	√	√	√		√	?	√	√	√	√	√	
	VERDE RIVER	-3332	-7857	√	√		√			√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
	VIRGIN RIVER	427	393	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√		
	WESTERN MEXICAN DRAINAGE	0	-1	√	√						?	√	√				√		√							?	√	√				
	WILLCOX	-1213	-3825	√	?		√			√	?	√	√	√	√	√			√	√	√	√	√		√	?	?	?	√	√	√	
Instate Subtotals (Non-Highlighted Basins Only)		-121,566	-251,038																													

Note! Basins Highlighted in Light Blue had Insignificant or No Projected Unmet Demand in 2035

Basins Which Receive Part of their Supply from the Colorado River or CAP	BASIN NAME	Instate+Normal Diversions of CR Supply: -Low Demands	Instate+Normal Diversions of CR Supply: -High Demands	Instate+Shortage Diversions of CR Supply: -Low Demands	Instate+Shortage Diversions of CR Supply: -High Demands	Conservation	Groundwater: Within Basin or AMA[2]	Groundwater: Basin or AMA Currently Allowed Some GW Imports From Other Legally Specified Basins	Surface Water: Instate[3]	Surface Water: CR[4]	Surface Water: CAP[5]	Effluent[6]	Other[7]	Groundwater: Decreasing Aquifer Storage or Aquifer Heterogenity May Limit Actual Well Production In Some Areas	Groundwater: Current or Near-Term GW-WQ Issues May Limit Some Uses in Some Areas	Groundwater: Current or Near-Term Land Subsidence Concerns In Some Areas	Groundwater: Current GW/SW Connection (h=historic connection, may not currently exist)[8]	Groundwater: Environmental Issues[9]	Groundwater: Tribal Rights/Claims[10]	Groundwater: Some State Legal Limits or Restrictions on Well Locations and/or GW Withdrawals Exist[11]	Groundwater: Complete or Partial Restrictions On Import/Export Of Groundwater Exist	Surface Water: Physical Availability/Extra SW Storage[12]	Surface Water: SW-WQ Issues	Surface Water: Water Rights (Acquire or Transfer)	Surface Water: Environmental Issues[13]	Surface Water: Tribal Rights/Claims[11]	Effluent: Environmental Issues[14]	Other: ?	Infrastructure Groundwater: Wells & Pipelines	Infrastructure Groundwater: Water Treatment Plants or Disinfection Systems	Infrastructure Surface Water: Dams, Diversion Works, Canals, Wells & Pipelines	Infrastructure Surface Water: Water Treatment Plants	Infrastructure Effluent: WWTPs	Infrastructure Other: ?
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	-23,132	-64,479	-23,132	-64,479	√	√		√	√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
Instate + CR Lower Mainstem[16,17]	BILL WILLIAMS	-9,718	-29,766	-9,908	-29,956	√	√		√	√		√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	DETRITAL VALLEY	-54	-73	-54	-73	√	√			√			?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	KANAB PLATEAU	-946	-1,033	-966	-1,053	√	√		√	√		√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	LAKE HAVASU	8,880	7,912	-1,602	-2,570	√	?			√		√	?	√	√		√	√		√	√	√	√	√	√		√	?	?	?	√	√	√	
	LAKE MOHAVE	4,613	-158	-5,742	-21,873	√	?			√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	Lake Mohave (Tribal Ag)	35,425	35,425	35,425	35,425	√	?			√			?	√	√		√	√	√		√	√	√	√	√	√		?	?	?	√	√		
	LOWER GILA	198	-18,247	-9	-18,455	√	√			√		√	?	√	√	√	√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	PARKER	7,170	5,401	-2,419	-4,189	√	?	√	√	√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	Parker (Tribal Ag)	45,226	45,226	44,014	44,014	√	?			√			?	√	√		√	√	√		√	√	√	√	√	√		?	?	?	√	√		
	YUMA	46,154	43,212	42,940	39,998	√	?			√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	Yuma (Tribal Ag)	10,963	10,963	10,963	10,963	√	?			√			?	√	√		√	√	√		√	√	√	√	√	√		?	?	?	√	√		
Instate + CAP	HARQUAHALA INA	-70,492	-70,732	-70,492	-70,732	√	?				√		?	√	√	√				√	√							?	?	?				
	PHOENIX AMA	-427,491	-5128	-619,308	-702,944	√	√	√	√		√	√	?	√	√	√	√	√	√	√	√					√	√	?	√	√	√	√	√	
	PINAL AMA	-314,985	-337,076	-365,181	-387,272	√	√	√			√	√	?	√	√	√	√	√	√	√	√					√	√	?	√	√		√	√	
	TUCSON AMA	27,882	18,669	-3,705	-2,918	√	√	√	√		√	√	?	√	√	√	√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
Colorado River + CAP Basin Subtotals (Non-Highlighted basins Only)		-846,765	-1,033,980	-112,454	-136,441																													
Statewide Total (Non-Highlighted Basins Only)		-968,330	-155,546	-1,363,492	-1,567,479																													

1 Please see WRDC Supply & Demand Committee Report - (Unmet Demand Analysis) - for more details on this analysis. Also, please note Cost is regarded as an underlying issue in the development of any additional water supplies to offset projected Unmet Demands.
2 Potential additional groundwater supply identified by √ (checkmark) if basin's Baseline GW Consumption was estimated to be sustainable for at least 100 years as per analysis shown in Basin Characteristic Worksheet.
Basins with uncertain 100 Year Baseline GW sustainability = ?. Mainstem Colorado River basins also received ? due to potential Accounting Surface restrictions.
Basins with Blank = Baseline GW Supply not estimated to be sustainable over Projection Period (ie, 2035, 2060, 2110).
3 Potential additional Instate Surface Water Supply identified for basins having perennial Instate streams within basin as per Basin Characteristic Worksheet. Gila Bend identified because it receives surface water from a diversion on the Gila Riverat basin boundary. Actual development of any such supplies subject to all potential issues and limitations listed.
4 Potential additional Colorado River Supply identified for basins having reachs of Colorado River bordering or within basin as Per Basin Characteristic Worksheet. Actual development of supplies is unlikely unless the flow of the Colorado River is augmented. Development is unlikely for the Hualapai Valley due to engineering reports, others subject to all potential issues and limitations listed.
5 Potential additional CAP supply identified for basins currently receiving CAP. Actual development of any such supplies subject to all potential issues and limitations listed.
6 Potential additional effluent supply identified for basins currently producing more effluent than used in 2006, and/or for basins with significant additional projected municipal growth that will likely be served by providers that will also have municipal sewer and waste water treatment systems.
7 Potential other supplies include, but are not limited to: currently underdeveloped poor quality groundwater, ag and mine drainage water, water harvesting, ocean desalination, weather modifcation, etc.
8 Current GW/SW connection analysis as per Basin Characteristic Worksheet.
9 Basins having current GW/SW connections identified received a √(checkmark) for potential impacts to surface water that could also have environmental impacts.
10 Basins having Tribal lands identified in Basin Characteristic Spreadsheet received a √(checkmark) if potential additional GW or surface water supplies were also identified for basin.
11 Basins identified with √ (checkmark) have some type of legal restriction or limitation on well locations and/or groundwater withdrawals.
12 Basins identified as having potential additional Instate surface water or Colorado River supplies received a √ (checkmark).
13 Basins identified as having potential additional surface water supplies that could be developed or transferred received a √ (checkmark) for potential environmental impacts.
14 Basins identified as having potential effluent resources to use were identified with a √ (checkmark) for potential environmental issues associated with its use. Wastewater discharged to watercourses may support water dependent natural resources. For additional information refer to the Environmental Conditions Basin tables.
15 Potential infrastructure needs checked for any basin having a particular potential source of supply available, regardless of potential volume(s) available or other practical, technical, legal or economic factors that may impact actual development and use of the potential supplies.
16 Any positive Unmet Demands for Colorado River mainstem basins represent water that could be used bY CAP or other Arizona Colorado River water users
17 Any positive Unmet Demand For Colorado River tribal agriculture is reserved for tribal uses.
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

Table 19. Potential Additional Water Supplies, Technical and Legal Issues and Potential Infrastructure Needs Necessary to Develop and Deliver Additional Supplies to Fully or Partially Offset projected Unmet Demands in 2060

Potential Additional Water Supplies, Technical and Legal Issues and Potential Infrastructure Needs Necessary to Develop and Deliver Additional Supplies to Fully or Partially Offset Projected Unment Demands in 2060

Note! Basins Highlighted in Light Blue had Insignificant or No Projected Unmet Demand in 2060

Part 1 – 2060 Supply-Demand (Projected Unmet Demand) and Potential Sources of Additional Water Supplies Sufficient to Offset a Portion of Projected Unmet Demand

	Basin	2060 Supply-Demand (Projected Unmet Demand): Instate Supply-Low Demand	Instate Supply-High Demand	Conservation	Groundwater: Within Basin or AMA[2]	Groundwater: Basin or AMA Currently Allowed Some GW Imports From Other Legally Specified Basins	Surface Water: Instate[3]	Surface Water: CR[4]	Surface Water: CAP[5]	Effluent[6]	Other[7]
Instate Water Supplies Only	AGUA FRIA	-1739	-1879	√	√		√			√	?
	ARAVAIPA CANYON	-50	-51	√	√		√				?
	BIG SANDY	14393	14370	√	√		√				?
	BONITA CREEK	-6	-6	√	√		√				?
	BUTLER VALLEY	3	3	√	?						?
	CIENEGA CREEK	-767	-1031	√	√		√			√	?
	COCONINO PLATEAU	605	480	√	√	√	√	√		√	?
	DONNELLY WASH	19	19	√	√		√				?
	DOUGLAS	-2591	-3147	√	?	√	√			√	?
	DRIPPING SPRINGS WASH	-6	-8	√	√		√				?
	DUNCAN VALLEY	-1047	-1076	√	√		√			√	?
	GILA BEND	-44495	-54593	√			√			√	?
	GRAND WASH	2	2	√	√			√			?
	HUALAPAI VALLEY	-7615	-8390	√	?			√		√	?
	LOWER SAN PEDRO	2167	-13927	√	√		√			√	?
	MCMULLEN VALLEY	-720	-785	√	?						?
	MEADVIEW	-167	-181	√	√			√			?
	MORENCI	-3691	-39729	√	√		√			√	?
	PARIA	-11222	-16147	√	√		√	√			?
	PEACH SPRINGS	-465	-491	√	√		√	√		√	?
	PRESCOTT AMA	-18323	-20143	√	?	√	√			√	?
	RANEGRAS PLAIN	-138	-148	√	?						?
	SACRAMENTO VALLEY	-18931	-25732	√	√			√		√	?
	SAFFORD	-27065	-49457	√	?		√			√	?
	SALT RIVER	-14127	-30610	√	?		√			√	?
	SAN BERNARDINO VALLEY	-8	-9	√	√		√				?
	SAN RAFAEL	-8	-10	√	√		√				?
	SAN SIMON WASH	-540	-633	√	√					√	?
	SANTA CRUZ AMA	8371	7761	√	√		√			√	?
	SHIVWITS PLATEAU	-1	-1	√	√		√	√			?
	TIGER WASH	2	2	√	√						?
	TONTO CREEK	-4456	-4836	√	√		√			√	?
	UPPER HASSAYAMPA	-2799	-2983	√	√		√			√	?
	UPPER SAN PEDRO	-11398	-22425	√	√	√	√			√	?
	VERDE RIVER	-9866	-14155	√	√		√			√	?
	VIRGIN RIVER	98	53	√	√		√			√	?
	WESTERN MEXICAN DRAINAGE	-2	-2	√	√						?
	WILLCOX	-3094	-6736	√	?		√			√	?
Instate Subtotals (Non-Highlighted Basins Only)		-182,782	-318,905								

Part 1 (continued) – Potential Physical, Technical and Legal Issues Related to Acquiring, Developing and Delivering Additional Water Supplies to Offset Projected Unmet Demand[1]

Basin	GW: Decreasing Aquifer Storage or Aquifer Heterogenity May Limit Actual Well Production In Some Areas	GW: Current or Near-Term GW-WQ Issues May Limit Some Uses in Some Areas	GW: Current or Near-Term Land Subsidence Concerns In Some Areas	GW: Current GW/SW Connection (h=historic connection, may not currently exist)[8]	GW: Environmental Issues[9]	GW: Tribal Rights/Claims[10]	GW: Some State Legal Limits or Restrictions on Well Locations and/or GW Withdrawals Exist[11]	GW: Complete or Partial Restrictions On Import/Export Of Groundwater Exist	SW: Physical Availability /Extra SW Storage[12]	SW: SW-WQ Issues	SW: Water Rights (Acquire or Transfer)	SW: Environmental Issues[13]	SW: Tribal Rights/Claims[10]	Effluent: Environmental Issues[14]	Other: ?
AGUA FRIA	√	√		√	√			√	√	√	√	√		√	?
ARAVAIPA CANYON	√	√		√	√	√		√	√	√	√	√	√		?
BIG SANDY	√	√		√	√	√		√	√	√	√	√	√		?
BONITA CREEK	√	√		√	√	√		√	√	√	√	√	√		?
BUTLER VALLEY	√	√					√	√							?
CIENEGA CREEK	√	√		√	√			√	√	√	√	√		√	?
COCONINO PLATEAU	√	√		√	√	√	√	√	√	√	√	√	√	√	?
DONNELLY WASH	√	√		√(h)	√			√	√	√	√	√			?
DOUGLAS	√	√	√	√	√		√	√		√	√	√		√	?
DRIPPING SPRINGS WASH	√	√		√(?)	√	√		√	√	√	√	√	√		?
DUNCAN VALLEY	√	√		√	√			√	√	√	√	√		√	?
GILA BEND	√	√	√	(h)	√	√		√	√	√	√	√	√	√	?
GRAND WASH	√	√		√	√			√	√	√	√	√			?
HUALAPAI VALLEY	√	√		√	√	√		√	√	√	√	√	√	√	?
LOWER SAN PEDRO	√	√		√	√	√		√	√	√	√	√	√	√	?
MCMULLEN VALLEY	√	√	√				√	√	√	√	√	√			?
MEADVIEW	√	√		√	√	√		√	√	√	√	√	√		?
MORENCI	√	√		√	√	√		√	√	√	√	√	√	√	?
PARIA	√	√		√	√			√	√	√	√	√			?
PEACH SPRINGS	√	√		√	√	√		√	√	√	√	√	√	√	?
PRESCOTT AMA	√	√		√	√	√	√	√	√	√	√	√	√	√	?
RANEGRAS PLAIN	√	√						√							?
SACRAMENTO VALLEY	√	√		√	√			√		√	√	√		√	?
SAFFORD	√	√	√	√	√	√	√	√	√	√	√	√	√	√	?
SALT RIVER	√	√		√	√	√		√	√	√	√	√	√	√	?
SAN BERNARDINO VALLEY	√	√		√	√			√	√	√	√	√			?
SAN RAFAEL	√	√		√	√			√	√	√	√	√			?
SAN SIMON WASH	√	√				√		√						√	?
SANTA CRUZ AMA	√	√		√	√			√	√	√	√	√		√	?
SHIVWITS PLATEAU	√	√		√	√	√		√	√	√	√	√	√		?
TIGER WASH	√	√						√							?
TONTO CREEK	√	√		√	√	√		√	√	√	√	√	√	√	?
UPPER HASSAYAMPA	√	√		√	√			√	√	√	√	√		√	?
UPPER SAN PEDRO	√	√		√	√		√	√	√	√	√	√		√	?
VERDE RIVER	√	√		√	√	√	√	√	√	√	√	√	√	√	?
VIRGIN RIVER	√	√		√	√			√	√	√	√	√		√	?
WESTERN MEXICAN DRAINAGE	√	√				√		√							?
WILLCOX	√	√	√	√	√			√	√	√	√	√		√	?

Part 1 (continued) – Potential Infrastructure Needs to Develop and Deliver Additional Water Supplies (For New Construction or Expansion, Upgrade, or Replacement of Existing Infrastructure)[15]

Basin	Groundwater: Wells & Pipelines	Groundwater: Water Treatment Plants or Disinfection Systems	Surface Water: Dams, Diversion Works, Canals, Wells & Pipelines	Surface Water: Water Treatment Plants	Effluent: WWTPs & Lift Stations	Other: ?
AGUA FRIA	√	√	√	√	√	
ARAVAIPA CANYON	√	√	√	√		
BIG SANDY	√	√	√	√		
BONITA CREEK	√	√	√	√		
BUTLER VALLEY	?	?				
CIENEGA CREEK	√	√	√	√	√	
COCONINO PLATEAU	√	√	√	√	√	
DONNELLY WASH	√	√	√	√		
DOUGLAS	?	?			√	
DRIPPING SPRINGS WASH	√	√	√	√		
DUNCAN VALLEY	√	√	√	√	√	
GILA BEND	?	?	√	√	√	
GRAND WASH	√	√	√	√		
HUALAPAI VALLEY	?	?	√	√	√	
LOWER SAN PEDRO	√	√	√	√	√	
MCMULLEN VALLEY	?	?				
MEADVIEW	√	√	√	√		
MORENCI	√	√	√	√	√	
PARIA	√	√	√	√		
PEACH SPRINGS	√	√	√	√	√	
PRESCOTT AMA	?	?	√	√	√	
RANEGRAS PLAIN	?	?				
SACRAMENTO VALLEY	√	√	√	√	√	
SAFFORD	?	?	√	√	√	
SALT RIVER	?	?	√	√	√	
SAN BERNARDINO VALLEY	√	√	√	√		
SAN RAFAEL	√	√	√	√		
SAN SIMON WASH	√	√			√	
SANTA CRUZ AMA	√	√	√	√	√	
SHIVWITS PLATEAU	√	√	√	√		
TIGER WASH	√	√				
TONTO CREEK	√	√	√	√	√	
UPPER HASSAYAMPA	√	√	√	√	√	
UPPER SAN PEDRO	√	√	√	√	√	
VERDE RIVER	√	√	√	√	√	
VIRGIN RIVER	√	√	√	√		
WESTERN MEXICAN DRAINAGE	√	√				
WILLCOX	?	?	√	√	√	

Note! Basins Highlighted in Light Blue had Insignificant or No Projected Unmet Demand in 2060

Part 2 – Basins Which Receive Part of their Supply from the Colorado River or CAP: 2060 Supply-Demand (Projected Unmet Demand) and Potential Sources of Additional Water Supplies Sufficient to Offset a Portion of Projected Unmet Demand

Basins Which Receive Part of their Supply from the Colorado River or CAP	BASIN NAME	Instate+Normal Diversions of CR Supply: -Low Demands	Instate+Normal Diversions of CR Supply: -High Demands	Instate+Shortage Diversions of CR Supply: -Low Demands	Instate+Shortage Diversions of CR Supply: -High Demands	Conservation	Groundwater: Within Basin or AMA[2]	Groundwater: Basin or AMA Currently Allowed Some GW Imports From Other Legally Specified Basins	Surface Water: Instate[3]	Surface Water: CR[4]	Surface Water: CAP[5]	Effluent[6]	Other[7]
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	-58059	-115484	-58059	-115484	√	√		√	√		√	?
Instate + CR Lower Mainstem[16,17]	BILL WILLIAMS	-9975	-30029	-10164	-30219	√	√		√	√		√	?
	DETRITAL VALLEY	-156	-180	-156	-180	√	√			√			?
	KANAB PLATEAU	-1968	-2077	-1988	-2097	√	√		√	√		√	?
	LAKE HAVASU	344	-829	-10138	-11311	√	?			√		√	?
	LAKE MOHAVE	-6852	-15115	-27207	-35470	√	?			√		√	?
	Lake Mohave (Tribal Ag)	35425	35425	35425	35425	√	?			√			?
	LOWER GILA	-6471	-25201	-6679	-25408	√	√			√		√	?
	PARKER	2225	-662	-7364	-10251	√	?	√	√	√		√	?
	Parker (Tribal Ag)	45226	45226	44014	44014	√	?			√			?
	YUMA	30725	27035	27620	23929	√	?			√		√	?
	Yuma (Tribal Ag)	10963	10963	10963	10963	√	?			√			?
Instate + CAP	HARQUAHALA INA	-71338	-71766	-71338	-71766	√	?				√		?
	PHOENIX AMA	-939806	-939993	-1131623	-1131810	√	√	√	√		√	√	?
	PINAL AMA	-234719	-258352	-284915	-308548	√	√	√			√	√	?
	TUCSON AMA	-30606	-40141	-62193	-71729	√	√	√	√		√	√	?
Colorado River + CAP Basin Subtotals (Non-Highlighted basins Only)		-1,322,717	-1,459,510	-1,609,473	-1,742,365								
Statewide Total (Non-Highlighted Basins Only)		-1,505,499	-1,642,291	-1,928,378	-2,061,270								

Part 2 (continued) – Potential Physical, Technical and Legal Issues Related to Acquiring, Developing and Delivering Additional Water Supplies to Offset Projected Unmet Demand[1]

BASIN NAME	GW: Decreasing Aquifer Storage or Aquifer Heterogenity May Limit Actual Well Production In Some Areas	GW: Current or Near-Term GW-WQ Issues May Limit Some Uses in Some Areas	GW: Current or Near-Term Land Subsidence Concerns In Some Areas	GW: Current GW/SW Connection (h=historic connection, may not currently exist)[8]	GW: Environmental Issues[9]	GW: Tribal Rights/Claims[10]	GW: Some State Legal Limits or Restrictions on Well Locations and/or GW Withdrawals Exist[11]	GW: Complete or Partial Restrictions On Import/Export Of Groundwater Exist	SW: Physical Availability /Extra SW Storage[12]	SW: SW-WQ Issues	SW: Water Rights (Acquire or Transfer)	SW: Environmental Issues[13]	SW: Tribal Rights/Claims[10]	Effluent: Environmental Issues[14]	Other: ?
LITTLE COLORADO RIVER PLATEAU	√	√		√	√	√	√	√	√	√	√	√	√	√	?
BILL WILLIAMS	√	√		√	√			√	√	√	√	√		√	?
DETRITAL VALLEY	√	√		√	√			√	√	√	√	√			?
KANAB PLATEAU	√	√		√	√	√		√	√	√	√	√	√	√	?
LAKE HAVASU	√	√		√	√		√	√	√	√	√	√		√	?
LAKE MOHAVE	√	√		√	√	√	√	√	√	√	√	√	√	√	?
Lake Mohave (Tribal Ag)	√	√		√	√	√		√	√	√	√	√	√		?
LOWER GILA	√	√	√	√	√	√		√	√	√	√	√	√	√	?
PARKER	√	√		√	√	√	√	√	√	√	√	√	√	√	?
Parker (Tribal Ag)	√	√		√	√	√		√	√	√	√	√	√		?
YUMA	√	√		√	√	√	√	√	√	√	√	√	√	√	?
Yuma (Tribal Ag)	√	√		√	√	√		√	√	√	√	√	√		?
HARQUAHALA INA	√	√	√				√	√							?
PHOENIX AMA	√	√	√	√	√	√	√	√					√	√	?
PINAL AMA	√	√	√	√	√	√	√	√					√	√	?
TUCSON AMA	√	√	√	√	√	√	√	√	√	√	√	√	√	√	?

Part 2 (continued) – Potential Infrastructure Needs to Develop and Deliver Additional Water Supplies (For New Construction or Expansion, Upgrade, or Replacement of Existing Infrastructure)[15]

BASIN NAME	Groundwater: Wells & Pipelines	Groundwater: Water Treatment Plants or Disinfection Systems	Surface Water: Dams, Diversion Works, Canals, Wells & Pipelines	Surface Water: Water Treatment Plants	Effluent: WWTPs	Other: ?
LITTLE COLORADO RIVER PLATEAU	√	√	√	√	√	
BILL WILLIAMS	√	√	√	√	√	
DETRITAL VALLEY	√	√	√	√		
KANAB PLATEAU	√	√	√	√	√	
LAKE HAVASU	?	?	√	√	√	
LAKE MOHAVE	?	?	√	√	√	
Lake Mohave (Tribal Ag)	?	?	√	√		
LOWER GILA	√	√	√	√	√	
PARKER	?	?	√	√	√	
Parker (Tribal Ag)	?	?	√	√		
YUMA	?	?	√	√	√	
Yuma (Tribal Ag)	?	?	√	√		
HARQUAHALA INA	?	?				
PHOENIX AMA	√	√	√	√	√	
PINAL AMA	√	√		√	√	
TUCSON AMA	√	√	√	√	√	

1 Please see WRDC Supply & Demand Committee Report - (Unmet Demand Analysis) - for more details on this analysis. Also, please note Cost is regarded as an underlying issue in the development of any additional water supplies to offset projected Unmet Demands.
2 Potential additional groundwater supply identified by √ (checkmark) if basin's Baseline GW Consumption was estimated to be sustainable for at least 100 years as per analysis shown in Basin Characteristic Worksheet.
Basins with uncertain 100 Year Baseline GW sustainability = ?. Mainstem Colorado River basins also received ? due to potential Accounting Surface restrictions.
Basins with Blank = Baseline GW Supply not estimated to be sustainable over Projection Period (ie, 2035, 2060, 2110).
3 Potential additional Instate Surface Water Supply identified for basins having perennial Instate streams within basin as per Basin Characteristic Worksheet. Gila Bend identified because it receives surface water from a diversion on the Gila River at basin boundary. Actual development of any such supplies subject to all potential issues and limitations listed.
4 Potential additional Colorado River Supply identified for basins having reachs of Colorado River bordering or within basin as Per Basin Characteristic Worksheet. Actual development of supplies is unlikely unless the flow of the Colorado River is augmented. Development is unlikely for the Hualapai Valley due to engineering reports, others subject to all potential issues and limitations listed.
5 Potential additional CAP supply identified for basins currently receiving CAP. Actual development of any such supplies subject to all potential issues and limitations listed.
6 Potential additional effluent supply identified for basins currently producing more effluent than used in 2006, and/or for basins with significant additional projected municipal growth that will likely be served by providers that will also have municipal sewer and waste water treatment systems.
7 Potential other supplies include, but are not limited to: currently underdeveloped poor quality groundwater, ag and mine drainage water, water harvesting, ocean desalination, weather modifcation, etc.
8 Current GW/SW connection analysis as per Basin Characteristic Worksheet.
9 Basins having current GW/SW connections identified received a √(checkmark) for potential impacts to surface water that could also have environmental impacts.
10 Basins having Tribal lands identified in Basin Characteristic Spreadsheet received a √(checkmark) if potential additional GW or surface water supplies were also identified for basin.
11 Basins identified with √ (checkmark) have some type of legal restriction or limitation on well locations and/or groundwater withdrawals.
12 Basins identified as having potential additional Instate surface water or Colorado River supplies received a √ (checkmark).
13 Basins identified as having potential additional surface water supplies that could be developed or transferred received a √ (checkmark) for potential environmental impacts.
14 Basins identified as having potential effluent resources to use were identified with a √ (checkmark) for potential environmental issues associated with its use. Wastewater discharged to watercourses may support water dependent natural resources. For additional information refer to the Environmental Conditions Basin tables.
15 Potential infrastructure needs checked for any basin having a particular potential source of supply available, regardless of potential volume(s) available or other practical, technical, legal or economic factors that may impact actual development and use of the potential supplies.
16 Any positive Unmet Demands for Colorado River mainstem basins represent water that could be used bY CAP or other Arizona Colorado River water users
17 Any positive Unmet Demand For Colorado River tribal agriculture is reserved for tribal uses.
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

Table 20. Potential Additional Water Supplies, Technical and Legal Issues and Potential Infrastructure Needs Necessary to Develop and Deliver Additional Supplies to Fully or Partially Offset projected Unmet Demands in 2110 (CS)

Potential Additional Water Supplies, Technical and Legal Issues and Potential Infrastructure Needs Necessary to Develop and Deliver Additional Supplies to Fully or Partially Offset Projected Unment Demands in 2110 Census Split

Note! Basins Highlighted in Light Blue had Insignificant or No Projected Unmet Demand in 2110 Census Split

Column groups: 2110 Supply - Demand (Projected Unmet Demand); Potential Sources of Additional Water Supplies Sufficient to Offset a Portion of Projected Unmet Demand; Potential Physical, Technical and Legal Issues Related to Acquiring, Developing and Delivering Additional Water Supplies to Offset Projected Unmet Demand[1]; Potential Infrastructure Needs to Develop and Deliver Additional Water Supplies (For New Construction or Expansion, Upgrade, or Replacement of Existing Infrastructure)[15]

	Basin	Instate Supply - Low Demand	Instate Supply - High Demand	Conservation	Groundwater: Within Basin or AMA[2]	Groundwater: Basin or AMA Currently Allowed Some GW Imports From Other Legally Specified Basins	Surface Water: Instate[3]	Surface Water: CR[4]	Surface Water: CAP[5]	Effluent[6]	Other[7]	Groundwater: Decreasing Aquifer Storage or Aquifer Heterogenity May Limit Actual Well Production In Some Areas	Groundwater: Current or Near-Term GW-WQ Issues May Limit Some Uses in Some Areas	Groundwater: Current or Near-Term Land Subsidence Concerns In Some Areas	Groundwater: Current GW/SW Connection (h=historic connection, may not currently exist)[8]	Groundwater: Environmental Issues[9]	Groundwater: Tribal Rights / Claims[10]	Groundwater: Some State Legal Limits or Restrictions on Well Locations and/or GW Withdrawals Exist[11]	Groundwater: Complete or Partial Restrictions On Import/Export Of Groundwater Exist	Surface Water: Physical Availability / Extra SW Storage[12]	Surface Water: SW-WQ Issues	Surface Water: Water Rights (Acquire or Transfer)	Surface Water: Environmental Issues[13]	Surface Water: Tribal Rights / Claims[10]	Effluent: Environmental Issues[14]	Other: ?	Infrastructure Groundwater: Wells & Pipelines	Infrastructure Groundwater: Water Treatment Plants or Disinfection Systems	Infrastructure Surface Water: Dams, Diversion Works, Canals, Wells & Pipelines	Infrastructure Surface Water: Water Treatment Plants	Infrastructure Effluent: WWTPs & Lift Stations	Infrastructure Other: ?
Instate Water Supplies Only	AGUA FRIA	-3106	-3299	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	ARAVAIPA CANYON	-56	-57	√	√		√				?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	BIG SANDY	14149	14118	√	√		√				?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	BONITA CREEK	-8	-8	√	√		√				?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	BUTLER VALLEY	3	3	√	?						?	√	√					√	√							?	?	?				
	CIENEGA CREEK	-1214	-1502	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	COCONINO PLATEAU	-128	-302	√	√	√	√	√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
	DONNELLY WASH	-831	-887	√	√		√				?	√	√		√(h)	√			√	√	√	√	√			?	√	√	√	√		
	DOUGLAS	-6145	-6833	√	?	√	√			√	?	√	√	√	√	√		√	√		√	√	√		√	?	?	?			√	
	DRIPPING SPRINGS WASH	-13	-16	√	√		√				?	√	√		√(?)	√	√		√	√	√	√	√	√		?	√	√	√	√		
	DUNCAN VALLEY	-1298	-1339	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	GILA BEND	-58605	-72576	√			√			√	?	√	√	√	(h)	√	√		√	√	√	√	√	√	√	?	?	?	√	√	√	
	GRAND WASH	2	2	√	√			√			?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	HUALAPAI VALLEY	-14703	-15694	√	?			√		√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	?	?	√	√	√	
	LOWER SAN PEDRO	285	-15895	√	√		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	MCMULLEN VALLEY	-1152	-1240	√	?						?	√	√	√				√	√	√	√	√	√			?	?	?				
	MEADVIEW	-286	-306	√	√			√			?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	MORENCI	-4611	-40664	√	√		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	PARIA	-12781	-19608	√	√		√	√			?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	PEACH SPRINGS	-700	-737	√	√		√	√		√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	PRESCOTT AMA	-34298	-37024	√	?	√	√			√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	RANEGRAS PLAIN	-253	-265	√	?						?	√	√						√							?	?	?				
	SACRAMENTO VALLEY	-23396	-31429	√	√			√		√	?	√	√		√	√			√		√	√	√		√	?	√	√	√	√	√	
	SAFFORD	-30648	-53190	√	?		√			√	?	√	√	√	√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	SALT RIVER	-16311	-32980	√	?		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	?	?	√	√	√	
	SAN BERNARDINO VALLEY	-19	-20	√	√		√				?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	SAN RAFAEL	-20	-22	√	√		√				?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	SAN SIMON WASH	-1282	-1411	√	√					√	?	√	√				√		√						√	?	√	√			√	
	SANTA CRUZ AMA	2385	1175	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	SHIVWITS PLATEAU	-2	-2	√	√		√	√			?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	TIGER WASH	2	2	√	√						?	√	√						√							?	√	√				
	TONTO CREEK	-7270	-7715	√	√		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	UPPER HASSAYAMPA	-5056	-5311	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	UPPER SAN PEDRO	-23565	-35316	√	√	√	√			√	?	√	√		√	√		√	√	√	√	√	√		√	?	√	√	√	√	√	
	VERDE RIVER	-21754	-27243	√	√		√			√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
	VIRGIN RIVER	-312	-374	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√		
	WESTERN MEXICAN DRAINAGE	-5	-6	√	√						?	√	√				√		√							?	√	√				
	WILLCOX	-5867	-10915	√	?		√			√	?	√	√	√	√	√			√	√	√	√	√		√	?	?	?	√	√	√	
Instate Subtotals (Non-Highlighted Basins Only)		-274,908	-423,789																													

Note! Basins Highlighted in Light Blue had Insignificant or No Projected Unmet Demand in 2110 Census Split

2110 Supply - Demand (Projected Unmet Demand): Instate + Normal Diversions of CR Supply; Instate + Shortage Diversions of CR Supply

Basins Which Receive Part of their Supply from the Colorado River or CAP	BASIN NAME	Instate + Normal Diversions of CR Supply - Low Demands	Instate + Normal Diversions of CR Supply - High Demands	Instate + Shortage Diversions of CR Supply - Low Demands	Instate + Shortage Diversions of CR Supply - High Demands	Conservation	Groundwater: Within Basin or AMA[2]	Groundwater: Basin or AMA Currently Allowed Some GW Imports From Other Legally Specified Basins	Surface Water: Instate[3]	Surface Water: CR[4]	Surface Water: CAP[5]	Effluent[6]	Other[7]	Groundwater: Decreasing Aquifer Storage or Aquifer Heterogenity May Limit Actual Well Production In Some Areas	Groundwater: Current or Near-Term GW-WQ Issues May Limit Some Uses in Some Areas	Groundwater: Current or Near-Term Land Subsidence Concerns In Some Areas	Groundwater: Current GW/SW Connection (h=historic connection, may not currently exist)[8]	Groundwater: Environmental Issues[9]	Groundwater: Tribal Rights / Claims[10]	Groundwater: Some State Legal Limits or Restrictions on Well Locations and/or GW Withdrawals Exist[11]	Groundwater: Complete or Partial Restrictions On Import/Export Of Groundwater Exist	Surface Water: Physical Availability / Extra SW Storage[12]	Surface Water: SW-WQ Issues	Surface Water: Water Rights (Acquire or Transfer)	Surface Water: Environmental Issues[13]	Surface Water: Tribal Rights / Claims[10]	Effluent: Environmental Issues[14]	Other: ?	Infrastructure Groundwater: Wells & Pipelines	Infrastructure Groundwater: Water Treatment Plants or Disinfection Systems	Infrastructure Surface Water: Dams, Diversion Works, Canals, Wells & Pipelines	Infrastructure Surface Water: Water Treatment Plants	Infrastructure Effluent: WWTPs	Infrastructure Other: ?
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	-100433	-180359	-100433	-180359	√	√		√	√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
Instate + CR Lower Mainstem[16,17]	BILL WILLIAMS	-10705	-30782	-10895	-30972	√	√		√	√		√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	DETRITAL VALLEY	-352	-385	-352	-385	√	√			√			?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	KANAB PLATEAU	-3854	-4006	-3874	-4025	√	√		√	√		√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	LAKE HAVASU	-15296	-16785	-25778	-27267	√	?			√		√	?	√	√		√	√		√	√	√	√	√	√		√	?	?	?	√	√	√	
	LAKE MOHAVE	-26447	-38110	-46801	-58464	√	?			√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	Lake Mohave (Tribal Ag)	35425	35425	35425	35425	√	?			√			?	√	√		√	√	√		√	√	√	√	√	√		?	?	?	√	√		
	LOWER GILA	-18483	-37463	-18691	-37670	√	√			√		√	?	√	√	√	√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	PARKER	-3183	-6973	-12772	-16562	√	?	√	√	√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	Parker (Tribal Ag)	45226	45226	44014	44014	√	?			√			?	√	√		√	√	√		√	√	√	√	√	√		?	?	?	√	√		
	YUMA	-6257	-11465	-9362	-14571	√	?			√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	Yuma (Tribal Ag)	10963	10963	10963	10963	√	?			√			?	√	√		√	√	√		√	√	√	√	√	√		?	?	?	√	√		
Instate + CAP	HARQUAHALA INA	-72196	-72775	-72196	-72775	√	?				√		?	√	√	√				√	√							?	?	?				
	PHOENIX AMA	-1795524	-1935397	-1987341	-2127214	√	√	√	√		√	√	?	√	√	√	√	√	√	√	√					√	√	?	√	√	√	√	√	
	PINAL AMA	-315691	-348525	-365887	-398721	√	√	√			√	√	?	√	√	√	√	√	√	√	√					√	√	?	√	√		√	√	
	TUCSON AMA	-141162	-152509	-172749	-184097	√	√	√	√		√	√	?	√	√	√	√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
Colorado River + CAP Basin Subtotals (Non-Highlighted basins Only)		-2,509,584	-2,835,533	-2,827,132	-3,153,081																													
Statewide Total (Non-Highlighted Basins Only)		-2,784,492	-3,110,441	-3,250,922	-3,576,871																													

1 Please see WRDC Supply & Demand Committee Report - (Unmet Demand Analysis) - for more details on this analysis. Also, please note Cost is regarded as an underlying issue in the development of any additional water supplies to offset projected Unmet Demands.
2 Potential additional groundwater supply identified by √ (checkmark) if basin's Baseline GW Consumption was estimated to be sustainable for at least 100 years as per analysis shown in Basin Characteristic Worksheet.
Basins with uncertain 100 Year Baseline GW sustainability = ?. Mainstem Colorado River basins also received ? due to potential Accounting Surface restrictions.
Basins with Blank = Baseline GW Supply not estimated to be sustainable over Projection Period (ie, 2035, 2060, 2110).
3 Potential additional Instate Surface Water Supply identified for basins having perennial Instate streams within basin as per Basin Characteristic Worksheet. Gila Bend identified because it receives surface water from a diversion on the Gila Riverat basin boundary. Actual development of any such supplies subject to all potential issues and limitations listed.
4 Potential additional Colorado River Supply identified for basins having reaches of Colorado River bordering or within basin as Per Basin Characteristic Worksheet. Actual development of supplies is unlikely unless the flow of the Colorado River is augmented. Development is unlikely for the Hualapai Valley due to engineering reports, others subject to all potential issues and limitations listed.
5 Potential additional CAP supply identified for basins currently receiving CAP. Actual development of any such supplies subject to all potential issues and limitations listed.
6 Potential additional effluent supply identified for basins currently producing more effluent than used in 2006, and/or for basins with significant additional projected municipal growth that will likely be served by providers that will also have municipal sewer and waste water treatment systems.
7 Potential other supplies include, but are not limited to: currently underdeveloped poor quality groundwater, ag and mine drainage water, water harvesting, ocean desalination, weather modifcation, etc.
8 Current GW/SW connection analysis as per Basin Characteristic Worksheet.
9 Basins having current GW/SW connections identified received a √(checkmark) for potential impacts to surface water that could also have environmental impacts.
10 Basins having Tribal lands identified in Basin Characteristic Spreadsheet received a √(checkmark) if potential additional GW or surface water supplies were also identified for basin.
11 Basins identified with √ (checkmark) have some type of legal restriction or limitation on well locations and/or groundwater withdrawals.
12 Basins identified as having potential additional Instate surface water or Colorado River supplies received a √ (checkmark).
13 Basins identified as having potential additional surface water supplies that could be developed or transferred received a √ (checkmark) for potential environmental impacts.
14 Basins identified as having potential effluent resources to use were identified with a √ (checkmark) for potential environmental issues associated with its use. Wastewater discharged to watercourses may support water dependent natural resources. For additional information refer to the Environmental Conditions Basin tables.
15 Potential infrastructure needs checked for any basin having a particular potential source of supply available, regardless of potential volume(s) available or other practical, technical, legal or economic factors that may impact actual development and use of the potential supplies.
16 Any positive Unmet Demands for Colorado River mainstem basins represent water that could be used by CAP or other Arizona Colorado River water users
17 Any positive Unmet Demand For Colorado River tribal agriculture is reserved for tribal uses.
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

Table 21. Potential Additional Water Supplies, Technical and Legal Issues and Potential Infrastructure Needs Necessary to Develop and Deliver Additional Supplies to Fully or Partially Offset projected Unmet Demands in 2110 (AS)

Potential Additional Water Supplies, Technical and Legal Issues and Potential Infrastructure Needs Necessary to Develop and Deliver Additional Supplies to Fully or Partially Offset Projected Unment Demands in 2110 Area Split

Note! Basins Highlighted in Light Blue had Insignificant or No Projected Unmet Demand in 2110 Area Split

	Basin	2110 Supply-Demand (Projected Unmet Demand): Instate Supply-Low Demand	Instate Supply-High Demand	Potential Sources of Additional Water Supplies Sufficient to Offset a Portion of Projected Unmet Demand: Conservation	Groundwater: Within Basin or AMA[2]	Groundwater: Basin or AMA Currently Allowed Some GW Imports From Other Legally Specified Basins	Surface Water: Instate[3]	Surface Water: CR[4]	Surface Water: CAP[5]	Effluent[6]	Other[7]	Potential Physical, Technical and Legal Issues Related to Acquiring, Developing and Delivering Additional Water Supplies to Offset Projected Unmet Demand[1] — Groundwater: Decreasing Aquifer Storage or Aquifer Heterogenity May Limit Actual Well Production In Some Areas	Groundwater: Current or Near-Term GW-WQ Issues May Limit Some Uses in Some Areas	Groundwater: Current or Near-Term Land Subsidence Concerns In Some Areas	Groundwater: Current GW/SW Connection (h=historic connection, may not currently exist)[8]	Groundwater: Environmental Issues[9]	Groundwater: Tribal Rights / Claims[10]	Groundwater: Some State Legal Limits or Restrictions on Well Locations and/or GW Withdrawals Exist[11]	Groundwater: Complete or Partial Restrictions On Import/Export Of Groundwater Exist	Surface Water: Physical Availability / Extra SW Storage[12]	Surface Water: SW-WQ Issues	Surface Water: Water Rights (Acquire or Transfer)	Surface Water: Environmental Issues[13]	Surface Water: Tribal Rights / Claims[10]	Effluent: Environmental Issues[14]	Other: ?	Potential Infrastructure Needs to Develop and Deliver Additional Water Supplies (For New Construction or Expansion, Upgrade, or Replacement of Existing Infrastructure)[15] — Groundwater: Wells & Pipelines	Groundwater: Water Treatment Plants or Disinfection Systems	Surface Water: Dams, Diversion Works, Canals, Wells & Pipelines	Surface Water: Water Treatment Plants	Effluent: WWTPs & Lift Stations	Other: ?
Instate Water Supplies Only	AGUA FRIA	-71872	-67372	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	ARAVAIPA CANYON	-134	-141	√	√		√				?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	BIG SANDY	11796	11681	√	√		√				?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	BONITA CREEK	-342	-357	√	√		√				?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	BUTLER VALLEY	3	3	√	?						?	√	√					√	√							?	?	?				
	CIENEGA CREEK	-994	-1270	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	COCONINO PLATEAU	-540	-741	√	√	√	√	√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
	DONNELLY WASH	-831	-887	√	√		√				?	√	√		√(h)	√			√	√	√	√	√			?	√	√	√	√		
	DOUGLAS	-5498	-6162	√	?	√	√			√	?	√	√	√	√	√		√	√		√	√	√		√	?	?	?			√	
	DRIPPING SPRINGS WASH	-576	-640	√	√		√				?	√	√		√(?)	√	√		√	√	√	√	√	√		?	√	√	√	√		
	DUNCAN VALLEY	-1364	-1408	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	GILA BEND	-82757	-94193	√			√			√	?	√	√	√	(h)	√	√		√	√	√	√	√	√	√	?	?	?	√	√	√	
	GRAND WASH	-77	-81	√	√			√			?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	HUALAPAI VALLEY	-12422	-13343	√	?			√		√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	?	?	√	√	√	
	LOWER SAN PEDRO	-538	-16995	√	√		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	MCMULLEN VALLEY	-1932	-2062	√	?						?	√	√	√				√	√	√	√	√	√			?	?	?				
	MEADVIEW	75	72	√	√			√			?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	MORENCI	-5011	-41070	√	√		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	PARIA	-12630	-19452	√	√		√	√			?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	PEACH SPRINGS	-1856	-1942	√	√		√	√		√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	PRESCOTT AMA	-28984	-31359	√	?	√	√			√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	RANEGRAS PLAIN	-97	-106	√	?						?	√	√						√							?	?	?				
	SACRAMENTO VALLEY	-23873	-31922	√	√			√		√	?	√	√		√	√			√		√	√	√		√	?	√	√	√	√	√	
	SAFFORD	-30588	-53127	√	?		√			√	?	√	√	√	√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	SALT RIVER	-17951	-34697	√	?		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	?	?	√	√	√	
	SAN BERNARDINO VALLEY	-887	-911	√	√		√				?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	SAN RAFAEL	-154	-163	√	√		√				?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	SAN SIMON WASH	-1505	-1644	√	√					√	?	√	√				√		√						√	?	√	√			√	
	SANTA CRUZ AMA	2084	831	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	SHIVWITS PLATEAU	-818	-851	√	√		√	√			?	√	√		√	√	√		√	√	√	√	√	√		?	√	√	√	√		
	TIGER WASH	-1283	-1305	√	√						?	√	√						√							?	√	√				
	TONTO CREEK	-11167	-11940	√	√		√			√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	UPPER HASSAYAMPA	425	342	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	UPPER SAN PEDRO	-22991	-34696	√	√	√	√			√	?	√	√		√	√		√	√	√	√	√	√		√	?	√	√	√	√	√	
	VERDE RIVER	-23465	-29200	√	√		√			√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
	VIRGIN RIVER	969	960	√	√		√			√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√		
	WESTERN MEXICAN DRAINAGE	-117	-122	√	√						?	√	√				√		√							?	√	√				
	WILLCOX	-5421	-10456	√	?		√			√	?	√	√	√	√	√			√	√	√	√	√		√	?	?	?	√	√	√	
Instate Subtotals (Non-Highlighted Basins Only)		-368,097	-510,003																													

Note! Basins Highlighted in Light Blue had Insignificant or No Projected Unmet Demand in 2110 Area Split

Basins Which Receive Part of their Supply from the Colorado River or CAP	BASIN NAME	2110 Supply-Demand (Projected Unmet Demand): Instate+Normal Diversions of CR Supply -Low Demands	Instate+Normal Diversions of CR Supply -High Demands	Instate+Shortage Diversions of CR Supply -Low Demands	Instate+Shortage Diversions of CR Supply -High Demands	Conservation	Groundwater: Within Basin or AMA[2]	Groundwater: Basin or AMA Currently Allowed Some GW Imports From Other Legally Specified Basins	Surface Water: Instate[3]	Surface Water: CR[4]	Surface Water: CAP[5]	Effluent[6]	Other[7]	Groundwater: Decreasing Aquifer Storage or Aquifer Heterogenity May Limit Actual Well Production In Some Areas	Groundwater: Current or Near-Term GW-WQ Issues May Limit Some Uses in Some Areas	Groundwater: Current or Near-Term Land Subsidence Concerns In Some Areas	Groundwater: Current GW/SW Connection (h=historic connection, may not currently exist)[8]	Groundwater: Environmental Issues[9]	Groundwater: Tribal Rights / Claims[10]	Groundwater: Some State Legal Limits or Restrictions on Well Locations and/or GW Withdrawals Exist[11]	Groundwater: Complete or Partial Restrictions On Import/Export Of Groundwater Exist	Surface Water: Physical Availability / Extra SW Storage[12]	Surface Water: SW-WQ Issues	Surface Water: Water Rights (Acquire or Transfer)	Surface Water: Environmental Issues[13]	Surface Water: Tribal Rights / Claims[10]	Effluent: Environmental Issues[14]	Other: ?	Infrastructure[15] Groundwater: Wells & Pipelines	Groundwater: Water Treatment Plants or Disinfection Systems	Surface Water: Dams, Diversion Works, Canals, Wells & Pipelines	Surface Water: Water Treatment Plants	Effluent: WWTPs	Other: ?
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	-100044	-179947	-100044	-179947	√	√		√	√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
Instate + CR Lower Mainstem[16,17]	BILL WILLIAMS	-16986	-37019	-17176	-37209	√	√		√	√		√	?	√	√		√	√			√	√	√	√	√		√	?	√	√	√	√	√	
	DETRITAL VALLEY	-596	-641	-596	-641	√	√			√			?	√	√		√	√			√	√	√	√	√			?	√	√	√	√		
	KANAB PLATEAU	-4812	-4985	-4832	-5005	√	√		√	√		√	?	√	√		√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	LAKE HAVASU	-14933	-16413	-25415	-26895	√	?			√		√	?	√	√		√	√		√	√	√	√	√	√		√	?	?	?	√	√	√	
	LAKE MOHAVE	-22697	-34211	-43051	-54565	√	?			√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	Lake Mohave (Tribal Ag)	35425	35425	35425	35425	√	?			√			?	√	√		√	√	√		√	√	√	√	√	√		?	?	?	√	√		
	LOWER GILA	-33360	-51324	-33567	-51531	√	√			√		√	?	√	√	√	√	√	√		√	√	√	√	√	√	√	?	√	√	√	√	√	
	PARKER	-2854	-6635	-12443	-16224	√	?	√	√	√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	Parker (Tribal Ag)	45226	45226	44014	44014	√	?			√			?	√	√		√	√	√		√	√	√	√	√	√		?	?	?	√	√		
	YUMA	-5548	-10733	-8654	-13839	√	?			√		√	?	√	√		√	√	√	√	√	√	√	√	√	√	√	?	?	?	√	√	√	
	Yuma (Tribal Ag)	10963	10963	10963	10963	√	?			√			?	√	√		√	√	√		√	√	√	√	√	√		?	?	?	√	√		
Instate + CAP	HARQUAHALA INA	-76464	-76985	-76464	-76985	√	?				√		?	√	√	√				√	√							?	?	?				
	PHOENIX AMA	-1612642	-1741968	-1804459	-1933785	√	√	√	√		√	√	?	√	√	√	√	√	√	√	√					√	√	?	√	√	√	√	√	
	PINAL AMA	-313822	-348653	-364018	-398849	√	√	√			√	√	?	√	√	√	√	√	√	√	√					√	√	?	√	√		√	√	
	TUCSON AMA	-140674	-151692	-172262	-183279	√	√	√	√		√	√	?	√	√	√	√	√	√	√	√	√	√	√	√	√	√	?	√	√	√	√	√	
Colorado River + CAP Basin Subtotals (Non-Highlighted basins Only)		-2,345,431	-2,661,205	-2,662,979	-2,978,753																													
Statewide Total (Non-Highlighted Basins Only)		-2,713,528	-3,029,301	-3,172,983	-3,488,756																													

1 Please see WRDC Supply & Demand Committee Report - (Unmet Demand Analysis) - for more details on this analysis. Also, please note Cost is regarded as an underlying issue in the development of any additional water supplies to offset projected Unmet Demands.
2 Potential additional groundwater supply identified by √ (checkmark) if basin's Baseline GW Consumption was estimated to be sustainable for at least 100 years as per analysis shown in Basin Characteristic Worksheet.
Basins with uncertain 100 Year Baseline GW sustainability = ?. Mainstem Colorado River basins also received ? due to potential Accounting Surface restrictions.
Basins with Blank = Baseline GW Supply not estimated to be sustainable over Projection Period (ie, 2035, 2060, 2110).
3 Potential additional Instate Surface Water Supply identified for basins having perennial Instate streams within basin as per Basin Characteristic Worksheet. Gila Bend identified because it receives surface water from a diversion on the Gila River at basin boundary. Actual development of any such supplies subject to all potential issues and limitations listed.
4 Potential additional Colorado River Supply identified for basins having reaches of Colorado River bordering or within basin as Per Basin Characteristic Worksheet. Actual development of supplies is unlikely unless the flow of the Colorado River is augmented. Development is unlikely for the Hualapai Valley due to engineering reports, others subject to all potential issues and limitations listed.
5 Potential additional CAP supply identified for basins currently receiving CAP. Actual development of any such supplies subject to all potential issues and limitations listed.
6 Potential additional effluent supply identified for basins currently producing more effluent than used in 2006, and/or for basins with significant additional projected municipal growth that will likely be served by providers that will also have municipal sewer and waste water treatment systems.
7 Potential other supplies include, but are not limited to: currently underdeveloped poor quality groundwater, ag and mine drainage water, water harvesting, ocean desalination, weather modifcation, etc.
8 Current GW/SW connection analysis as per Basin Characteristic Worksheet.
9 Basins having current GW/SW connections identified received a √(checkmark) for potential impacts to surface water that could also have environmental impacts.
10 Basins having Tribal lands identified in Basin Characteristic Spreadsheet received a √(checkmark) if potential additional GW or surface water supplies were also identified for basin.
11 Basins identified with √ (checkmark) have some type of legal restriction or limitation on well locations and/or groundwater withdrawals.
12 Basins identified as having potential additional Instate surface water or Colorado River supplies received a √ (checkmark).
13 Basins identified as having potential additional surface water supplies that could be developed or transferred received a √ (checkmark) for potential environmental impacts.
14 Basins identified as having potential effluent resources to use were identified with a √ (checkmark) for potential environmental issues associated with its use. Wastewater discharged to watercourses may support water dependent natural resources. For additional information refer to the Environmental Conditions Basin tables.
15 Potential infrastructure needs checked for any basin having a particular potential source of supply available, regardless of potential volume(s) available or other practical, technical, legal or economic factors that may impact actual development and use of the potential supplies.
16 Any positive Unmet Demands for Colorado River mainstem basins represent water that could be used bY CAP or other Arizona Colorado River water users
17 Any positive Unmet Demand For Colorado River tribal agriculture is reserved for tribal uses.
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

CONCLUSIONS

The WS&D Working Group was asked to identify whether current water supplies exist to meet projected demands by county and groundwater basin for 2035, 2060 and 2110 for agriculture, municipal, and industrial needs. Additionally, the WS&D Working Group was to evaluate future water supply options for potential impacts on and risks to water-dependent natural resources. It is impossible to look at the State of Arizona's water situation without considering the tribal water settlements. Data from the Arizona Water Atlas was utilized for baseline information to develop this report. While the Atlas did consider tribal water demands, in some cases, the information was based on estimates due to the availability of information. The Inter Tribal Council of Arizona and the Navajo Department of Water Resources participated in the Working Group and provided the report titled The Future of Water Resources in Arizona: A Tribal Report. The report is included in Appendix 6. The water rights and entitlements identified in the report must be considered along with the projections made by the WS&D Working Group and in analyzing future water demands in the State.

Review of the data for 2035 (statewide) reveals a minimum of 968,000 acre-feet to a maximum of 1,567,000 acre-feet of water may be needed to meet the projected demands for some basins. In the best case scenario, when low demand and normal supply occurs, nine basins may have a need for an excess of 10,000 acre-feet, three basins an excess of 50,000 acre-feet and two basins in excess of 100,000 acre-feet of water. If high demand and shortage supplies occur, the number of basins that may have a need for an excess of 10,000 acre-feet grows to seventeen and an excess of 50,000 acre-feet grows to four. To put this in perspective, Flagstaff currently uses 8,000 to 10,000 acre-feet of water in one year. Thirteen basins are projected to have unmet demands of 30% of greater.

Looking at the data for 2060, a minimum of 1,505,000 acre-feet and a maximum of 2,061,000 acre-feet of water needed for some basins. In the best case scenario, when low demand and normal supply occurs, twelve basins will have a need for an excess of 10,000 acre-feet, four basins an excess of 50,000 acre-feet and two basins in excess of 100,000 acre-feet of water. If high demand and shortage supplies occur, the number of basins that will have a need for an excess of 10,000 acre-feet grows to twenty and basins with a need in excess of 50,000 acre-feet grows to six. The number of basins needing an excess of 100,000 acre-feet increases to three. Sixteen basins are projected to have unmet demands of 30% or greater.

Data for 2110 (census split method) shows a statewide need of from 2,784,000 to 3,577,000 acre-feet of water. In the best case scenario, when low demand and normal supply occurs, eighteen basins will have a need for an excess of 10,000 acre-feet, six basins an excess of 50,000 acre-feet and four basins in excess of 100,000 acre-feet of water. If high demand and shortage supplies occur, the number of basins that will have a need for an excess of 10,000 acre-feet grows to twenty-three and basins with a need in excess of 50,000 acre-feet grows to eight. The number of basins needing an excess of 100,000 acre-feet remains at four. Twenty-eight basins are projected to have unmet demands of 30% or greater.

The 2110 data for the area split method shows a statewide need of from 2,714,000 acre-feet to 3,489,000 acre-feet of water. In the best case scenario, when low demand and normal supply occurs, twenty basins will have a need for an excess of 10,000 acre-feet, seven basins an excess of 50,000 acre-feet and four basins in excess of 100,000 acre-feet of water. If high demand and shortage supplies occur, the number of basins that will have a need for an excess of 10,000 acre-feet grows to twenty-five and basins with a need in excess of 50,000 acre-feet grows to ten. The number of basins needing an excess of 100,000 acre-feet remains at four.

Important to note is that the projected needs do not take into account additional water resources that can be developed. The projected water needs are based on currently developed/entitled supplies. A combination of groundwater development, reuse of effluent, and conservation strategies are identified as having potential for further development to help meet future demands. Use of surface water, a renewable resource, is a potential source of supply when transfer of entitlements can occur. Conservation is currently widely used across the State with varying results, depending on the requirements in place and strategy of the water provider. For conservation alone to meet the State's water needs for 2060, consumption would need to be reduced by approximately 14% for the low demand scenario and 17% for the high demand scenario across all sectors. This assumes normal supplies are available. Reuse of effluent from wastewater treatment plants is also currently utilized by many water providers to offset demands. Often, the cost of infrastructure to increase the level of treatment and deliver the reclaimed water acts as a barrier for additional reuse. Public perception of the use of treated effluent will also have to be improved before some indirect or any direct reuse projects can be developed. Current environmental use of effluent also needs to be considered when identifying how much impact additional reuse can have on meeting projected demands.

In some basins, augmentation of surface water entitlements and additional groundwater development hold the most promise for meeting future needs other than a major desalination project. These projects face technical and, in some cases, legal obstacles as well as being very expensive.

Figures 15 through 18. Currently Developed & Adjusted Supplies Vs. 2035-2110 Projected Demands show maps of the Arizona counties and their associated groundwater basins.

RECOMMENDATIONS

The compilation and projection of water supply and demand data is only one part of the overall task of assessing and preparing for Arizona's future water needs. It will be important to continue to improve and refine estimates and plans on a more detailed local or sub-regional basis before significant decisions regarding the development of future additional water supplies occurs.

The following recommendations are provided to support and promote sound water management policies and the analysis of the state's future water needs:

- Continue to support and promote water conservation at all levels and in all areas of the state. The potential for water conservation to reduce future water demand was not addressed in this analysis and should be evaluated and taken into account in further analysis of future water demand and supply needs.
- Continue to support the use and development of renewable water supplies when available and practical
- Continue to collect and analyze water consumption data, throughout the state, added efforts are needed with respect to rural areas and on Tribal lands, with the cooperation of Tribal governments involved.
- Continue to collect and analyze hydrogeologic data to better estimate basin and local area recharge, groundwater storage, water level change trends and other basin characteristics and water budget components.
- Using GIS and other methods, begin a process to analyze basin-level supply and demand data, and hydrogeologic data at the county-level or other planning area levels of analysis.
- Continue to support research on potential impacts of climate change on future water supplies and demands.
- Integrate the most recent census data into future population projections and water demand analyses.
- Compile and evaluate weather modification data for the state and for the Colorado River basin area in general. Potentially support efforts, even if conducted out of state, that may significantly enhance Colorado River Basin precipitation and runoff.
- The Commission create and support a continuing Departmental effort to refine, update, expand and use

the information generated by all the working groups. Work is still needed to fill data gaps and enhance analytical methodologies, to evaluate future water supply alternatives for each of Arizona's counties and groundwater basins, and to further analyze and address the associated technical and legal issues associated with those alternatives.

- The potential for Colorado River shortages beyond the "first-tier" shortage have not been addressed in this analysis. Drought and shortage should be taken further into account by further analysis.
- Continue to support needed research and data collection and develop methods to incorporate consideration of water supplies that support water-dependent natural resources and environmental issues into the analysis of water supply needs and alternatives.

Figure 15. Currently Developed and Adjusted Supplies Vs. 2035 Projected Demands

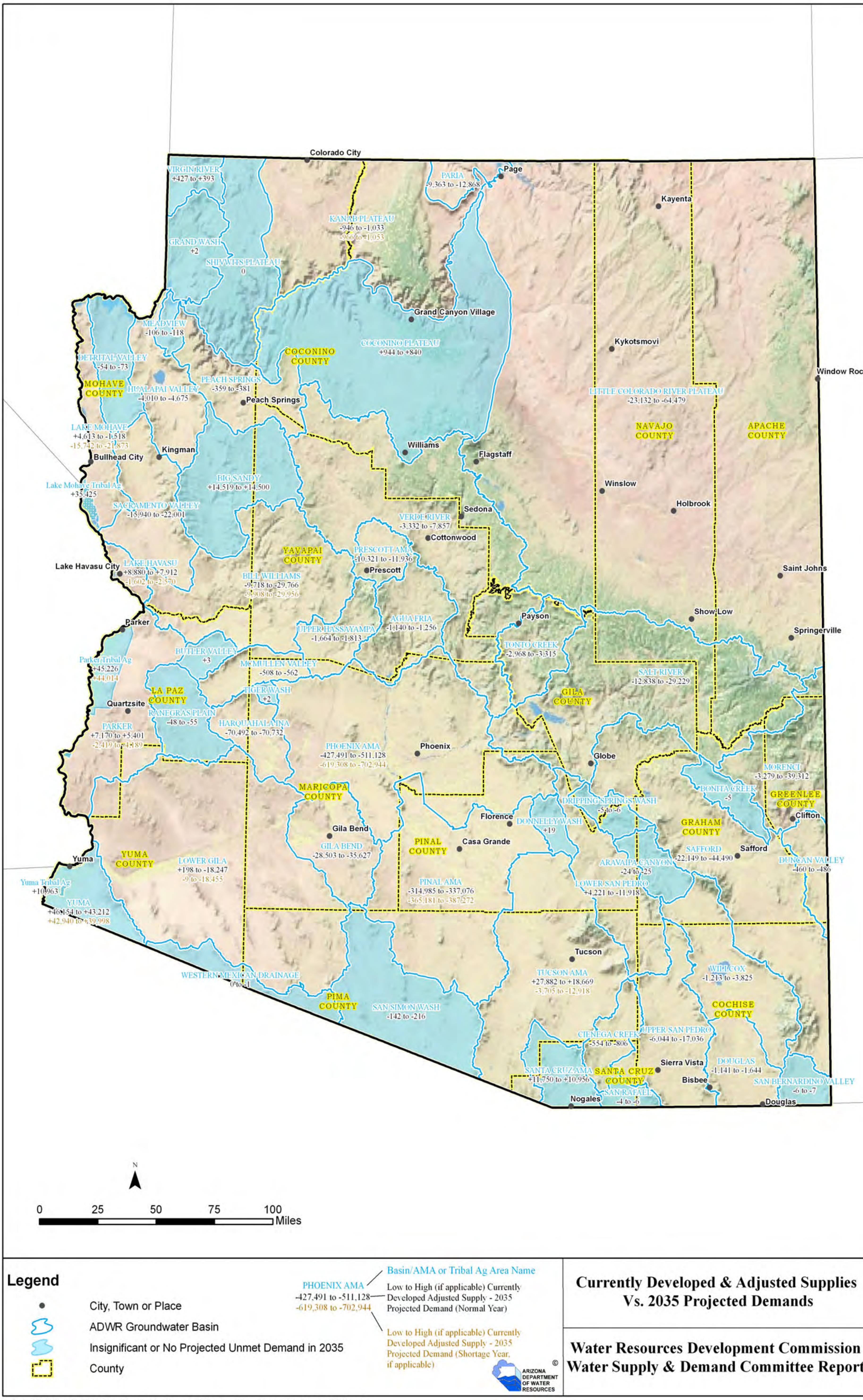


Figure 16. Currently Developed and Adjusted Supplies Vs. 2060 Projected Demands

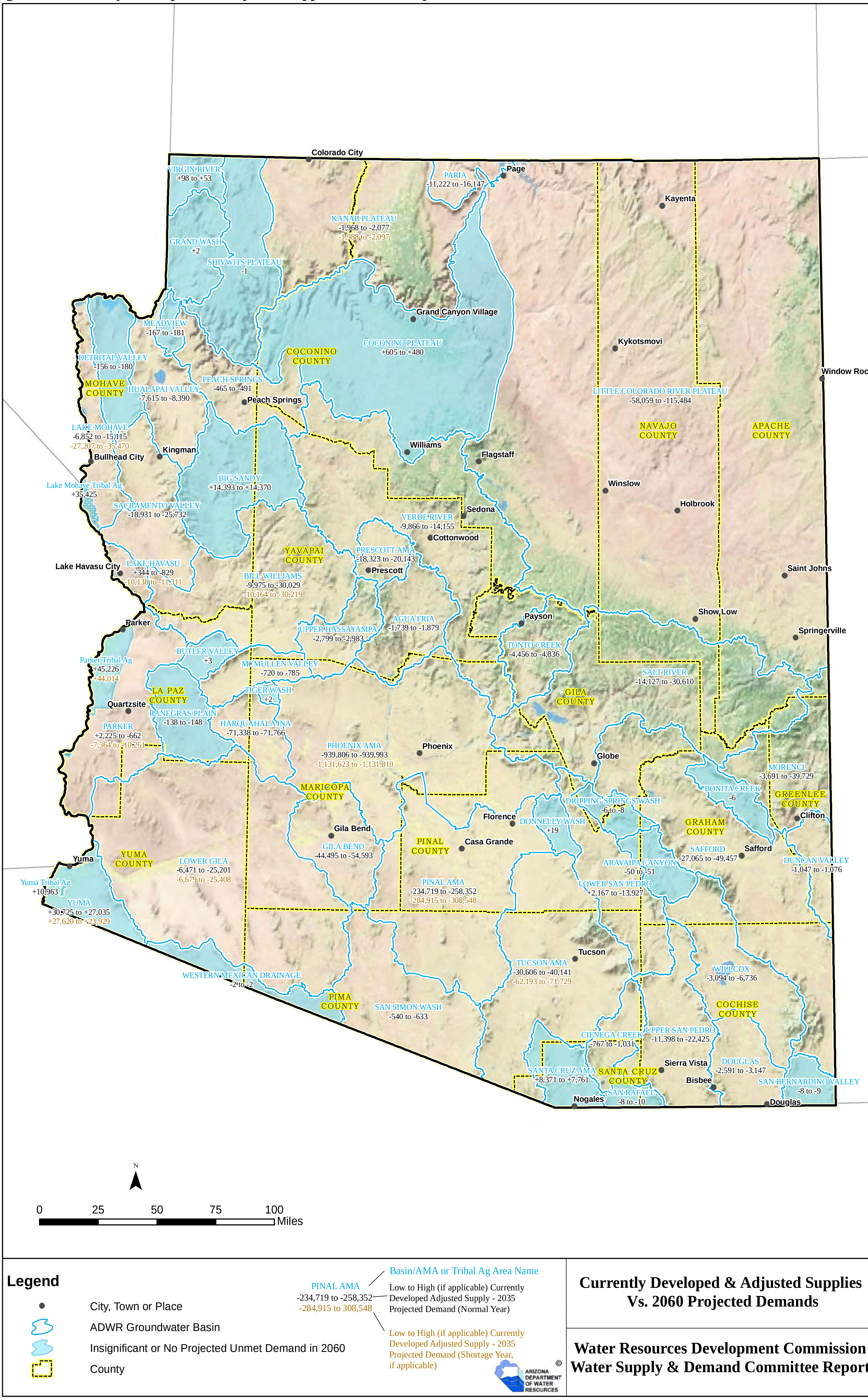


Figure 17. Currently Developed and Adjusted Supplies Vs. 2110 (CS) Projected Demands

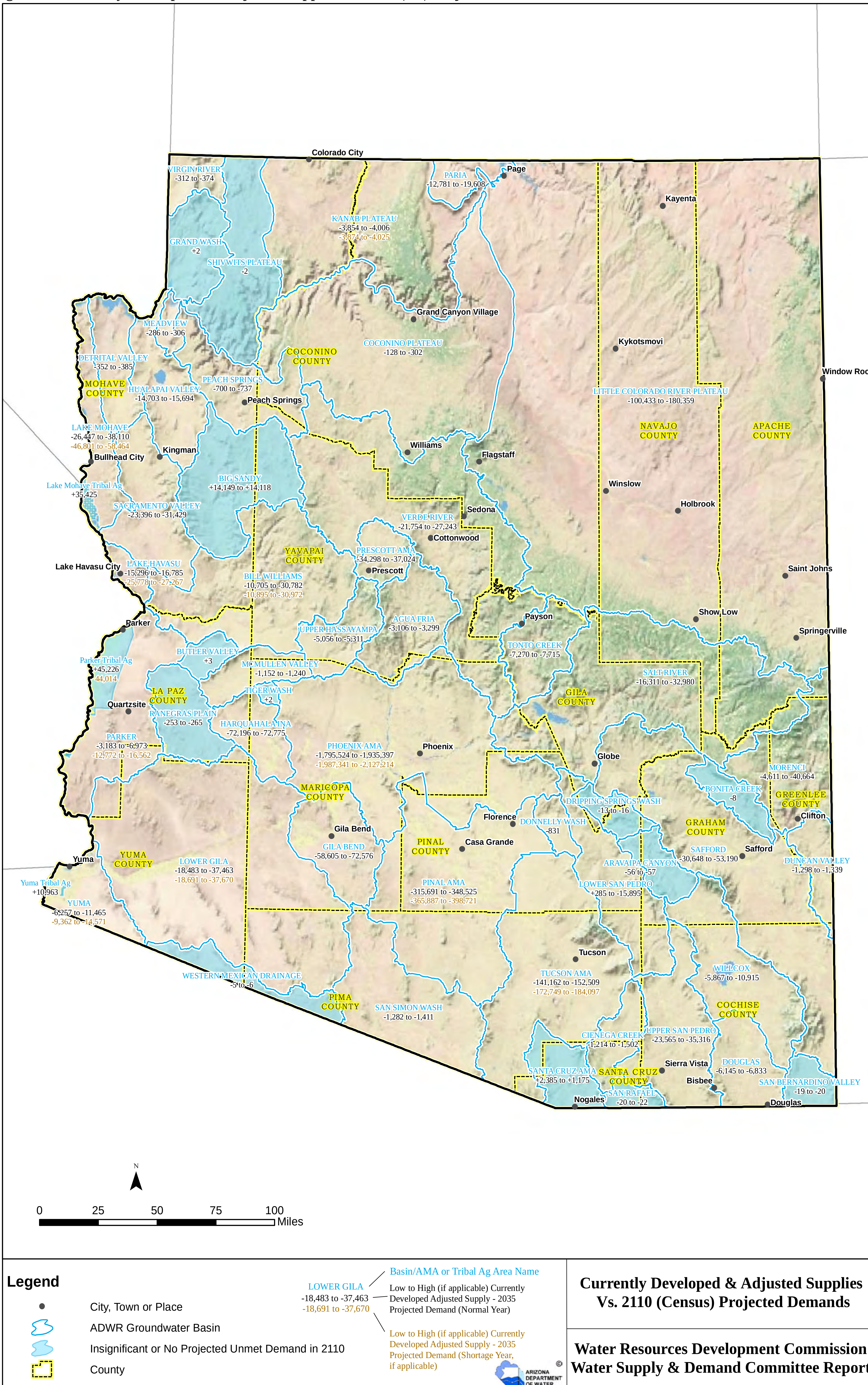


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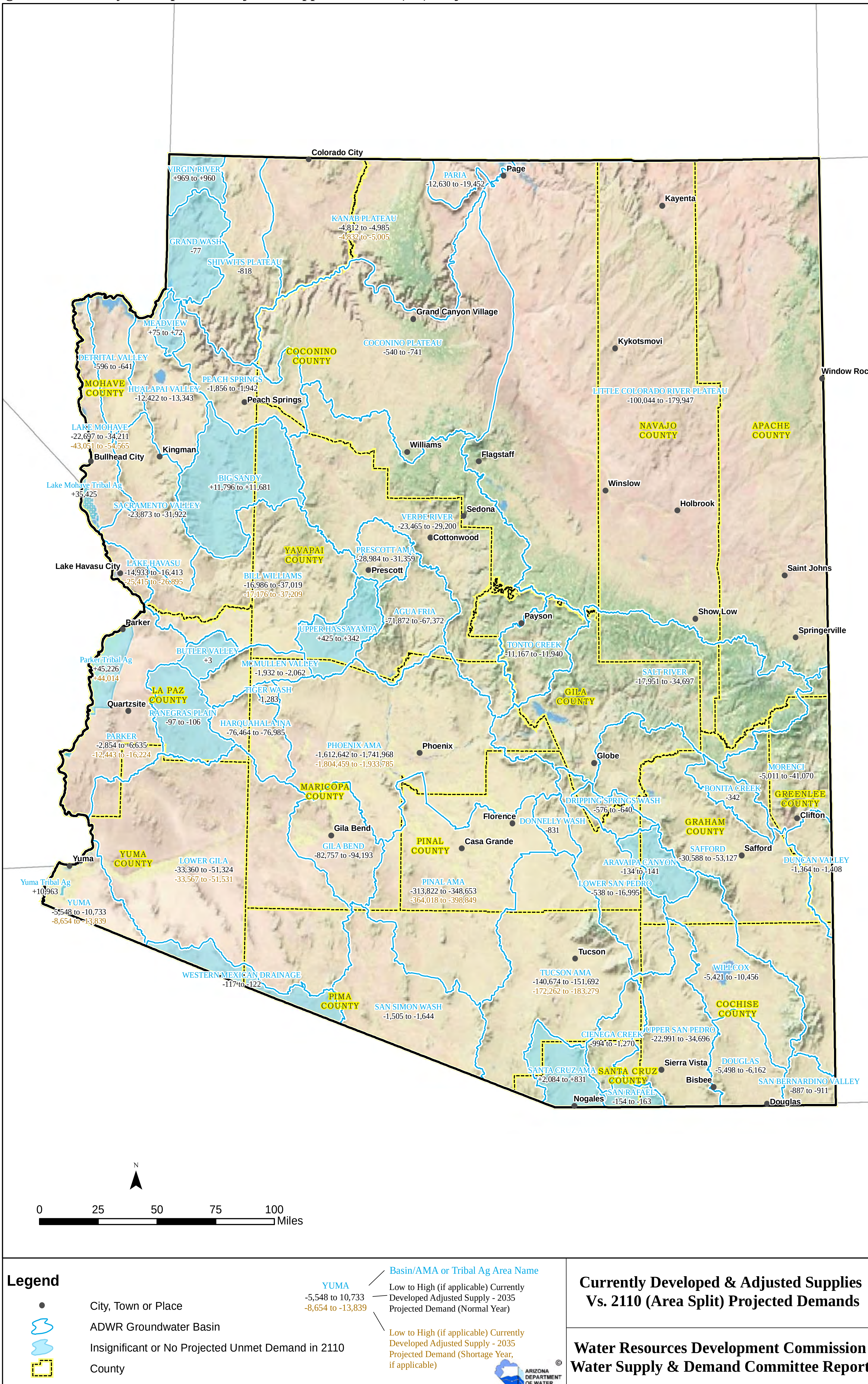
Figure 18. Currently Developed and Adjusted Supplies Vs. 2110 (AS) Projected Demands



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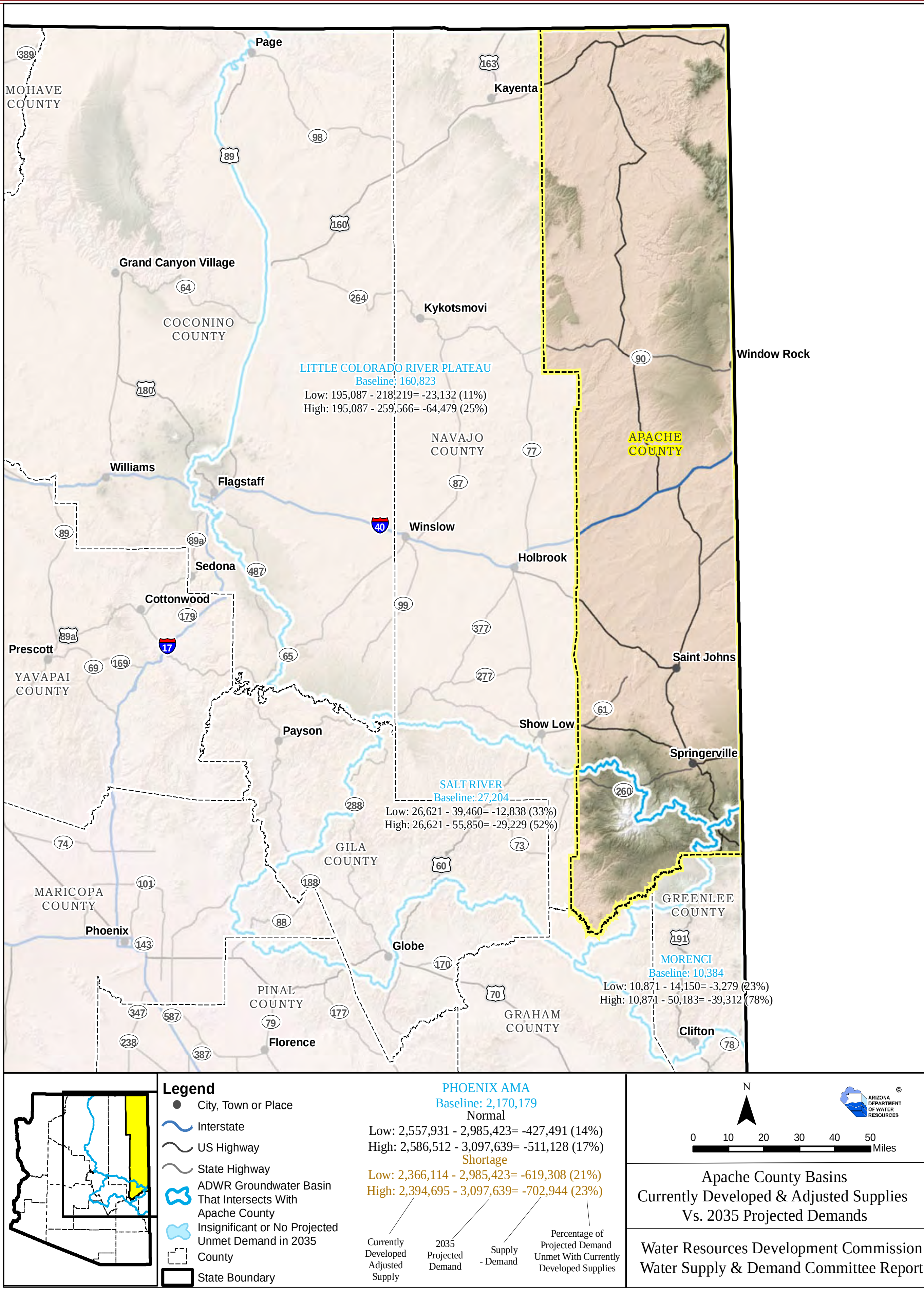
LIST OF ABBREVIATIONS

A/F	Acre-Feet of water (325,851 gallons)
Ag	Agriculture
Ag Sub	Agriculture Subcommittee
AMA	Active Management Area
ACC	Arizona Corporation Commission
ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AS	Area Split method of population projections
CAM	Central Arizona Model
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CS	Census Split method of population projections
CWS	Community Water System
BLM	Bureau of Land Management
DWR	Department of Water Resources
FTP	File Transfer Protocol
GPCD	Gallons Per Capita Per day
gpm	Gallons per minute
H.B.	House Bill
ITCA	Inter Tribal Council of Arizona
MAF	Million acre-feet
UDA	United Dairymen of Arizona
US	United States
WRDC	Water Resource Development Commission
WS&D	Water Supply and Demand

APPENDIX 1

COUNTY BASIN MAPS: CURRENTLY DEVELOPED & ADJUSTED SUPPLIES VS. PROJECTED DEMANDS



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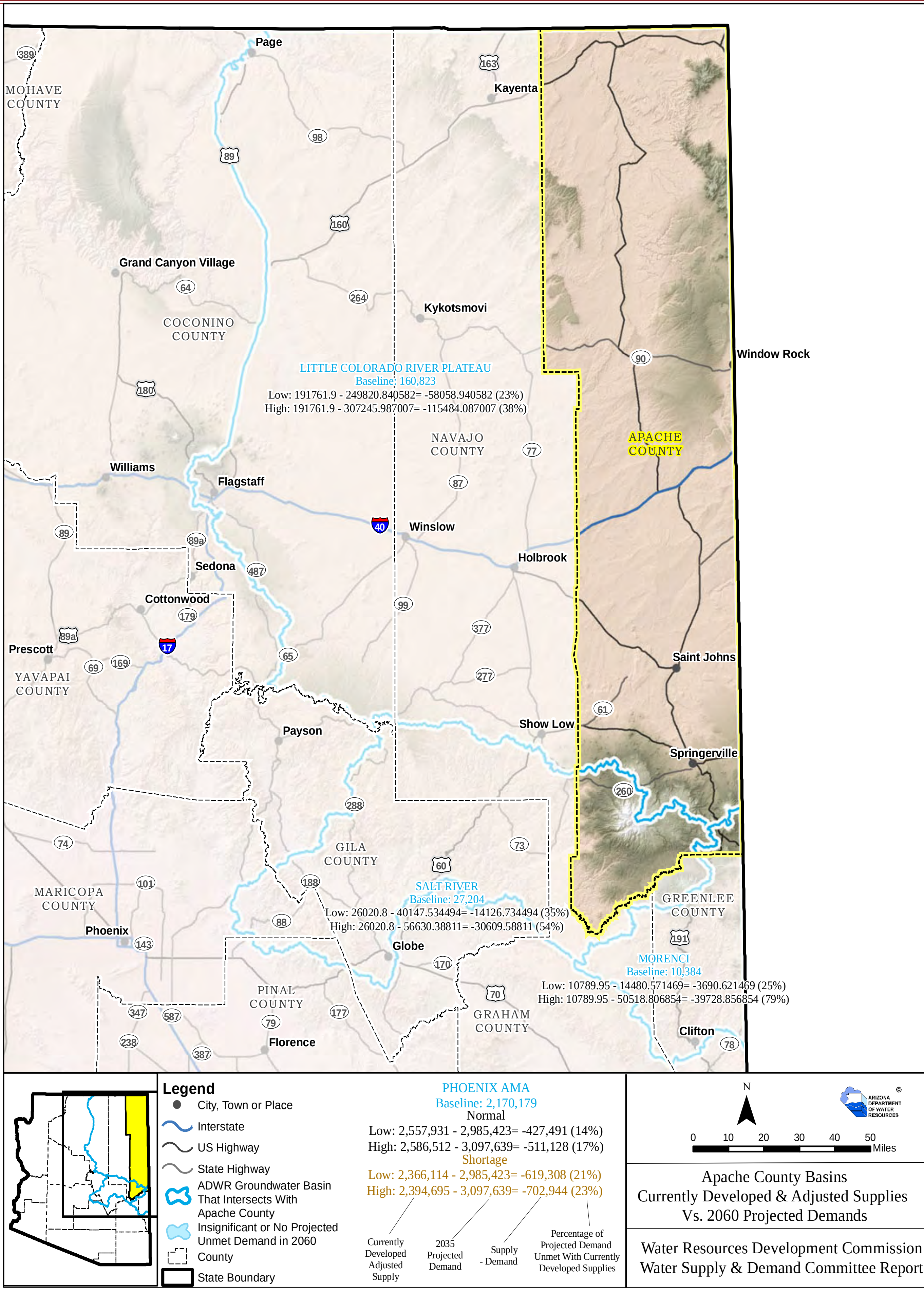

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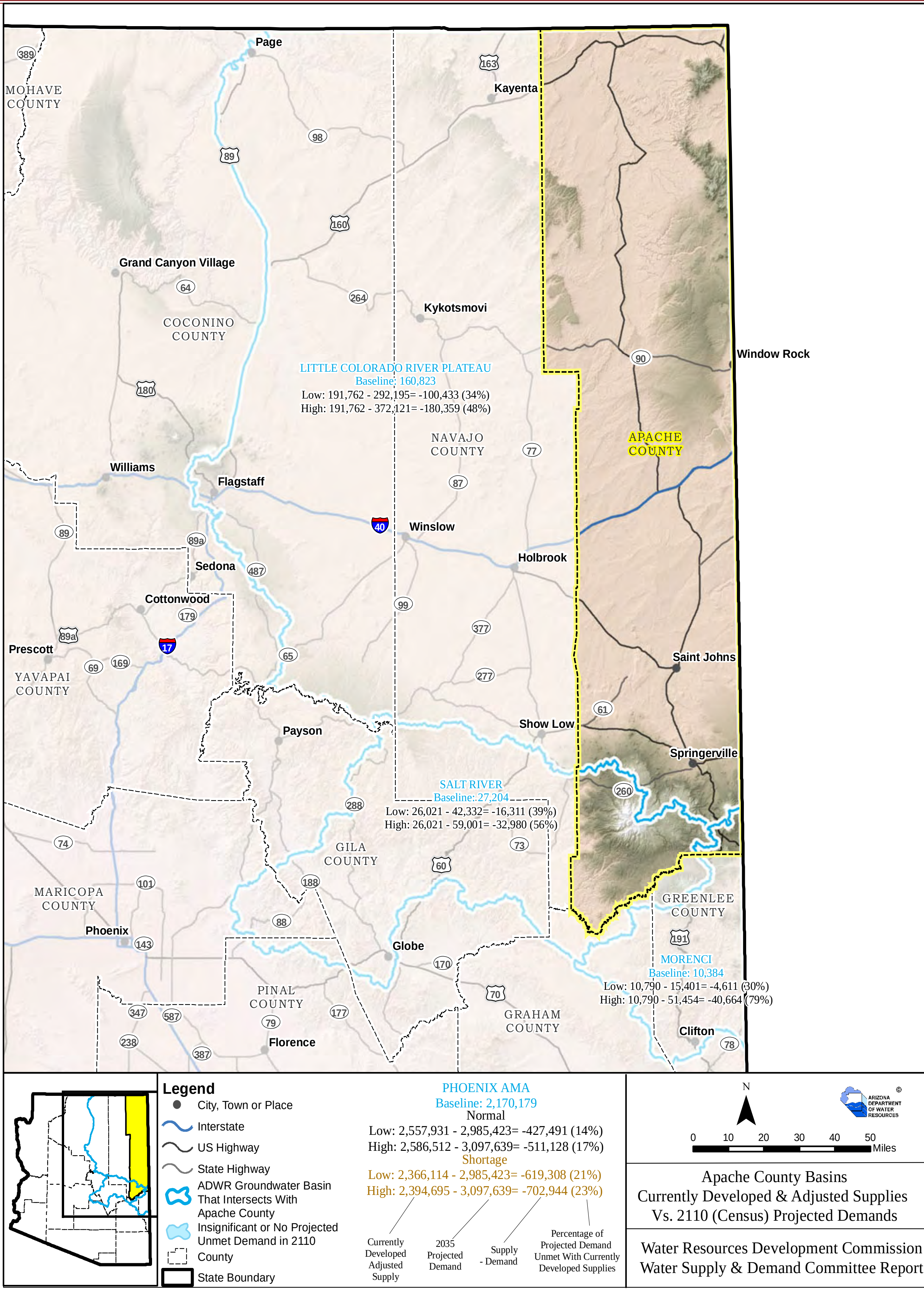
Page
Kayenta
MOHAVE COUNTY
Grand Canyon Village
Kykotsmovi
COCONINO COUNTY
Window Rock
LITTLE COLORADO RIVER PLATEAU
Baseline: 160,823
Low: 191,762 - 292,195= -100,433 (34%)
High: 191,762 - 372,121= -180,359 (48%)
NAVAJO COUNTY
APACHE COUNTY
Williams
Flagstaff
Winslow
Holbrook
Sedona
Cottonwood
Prescott
YAVAPAI COUNTY
Saint Johns
Show Low
Payson
Springerville
SALT RIVER
Baseline: 27,204
Low: 26,021 - 42,332= -16,311 (39%)
High: 26,021 - 59,001= -32,980 (56%)
GILA COUNTY
MARICOPA COUNTY
GREENLEE COUNTY
Phoenix
Globe
MORENCI
Baseline: 10,384
Low: 10,790 - 15,401= -4,611 (30%)
High: 10,790 - 51,454= -40,664 (79%)
PINAL COUNTY
GRAHAM COUNTY
Clifton
Florence
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Apache County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
ARIZONA DEPARTMENT OF WATER RESOURCES
0 10 20 30 40 50 Miles
Apache County Basins
Currently Developed & Adjusted Supplies
Vs. 2110 (Census) Projected Demands
Water Resources Development Commission
Water Supply & Demand Committee Report
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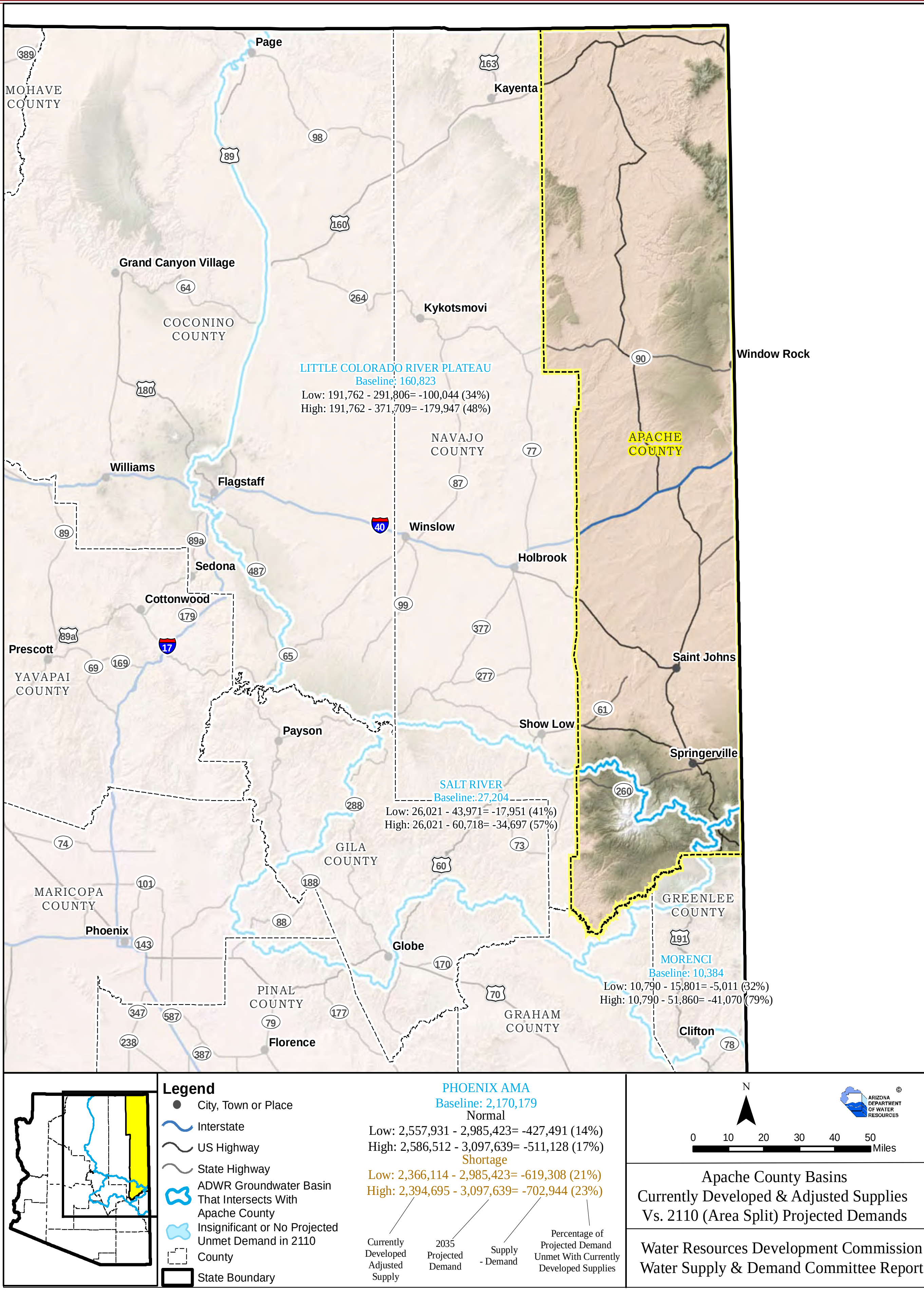

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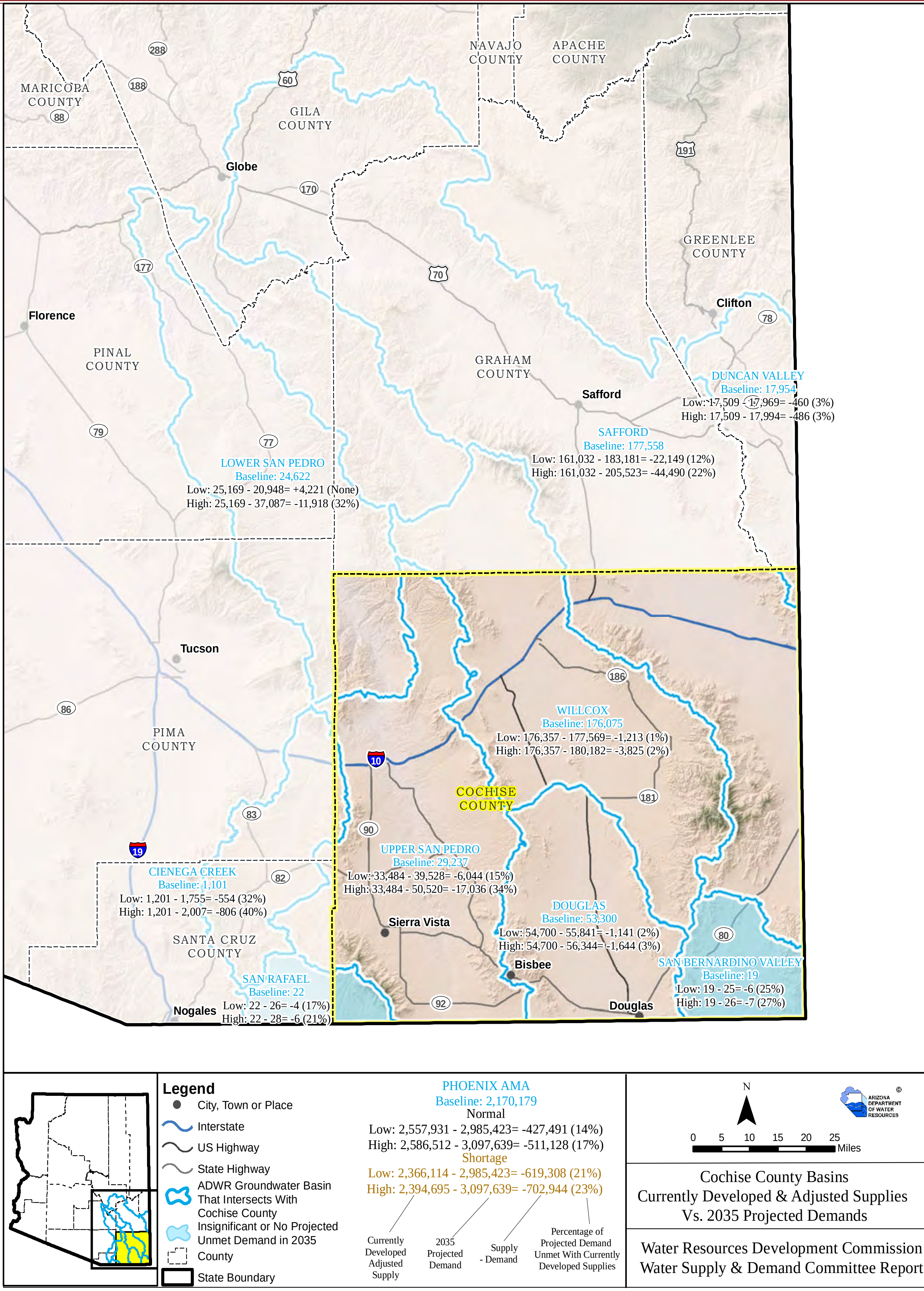

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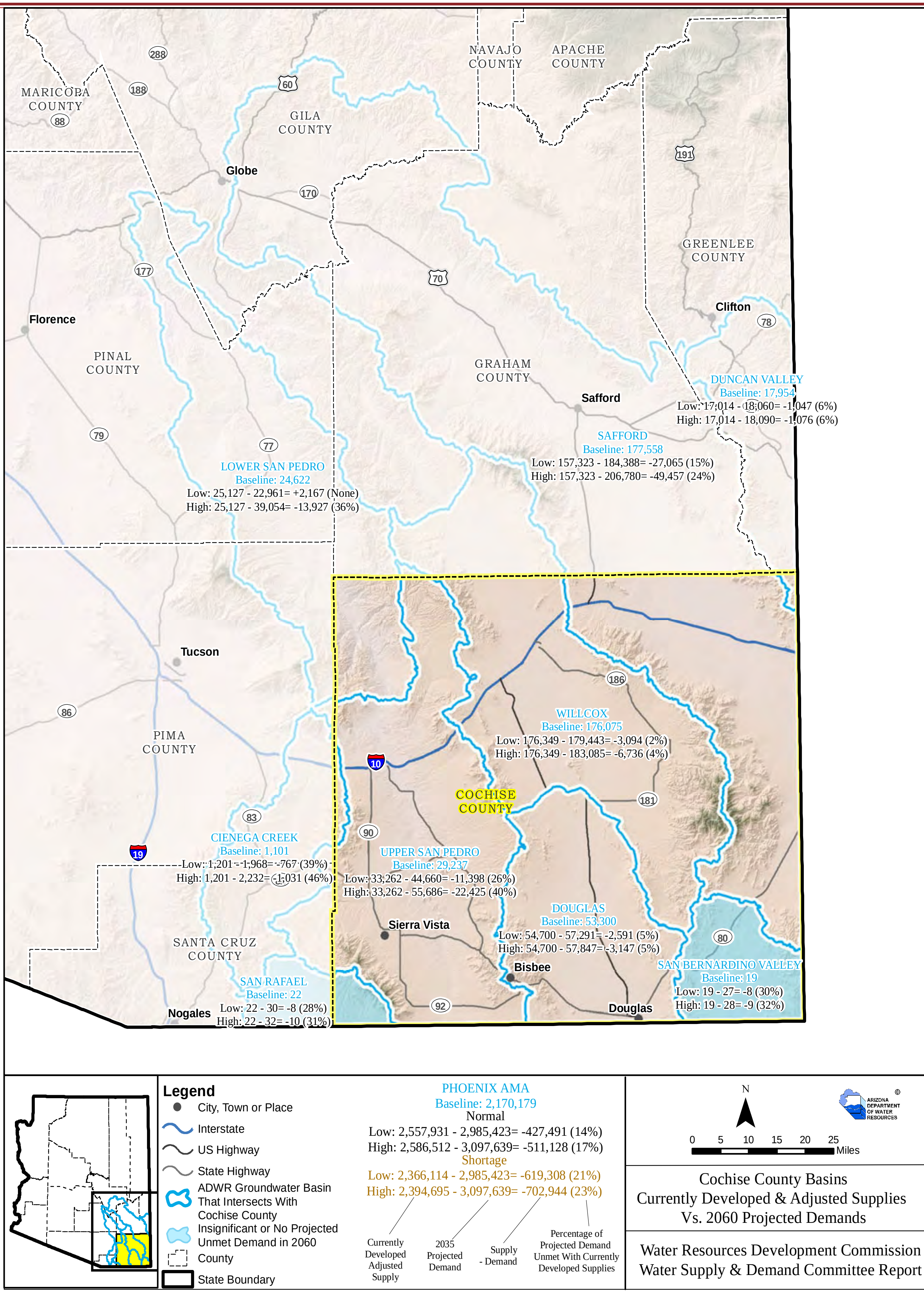

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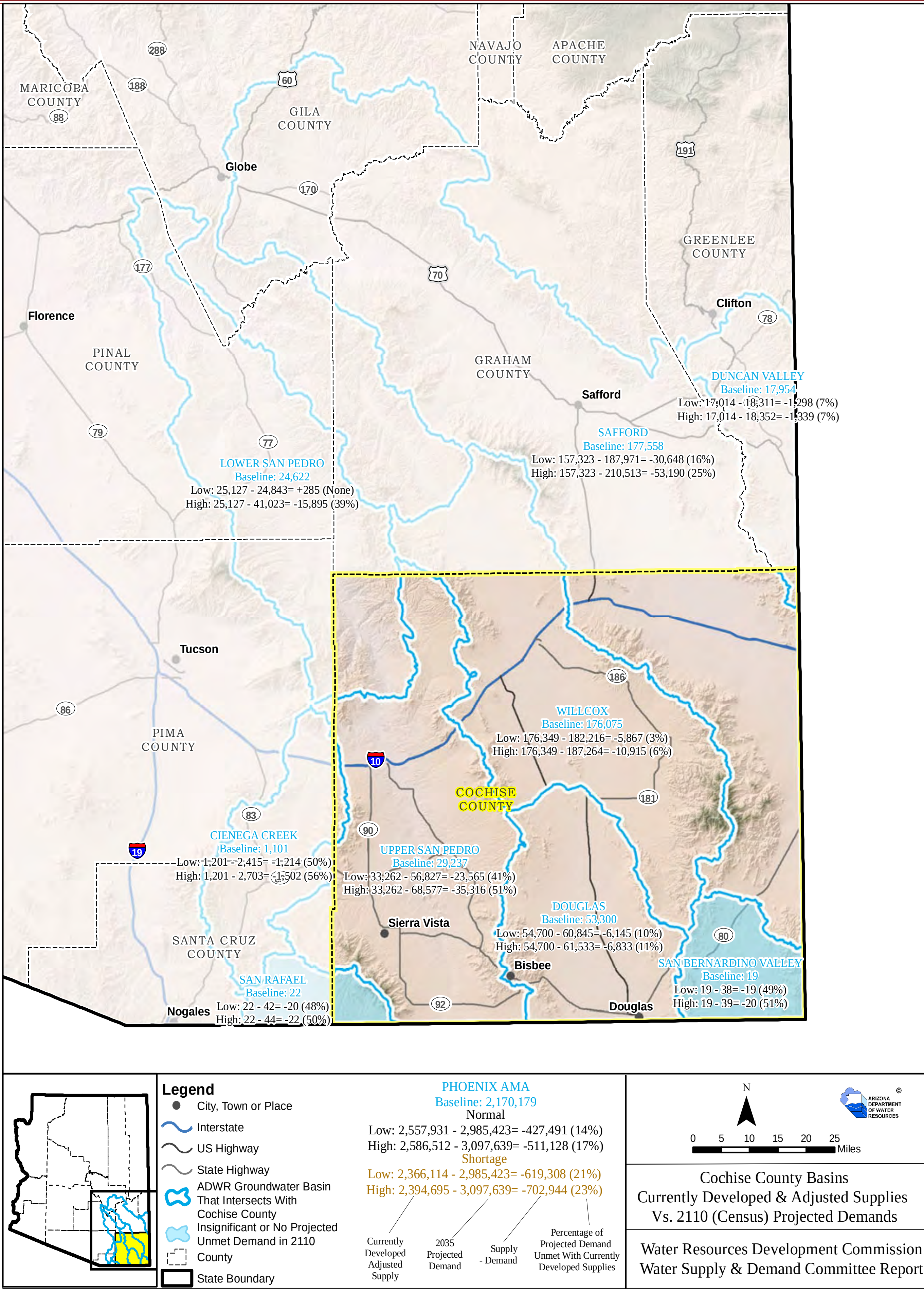

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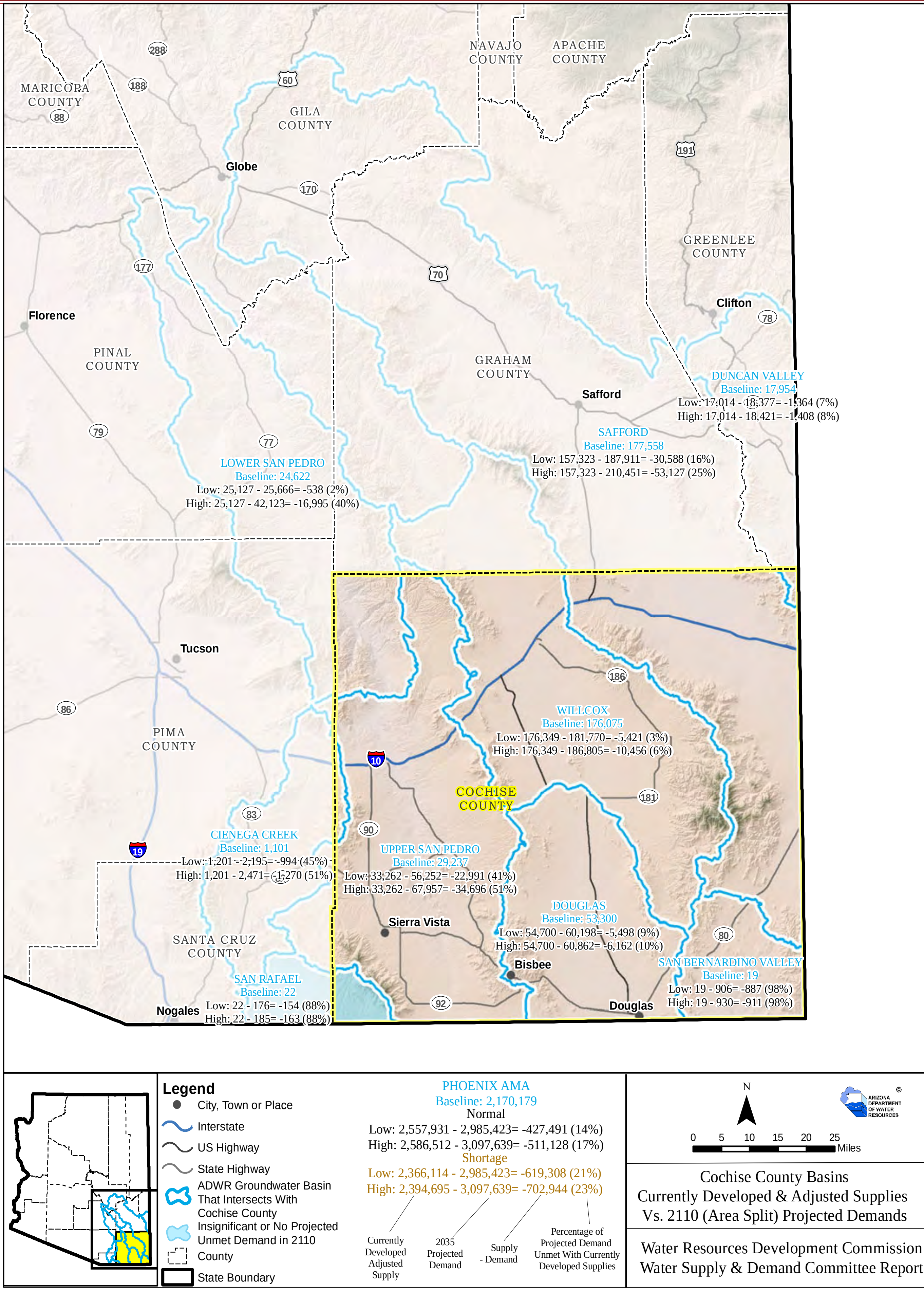

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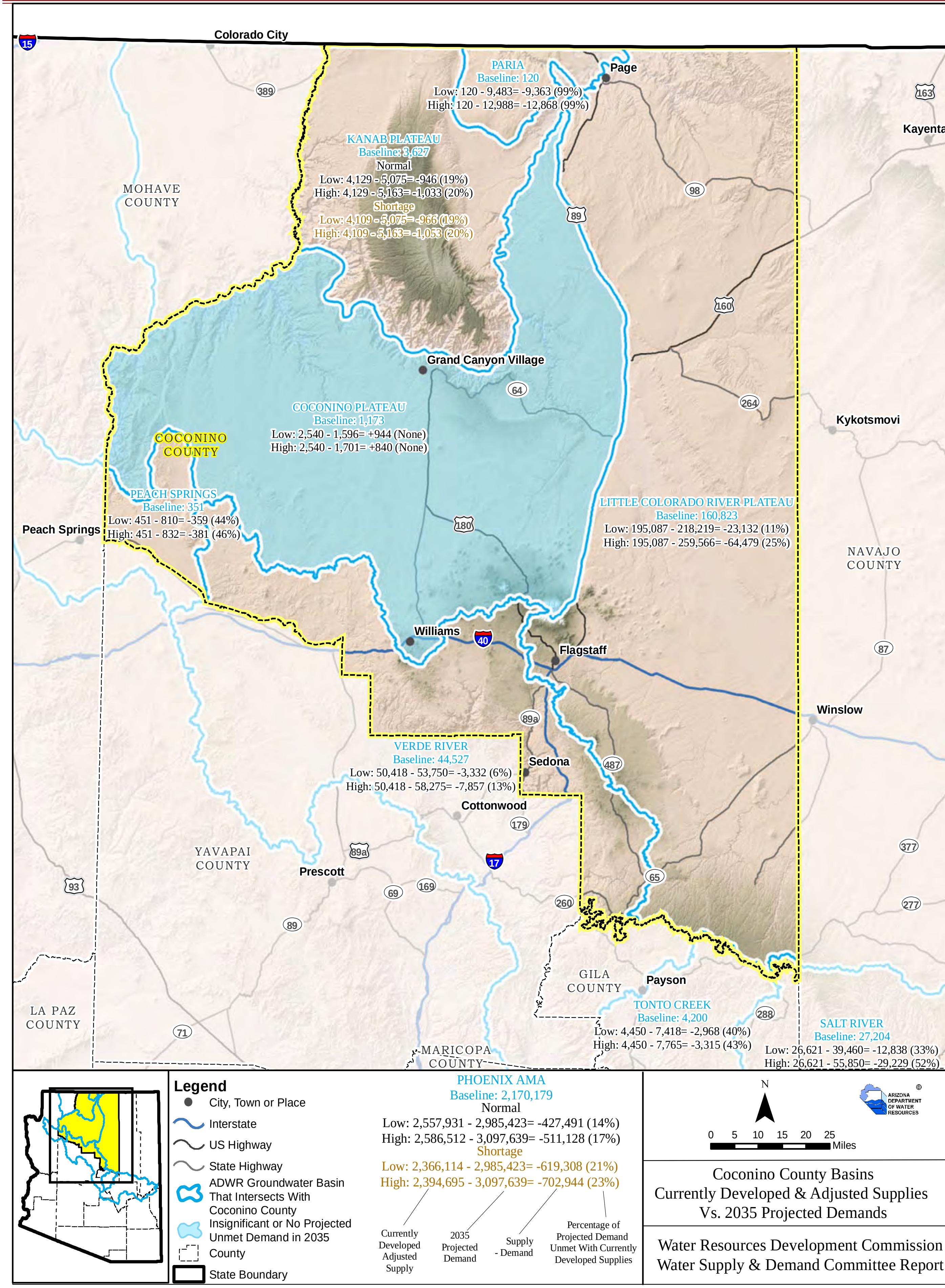

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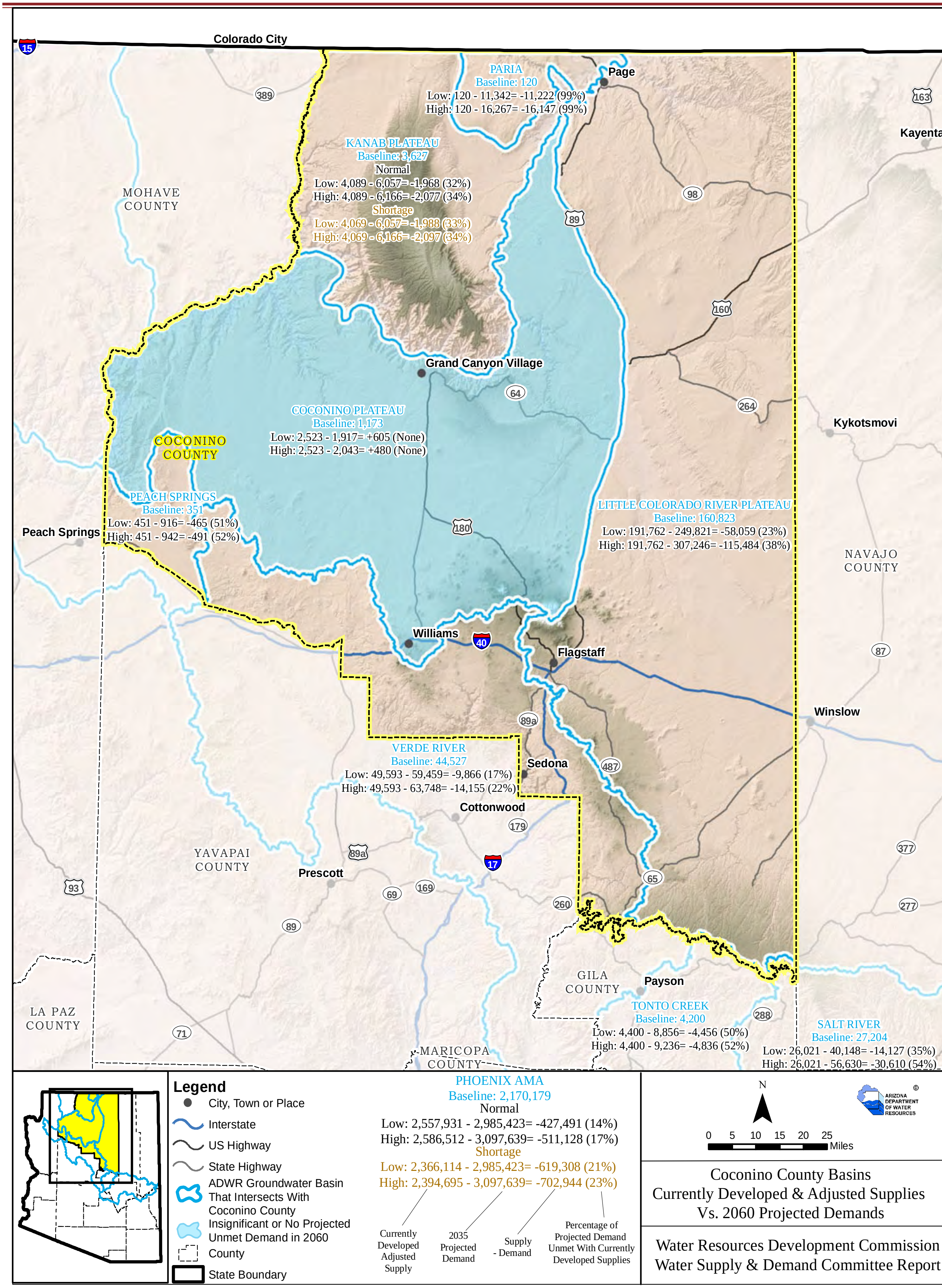

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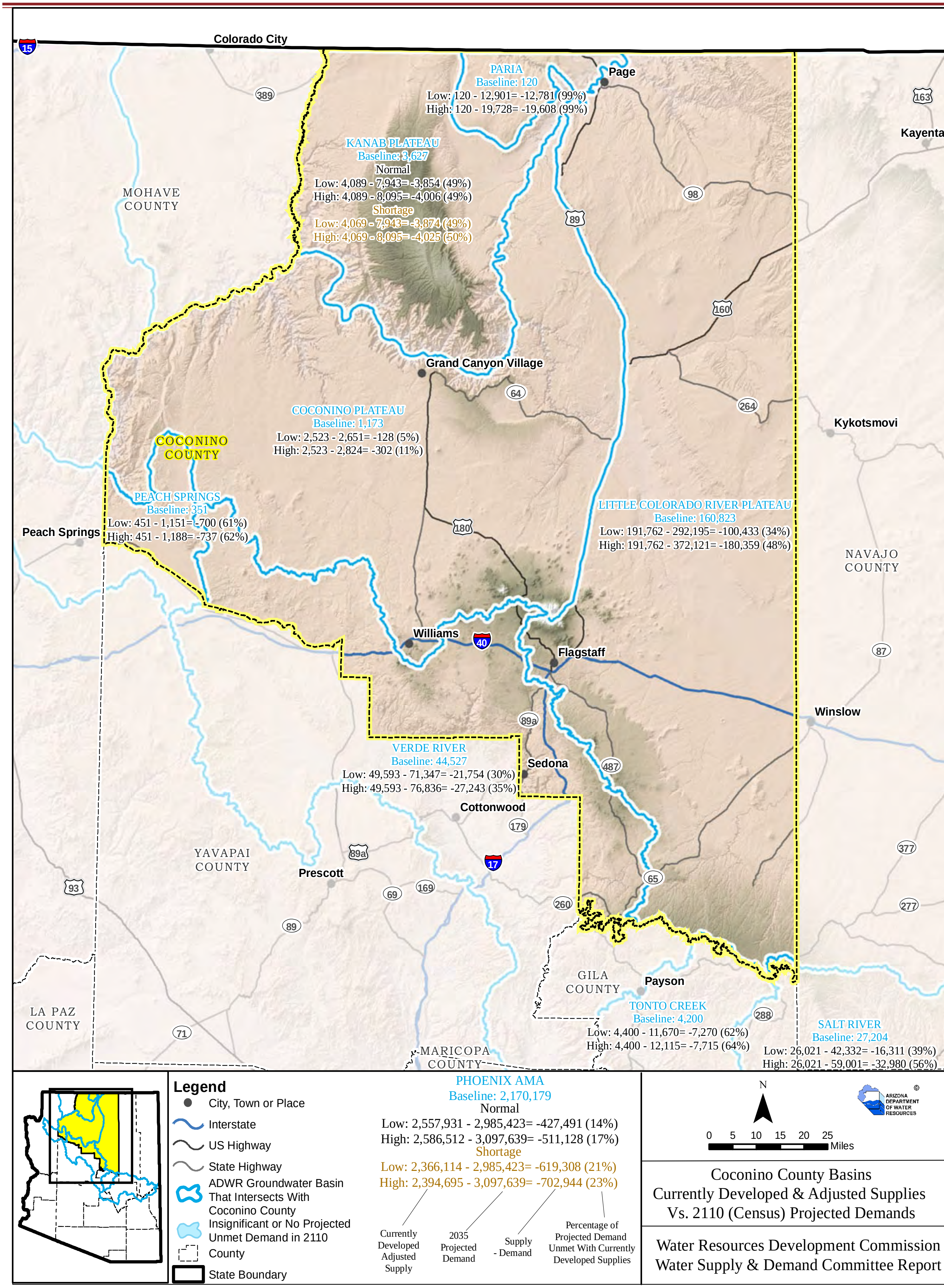
Colorado City
Page
PARIA
Baseline: 120
Low: 120 - 12,901= -12,781 (99%)
High: 120 - 19,728= -19,608 (99%)
Kayenta
KANAB PLATEAU
Baseline: 3,627
Normal
Low: 4,089 - 7,943= -3,854 (49%)
High: 4,089 - 8,095= -4,006 (49%)
Shortage
Low: 4,069 - 7,943= -3,874 (49%)
High: 4,069 - 8,095= -4,025 (50%)
MOHAVE COUNTY
Grand Canyon Village
COCONINO PLATEAU
Baseline: 1,173
Low: 2,523 - 2,651= -128 (5%)
High: 2,523 - 2,824= -302 (11%)
COCONINO COUNTY
Kykotsmovi
PEACH SPRINGS
Baseline: 351
Low: 451 - 1,151= -700 (61%)
High: 451 - 1,188= -737 (62%)
Peach Springs
LITTLE COLORADO RIVER PLATEAU
Baseline: 160,823
Low: 191,762 - 292,195= -100,433 (34%)
High: 191,762 - 372,121= -180,359 (48%)
NAVAJO COUNTY
Williams
Flagstaff
Winslow
VERDE RIVER
Baseline: 44,527
Low: 49,593 - 71,347= -21,754 (30%)
High: 49,593 - 76,836= -27,243 (35%)
Sedona
Cottonwood
YAVAPAI COUNTY
Prescott
GILA COUNTY
Payson
LA PAZ COUNTY
TONTO CREEK
Baseline: 4,200
Low: 4,400 - 11,670= -7,270 (62%)
High: 4,400 - 12,115= -7,715 (64%)
SALT RIVER
Baseline: 27,204
Low: 26,021 - 42,332= -16,311 (39%)
High: 26,021 - 59,001= -32,980 (56%)
MARICOPA COUNTY
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Coconino County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 15 20 25 Miles
ARIZONA DEPARTMENT OF WATER RESOURCES
Coconino County Basins
Currently Developed & Adjusted Supplies
Vs. 2110 (Census) Projected Demands
Water Resources Development Commission
Water Supply & Demand Committee Report
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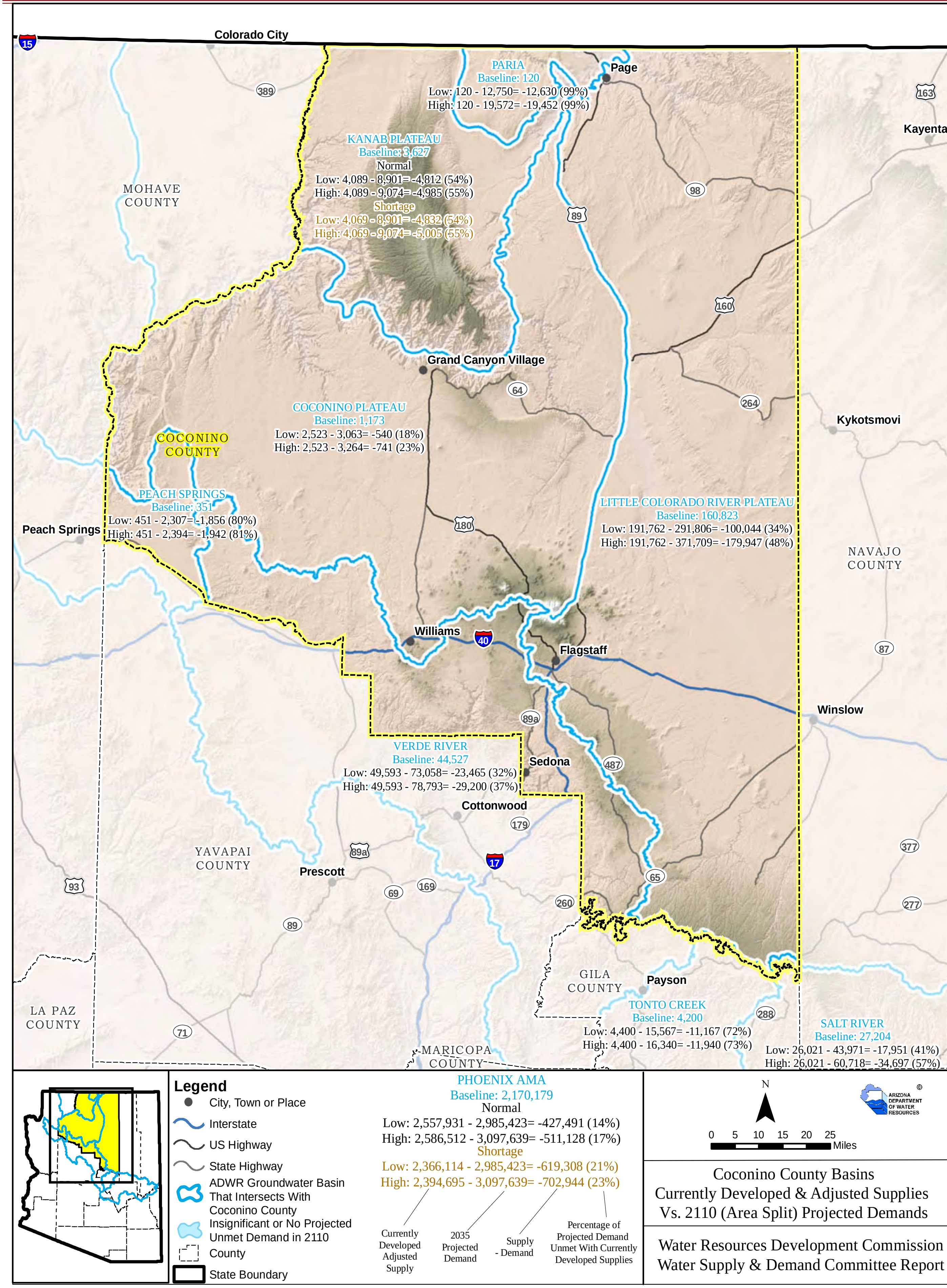

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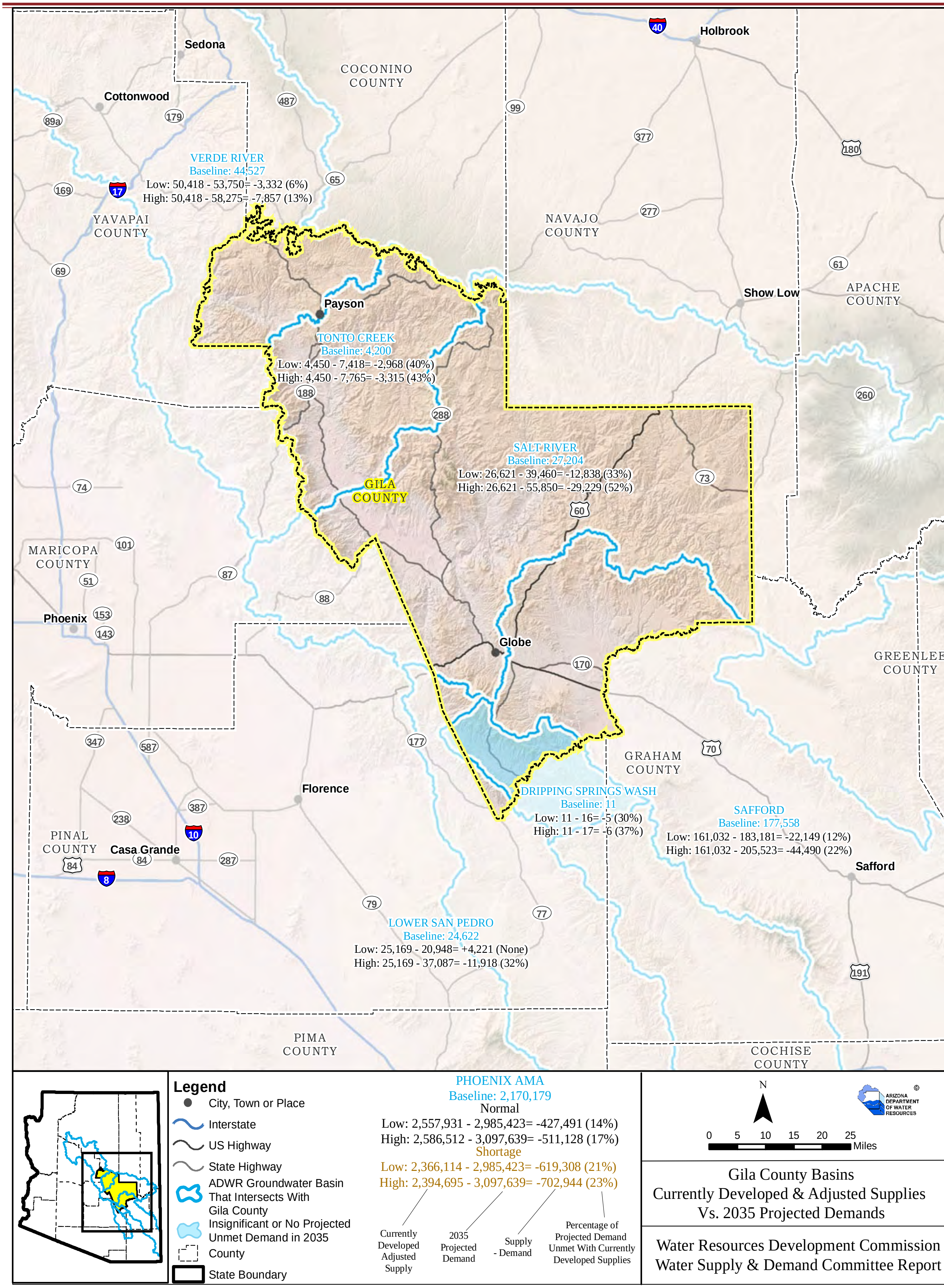

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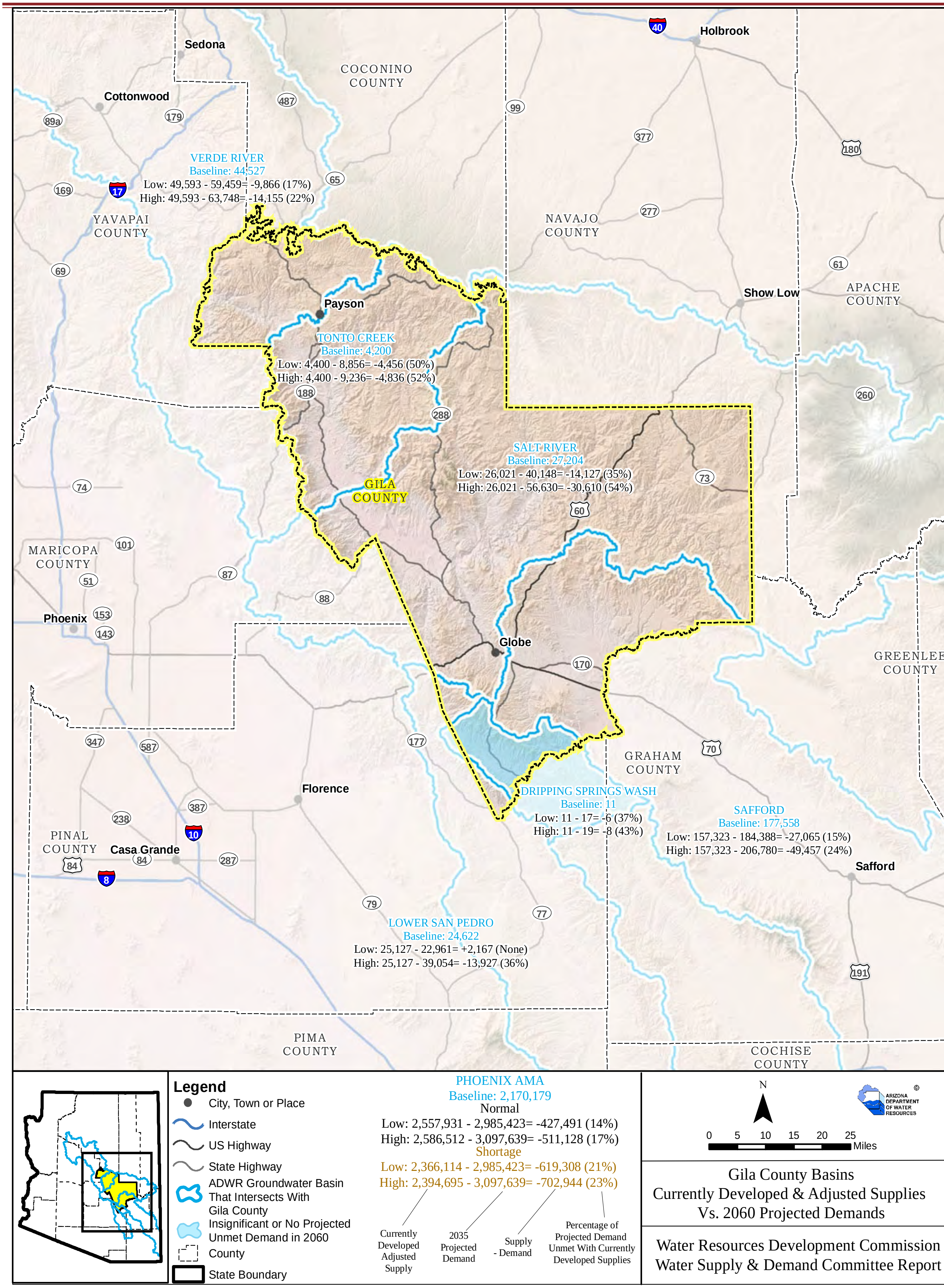
Sedona
Cottonwood
COCONINO COUNTY
Holbrook
VERDE RIVER
Baseline: 44,527
Low: 49,593 - 59,459= -9,866 (17%)
High: 49,593 - 63,748= -14,155 (22%)
YAVAPAI COUNTY
NAVAJO COUNTY
APACHE COUNTY
Show Low
Payson
TONTO CREEK
Baseline: 4,200
Low: 4,400 - 8,856= -4,456 (50%)
High: 4,400 - 9,236= -4,836 (52%)
SALT RIVER
Baseline: 27,204
Low: 26,021 - 40,148= -14,127 (35%)
High: 26,021 - 56,630= -30,610 (54%)
GILA COUNTY
MARICOPA COUNTY
Phoenix
Globe
GREENLEE COUNTY
GRAHAM COUNTY
Florence
DRIPPING SPRINGS WASH
Baseline: 11
Low: 11 - 17= -6 (37%)
High: 11 - 19= -8 (43%)
SAFFORD
Baseline: 177,558
Low: 157,323 - 184,388= -27,065 (15%)
High: 157,323 - 206,780= -49,457 (24%)
Safford
PINAL COUNTY
Casa Grande
LOWER SAN PEDRO
Baseline: 24,622
Low: 25,127 - 22,961= +2,167 (None)
High: 25,127 - 39,054= -13,927 (36%)
PIMA COUNTY
COCHISE COUNTY
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Gila County
Insignificant or No Projected Unmet Demand in 2060
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 15 20 25 Miles
ARIZONA DEPARTMENT OF WATER RESOURCES
Gila County Basins
Currently Developed & Adjusted Supplies
Vs. 2060 Projected Demands
Water Resources Development Commission
Water Supply & Demand Committee Report
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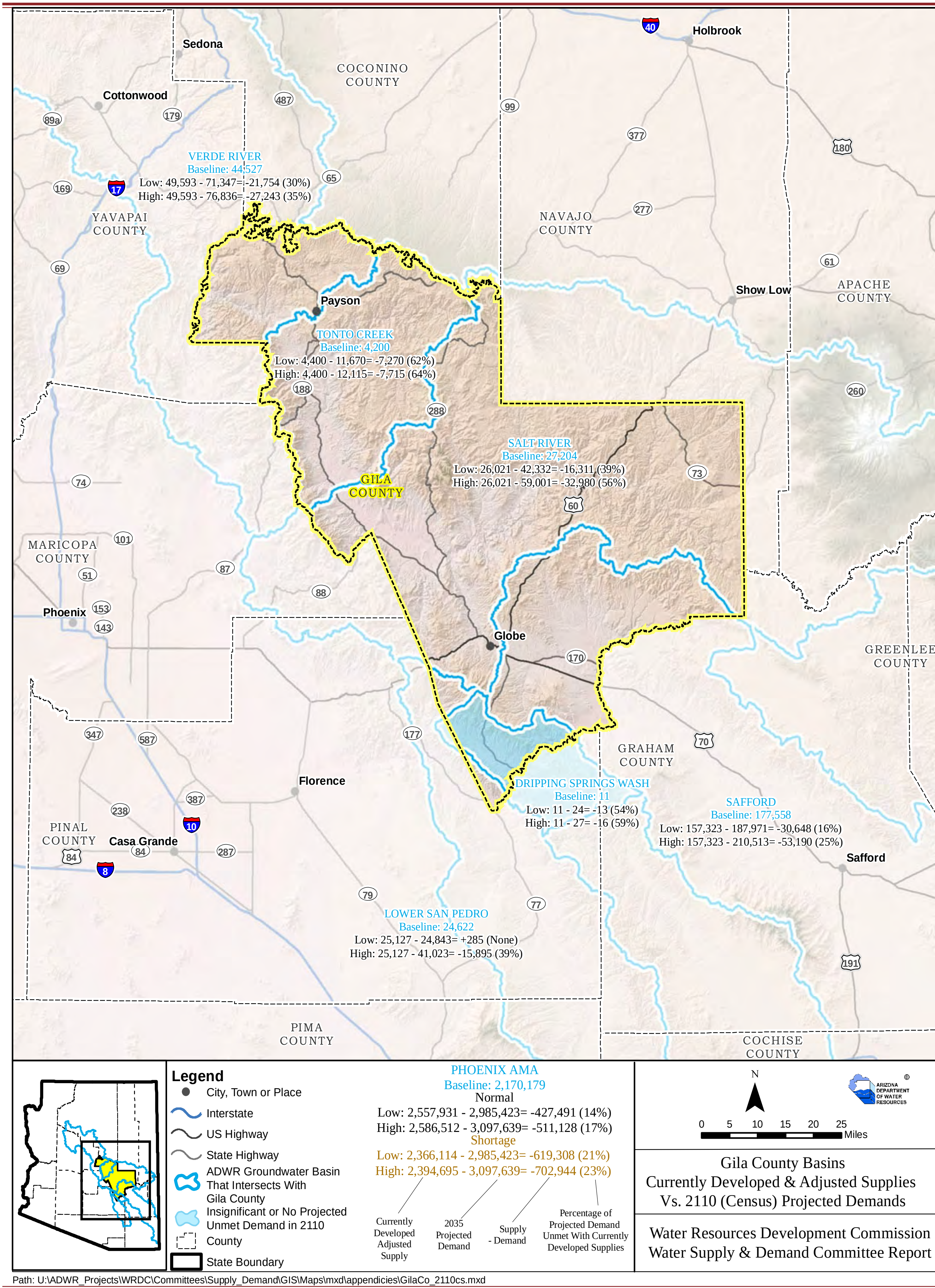
Sedona
Cottonwood
COCONINO COUNTY
Holbrook
VERDE RIVER
Baseline: 44,527
Low: 49,593 - 71,347= -21,754 (30%)
High: 49,593 - 76,836= -27,243 (35%)
YAVAPAI COUNTY
NAVAJO COUNTY
Show Low
APACHE COUNTY
Payson
TONTO CREEK
Baseline: 4,200
Low: 4,400 - 11,670= -7,270 (62%)
High: 4,400 - 12,115= -7,715 (64%)
SALT RIVER
Baseline: 27,204
Low: 26,021 - 42,332= -16,311 (39%)
High: 26,021 - 59,001= -32,980 (56%)
GILA COUNTY
MARICOPA COUNTY
Phoenix
Globe
GREENLEE COUNTY
GRAHAM COUNTY
Florence
DRIPPING SPRINGS WASH
Baseline: 11
Low: 11 - 24= -13 (54%)
High: 11 - 27= -16 (59%)
SAFFORD
Baseline: 177,558
Low: 157,323 - 187,971= -30,648 (16%)
High: 157,323 - 210,513= -53,190 (25%)
Safford
PINAL COUNTY
Casa Grande
LOWER SAN PEDRO
Baseline: 24,622
Low: 25,127 - 24,843= +285 (None)
High: 25,127 - 41,023= -15,895 (39%)
PIMA COUNTY
COCHISE COUNTY
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Gila County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
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Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
ARIZONA DEPARTMENT OF WATER RESOURCES
0 5 10 15 20 25 Miles
Gila County Basins
Currently Developed & Adjusted Supplies
Vs. 2110 (Census) Projected Demands
Water Resources Development Commission
Water Supply & Demand Committee Report
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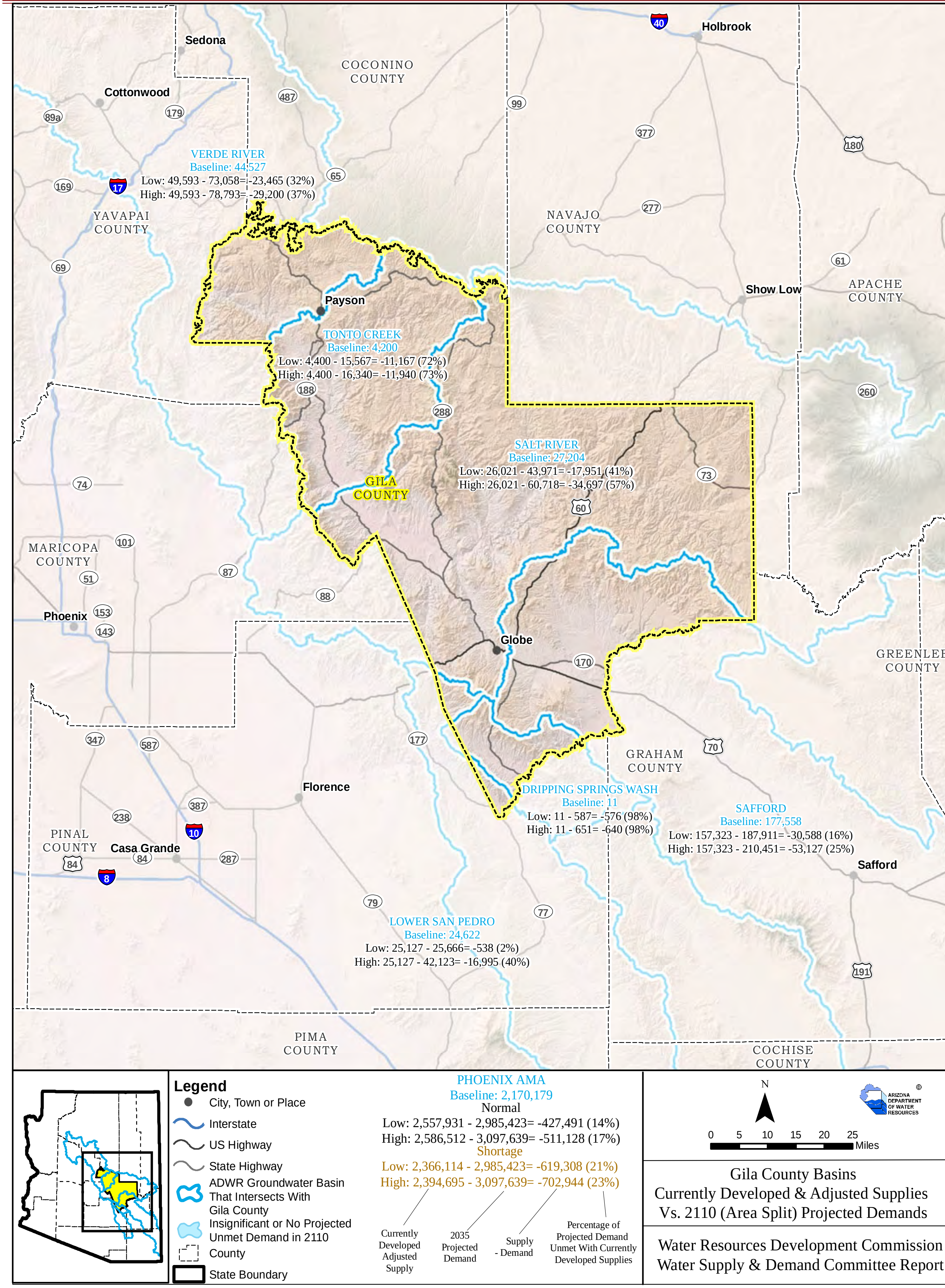

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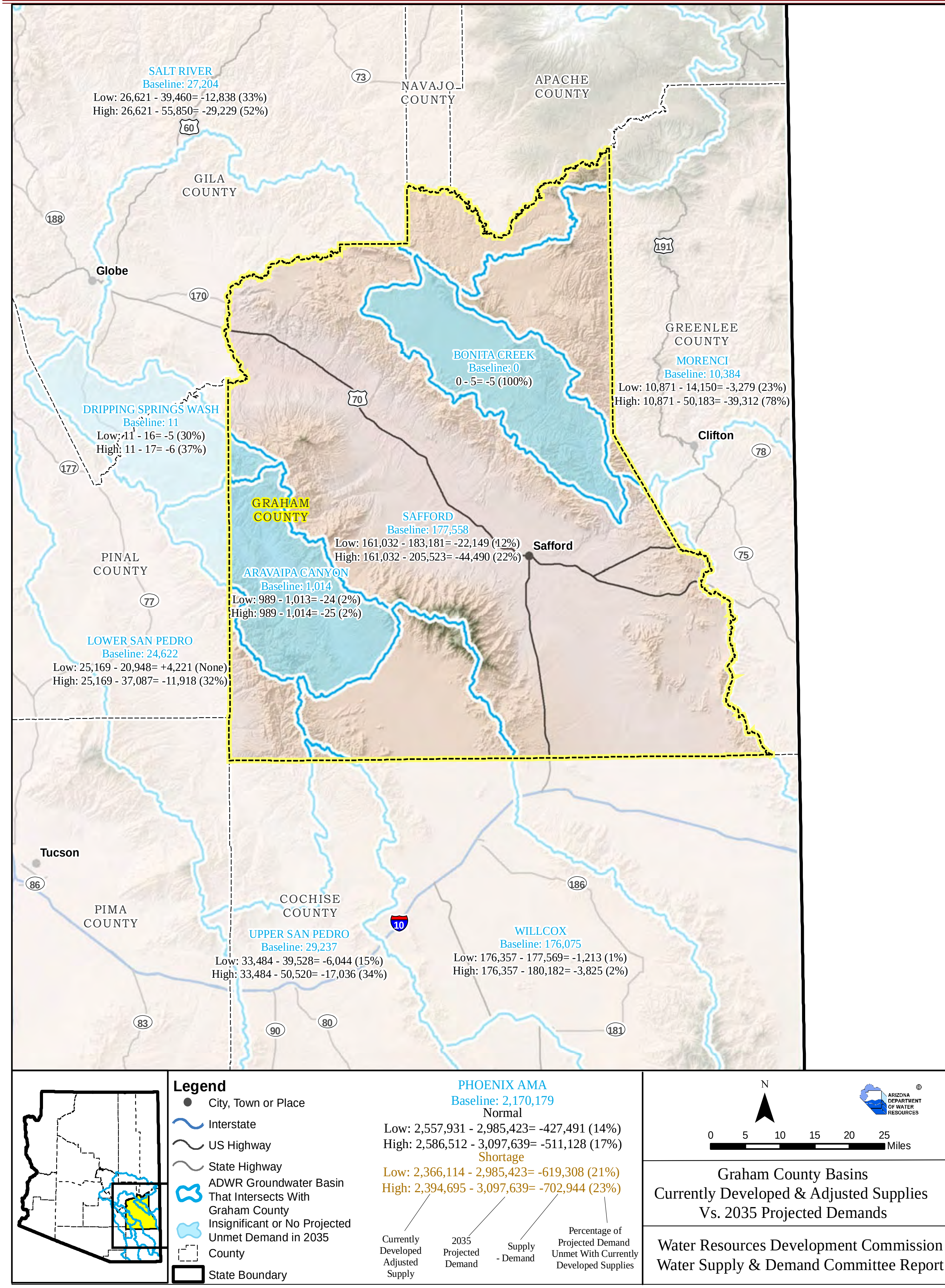
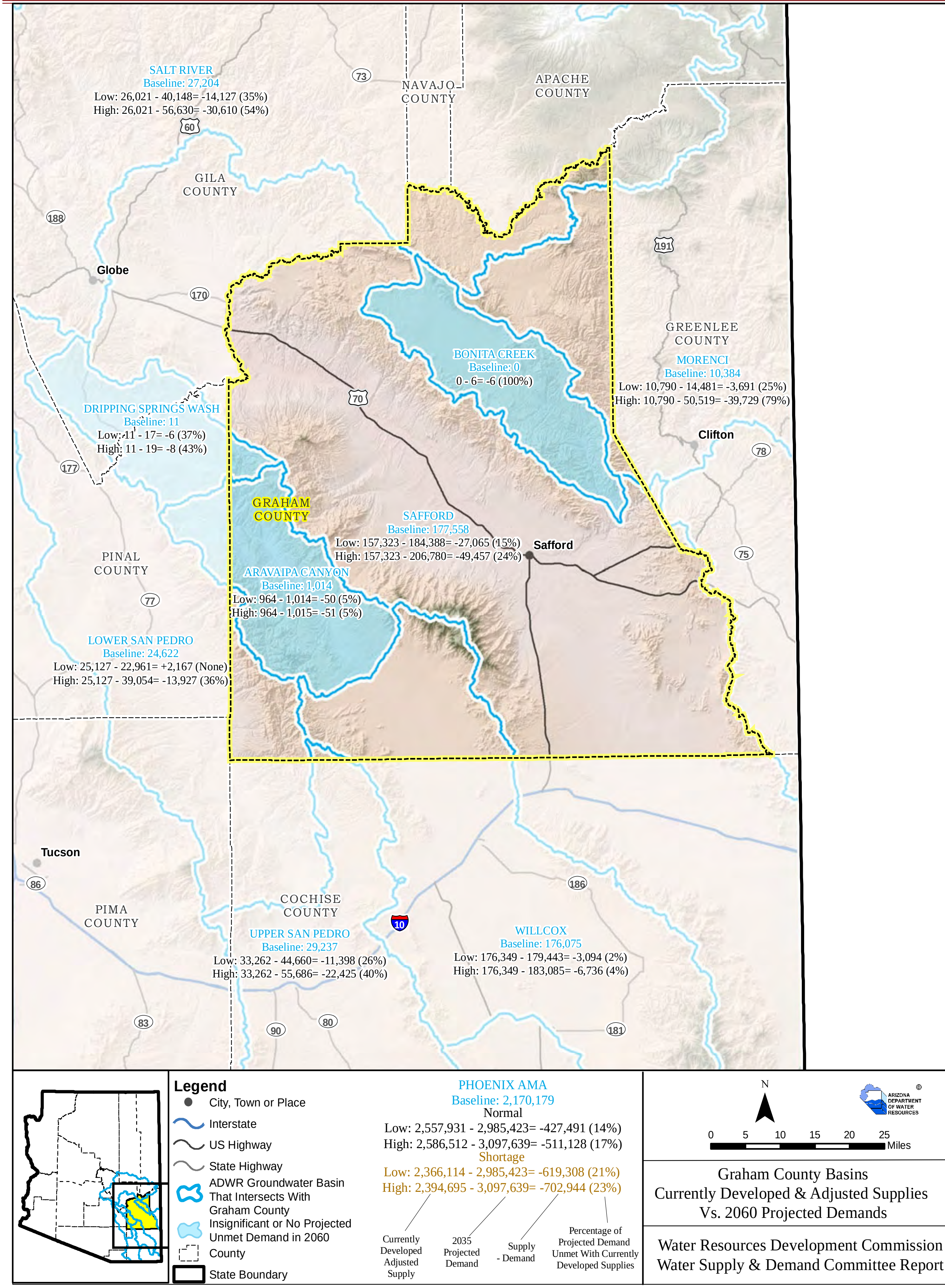

SALT RIVER
Baseline: 27,204
Low: 26,621 - 39,460= -12,838 (33%)
High: 26,621 - 55,850= -29,229 (52%)
NAVAJO COUNTY
APACHE COUNTY
GILA COUNTY
Globe
BONITA CREEK
Baseline: 0
0 - 5= -5 (100%)
GREENLEE COUNTY
MORENCI
Baseline: 10,384
Low: 10,871 - 14,150= -3,279 (23%)
High: 10,871 - 50,183= -39,312 (78%)
DRIPPING SPRINGS WASH
Baseline: 11
Low: 11 - 16= -5 (30%)
High: 11 - 17= -6 (37%)
Clifton
GRAHAM COUNTY
SAFFORD
Baseline: 177,558
Low: 161,032 - 183,181= -22,149 (12%)
High: 161,032 - 205,523= -44,490 (22%)
Safford
PINAL COUNTY
ARAVAIPA CANYON
Baseline: 1,014
Low: 989 - 1,013= -24 (2%)
High: 989 - 1,014= -25 (2%)
LOWER SAN PEDRO
Baseline: 24,622
Low: 25,169 - 20,948= +4,221 (None)
High: 25,169 - 37,087= -11,918 (32%)
Tucson
PIMA COUNTY
COCHISE COUNTY
UPPER SAN PEDRO
Baseline: 29,237
Low: 33,484 - 39,528= -6,044 (15%)
High: 33,484 - 50,520= -17,036 (34%)
WILLCOX
Baseline: 176,075
Low: 176,357 - 177,569= -1,213 (1%)
High: 176,357 - 180,182= -3,825 (2%)
73
60
188
170
191
70
177
78
75
77
86
186
10
83
90
80
181
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Graham County
Insignificant or No Projected Unmet Demand in 2035
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 15 20 25 Miles
ARIZONA DEPARTMENT OF WATER RESOURCES
Graham County Basins
Currently Developed & Adjusted Supplies
Vs. 2035 Projected Demands
Water Resources Development Commission
Water Supply & Demand Committee Report
Path: U:\ADWR_Projects\WRDC\Committees\Supply_Demand\GIS\Maps\mxd\appendicies\GrahamCo_2035.mxd



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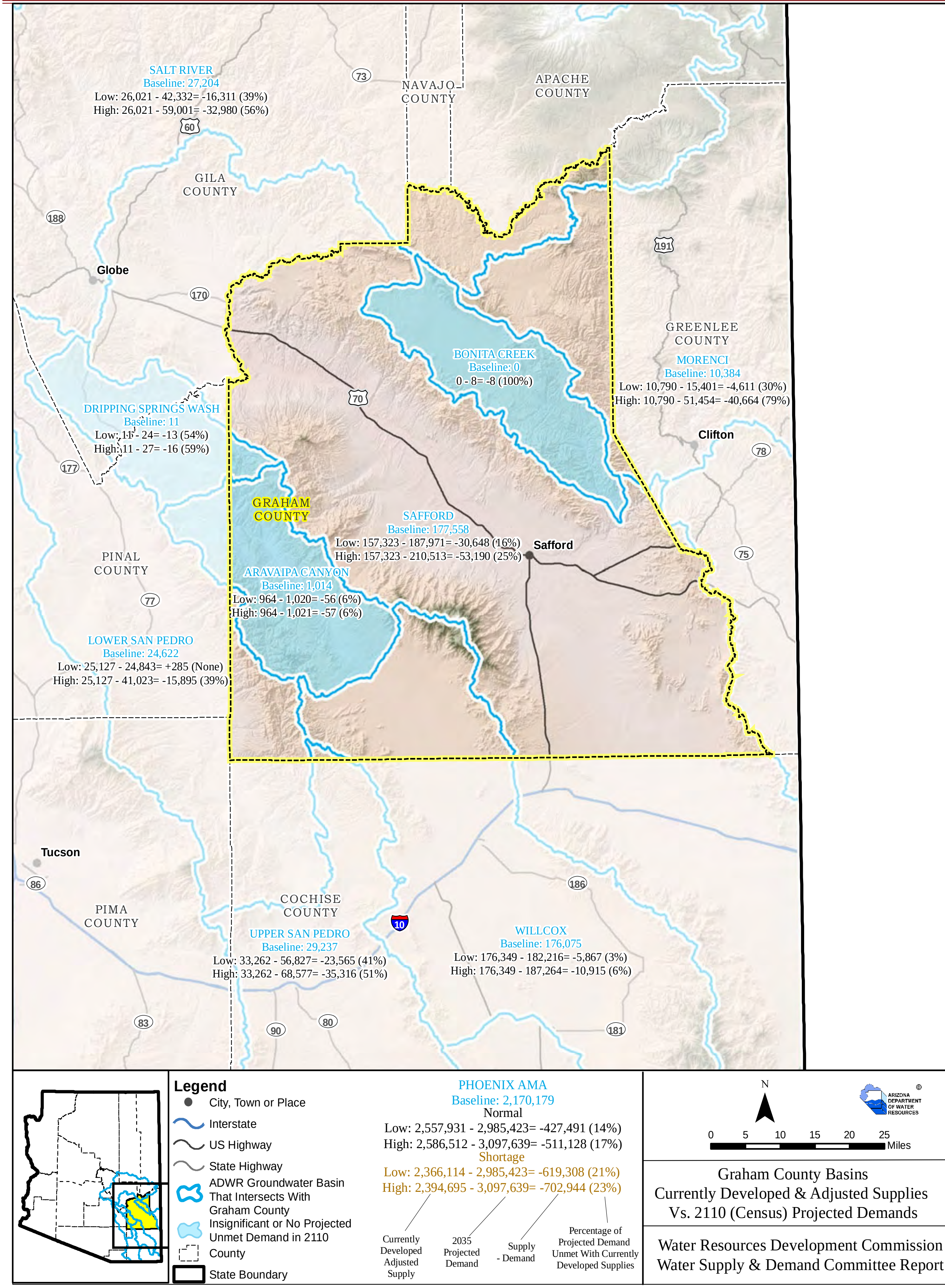

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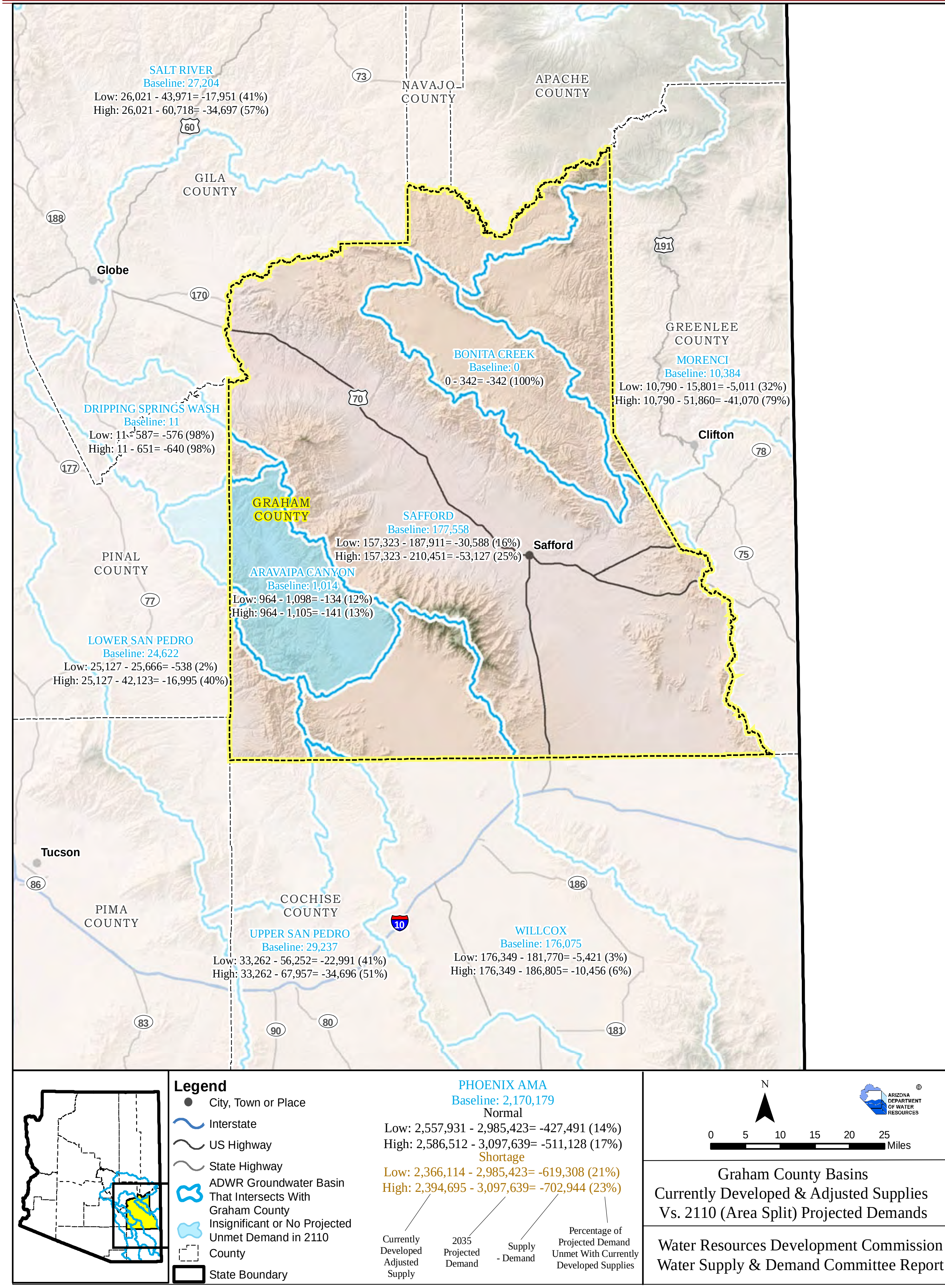

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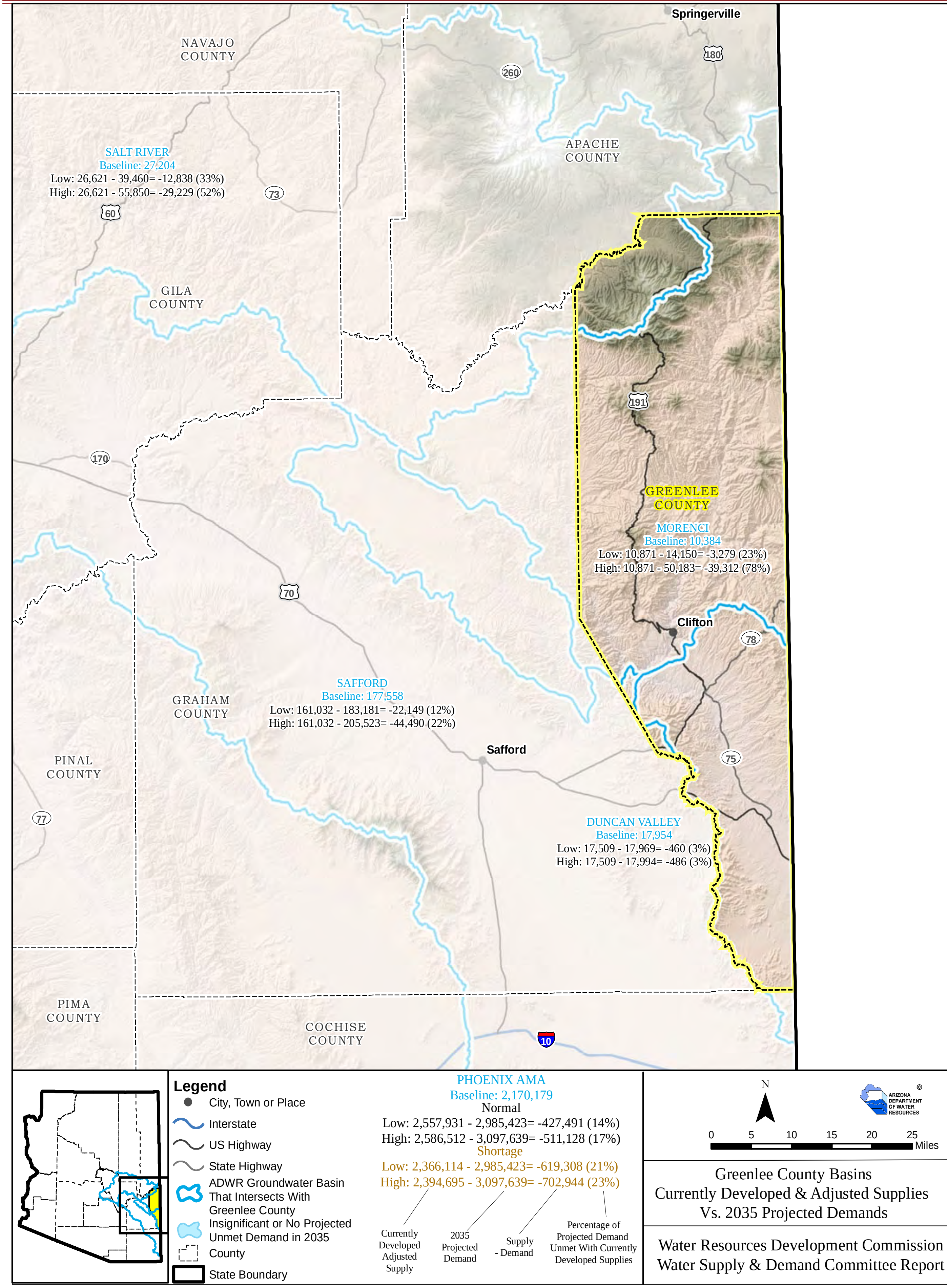

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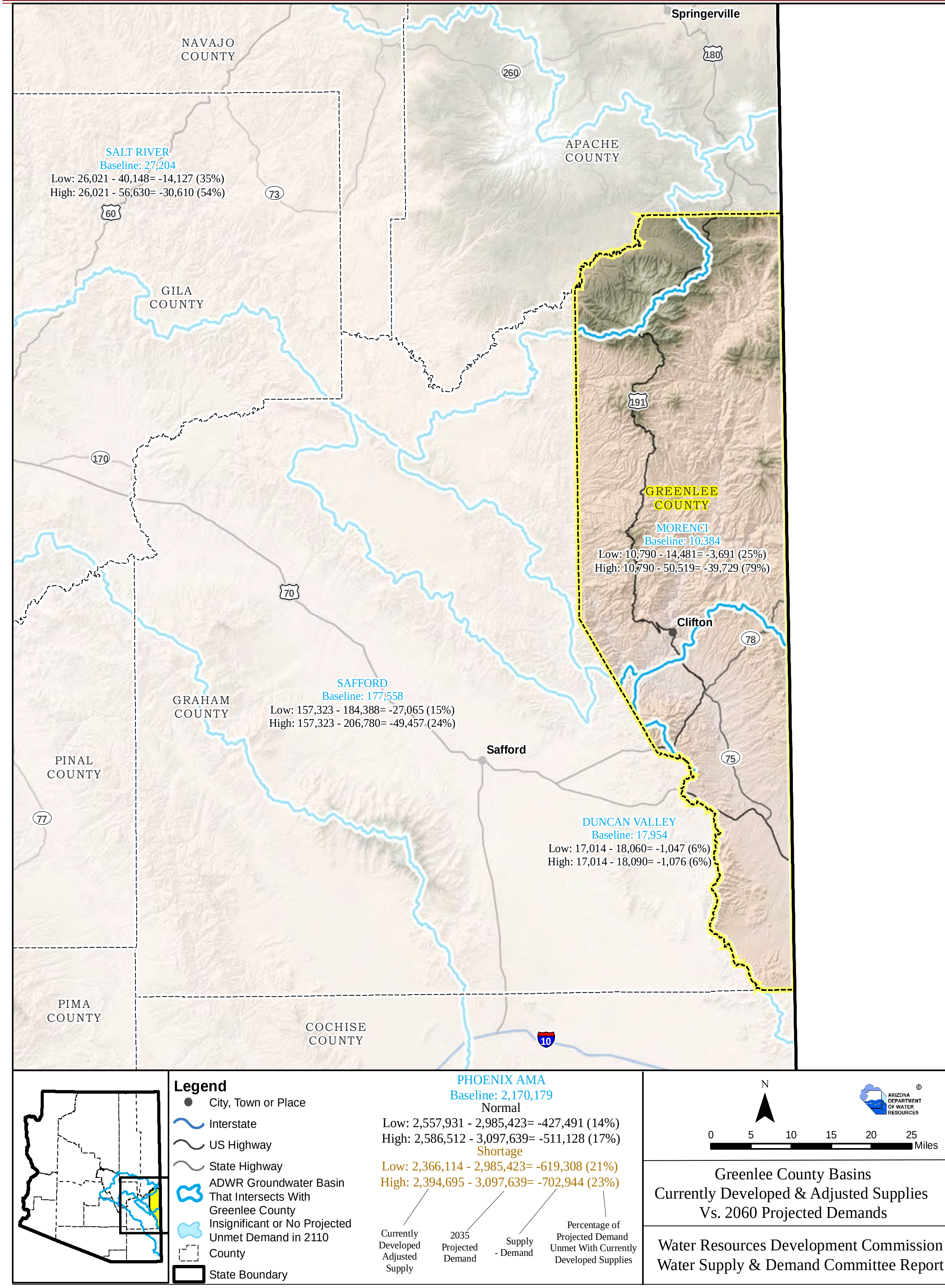
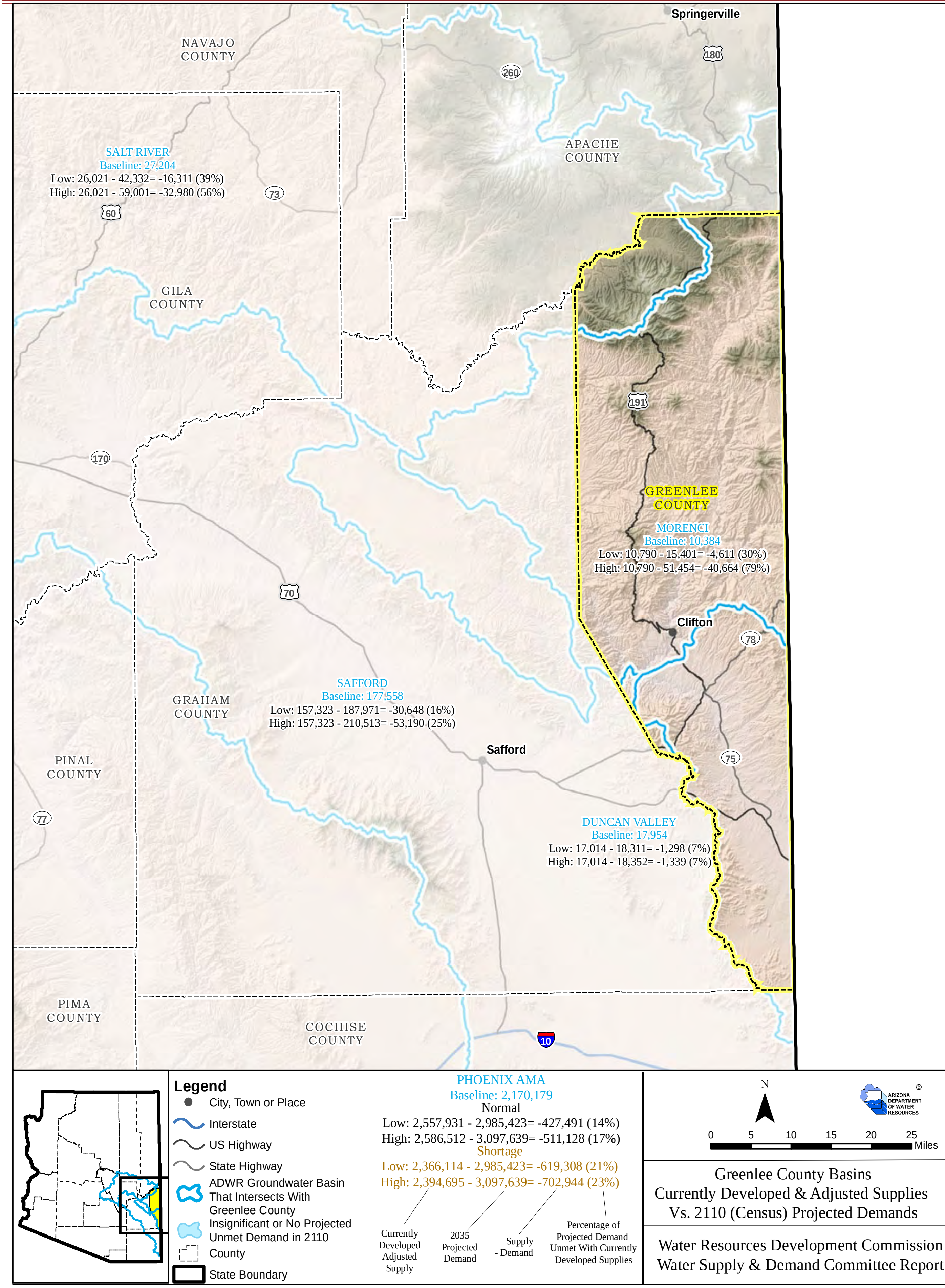

Springerville
NAVAJO COUNTY
APACHE COUNTY
SALT RIVER
Baseline: 27,204
Low: 26,021 - 40,148= -14,127 (35%)
High: 26,021 - 56,630= -30,610 (54%)
GILA COUNTY
GREENLEE COUNTY
MORENCI
Baseline: 10,384
Low: 10,790 - 14,481= -3,691 (25%)
High: 10,790 - 50,519= -39,729 (79%)
Clifton
GRAHAM COUNTY
SAFFORD
Baseline: 177,558
Low: 157,323 - 184,388= -27,065 (15%)
High: 157,323 - 206,780= -49,457 (24%)
Safford
PINAL COUNTY
DUNCAN VALLEY
Baseline: 17,954
Low: 17,014 - 18,060= -1,047 (6%)
High: 17,014 - 18,090= -1,076 (6%)
PIMA COUNTY
COCHISE COUNTY
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Greenlee County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 15 20 25 Miles
ARIZONA DEPARTMENT OF WATER RESOURCES
Greenlee County Basins
Currently Developed & Adjusted Supplies
Vs. 2060 Projected Demands
Water Resources Development Commission
Water Supply & Demand Committee Report
Path: U:\ADWR_Projects\WRDC\Committees\Supply_Demand\GIS\Maps\mxd\appendicies\GreenleeCo_2060.mxd



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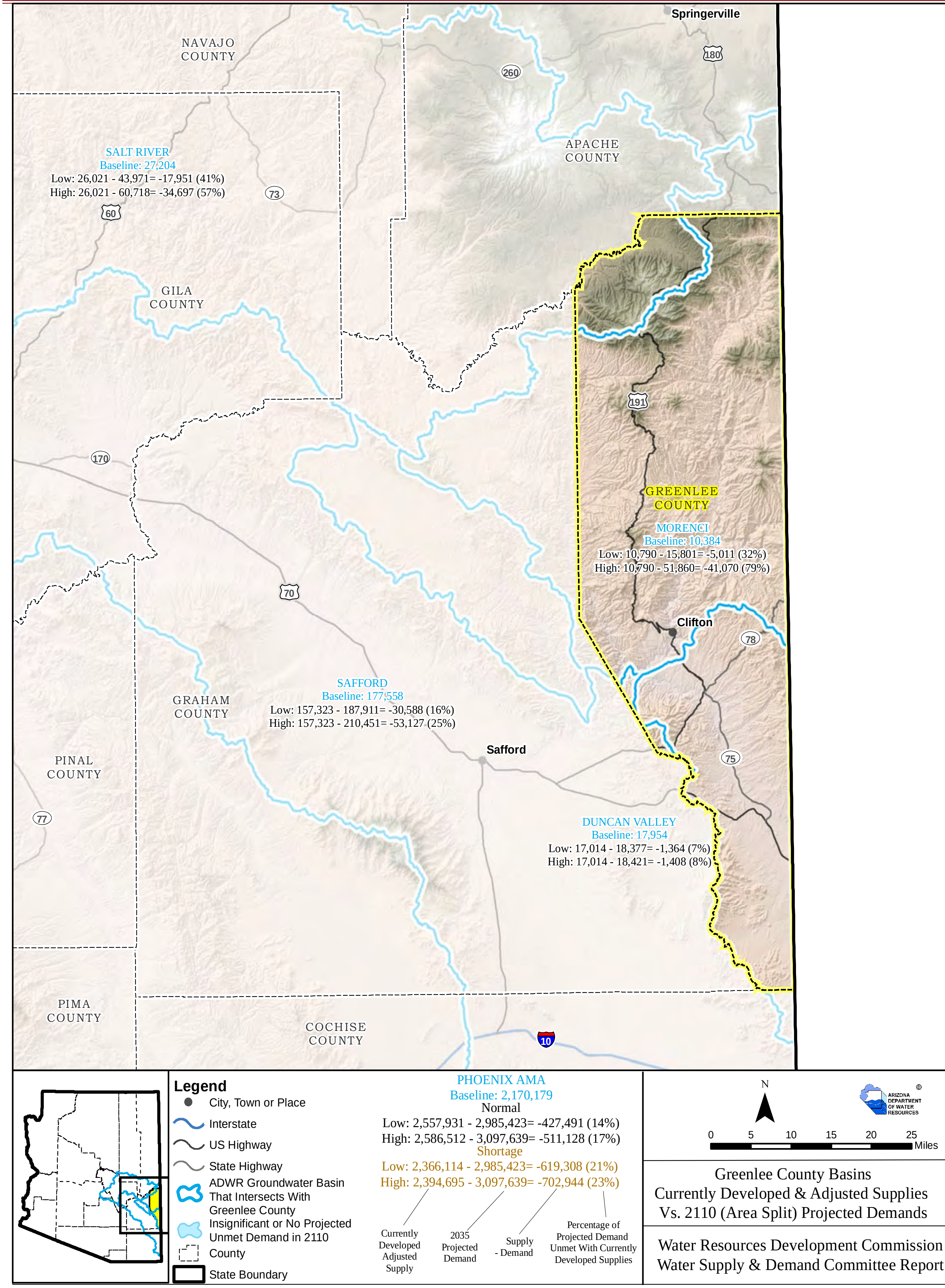

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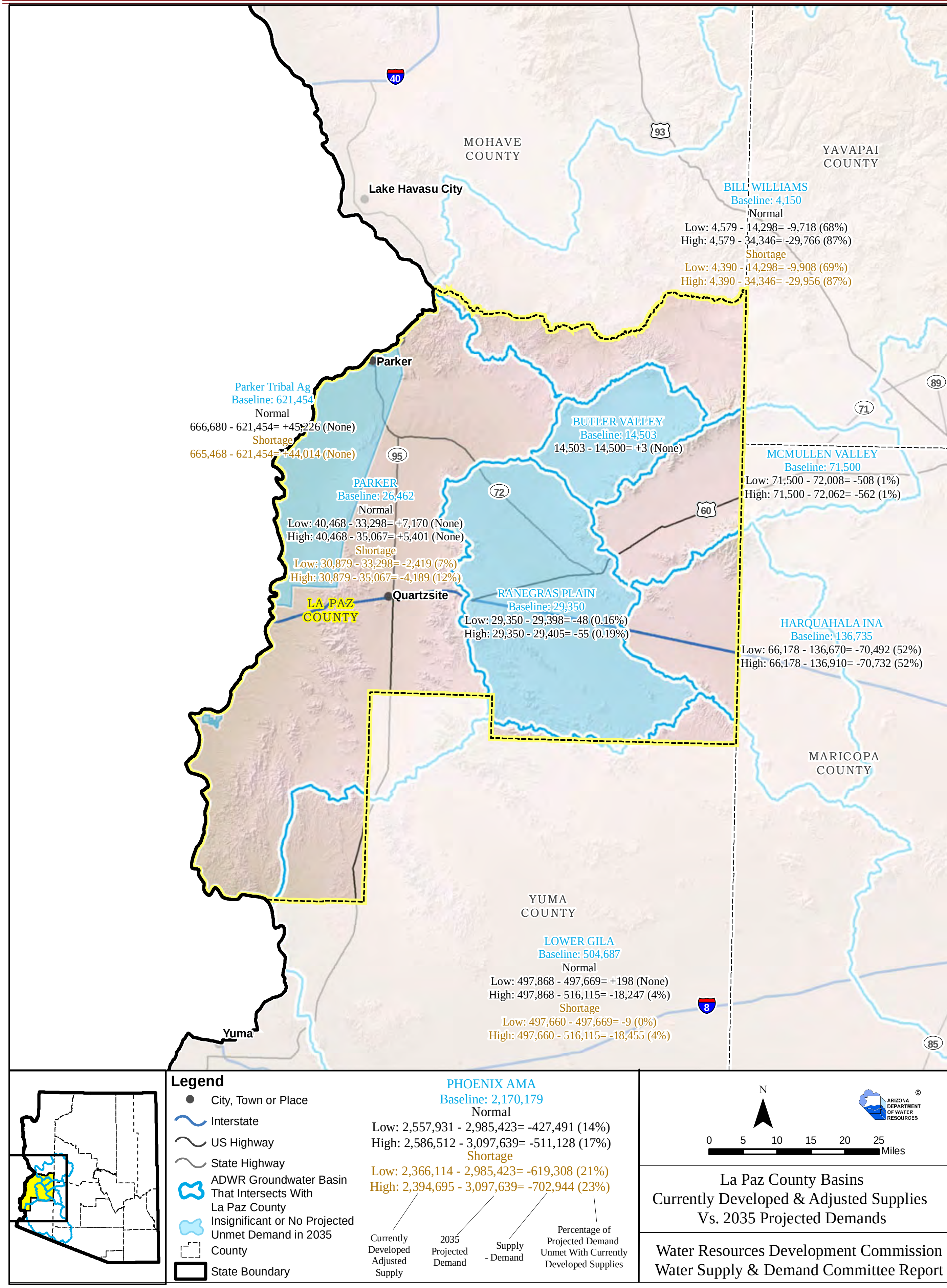

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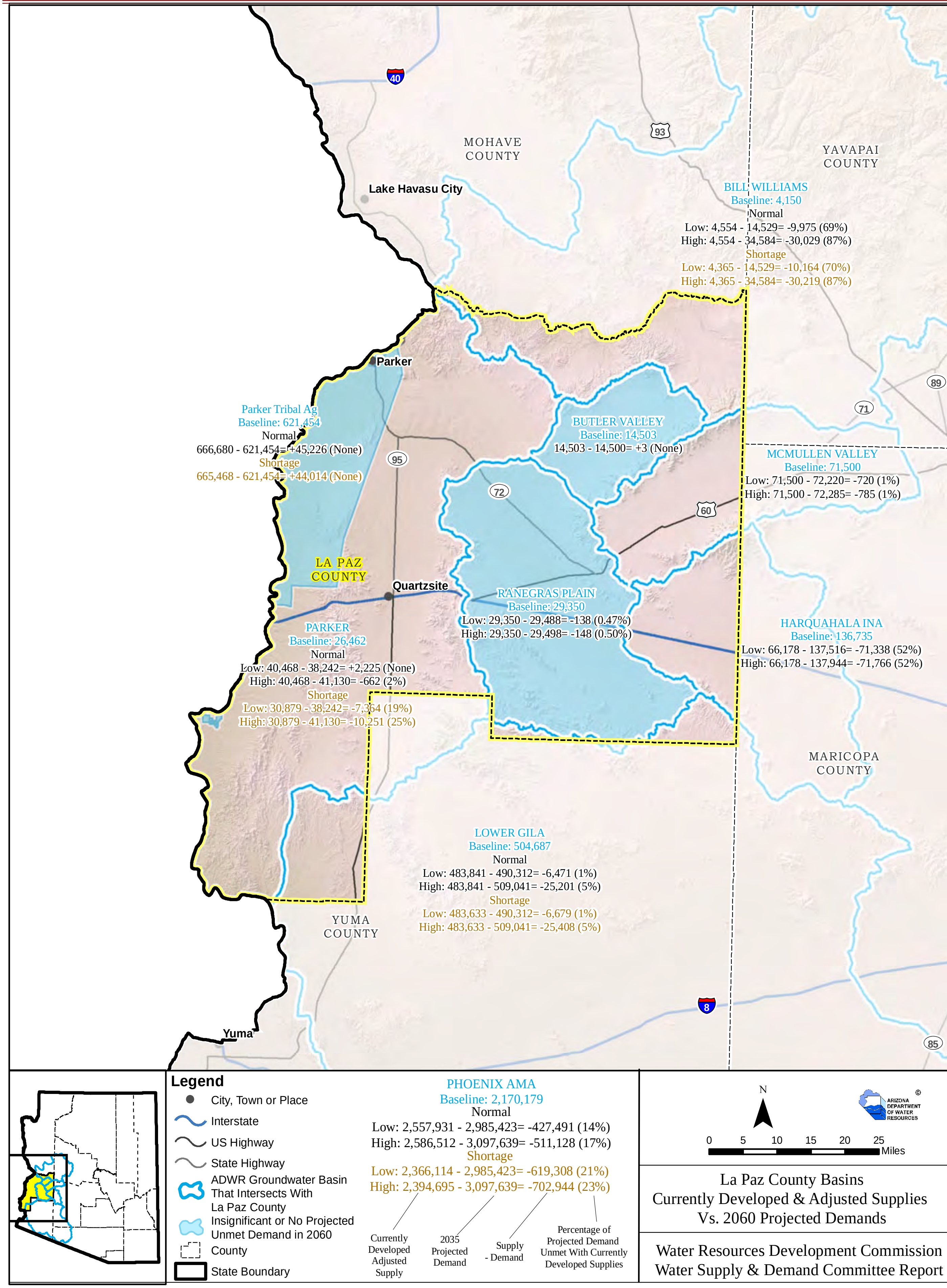

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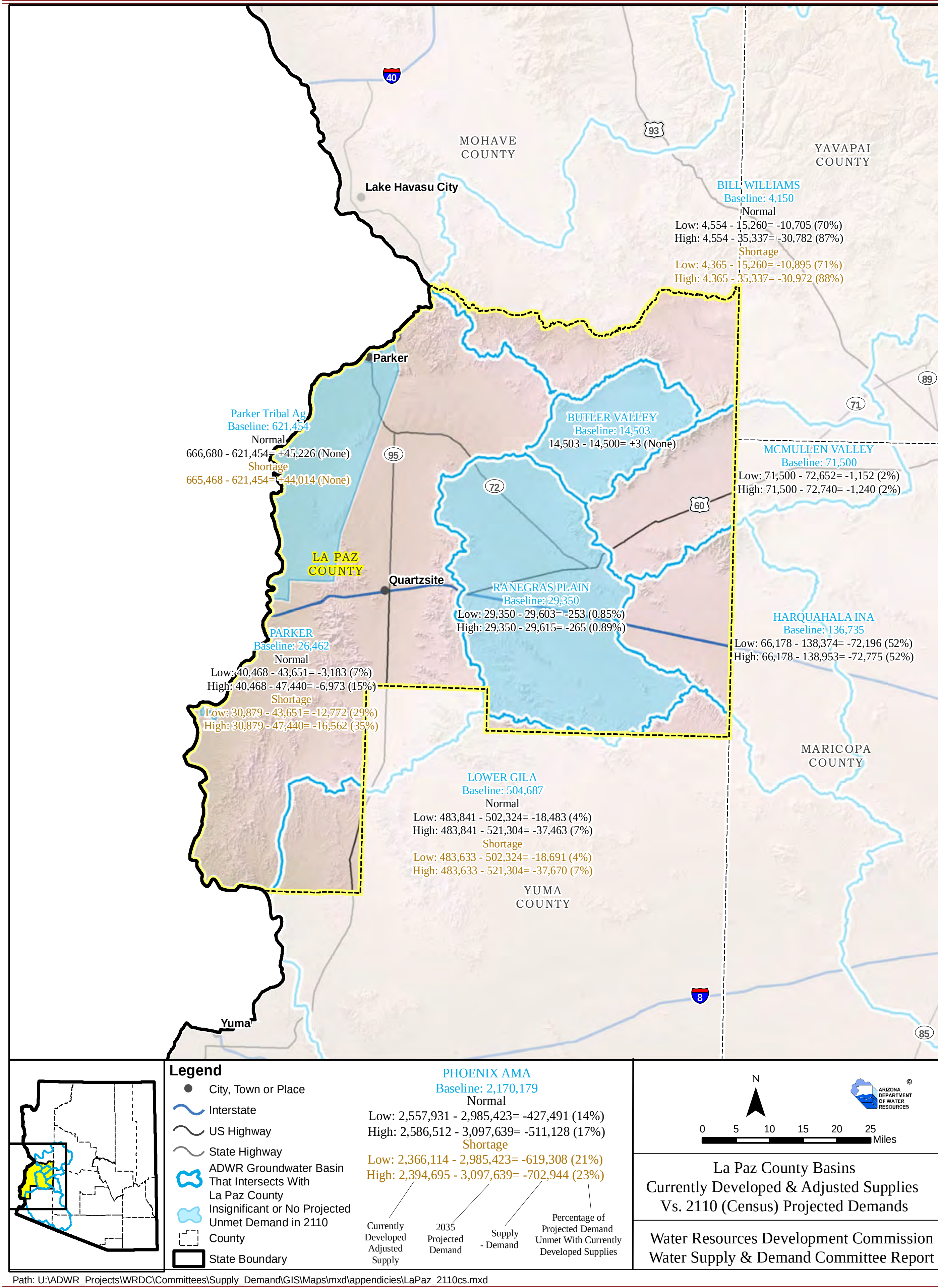
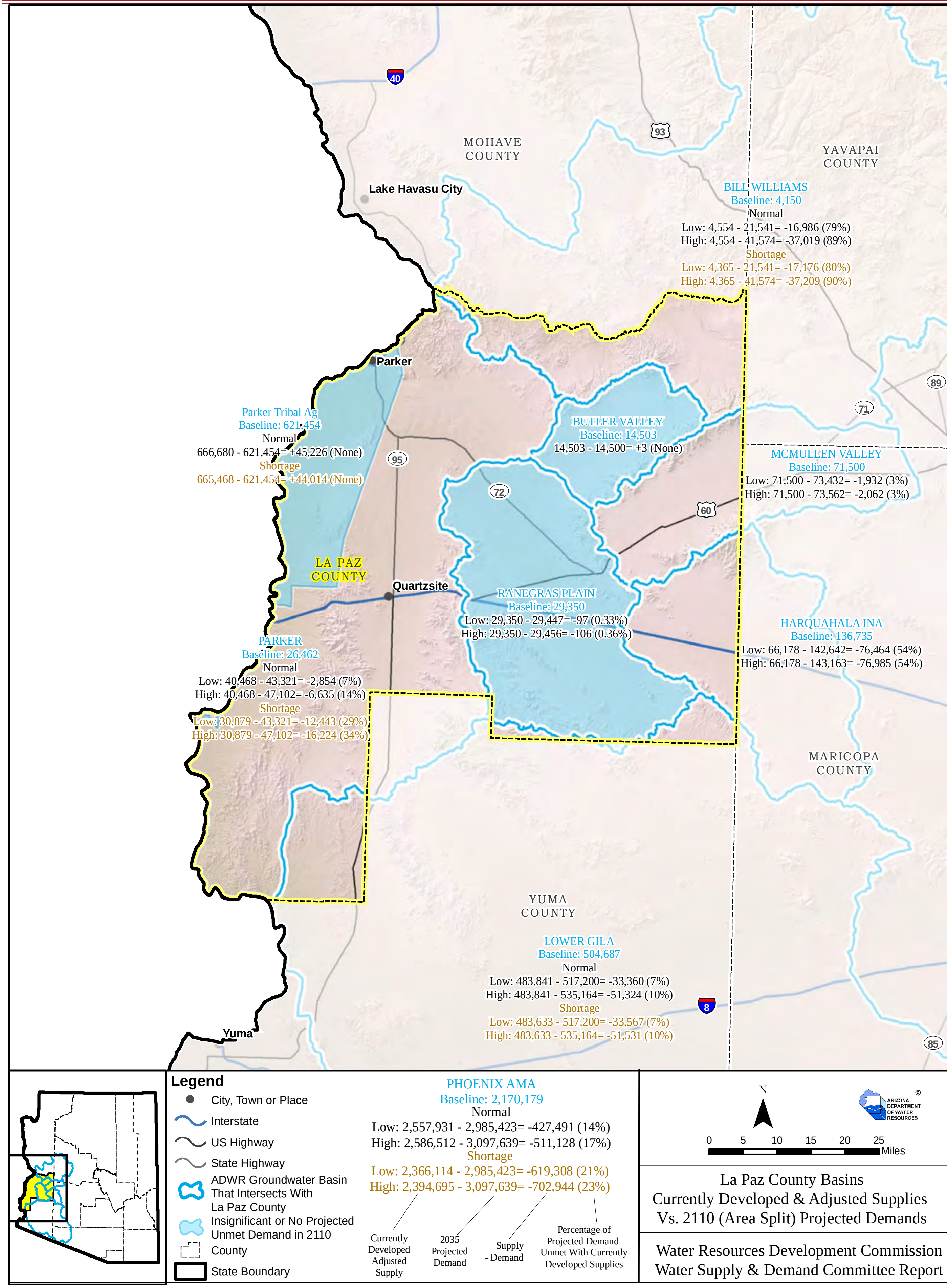

MOHAVE COUNTY
YAVAPAI COUNTY
Lake Havasu City
BILL WILLIAMS
Baseline: 4,150
Normal
Low: 4,554 - 15,260= -10,705 (70%)
High: 4,554 - 35,337= -30,782 (87%)
Shortage
Low: 4,365 - 15,260= -10,895 (71%)
High: 4,365 - 35,337= -30,972 (88%)
Parker
Parker Tribal Ag
Baseline: 621,454
Normal
666,680 - 621,454= +45,226 (None)
Shortage
665,468 - 621,454= +44,014 (None)
BUTLER VALLEY
Baseline: 14,503
14,503 - 14,500= +3 (None)
MCMULLEN VALLEY
Baseline: 71,500
Low: 71,500 - 72,652= -1,152 (2%)
High: 71,500 - 72,740= -1,240 (2%)
LA PAZ COUNTY
Quartzsite
RANEGRAS PLAIN
Baseline: 29,350
Low: 29,350 - 29,603= -253 (0.85%)
High: 29,350 - 29,615= -265 (0.89%)
HARQUAHALA INA
Baseline: 136,735
Low: 66,178 - 138,374= -72,196 (52%)
High: 66,178 - 138,953= -72,775 (52%)
PARKER
Baseline: 26,462
Normal
Low: 40,468 - 43,651= -3,183 (7%)
High: 40,468 - 47,440= -6,973 (15%)
Shortage
Low: 30,879 - 43,651= -12,772 (29%)
High: 30,879 - 47,440= -16,562 (35%)
MARICOPA COUNTY
LOWER GILA
Baseline: 504,687
Normal
Low: 483,841 - 502,324= -18,483 (4%)
High: 483,841 - 521,304= -37,463 (7%)
Shortage
Low: 483,633 - 502,324= -18,691 (4%)
High: 483,633 - 521,304= -37,670 (7%)
YUMA COUNTY
Yuma
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With La Paz County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 15 20 25 Miles
ARIZONA DEPARTMENT OF WATER RESOURCES
La Paz County Basins
Currently Developed & Adjusted Supplies
Vs. 2110 (Census) Projected Demands
Water Resources Development Commission
Water Supply & Demand Committee Report
Path: U:\ADWR_Projects\WRDC\Committees\Supply_Demand\GIS\Maps\mxd\appendicies\LaPaz_2110cs.mxd



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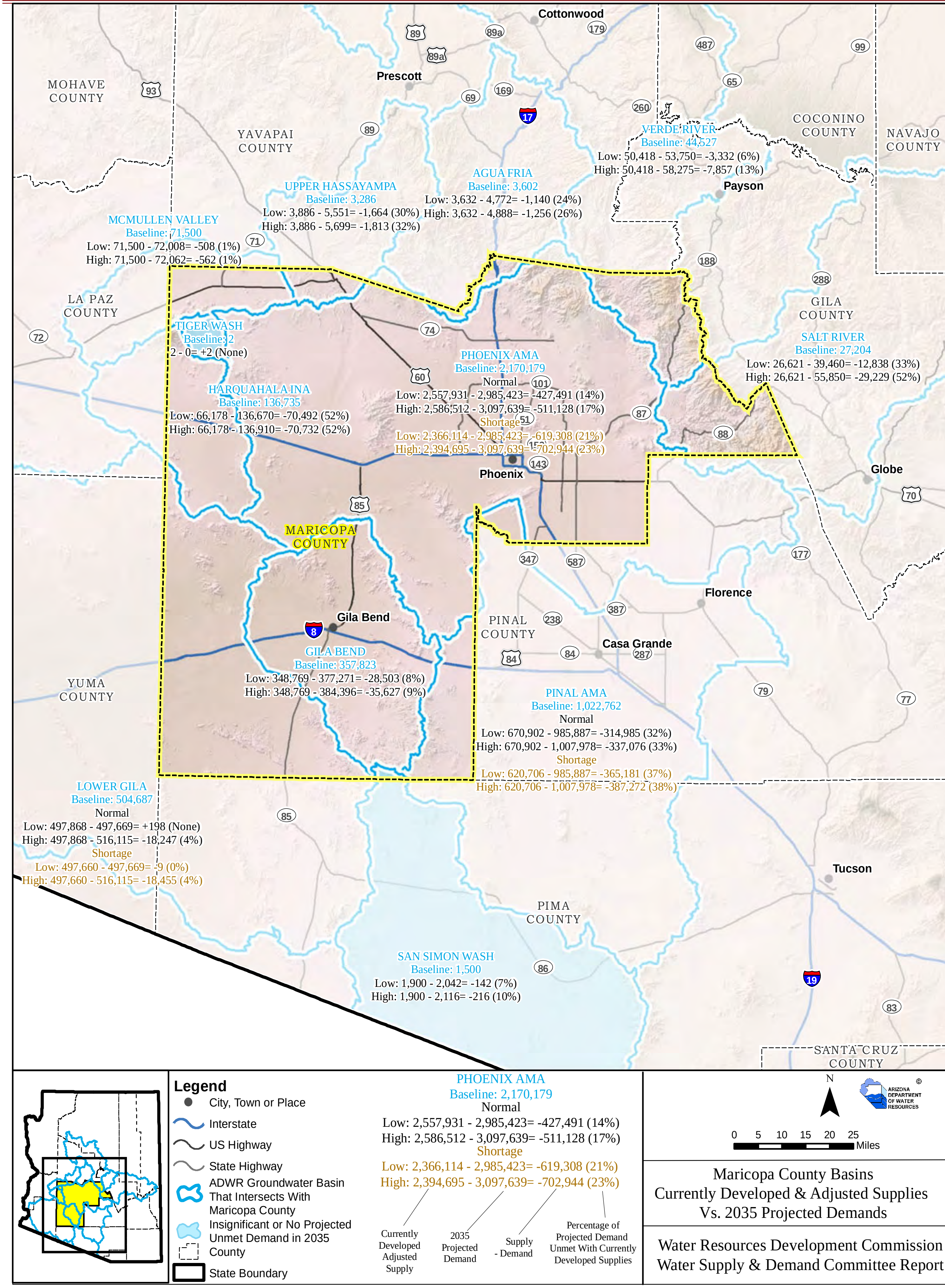

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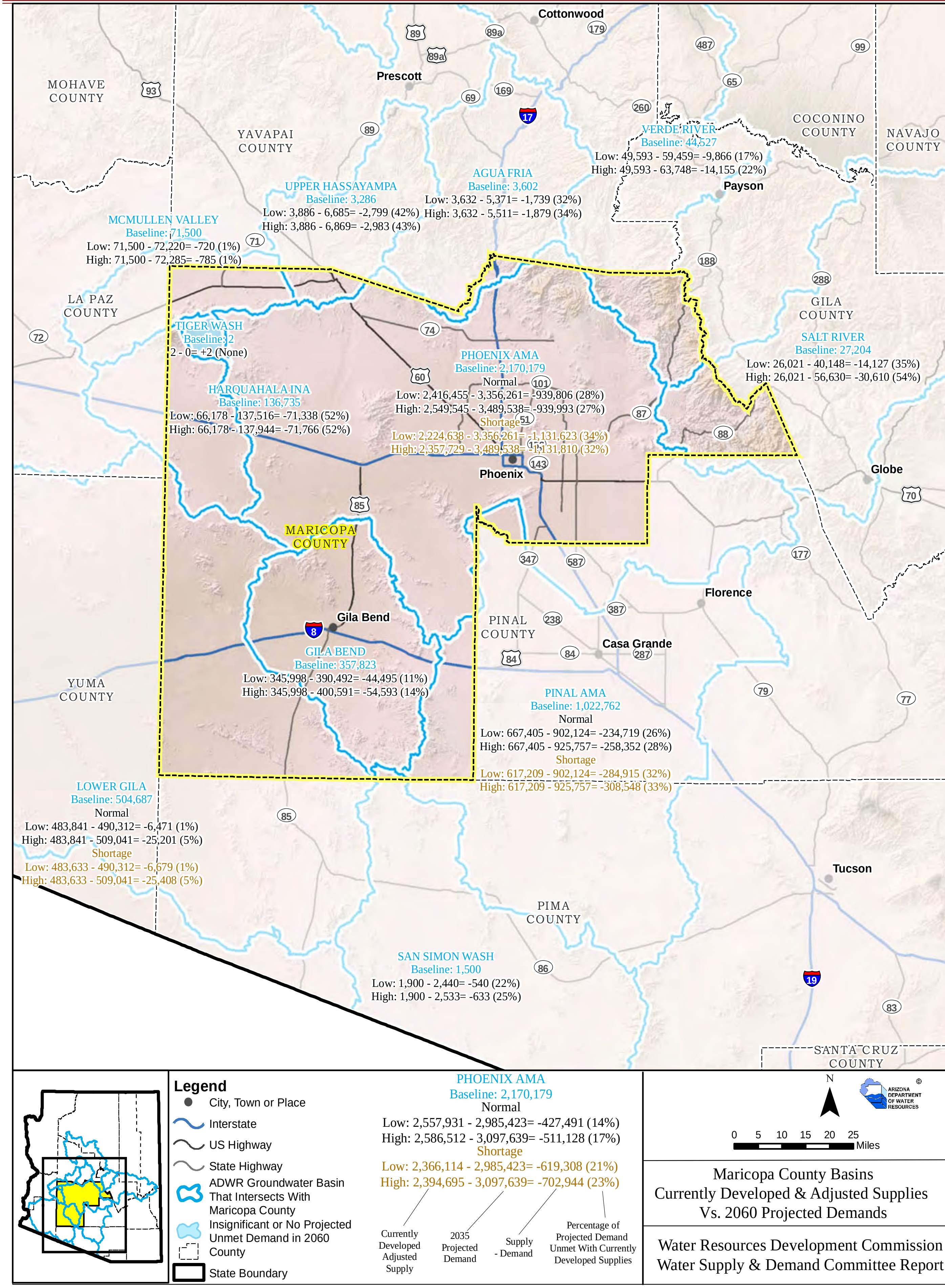

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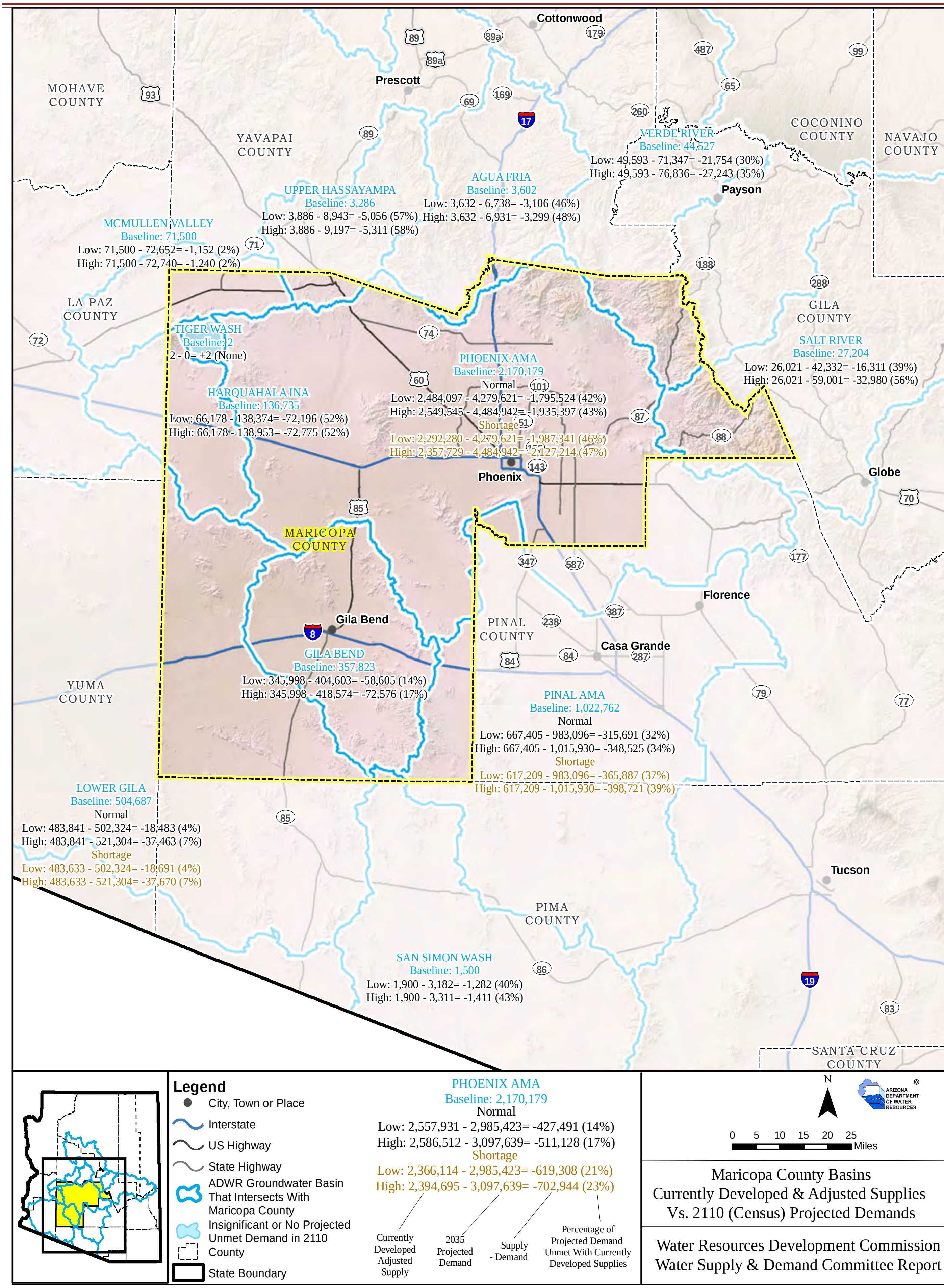

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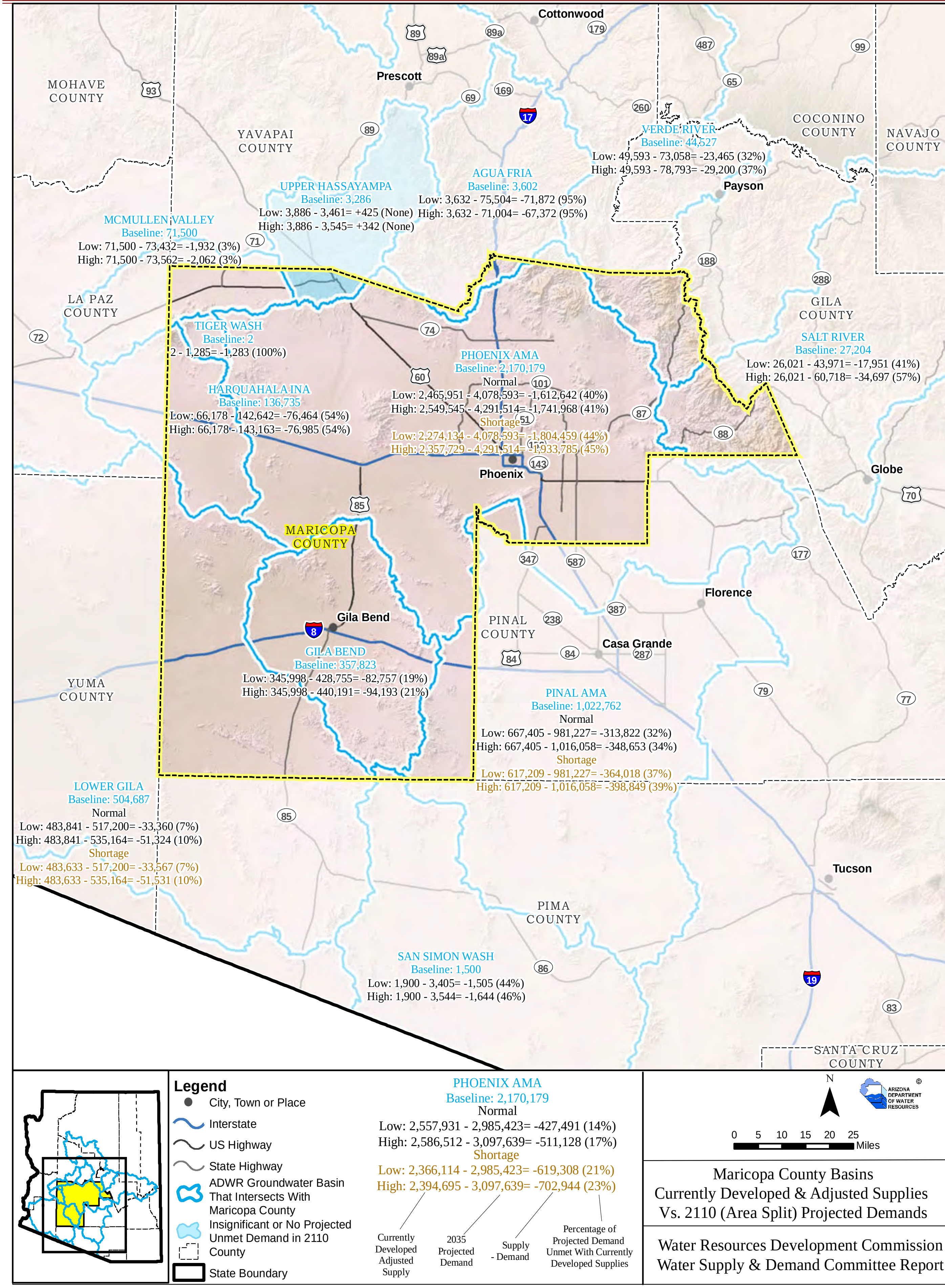

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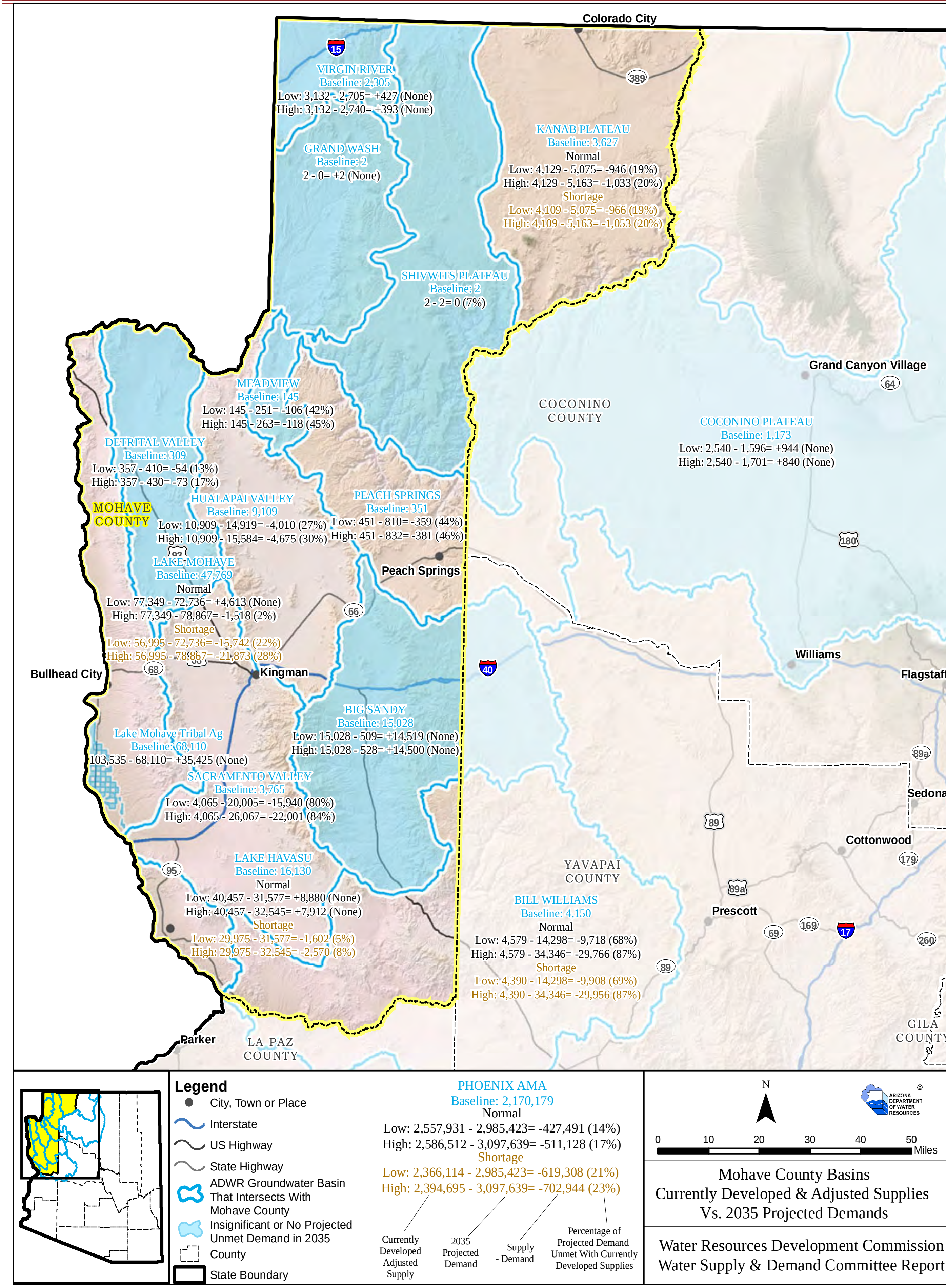

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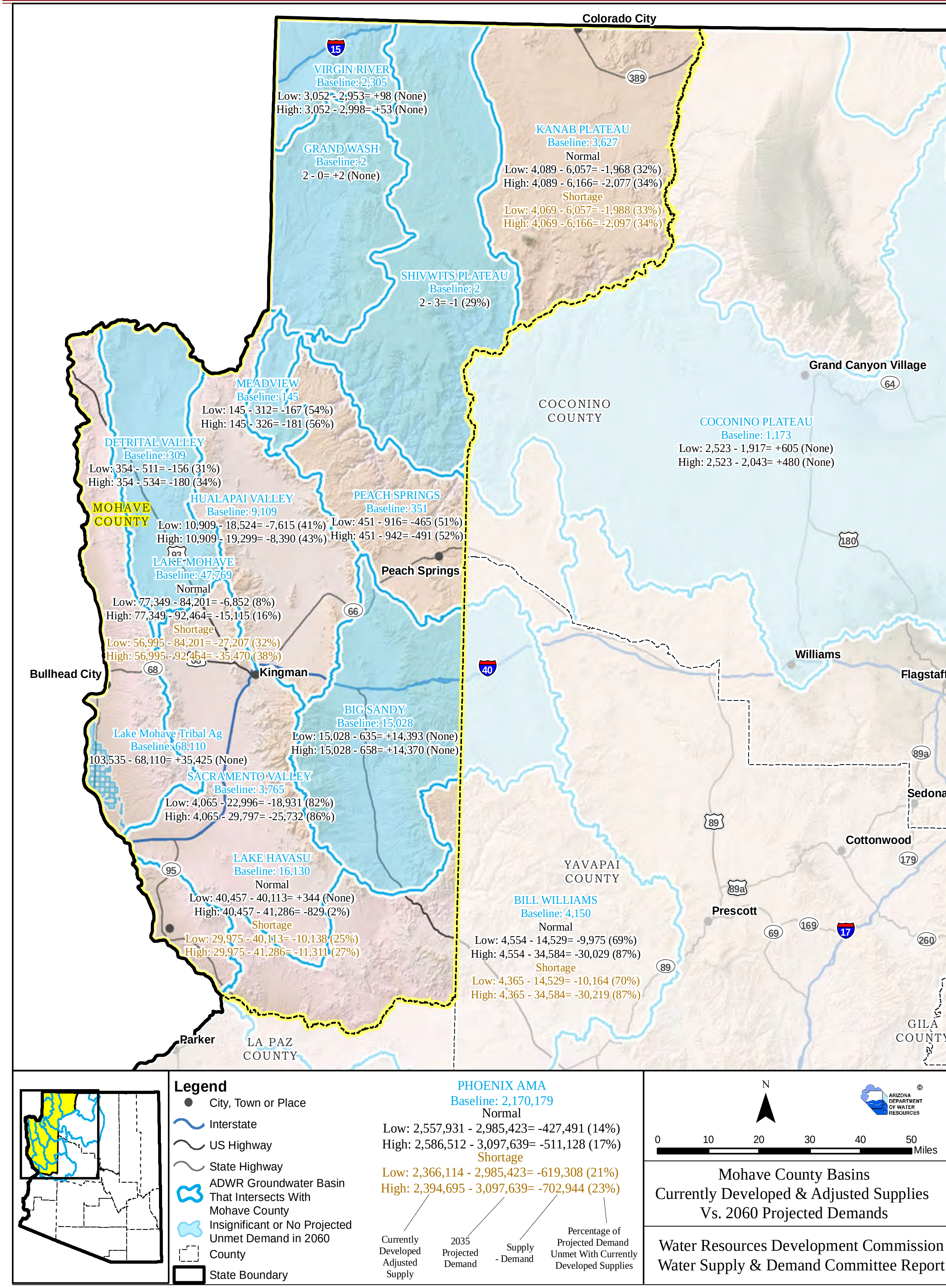

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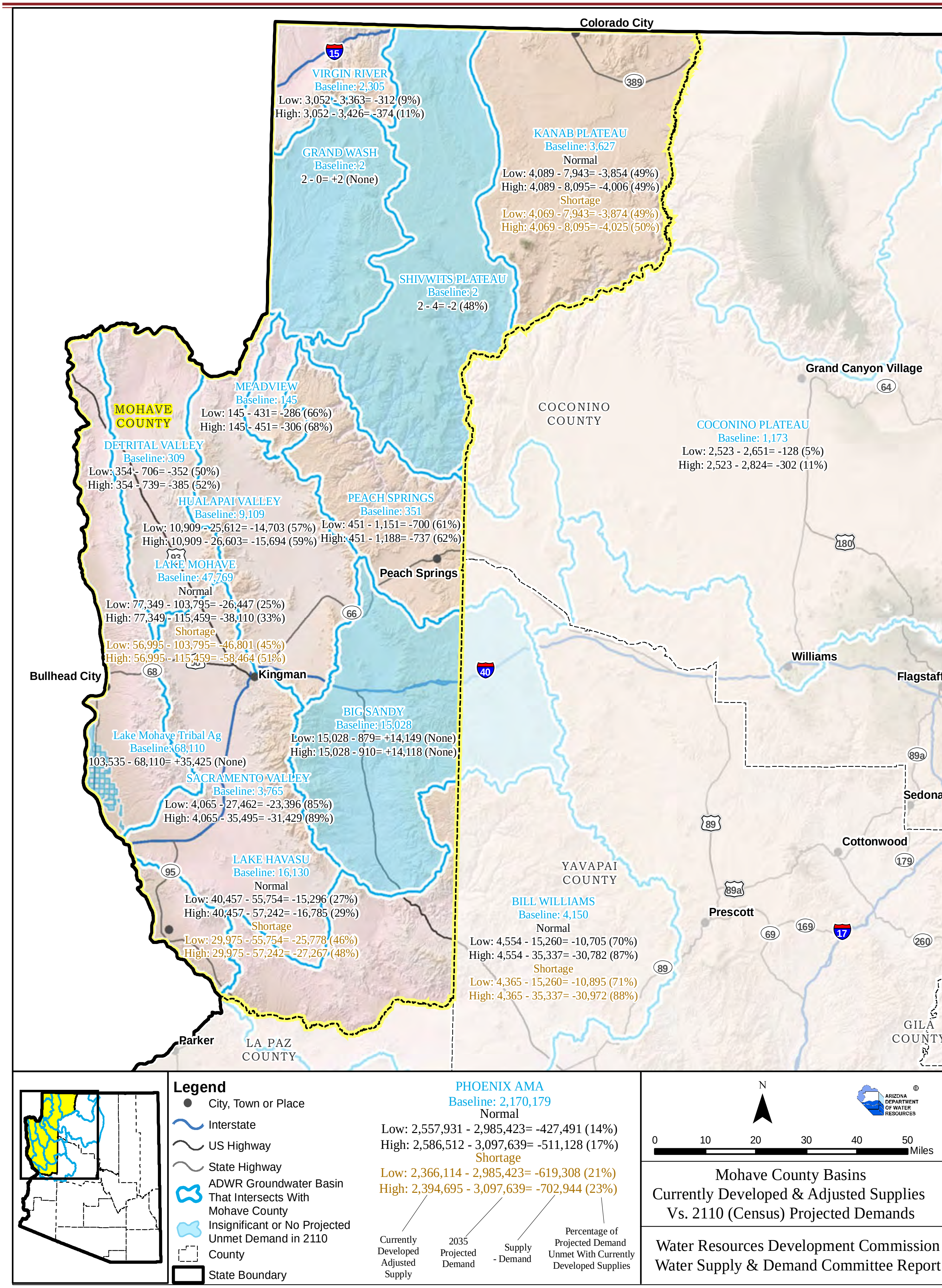

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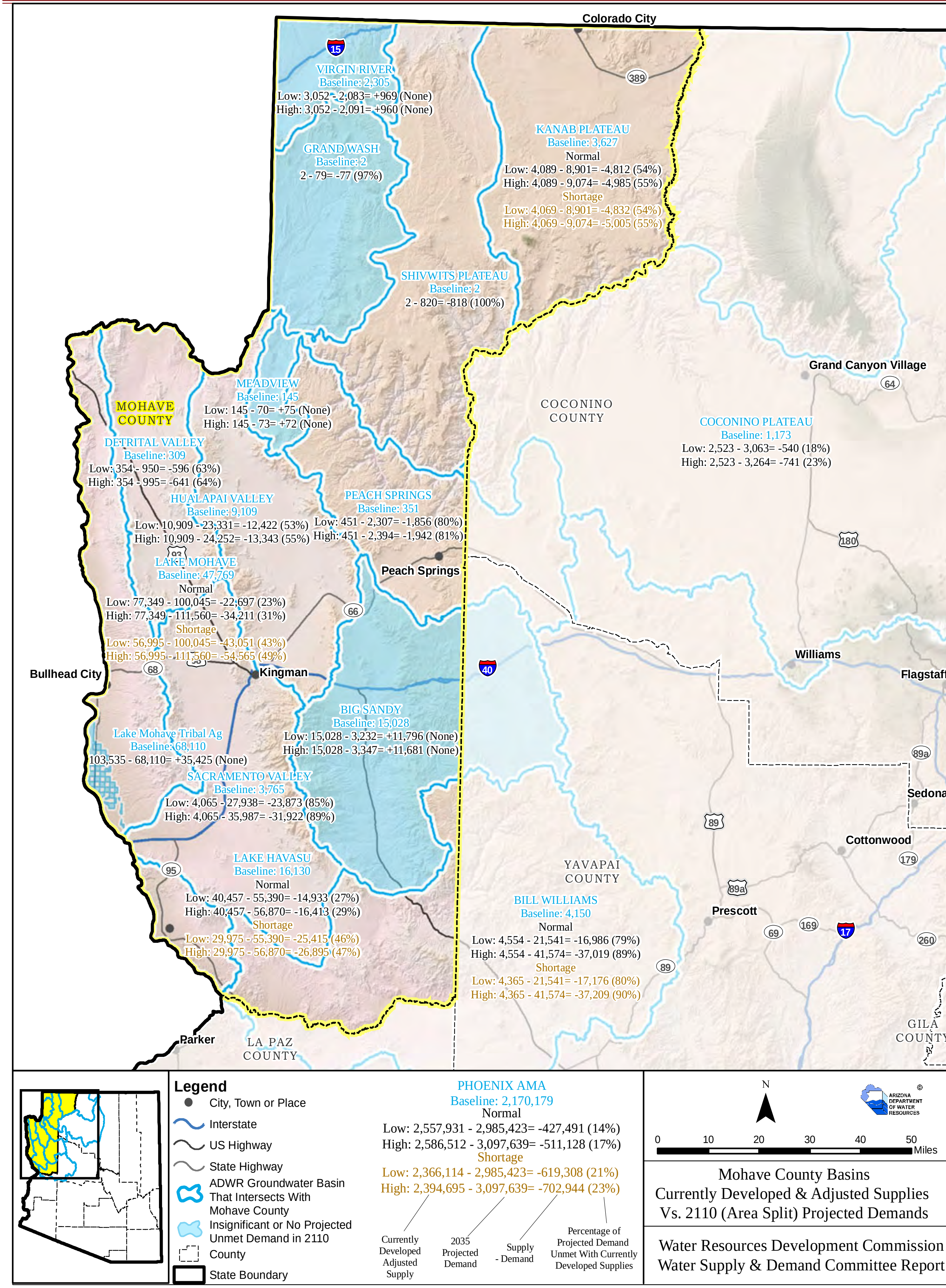

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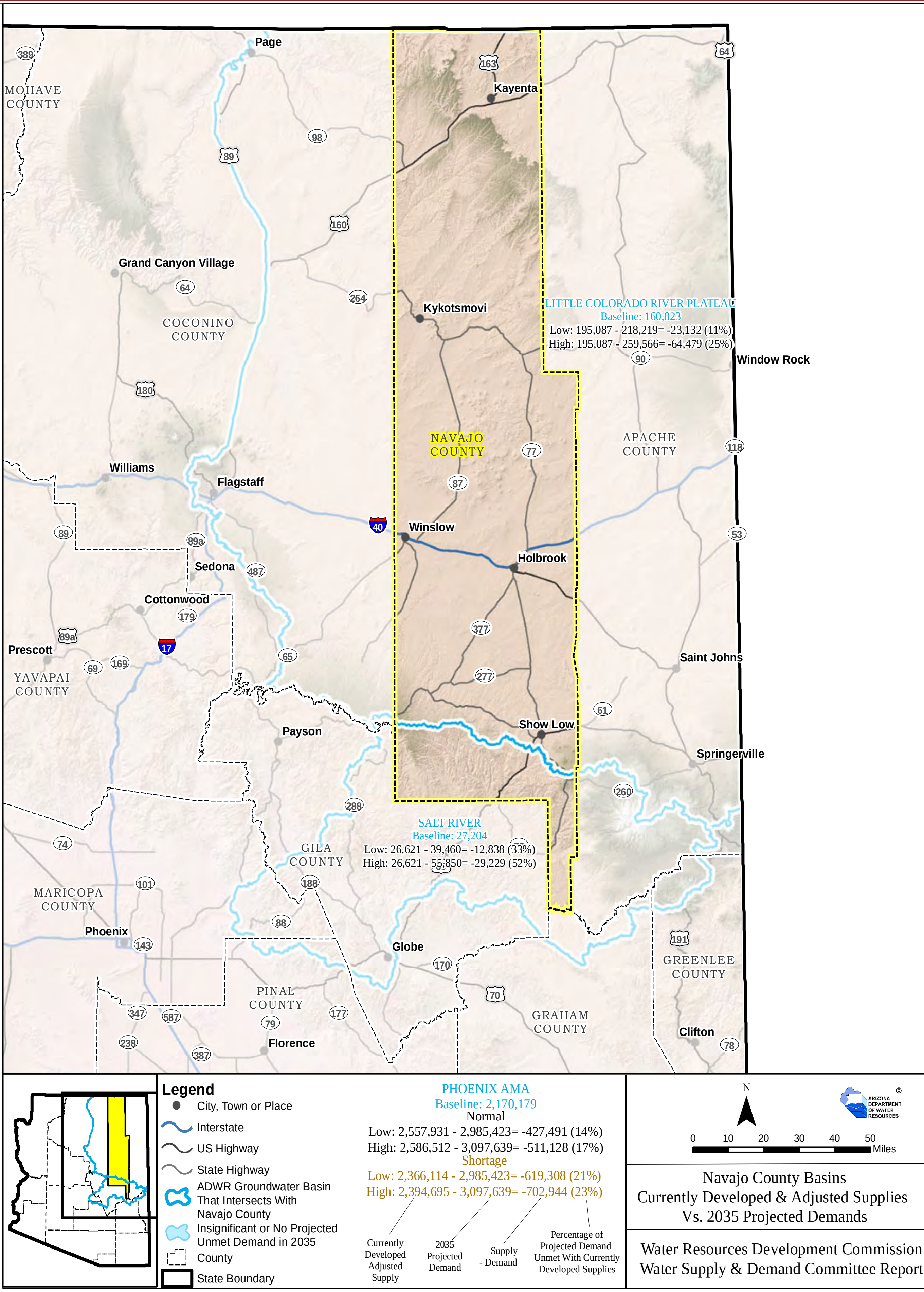

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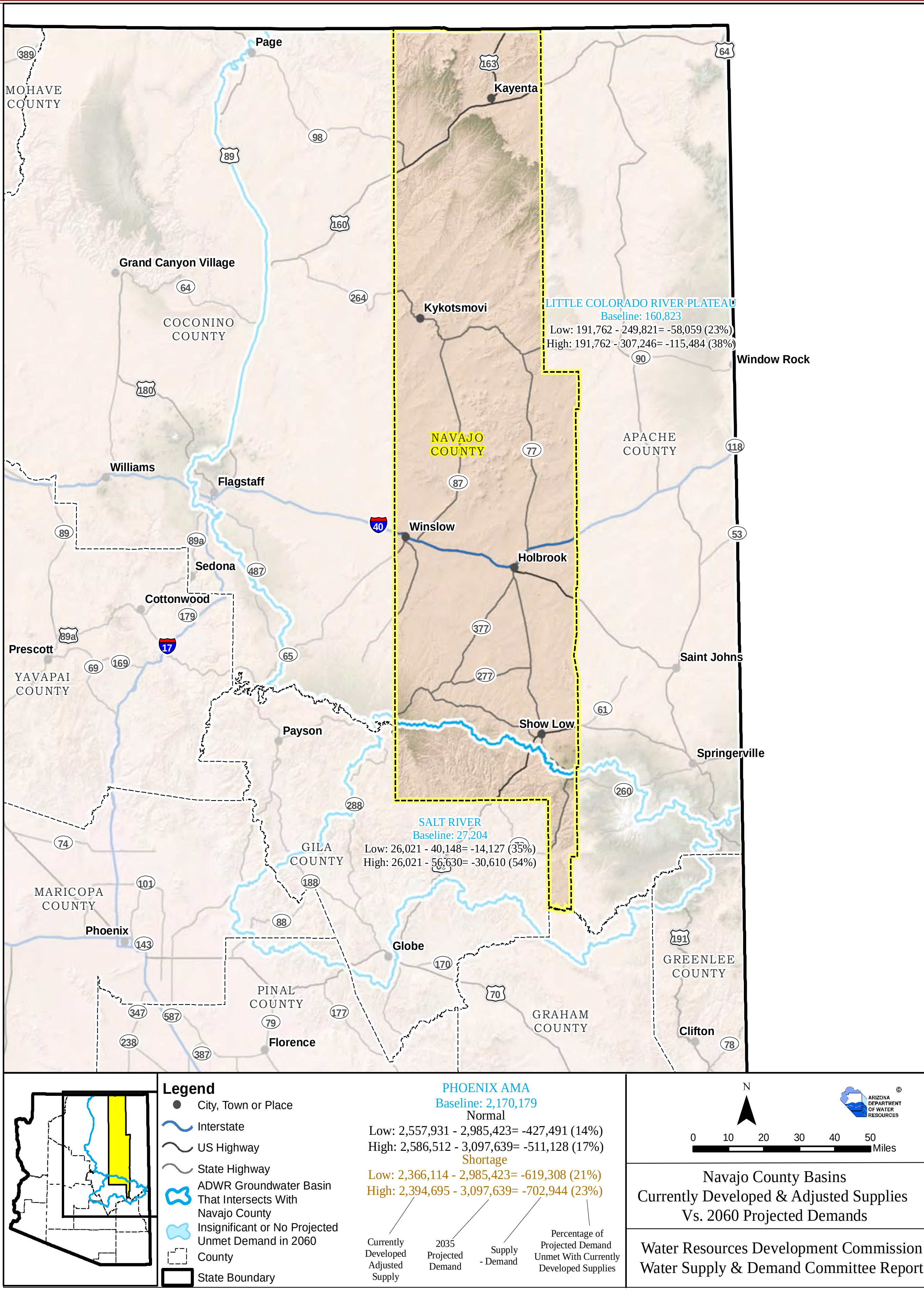

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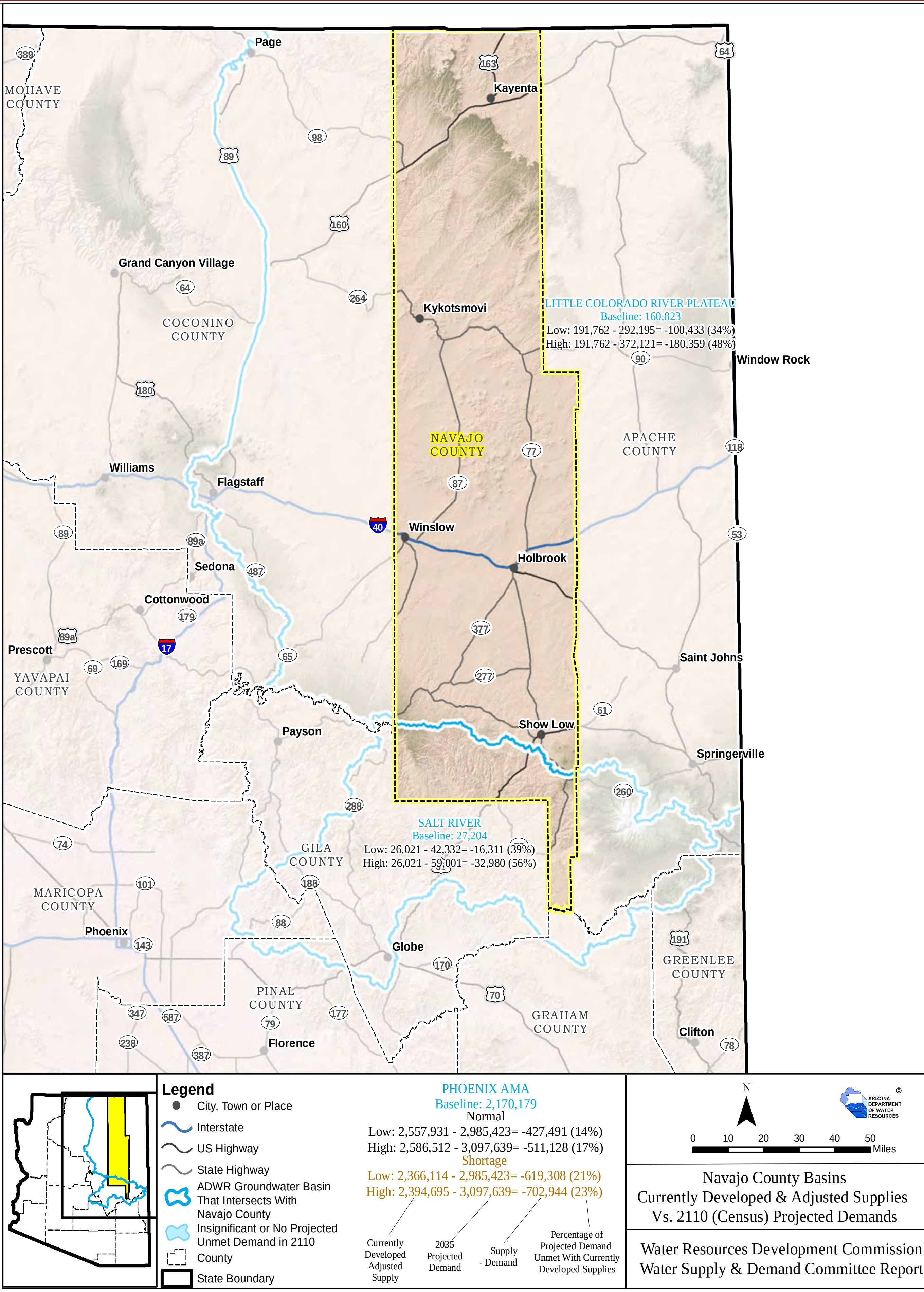
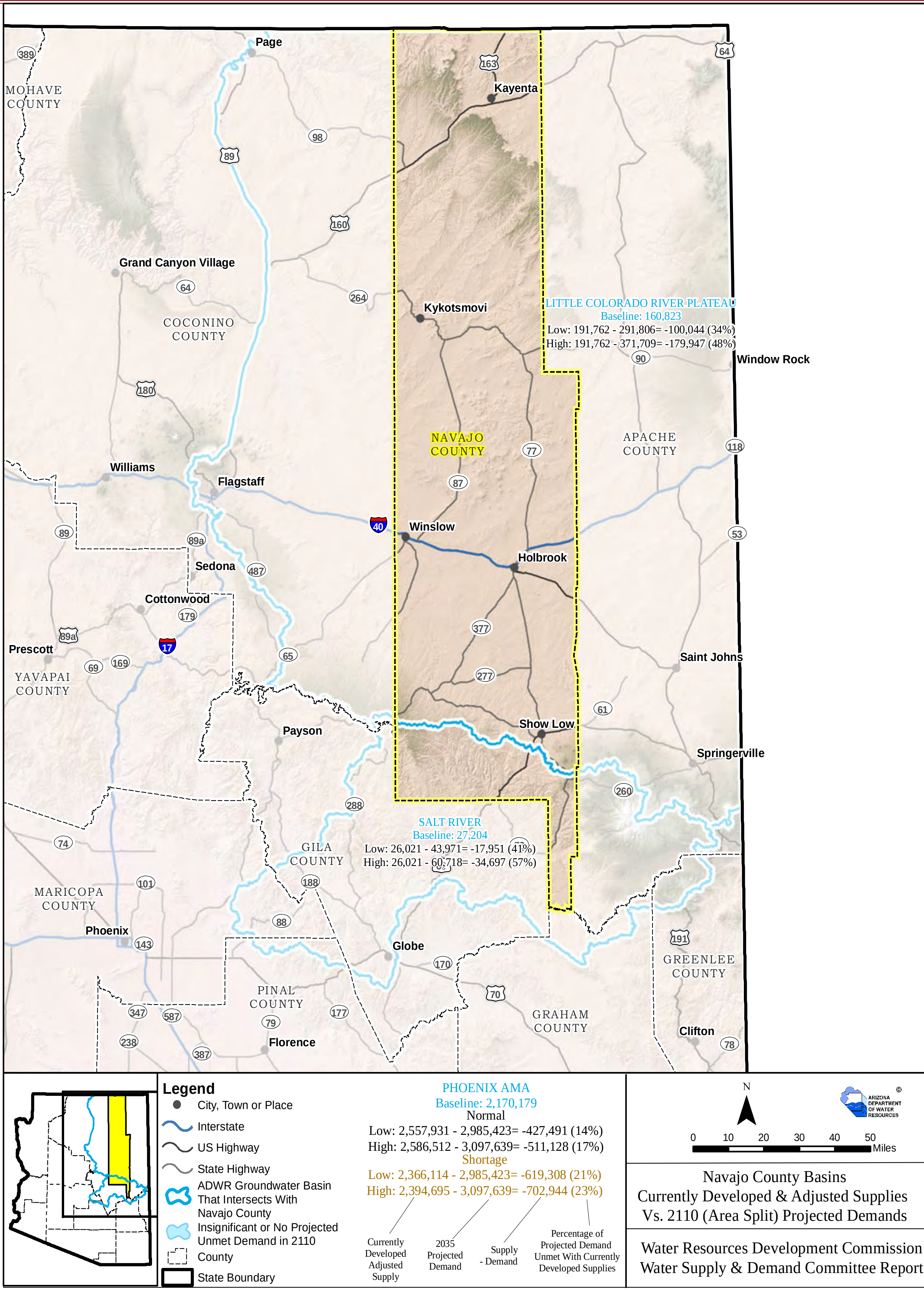

Page
Kayenta
MOHAVE COUNTY
Grand Canyon Village
COCONINO COUNTY
Kykotsmovi
LITTLE COLORADO RIVER PLATEAU
Baseline: 160,823
Low: 191,762 - 292,195= -100,433 (34%)
High: 191,762 - 372,121= -180,359 (48%)
Window Rock
NAVAJO COUNTY
APACHE COUNTY
Williams
Flagstaff
Winslow
Holbrook
Sedona
Cottonwood
Prescott
YAVAPAI COUNTY
Saint Johns
Payson
Show Low
Springerville
SALT RIVER
Baseline: 27,204
Low: 26,021 - 42,332= -16,311 (39%)
High: 26,021 - 59,001= -32,980 (56%)
GILA COUNTY
MARICOPA COUNTY
Phoenix
Globe
GREENLEE COUNTY
PINAL COUNTY
GRAHAM COUNTY
Clifton
Florence
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Navajo County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 10 20 30 40 50 Miles
ARIZONA DEPARTMENT OF WATER RESOURCES
Navajo County Basins
Currently Developed & Adjusted Supplies
Vs. 2110 (Census) Projected Demands
Water Resources Development Commission
Water Supply & Demand Committee Report
Path: U:\ADWR_Projects\WRDC\Committees\Supply_Demand\GIS\Maps\mxd\appendicies\Navajo_2110cs.mxd



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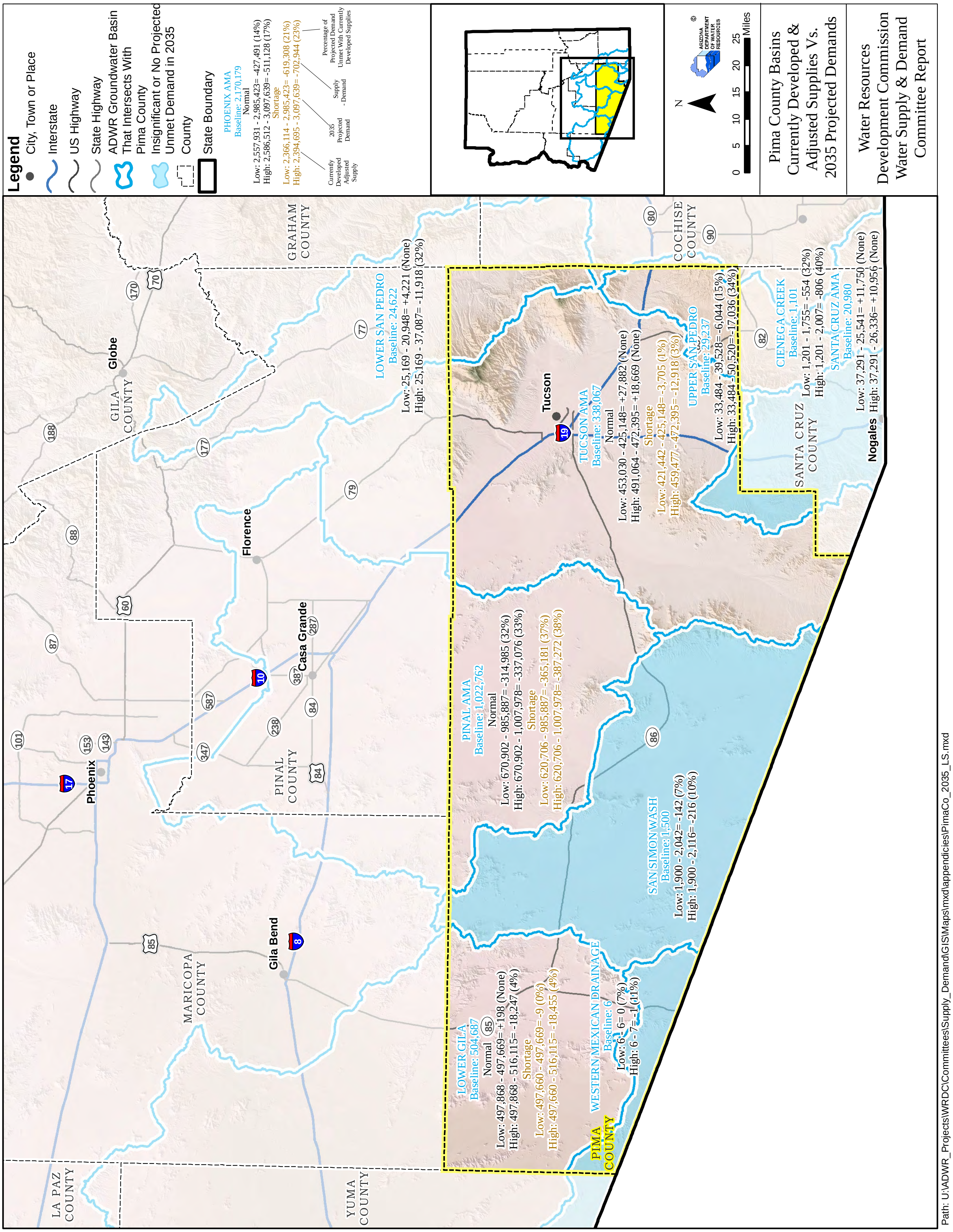
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Pima County
Insignificant or No Projected Unmet Demand in 2035
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 15 20 25 Miles
Pima County Basins Currently Developed & Adjusted Supplies Vs. 2035 Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
LOWER SAN PEDRO
Baseline: 24,622
Low: 25,169 - 20,948= +4,221 (None)
High: 25,169 - 37,087= -11,918 (32%)
PINAL AMA
Baseline: 1,022,762
Normal
Low: 670,902 - 985,887= -314,985 (32%)
High: 670,902 - 1,007,978= -337,076 (33%)
Shortage
Low: 620,706 - 985,887= -365,181 (37%)
High: 620,706 - 1,007,978= -387,272 (38%)
TUCSON AMA
Baseline: 338,067
Normal
Low: 453,030 - 425,148= +27,882 (None)
High: 491,064 - 472,395= +18,669 (None)
Shortage
Low: 421,442 - 425,148= -3,705 (1%)
High: 459,477 - 472,395= -12,918 (3%)
UPPER SAN PEDRO
Baseline: 29,237
Low: 33,484 - 39,528= -6,044 (15%)
High: 33,484 - 50,520= -17,036 (34%)
CIENEGA CREEK
Baseline: 1,101
Low: 1,201 - 1,755= -554 (32%)
High: 1,201 - 2,007= -806 (40%)
SANTA CRUZ AMA
Baseline: 20,980
Low: 37,291 - 25,541= +11,750 (None)
High: 37,291 - 26,336= +10,956 (None)
SAN SIMON WASH
Baseline: 1,500
Low: 1,900 - 2,042= -142 (7%)
High: 1,900 - 2,116= -216 (10%)
LOWER GILA
Baseline: 504,687
Normal
Low: 497,868 - 497,669= +198 (None)
High: 497,868 - 516,115= -18,247 (4%)
Shortage
Low: 497,660 - 497,669= -9 (0%)
High: 497,660 - 516,115= -18,455 (4%)
WESTERN MEXICAN DRAINAGE
Baseline: 6
Low: 6 - 6= 0 (7%)
High: 6 - 7= -1 (11%)
PIMA COUNTY
LA PAZ COUNTY
YUMA COUNTY
MARICOPA COUNTY
PINAL COUNTY
GILA COUNTY
GRAHAM COUNTY
COCHISE COUNTY
SANTA CRUZ COUNTY
Phoenix
Globe
Florence
Casa Grande
Gila Bend
Tucson
Nogales
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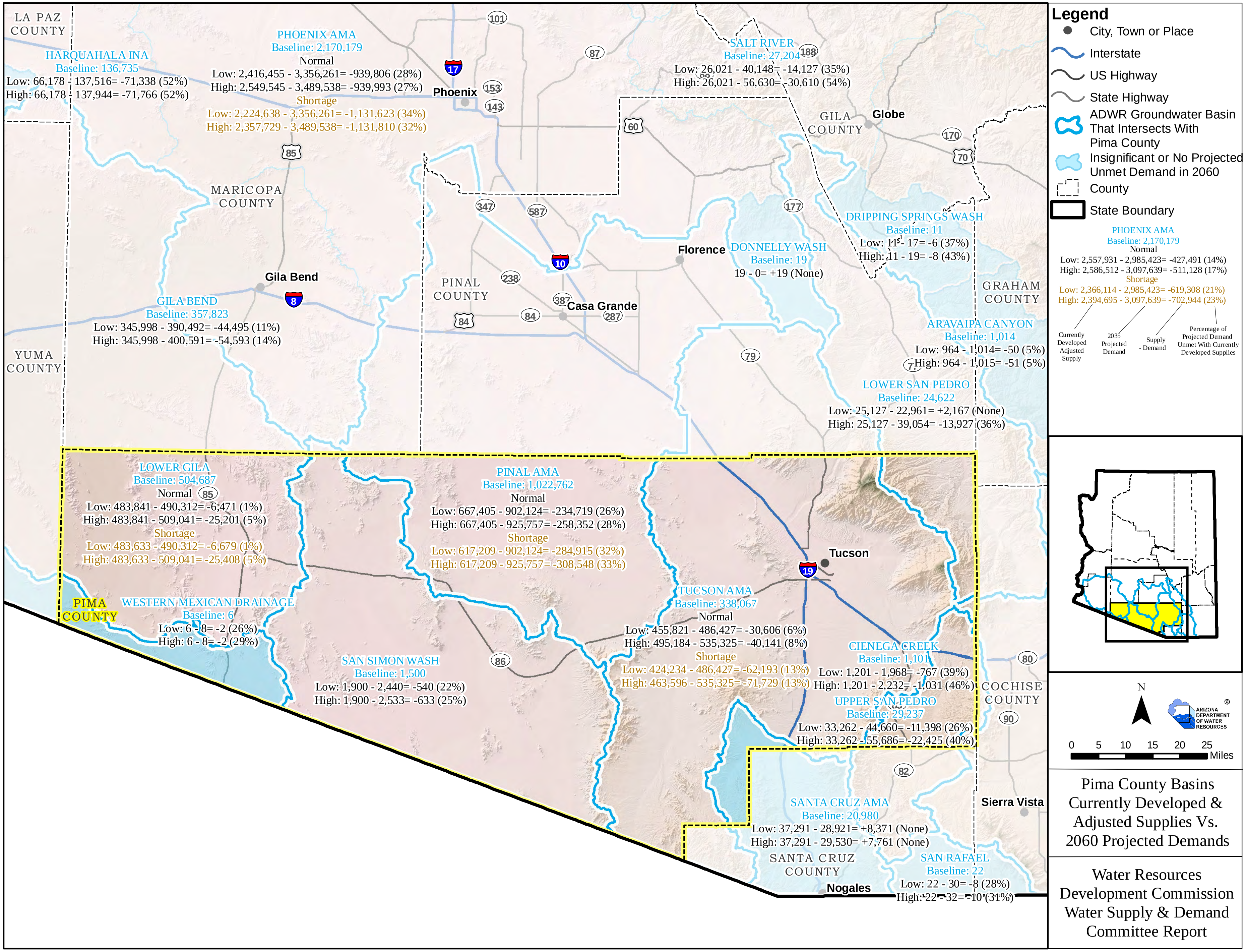

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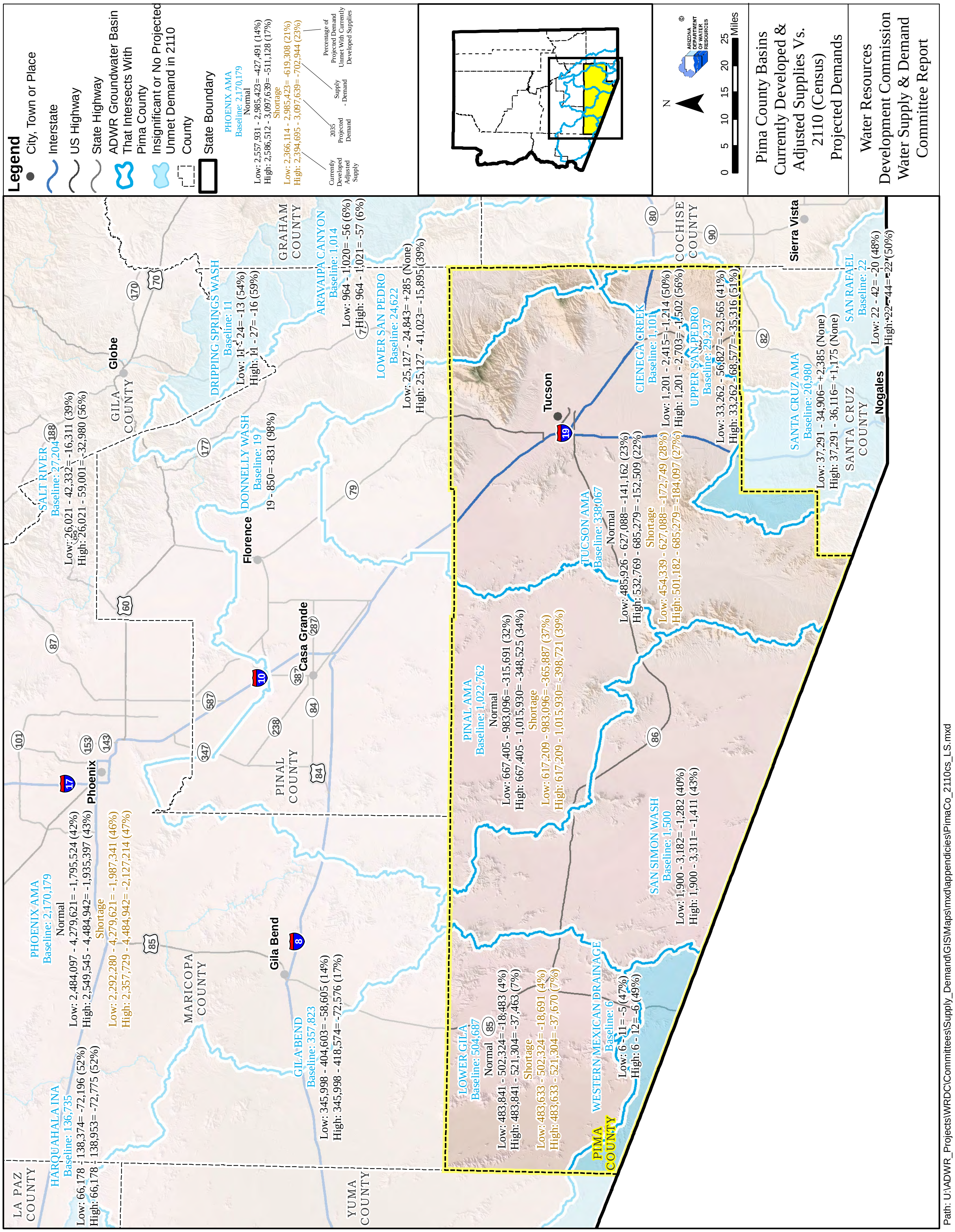
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Pima County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 15 20 25 Miles
Pima County Basins Currently Developed & Adjusted Supplies Vs. 2110 (Census) Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
LA PAZ COUNTY
HARQUAHALA INA
Baseline: 136,735
Low: 66,178 - 138,374= -72,196 (52%)
High: 66,178 - 138,953= -72,775 (52%)
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,484,097 - 4,279,621= -1,795,524 (42%)
High: 2,549,545 - 4,484,942= -1,935,397 (43%)
Shortage
Low: 2,292,280 - 4,279,621= -1,987,341 (46%)
High: 2,357,729 - 4,484,942= -2,127,214 (47%)
SALT RIVER
Baseline: 27,204
Low: 26,021 - 42,332= -16,311 (39%)
High: 26,021 - 59,001= -32,980 (56%)
Phoenix
Globe
GILA COUNTY
MARICOPA COUNTY
Gila Bend
GILA BEND
Baseline: 357,823
Low: 345,998 - 404,603= -58,605 (14%)
High: 345,998 - 418,574= -72,576 (17%)
YUMA COUNTY
PINAL COUNTY
Casa Grande
Florence
DRIPPING SPRINGS WASH
Baseline: 11
Low: 11 - 24= -13 (54%)
High: 11 - 27= -16 (59%)
DONNELLY WASH
Baseline: 19
19 - 850= -831 (98%)
GRAHAM COUNTY
ARAVAIPA CANYON
Baseline: 1,014
Low: 964 - 1,020= -56 (6%)
High: 964 - 1,021= -57 (6%)
LOWER SAN PEDRO
Baseline: 24,622
Low: 25,127 - 24,843= +285 (None)
High: 25,127 - 41,023= -15,895 (39%)
PINAL AMA
Baseline: 1,022,762
Normal
Low: 667,405 - 983,096= -315,691 (32%)
High: 667,405 - 1,015,930= -348,525 (34%)
Shortage
Low: 617,209 - 983,096= -365,887 (37%)
High: 617,209 - 1,015,930= -398,721 (39%)
Tucson
TUCSON AMA
Baseline: 338,067
Normal
Low: 485,926 - 627,088= -141,162 (23%)
High: 532,769 - 685,279= -152,509 (22%)
Shortage
Low: 454,339 - 627,088= -172,749 (28%)
High: 501,182 - 685,279= -184,097 (27%)
CIENEGA CREEK
Baseline: 1,101
Low: 1,201 - 2,415= -1,214 (50%)
High: 1,201 - 2,703= -1,502 (56%)
COCHISE COUNTY
UPPER SAN PEDRO
Baseline: 29,237
Low: 33,262 - 56,827= -23,565 (41%)
High: 33,262 - 68,577= -35,316 (51%)
Sierra Vista
SANTA CRUZ AMA
Baseline: 20,980
Low: 37,291 - 34,906= +2,385 (None)
High: 37,291 - 36,116= +1,175 (None)
SANTA CRUZ COUNTY
Nogales
SAN RAFAEL
Baseline: 22
Low: 22 - 42= -20 (48%)
High: 22 - 44= -22 (50%)
LOWER GILA
Baseline: 504,687
Normal
Low: 483,841 - 502,324= -18,483 (4%)
High: 483,841 - 521,304= -37,463 (7%)
Shortage
Low: 483,633 - 502,324= -18,691 (4%)
High: 483,633 - 521,304= -37,670 (7%)
SAN SIMON WASH
Baseline: 1,500
Low: 1,900 - 3,182= -1,282 (40%)
High: 1,900 - 3,311= -1,411 (43%)
WESTERN MEXICAN DRAINAGE
Baseline: 6
Low: 6 - 11= -5 (47%)
High: 6 - 12= -6 (49%)
PIMA COUNTY
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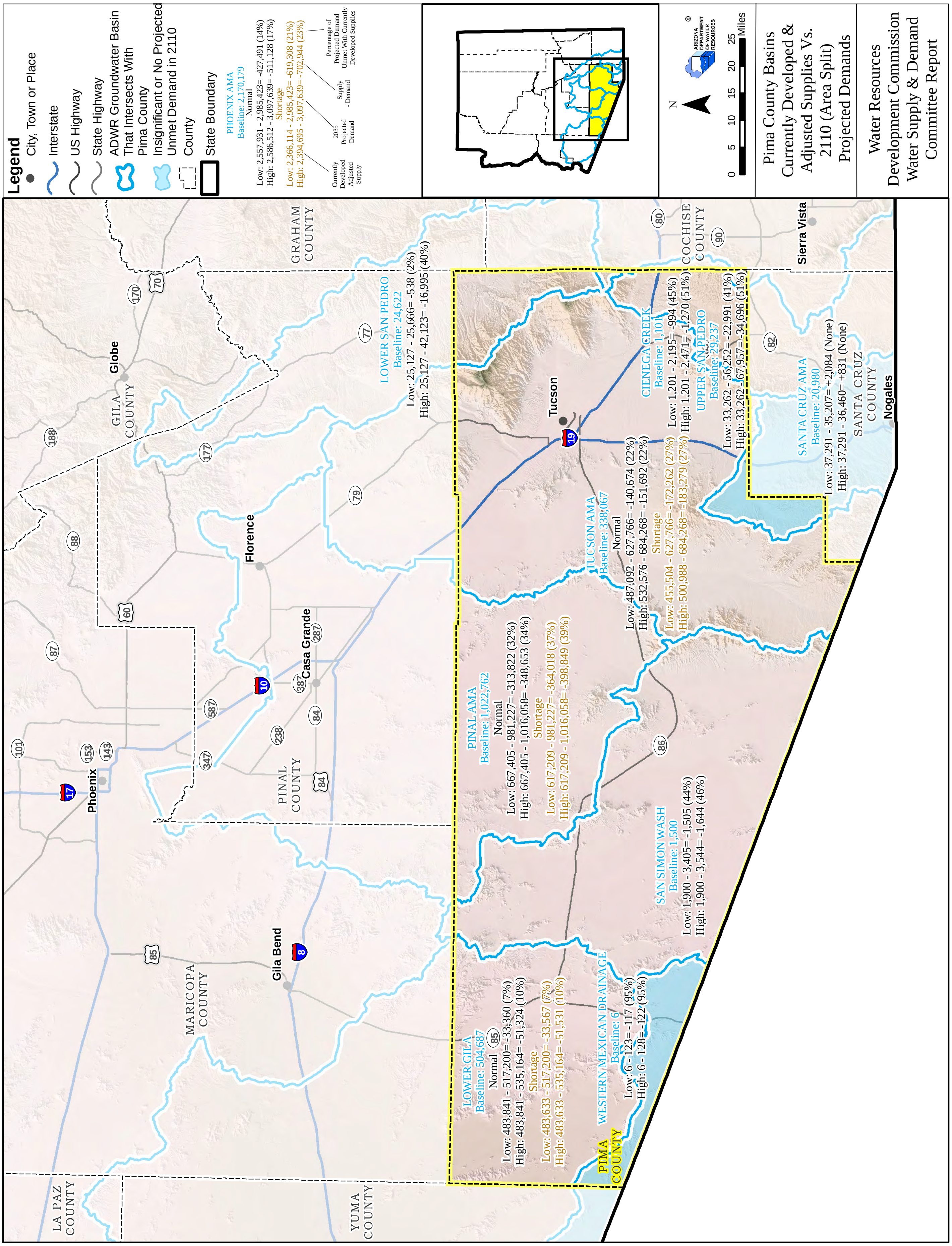
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Pima County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 15 20 25 Miles
ARIZONA DEPARTMENT OF WATER RESOURCES
Pima County Basins Currently Developed & Adjusted Supplies Vs. 2110 (Area Split) Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
LOWER SAN PEDRO
Baseline: 24,622
Low: 25,127 - 25,666= -538 (2%)
High: 25,127 - 42,123= -16,995 (40%)
PINAL AMA
Baseline: 1,022,762
Normal
Low: 667,405 - 981,227= -313,822 (32%)
High: 667,405 - 1,016,058= -348,653 (34%)
Shortage
Low: 617,209 - 981,227= -364,018 (37%)
High: 617,209 - 1,016,058= -398,849 (39%)
TUCSON AMA
Baseline: 338,067
Normal
Low: 487,092 - 627,766= -140,674 (22%)
High: 532,576 - 684,268= -151,692 (22%)
Shortage
Low: 455,504 - 627,766= -172,262 (27%)
High: 500,988 - 684,268= -183,279 (27%)
CIENEGA CREEK
Baseline: 1,101
Low: 1,201 - 2,195= -994 (45%)
High: 1,201 - 2,471= -1,270 (51%)
UPPER SAN PEDRO
Baseline: 29,237
Low: 33,262 - 56,252= -22,991 (41%)
High: 33,262 - 67,957= -34,696 (51%)
SANTA CRUZ AMA
Baseline: 20,980
Low: 37,291 - 35,207= +2,084 (None)
High: 37,291 - 36,460= +831 (None)
SAN SIMON WASH
Baseline: 1,500
Low: 1,900 - 3,405= -1,505 (44%)
High: 1,900 - 3,544= -1,644 (46%)
LOWER GILA
Baseline: 504,687
Normal
Low: 483,841 - 517,200= -33,360 (7%)
High: 483,841 - 535,164= -51,324 (10%)
Shortage
Low: 483,633 - 517,200= -33,567 (7%)
High: 483,633 - 535,164= -51,531 (10%)
WESTERN MEXICAN DRAINAGE
Baseline: 6
Low: 6 - 123= -117 (95%)
High: 6 - 128= -122 (95%)
PIMA COUNTY
GRAHAM COUNTY
GILA COUNTY
PINAL COUNTY
MARICOPA COUNTY
LA PAZ COUNTY
YUMA COUNTY
COCHISE COUNTY
SANTA CRUZ COUNTY
Globe
Florence
Casa Grande
Phoenix
Gila Bend
Tucson
Sierra Vista
Nogales
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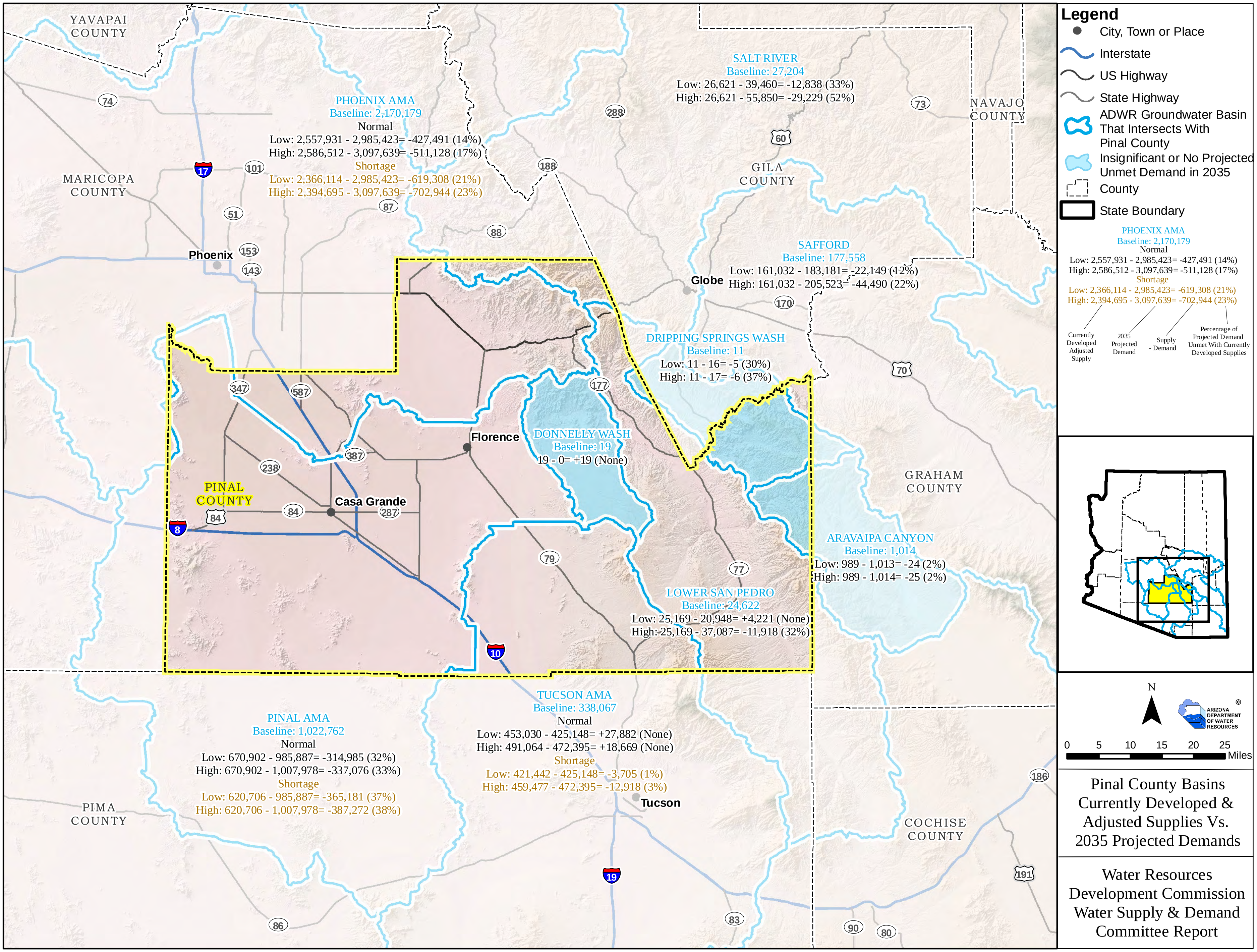

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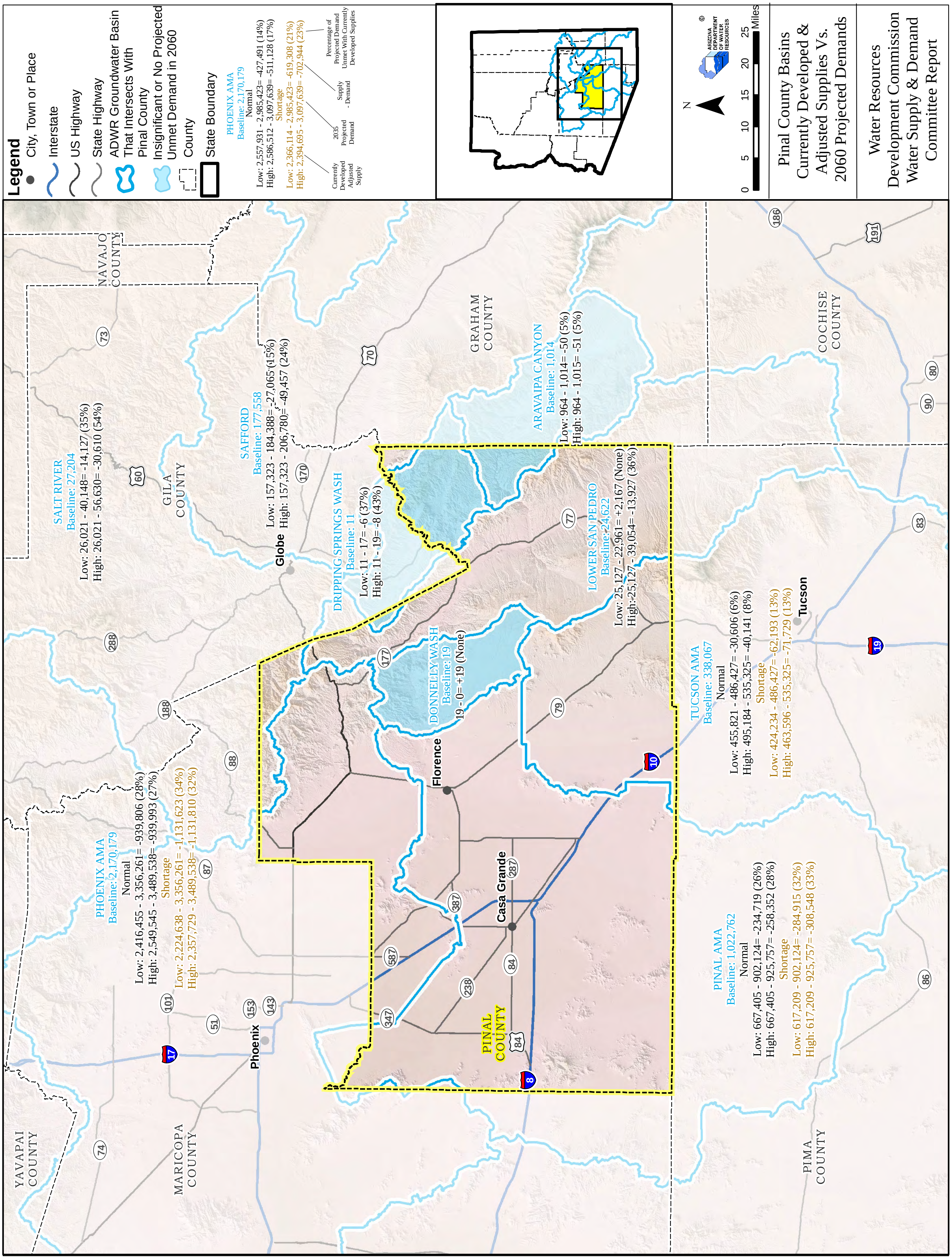
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Pinal County
Insignificant or No Projected Unmet Demand in 2060
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
Miles
0 5 10 15 20 25
Pinal County Basins Currently Developed & Adjusted Supplies Vs. 2060 Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
SALT RIVER
Baseline: 27,204
Low: 26,021 - 40,148= -14,127 (35%)
High: 26,021 - 56,630= -30,610 (54%)
SAFFORD
Baseline: 177,558
Low: 157,323 - 184,388= -27,065 (15%)
High: 157,323 - 206,780= -49,457 (24%)
DRIPPING SPRINGS WASH
Baseline: 11
Low: 11 - 17= -6 (37%)
High: 11 - 19= -8 (43%)
ARAVAIPA CANYON
Baseline: 1,014
Low: 964 - 1,014= -50 (5%)
High: 964 - 1,015= -51 (5%)
LOWER SAN PEDRO
Baseline: 24,622
Low: 25,127 - 22,961= +2,167 (None)
High: 25,127 - 39,054= -13,927 (36%)
DONNELLY WASH
Baseline: 19
19 - 0= +19 (None)
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,416,455 - 3,356,261= -939,806 (28%)
High: 2,549,545 - 3,489,538= -939,993 (27%)
Shortage
Low: 2,224,638 - 3,356,261= -1,131,623 (34%)
High: 2,357,729 - 3,489,538= -1,131,810 (32%)
TUCSON AMA
Baseline: 338,067
Normal
Low: 455,821 - 486,427= -30,606 (6%)
High: 495,184 - 535,325= -40,141 (8%)
Shortage
Low: 424,234 - 486,427= -62,193 (13%)
High: 463,596 - 535,325= -71,729 (13%)
PINAL AMA
Baseline: 1,022,762
Normal
Low: 667,405 - 902,124= -234,719 (26%)
High: 667,405 - 925,757= -258,352 (28%)
Shortage
Low: 617,209 - 902,124= -284,915 (32%)
High: 617,209 - 925,757= -308,548 (33%)
YAVAPAI COUNTY
NAVAJO COUNTY
GILA COUNTY
GRAHAM COUNTY
MARICOPA COUNTY
PINAL COUNTY
COCHISE COUNTY
PIMA COUNTY
Phoenix
Globe
Florence
Casa Grande
Tucson
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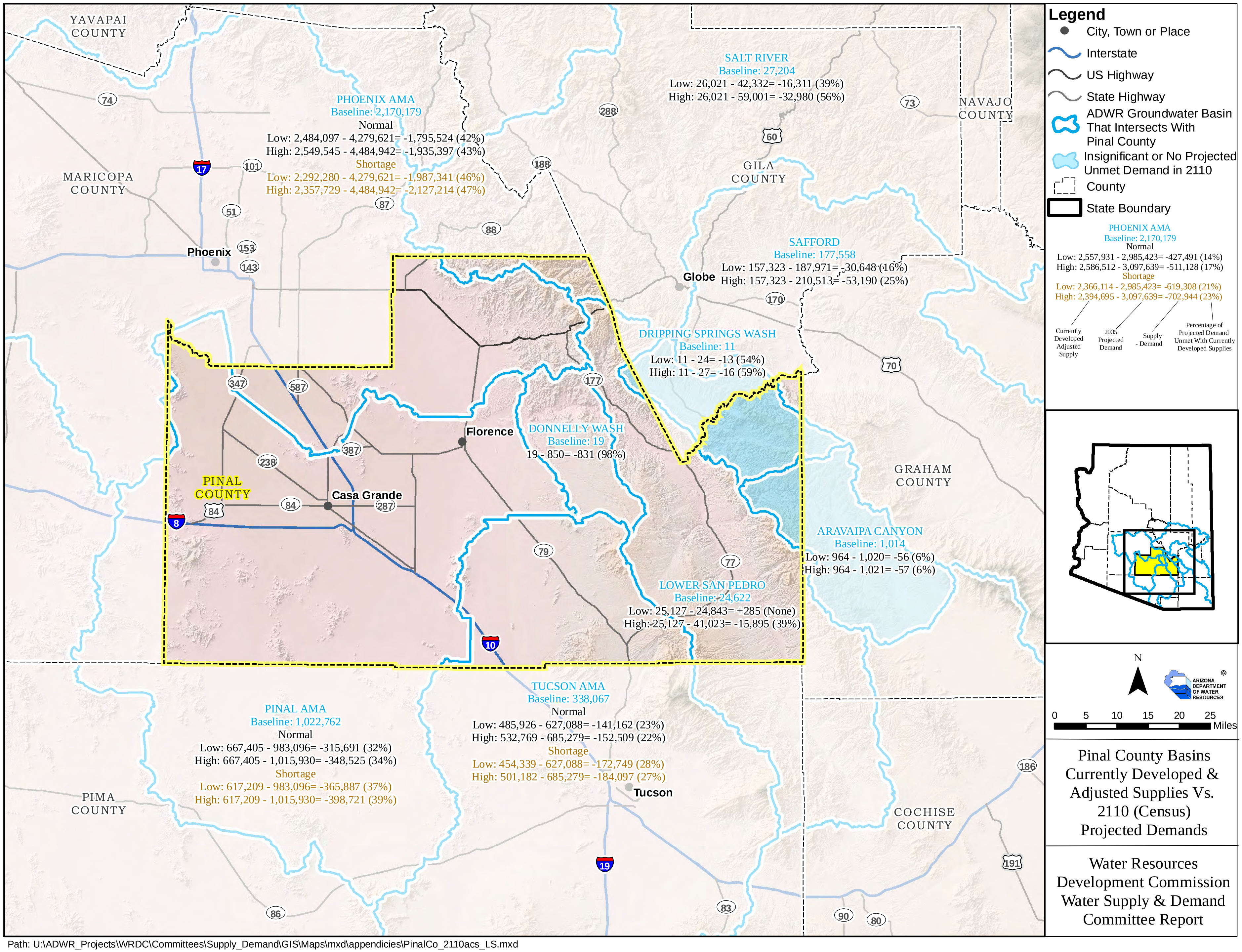
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Pinal County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
YAVAPAI COUNTY
MARICOPA COUNTY
PIMA COUNTY
GILA COUNTY
NAVAJO COUNTY
GRAHAM COUNTY
COCHISE COUNTY
PINAL COUNTY
Phoenix
Globe
Florence
Casa Grande
Tucson
SALT RIVER
Baseline: 27,204
Low: 26,021 - 42,332= -16,311 (39%)
High: 26,021 - 59,001= -32,980 (56%)
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,484,097 - 4,279,621= -1,795,524 (42%)
High: 2,549,545 - 4,484,942= -1,935,397 (43%)
Shortage
Low: 2,292,280 - 4,279,621= -1,987,341 (46%)
High: 2,357,729 - 4,484,942= -2,127,214 (47%)
SAFFORD
Baseline: 177,558
Low: 157,323 - 187,971= -30,648 (16%)
High: 157,323 - 210,513= -53,190 (25%)
DRIPPING SPRINGS WASH
Baseline: 11
Low: 11 - 24= -13 (54%)
High: 11 - 27= -16 (59%)
DONNELLY WASH
Baseline: 19
19 - 850= -831 (98%)
ARAVAIPA CANYON
Baseline: 1,014
Low: 964 - 1,020= -56 (6%)
High: 964 - 1,021= -57 (6%)
LOWER SAN PEDRO
Baseline: 24,622
Low: 25,127 - 24,843= +285 (None)
High: 25,127 - 41,023= -15,895 (39%)
TUCSON AMA
Baseline: 338,067
Normal
Low: 485,926 - 627,088= -141,162 (23%)
High: 532,769 - 685,279= -152,509 (22%)
Shortage
Low: 454,339 - 627,088= -172,749 (28%)
High: 501,182 - 685,279= -184,097 (27%)
PINAL AMA
Baseline: 1,022,762
Normal
Low: 667,405 - 983,096= -315,691 (32%)
High: 667,405 - 1,015,930= -348,525 (34%)
Shortage
Low: 617,209 - 983,096= -365,887 (37%)
High: 617,209 - 1,015,930= -398,721 (39%)
N
ARIZONA DEPARTMENT OF WATER RESOURCES
0 5 10 15 20 25 Miles
Pinal County Basins Currently Developed & Adjusted Supplies Vs. 2110 (Census) Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
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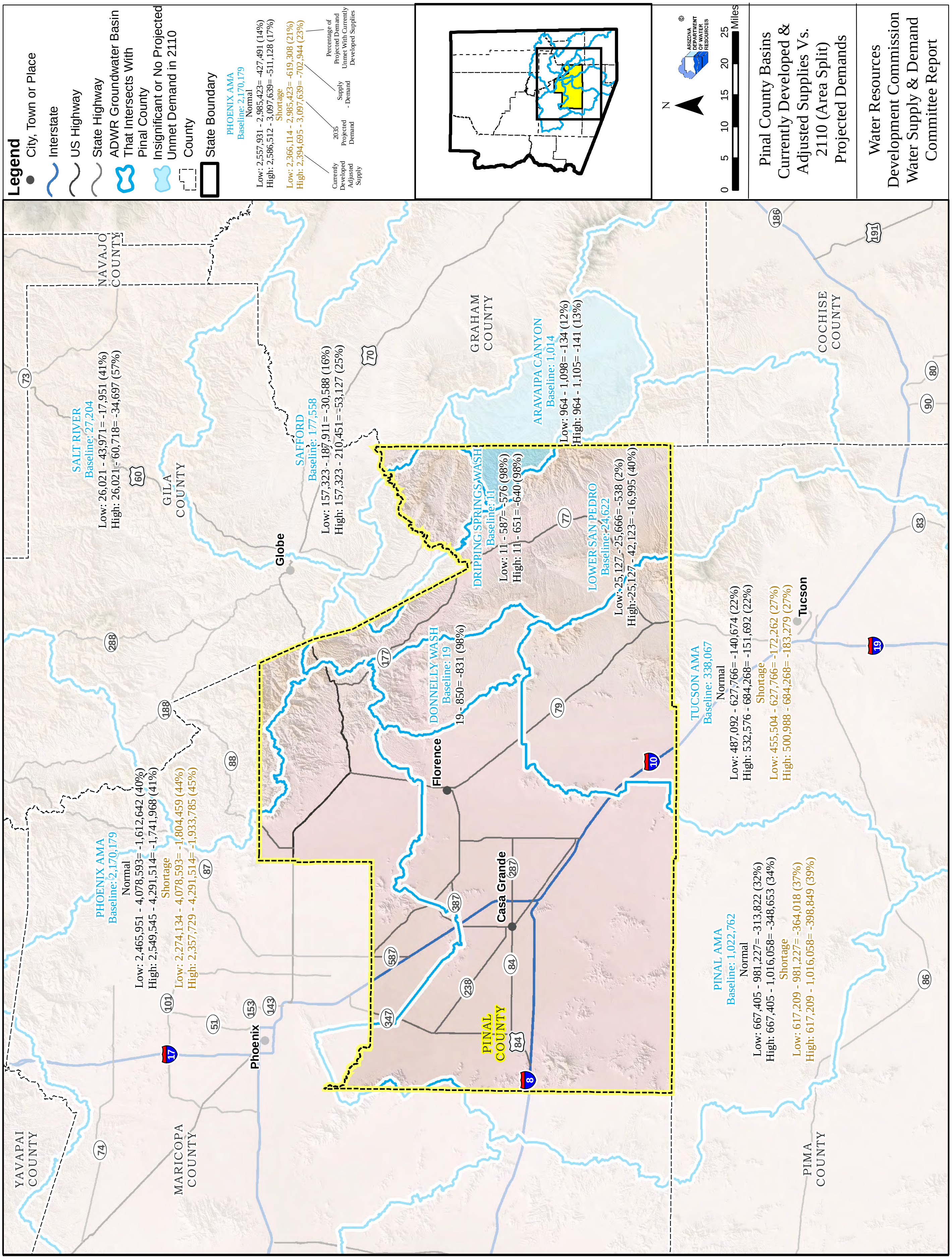
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Pinal County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 15 20 25 Miles
Pinal County Basins Currently Developed & Adjusted Supplies Vs. 2110 (Area Split) Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
YAVAPAI COUNTY
NAVAJO COUNTY
GILA COUNTY
GRAHAM COUNTY
COCHISE COUNTY
MARICOPA COUNTY
PINAL COUNTY
PIMA COUNTY
SALT RIVER
Baseline: 27,204
Low: 26,021 - 43,971= -17,951 (41%)
High: 26,021 - 60,718= -34,697 (57%)
SAFFORD
Baseline: 177,558
Low: 157,323 - 187,911= -30,588 (16%)
High: 157,323 - 210,451= -53,127 (25%)
ARAVAIPA CANYON
Baseline: 1,014
Low: 964 - 1,098= -134 (12%)
High: 964 - 1,105= -141 (13%)
DRIPPING SPRINGS WASH
Baseline: 11
Low: 11 - 587= -576 (98%)
High: 11 - 651= -640 (98%)
LOWER SAN PEDRO
Baseline: 24,622
Low: 25,127 - 25,666= -538 (2%)
High: 25,127 - 42,123= -16,995 (40%)
DONNELLY WASH
Baseline: 19
19 - 850= -831 (98%)
TUCSON AMA
Baseline: 338,067
Normal
Low: 487,092 - 627,766= -140,674 (22%)
High: 532,576 - 684,268= -151,692 (22%)
Shortage
Low: 455,504 - 627,766= -172,262 (27%)
High: 500,988 - 684,268= -183,279 (27%)
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,465,951 - 4,078,593= -1,612,642 (40%)
High: 2,549,545 - 4,291,514= -1,741,968 (41%)
Shortage
Low: 2,274,134 - 4,078,593= -1,804,459 (44%)
High: 2,357,729 - 4,291,514= -1,933,785 (45%)
PINAL AMA
Baseline: 1,022,762
Normal
Low: 667,405 - 981,227= -313,822 (32%)
High: 667,405 - 1,016,058= -348,653 (34%)
Shortage
Low: 617,209 - 981,227= -364,018 (37%)
High: 617,209 - 1,016,058= -398,849 (39%)
Globe
Florence
Casa Grande
Phoenix
Tucson
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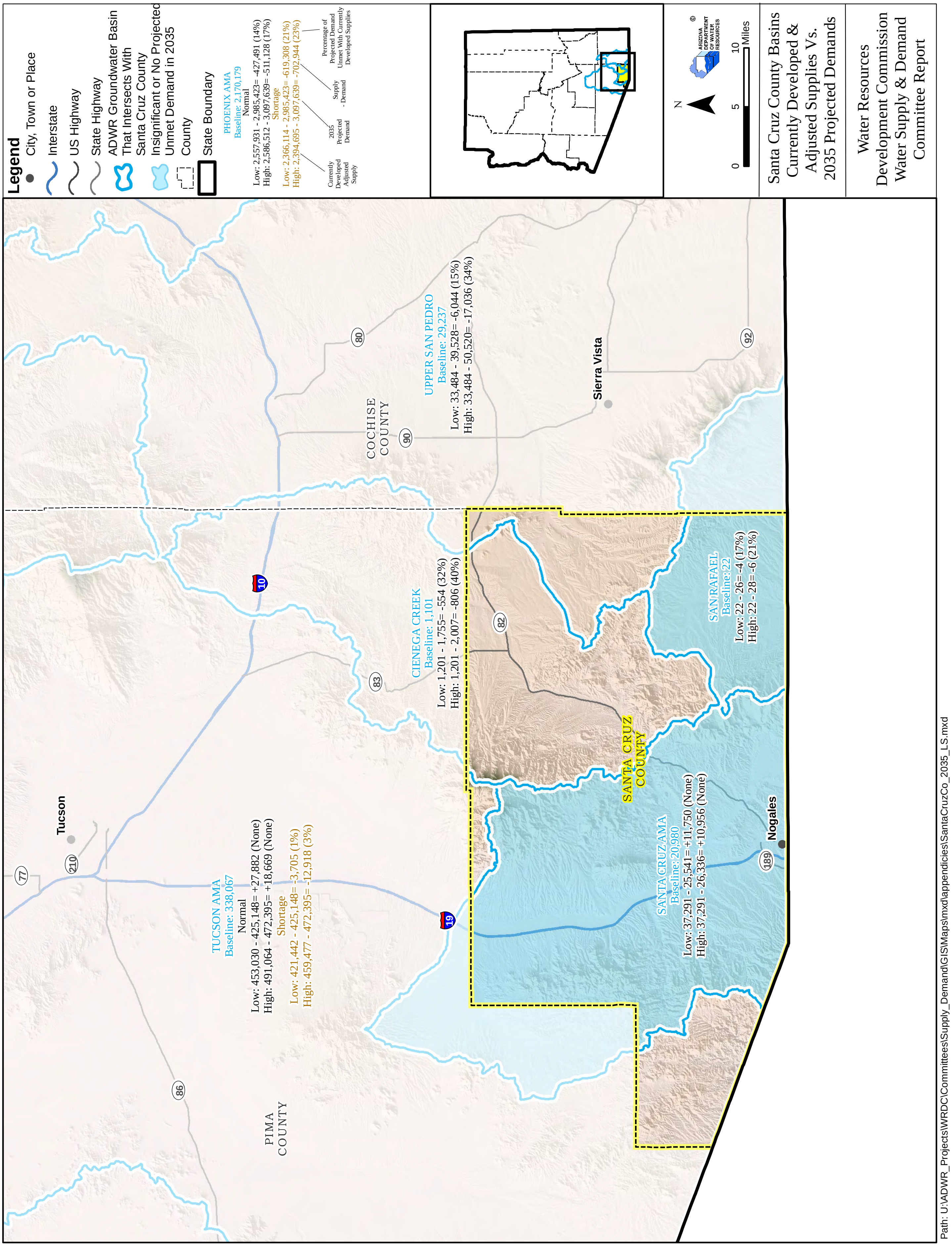
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Santa Cruz County
Insignificant or No Projected Unmet Demand in 2035
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0 5 10 Miles
ARIZONA DEPARTMENT OF WATER RESOURCES
Santa Cruz County Basins Currently Developed & Adjusted Supplies Vs. 2035 Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
Tucson
Sierra Vista
Nogales
COCHISE COUNTY
PIMA COUNTY
SANTA CRUZ COUNTY
UPPER SAN PEDRO
Baseline: 29,237
Low: 33,484 - 39,528= -6,044 (15%)
High: 33,484 - 50,520= -17,036 (34%)
CIENEGA CREEK
Baseline: 1,101
Low: 1,201 - 1,755= -554 (32%)
High: 1,201 - 2,007= -806 (40%)
SAN RAFAEL
Baseline: 22
Low: 22 - 26= -4 (17%)
High: 22 - 28= -6 (21%)
TUCSON AMA
Baseline: 338,067
Normal
Low: 453,030 - 425,148= +27,882 (None)
High: 491,064 - 472,395= +18,669 (None)
Shortage
Low: 421,442 - 425,148= -3,705 (1%)
High: 459,477 - 472,395= -12,918 (3%)
SANTA CRUZ AMA
Baseline: 20,980
Low: 37,291 - 25,541= +11,750 (None)
High: 37,291 - 26,336= +10,956 (None)
10
19
77
80
82
83
86
90
92
189
210
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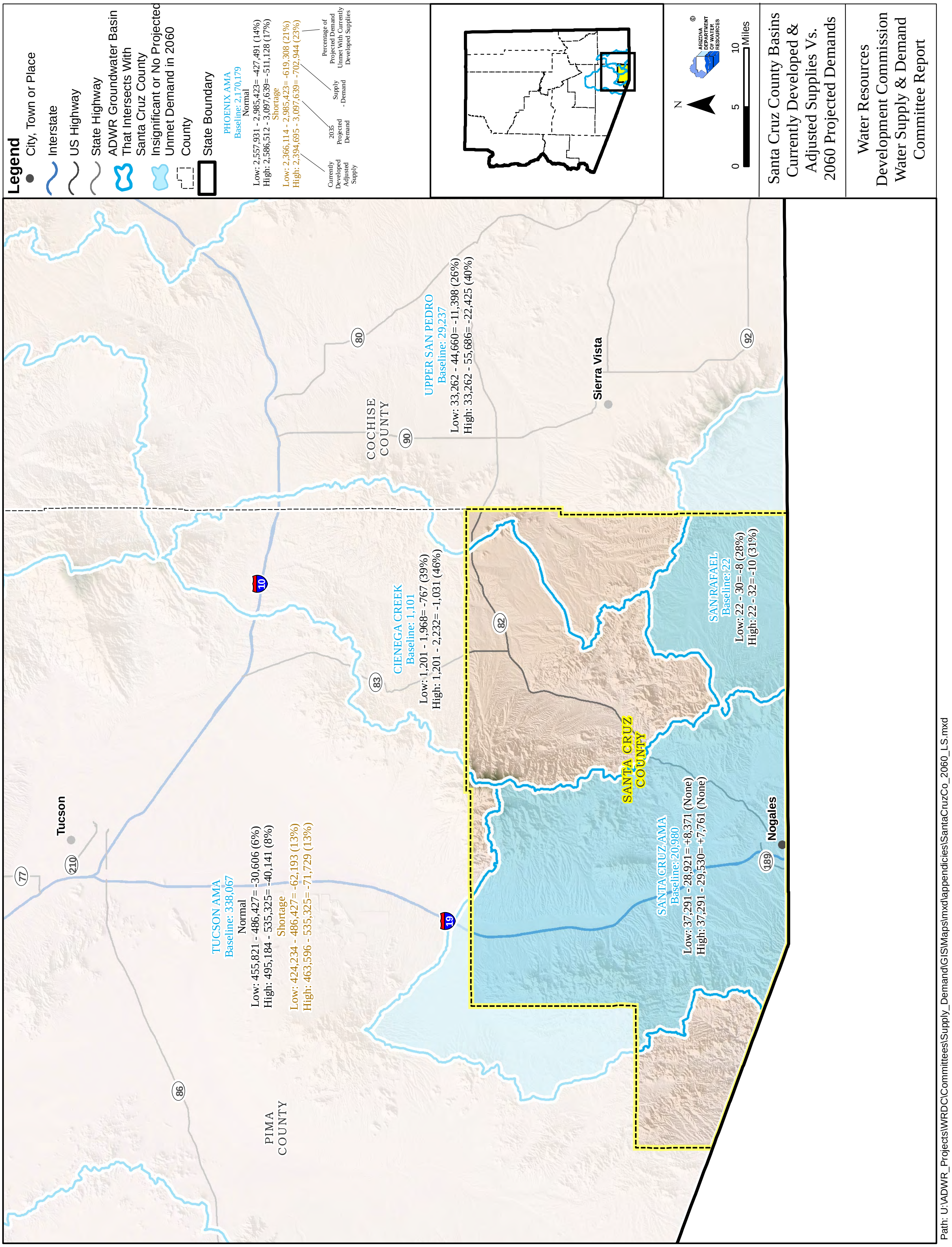
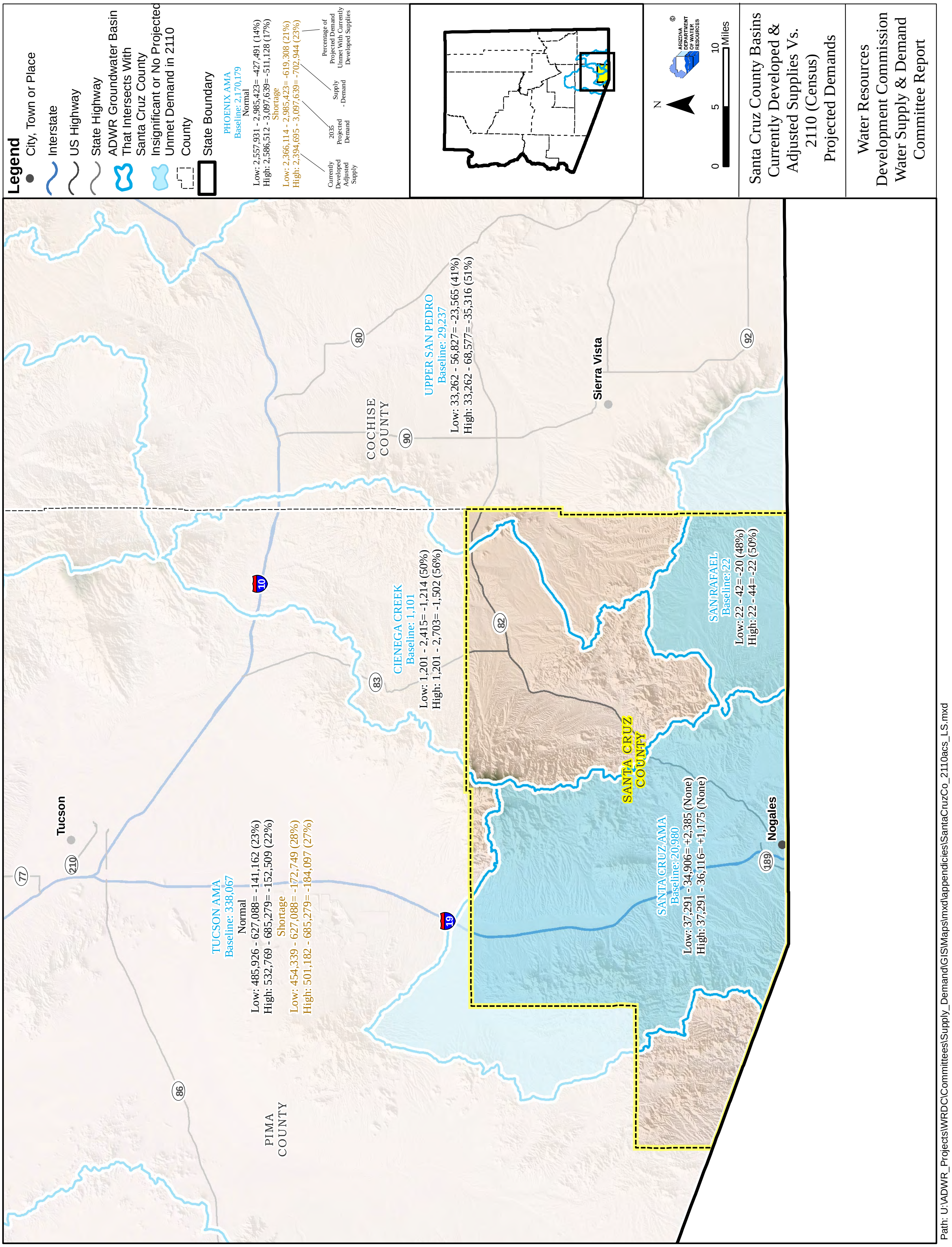

Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Santa Cruz County
Insignificant or No Projected Unmet Demand in 2060
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0
5
10
Miles
Santa Cruz County Basins Currently Developed & Adjusted Supplies Vs. 2060 Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
Tucson
Sierra Vista
Nogales
PIMA COUNTY
COCHISE COUNTY
SANTA CRUZ COUNTY
TUCSON AMA
Baseline: 338,067
Normal
Low: 455,821 - 486,427= -30,606 (6%)
High: 495,184 - 535,325= -40,141 (8%)
Shortage
Low: 424,234 - 486,427= -62,193 (13%)
High: 463,596 - 535,325= -71,729 (13%)
CIENEGA CREEK
Baseline: 1,101
Low: 1,201 - 1,968= -767 (39%)
High: 1,201 - 2,232= -1,031 (46%)
UPPER SAN PEDRO
Baseline: 29,237
Low: 33,262 - 44,660= -11,398 (26%)
High: 33,262 - 55,686= -22,425 (40%)
SAN RAFAEL
Baseline: 22
Low: 22 - 30= -8 (28%)
High: 22 - 32= -10 (31%)
SANTA CRUZ AMA
Baseline: 20,980
Low: 37,291 - 28,921= +8,371 (None)
High: 37,291 - 29,530= +7,761 (None)
10
19
77
80
82
83
86
90
92
189
210
Path: U:\ADWR_Projects\WRDC\Committees\Supply_Demand\GIS\Maps\mxd\appendicies\SantaCruzCo_2060_LS.mxd



Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Santa Cruz County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
0
5
10
Miles
Santa Cruz County Basins Currently Developed & Adjusted Supplies Vs. 2110 (Census) Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
Tucson
TUCSON AMA
Baseline: 338,067
Normal
Low: 485,926 - 627,088= -141,162 (23%)
High: 532,769 - 685,279= -152,509 (22%)
Shortage
Low: 454,339 - 627,088= -172,749 (28%)
High: 501,182 - 685,279= -184,097 (27%)
PIMA COUNTY
COCHISE COUNTY
UPPER SAN PEDRO
Baseline: 29,237
Low: 33,262 - 56,827= -23,565 (41%)
High: 33,262 - 68,577= -35,316 (51%)
Sierra Vista
CIENEGA CREEK
Baseline: 1,101
Low: 1,201 - 2,415= -1,214 (50%)
High: 1,201 - 2,703= -1,502 (56%)
SAN RAFAEL
Baseline: 22
Low: 22 - 42= -20 (48%)
High: 22 - 44= -22 (50%)
SANTA CRUZ COUNTY
SANTA CRUZ AMA
Baseline: 20,980
Low: 37,291 - 34,906= +2,385 (None)
High: 37,291 - 36,116= +1,175 (None)
Nogales
10
19
77
210
86
80
90
82
83
92
189
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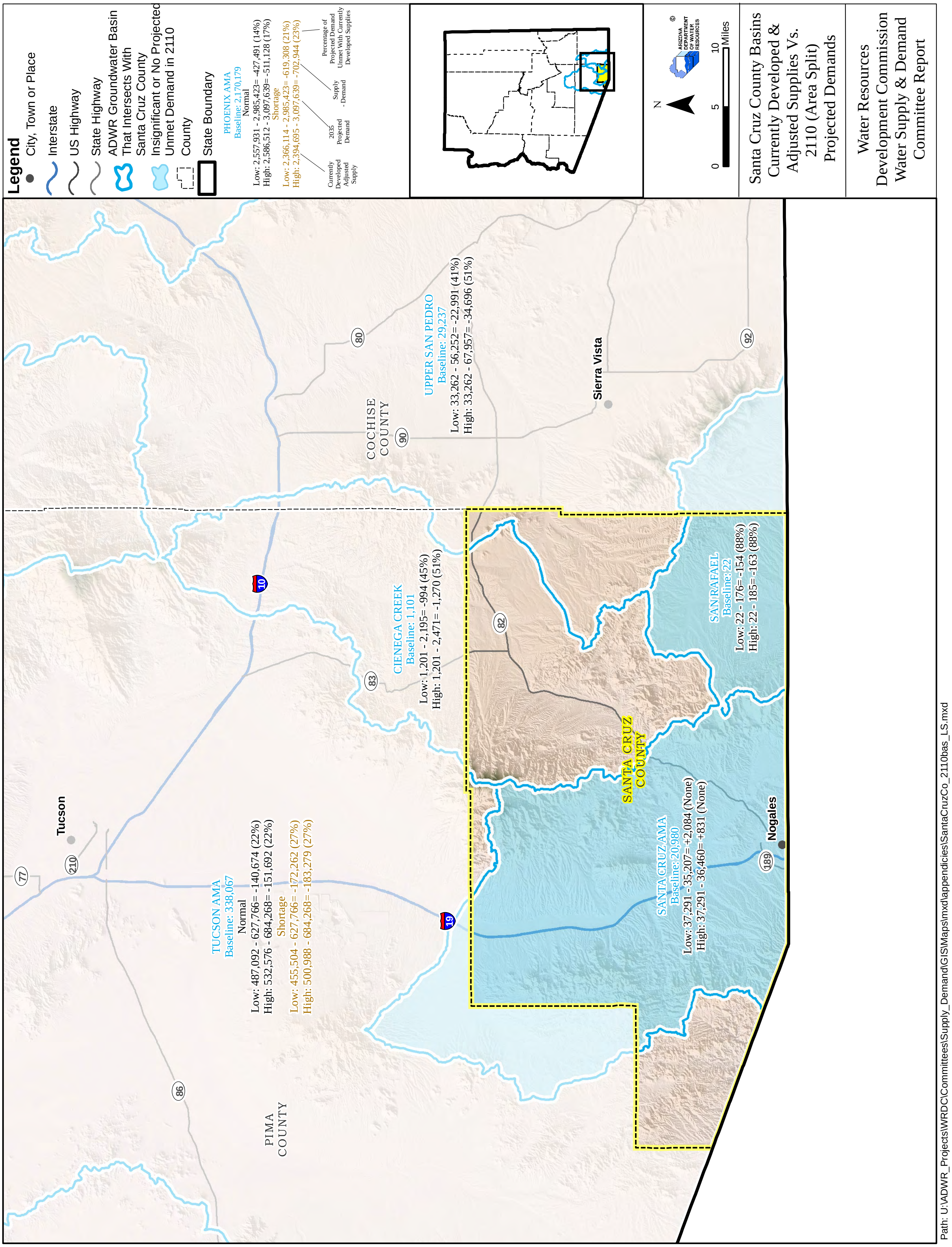
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Santa Cruz County
Insignificant or No Projected Unmet Demand in 2110
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
ARIZONA DEPARTMENT OF WATER RESOURCES
N
0 5 10 Miles
Santa Cruz County Basins Currently Developed & Adjusted Supplies Vs. 2110 (Area Split) Projected Demands
Water Resources Development Commission Water Supply & Demand Committee Report
Tucson
Sierra Vista
Nogales
PIMA COUNTY
COCHISE COUNTY
SANTA CRUZ COUNTY
TUCSON AMA
Baseline: 338,067
Normal
Low: 487,092 - 627,766= -140,674 (22%)
High: 532,576 - 684,268= -151,692 (22%)
Shortage
Low: 455,504 - 627,766= -172,262 (27%)
High: 500,988 - 684,268= -183,279 (27%)
CIENEGA CREEK
Baseline: 1,101
Low: 1,201 - 2,195= -994 (45%)
High: 1,201 - 2,471= -1,270 (51%)
UPPER SAN PEDRO
Baseline: 29,237
Low: 33,262 - 56,252= -22,991 (41%)
High: 33,262 - 67,957= -34,696 (51%)
SAN RAFAEL
Baseline: 22
Low: 22 - 176= -154 (88%)
High: 22 - 185= -163 (88%)
SANTA CRUZ AMA
Baseline: 20,980
Low: 37,291 - 35,207= +2,084 (None)
High: 37,291 - 36,460= +831 (None)
10
19
77
210
86
80
90
83
82
92
189
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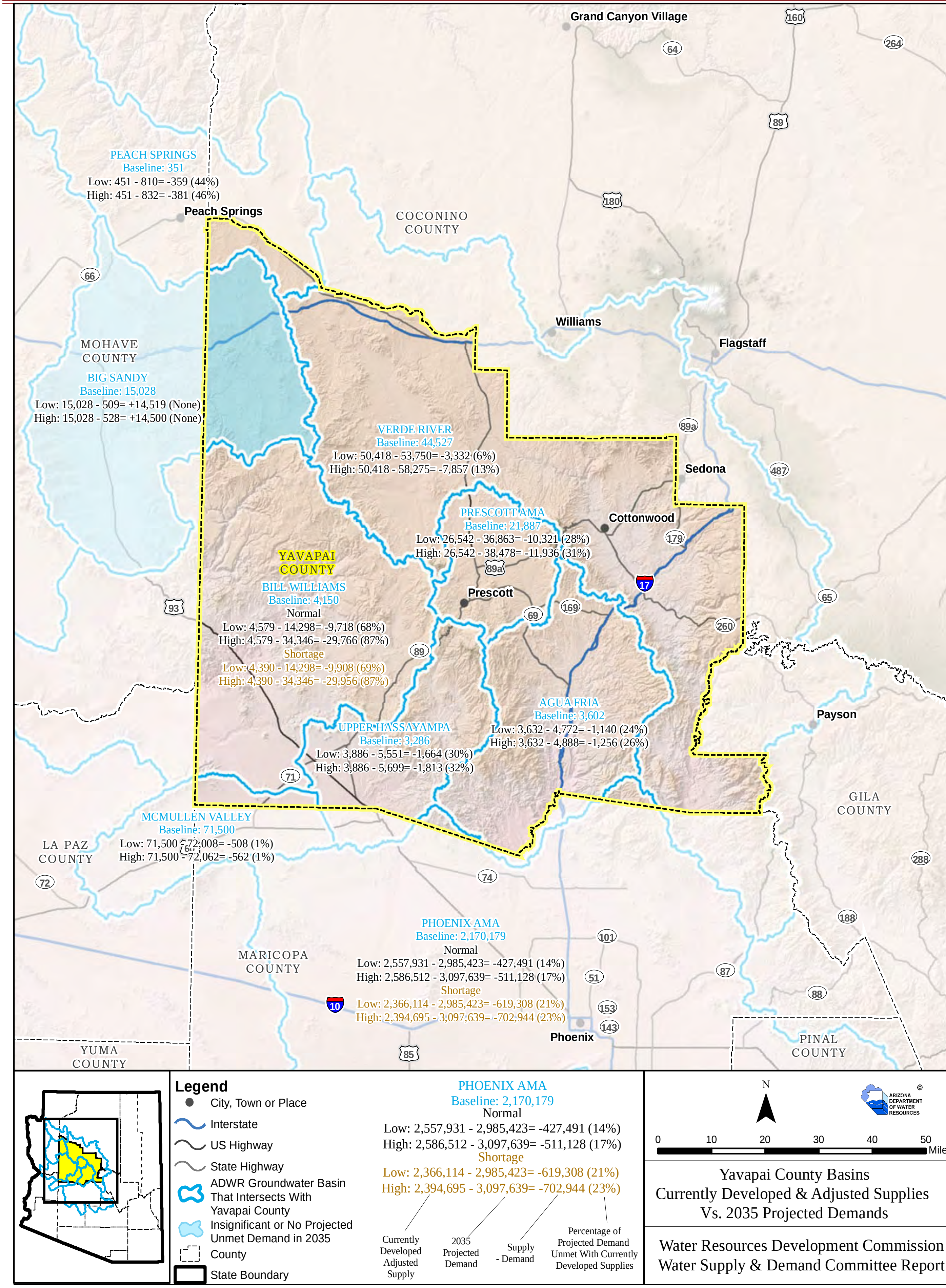

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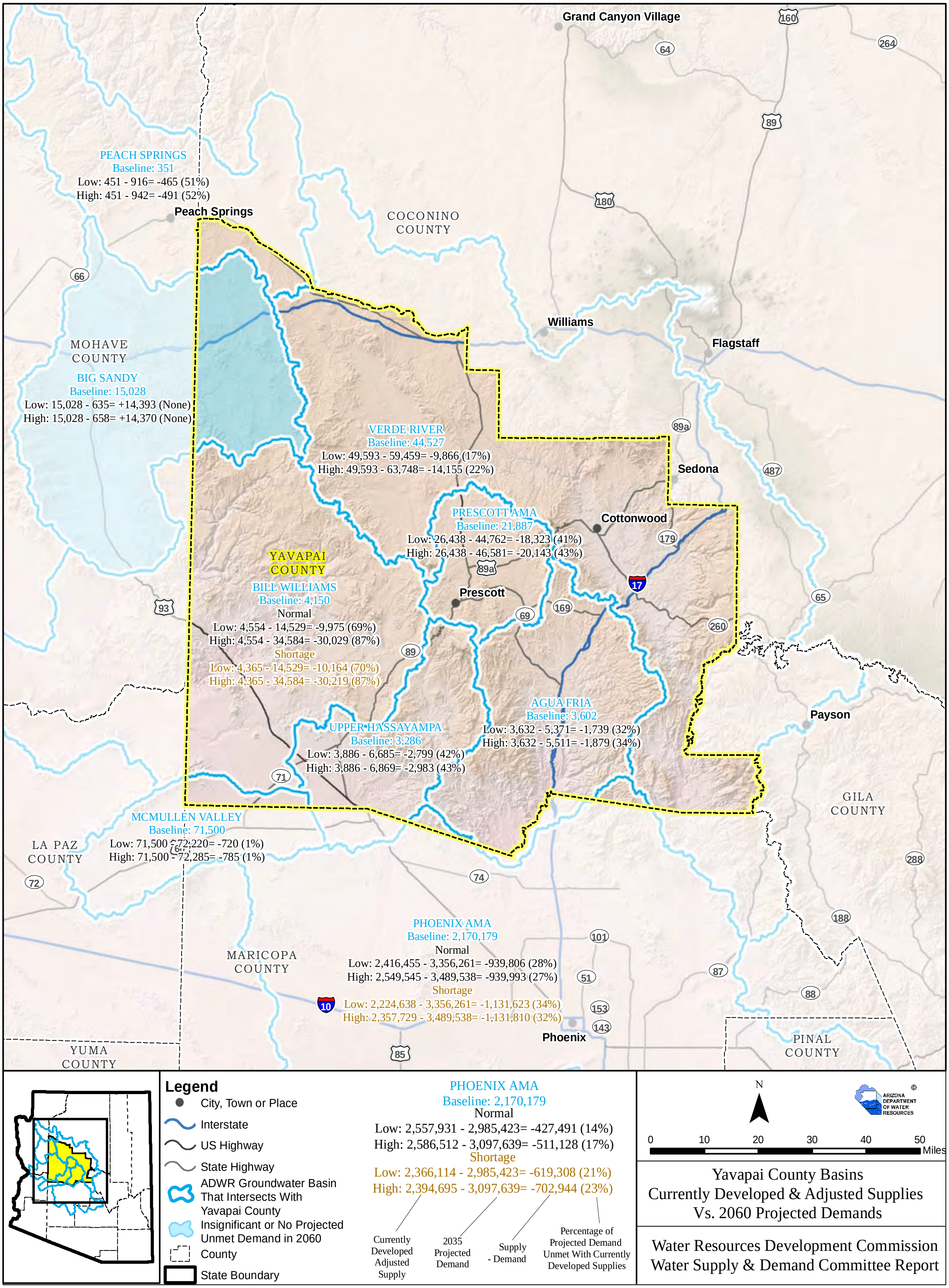
Grand Canyon Village
160
264
64
89
180
PEACH SPRINGS
Baseline: 351
Low: 451 - 916= -465 (51%)
High: 451 - 942= -491 (52%)
Peach Springs
COCONINO
COUNTY
66
Williams
Flagstaff
MOHAVE
COUNTY
BIG SANDY
Baseline: 15,028
Low: 15,028 - 635= +14,393 (None)
High: 15,028 - 658= +14,370 (None)
VERDE RIVER
Baseline: 44,527
Low: 49,593 - 59,459= -9,866 (17%)
High: 49,593 - 63,748= -14,155 (22%)
89a
Sedona
487
PRESCOTT AMA
Baseline: 21,887
Low: 26,438 - 44,762= -18,323 (41%)
High: 26,438 - 46,581= -20,143 (43%)
Cottonwood
179
YAVAPAI
COUNTY
BILL WILLIAMS
Baseline: 4,150
Normal
Low: 4,554 - 14,529= -9,975 (69%)
High: 4,554 - 34,584= -30,029 (87%)
Shortage
Low: 4,365 - 14,529= -10,164 (70%)
High: 4,365 - 34,584= -30,219 (87%)
93
Prescott
17
65
69
169
260
89
AGUA FRIA
Baseline: 3,602
Low: 3,632 - 5,371= -1,739 (32%)
High: 3,632 - 5,511= -1,879 (34%)
Payson
UPPER HASSAYAMPA
Baseline: 3,286
Low: 3,886 - 6,685= -2,799 (42%)
High: 3,886 - 6,869= -2,983 (43%)
71
GILA
COUNTY
MCMULLEN VALLEY
Baseline: 71,500
Low: 71,500 - 72,220= -720 (1%)
High: 71,500 - 72,285= -785 (1%)
LA PAZ
COUNTY
72
74
288
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,416,455 - 3,356,261= -939,806 (28%)
High: 2,549,545 - 3,489,538= -939,993 (27%)
Shortage
Low: 2,224,638 - 3,356,261= -1,131,623 (34%)
High: 2,357,729 - 3,489,538= -1,131,810 (32%)
MARICOPA
COUNTY
101
188
51
87
88
10
153
143
Phoenix
YUMA
COUNTY
85
PINAL
COUNTY
Legend
City, Town or Place
Interstate
US Highway
State Highway
ADWR Groundwater Basin That Intersects With Yavapai County
Insignificant or No Projected Unmet Demand in 2060
County
State Boundary
PHOENIX AMA
Baseline: 2,170,179
Normal
Low: 2,557,931 - 2,985,423= -427,491 (14%)
High: 2,586,512 - 3,097,639= -511,128 (17%)
Shortage
Low: 2,366,114 - 2,985,423= -619,308 (21%)
High: 2,394,695 - 3,097,639= -702,944 (23%)
Currently Developed Adjusted Supply
2035 Projected Demand
Supply - Demand
Percentage of Projected Demand Unmet With Currently Developed Supplies
N
ARIZONA DEPARTMENT OF WATER RESOURCES
0
10
20
30
40
50
Miles
Yavapai County Basins
Currently Developed & Adjusted Supplies
Vs. 2060 Projected Demands
Water Resources Development Commission
Water Supply & Demand Committee Report
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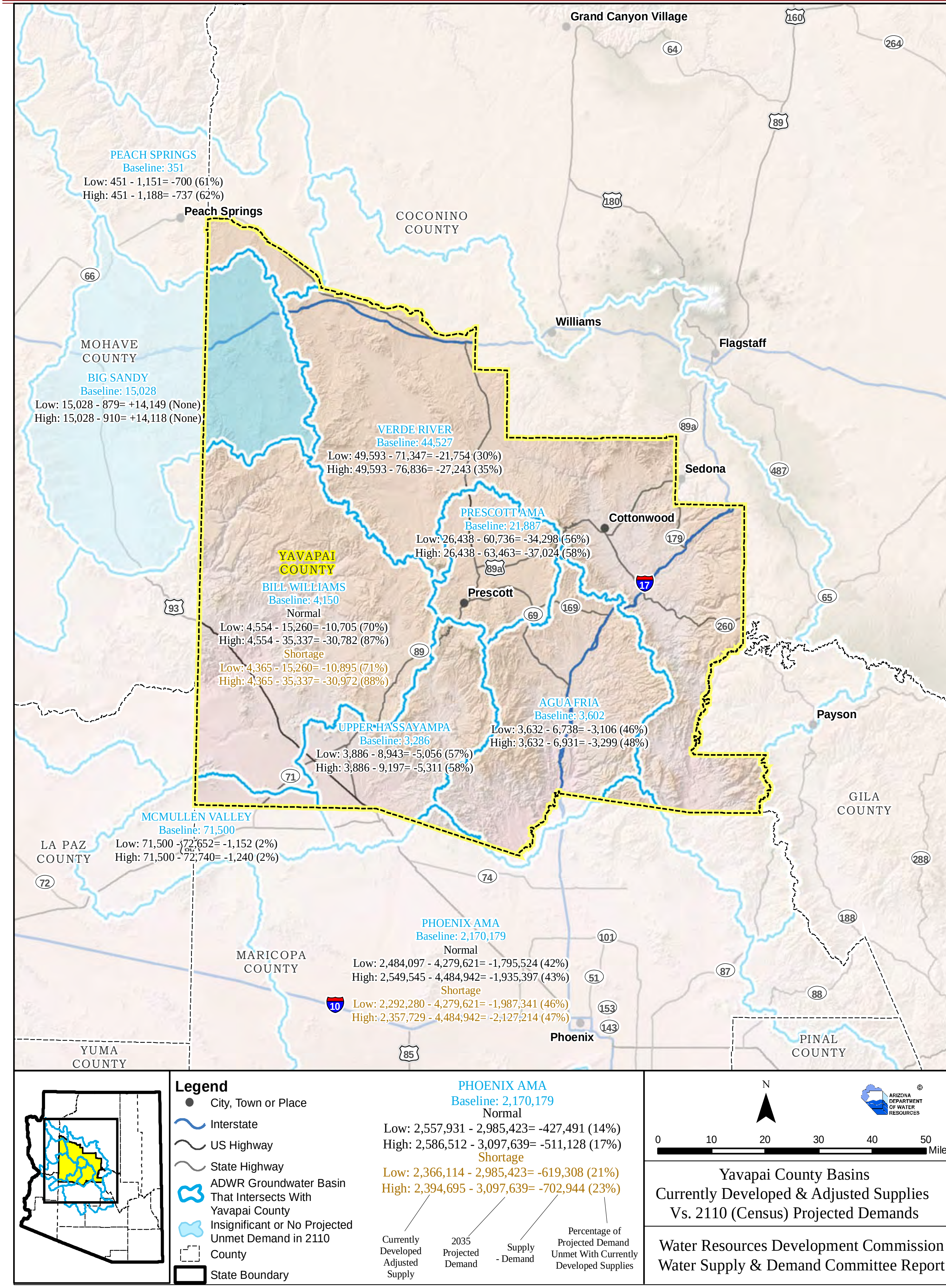

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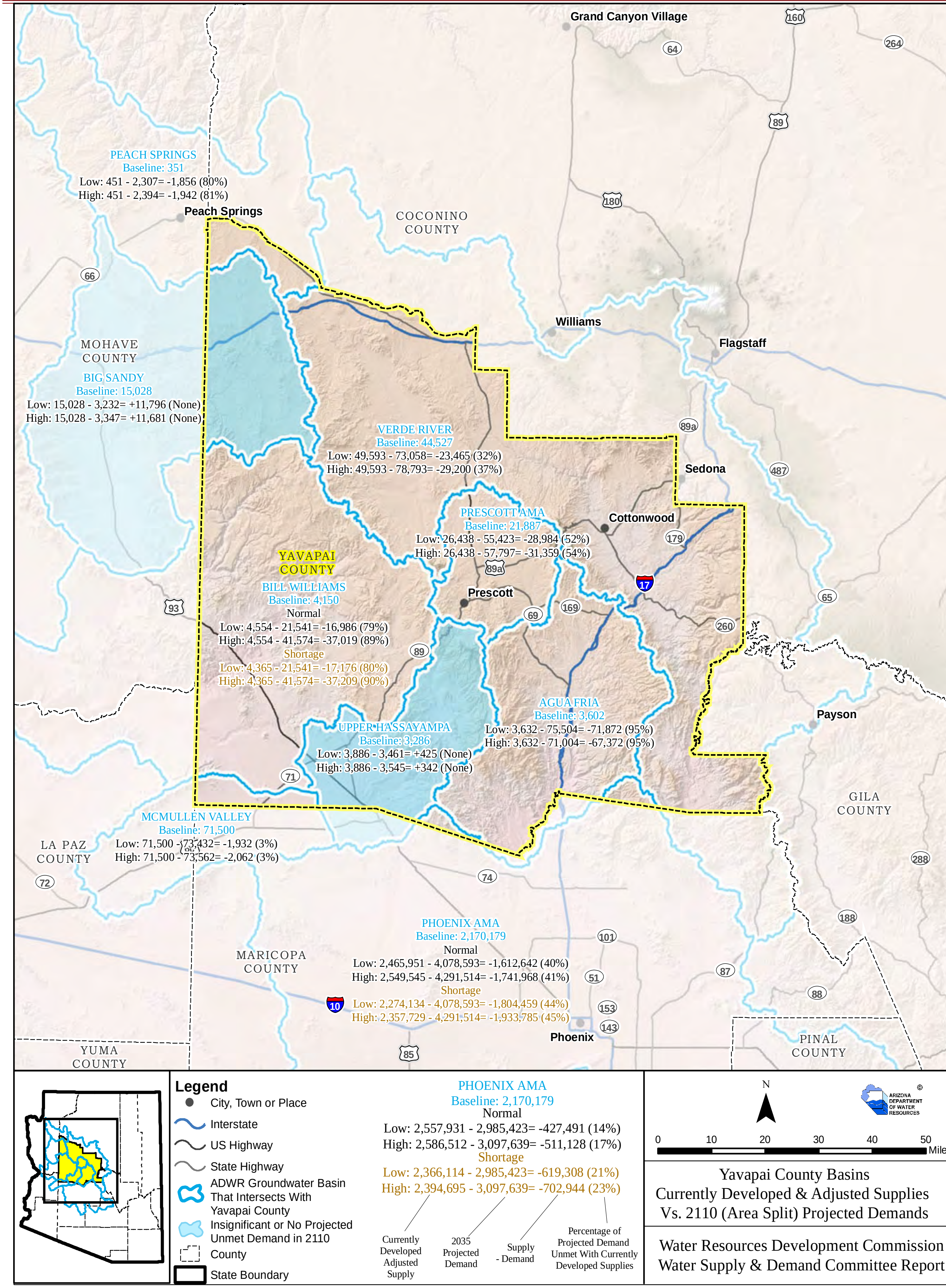

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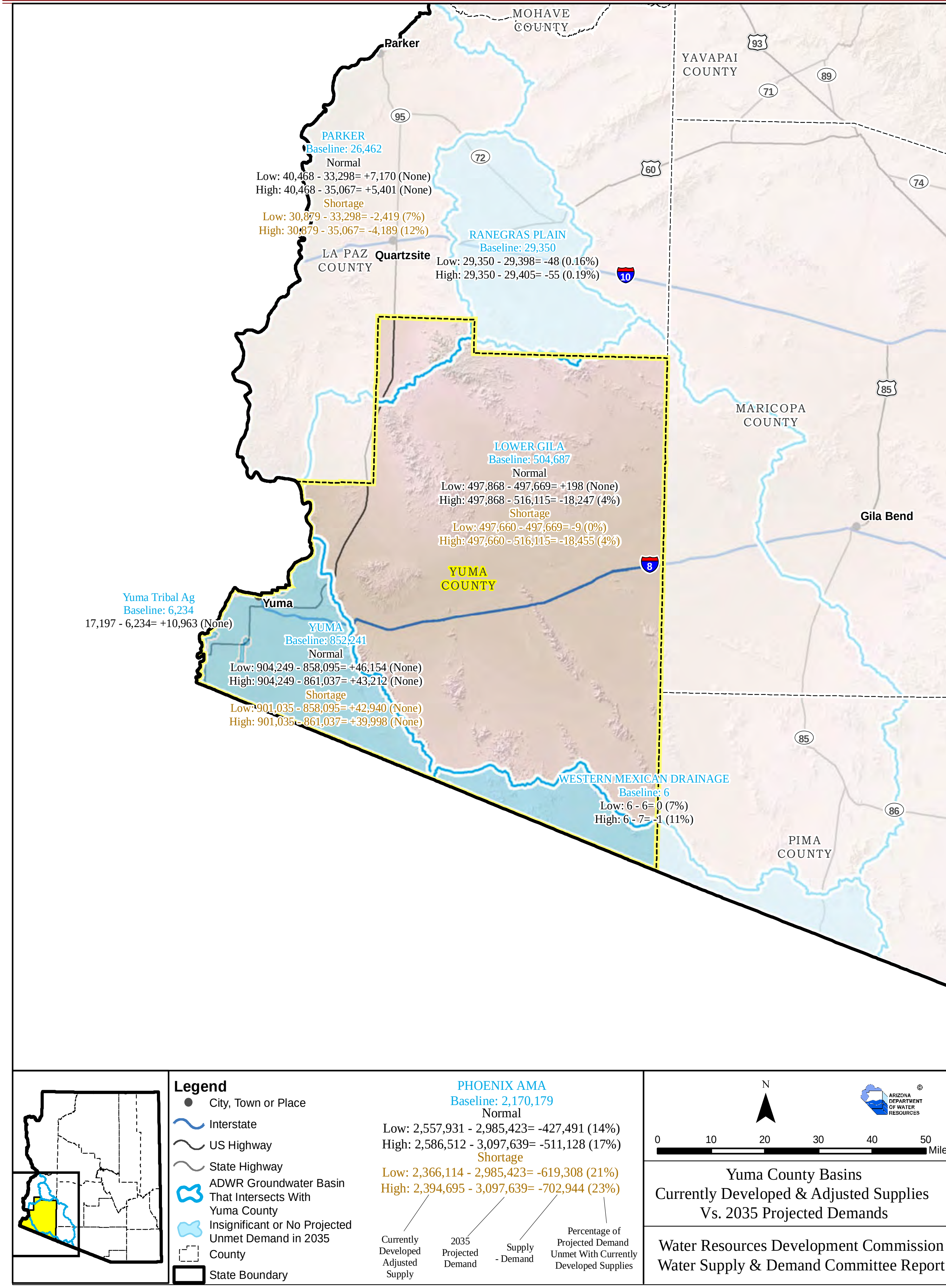

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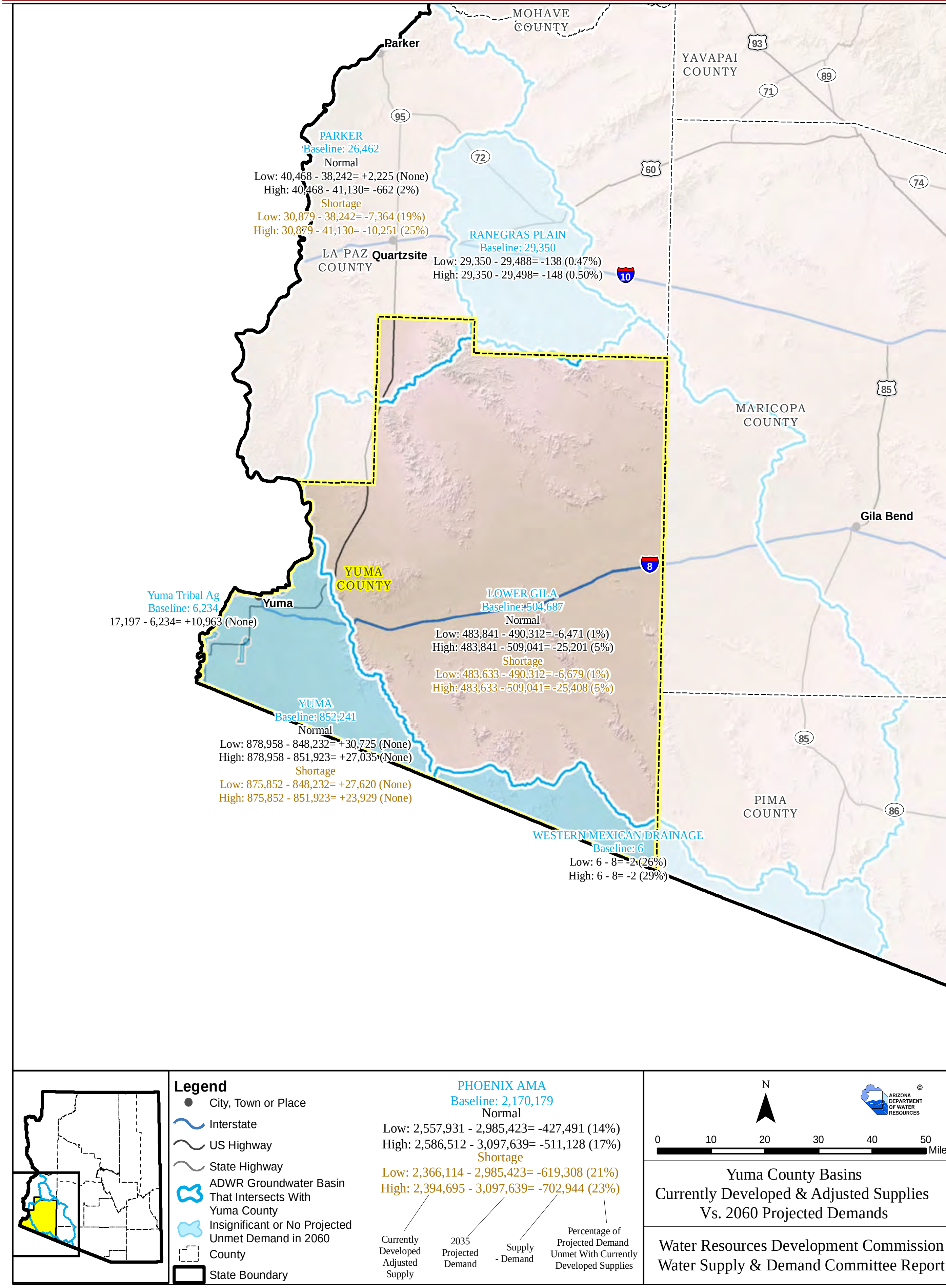

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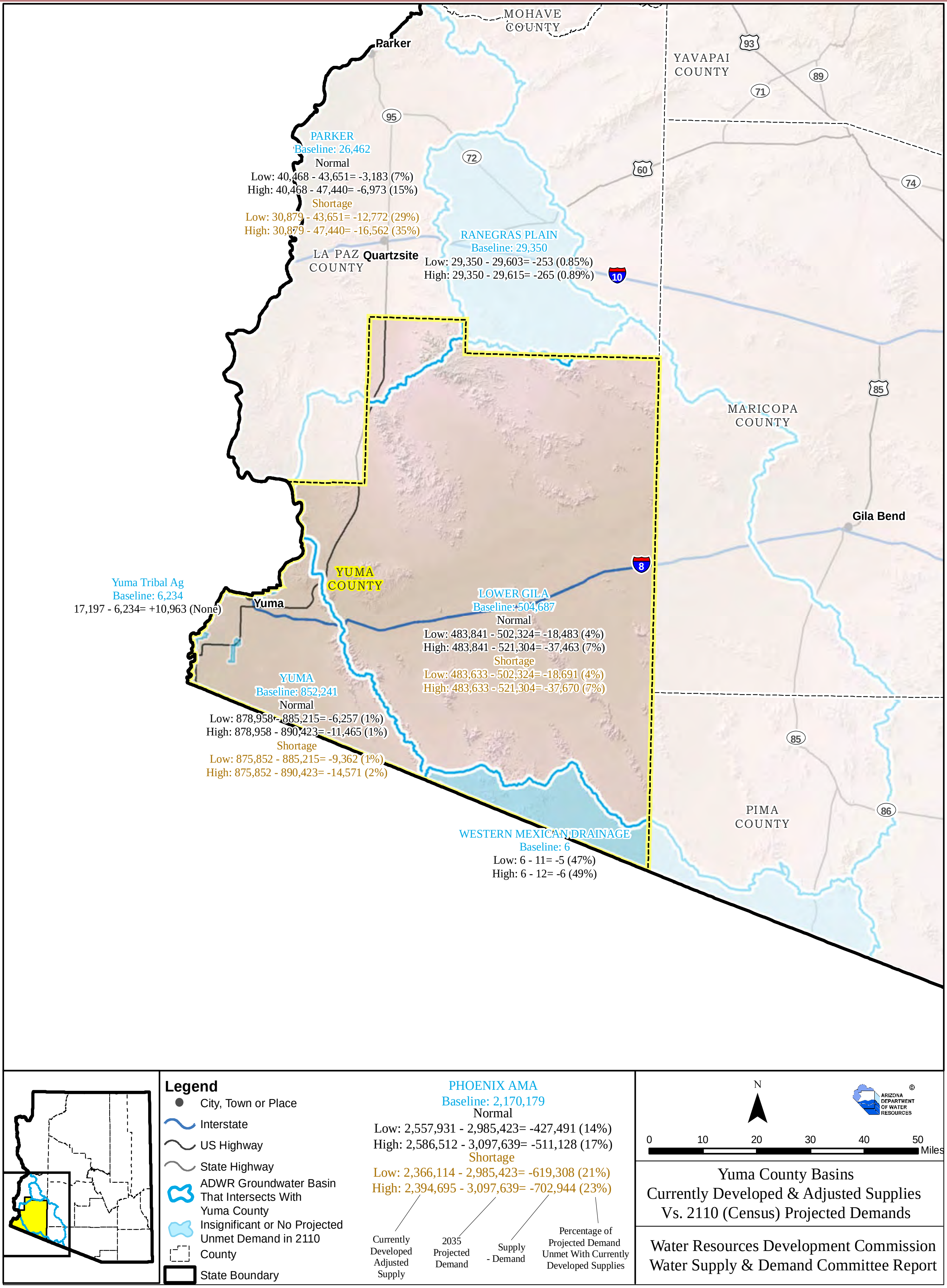

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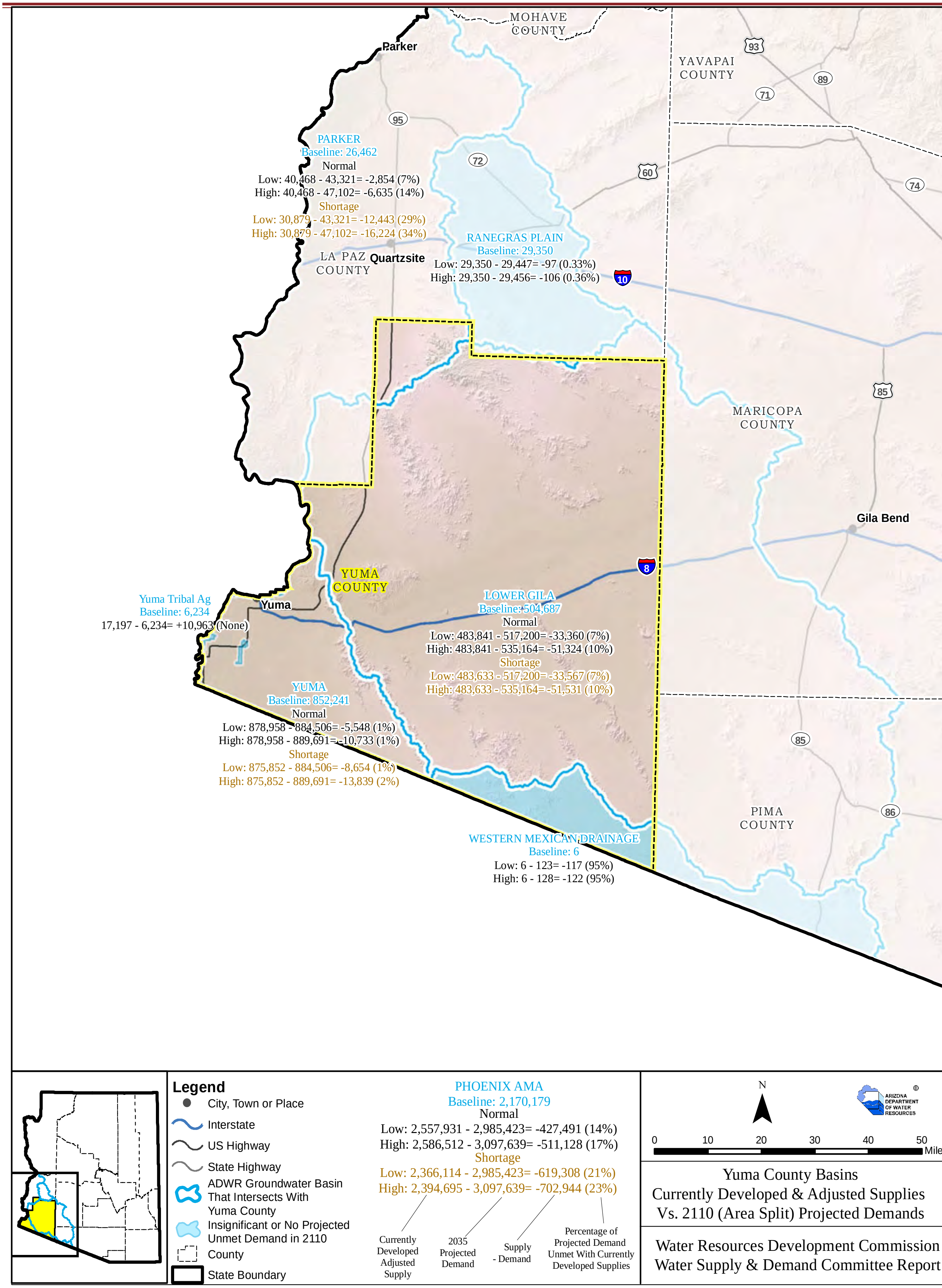

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APPENDIX 2

WRDC AGRICULTURE SUBCOMMITTEE REPORT

WRDC Agricultural Demand Subcommittee Report

Subcommittee Chair:

Cliff Cauthen, Hohokam Irrigation and Drainage District

cliffcauthen@hohokam.tuccoxmail.com

INTRODUCTION

The Agriculture Subcommittee (Ag Sub) has been charged with analyzing the Agriculture (Ag) demands within the State of Arizona in the first stage of the Water Supply and Demand Committee of the Water Resources Development Commission. This portion of the analysis was a huge under-taking when you consider that this group was responsible to consider the demands across the state and come up with an acceptable description of the agriculture demands as they currently exist and then project these areas Ag water demands for the next 25, 50 and 100 years. The task of projecting out 25 years is fairly significant and difficult, to which we feel as though we have accomplished this portion of the assignment with a great deal of surety. The 50 year projection was somewhat more of a trending of the 25 year projections, while the 100 year projection is simply no more than an attempt to classify the possible land uses and resulting water demands – somewhat similar to that of forecasting the weather in Arizona. Nye onto impossible to get this close to being what it will actually look like then.

METHODS

When you look at the composition of this work you must keep in mind that we used the resources, for the test year 2006, we had at hand; the USGS reports, the DWR resources, including the Water Atlas, BOR input and the various committee member's knowledge of the areas in question and how the land use was currently being used.

Our committee took into consideration all the variables we had knowledge of when putting our material together. There were many discussions regarding the verification of the data presented, some of these discussions were outside the committee meetings with the entities that prepared the initial data. We had numerous presentations from the individuals who helped prepare the supporting data, these presentations helped immensely when it came to understanding how the data was compiled.

This committee came to the conclusions, which I will be presenting throughout this paper, after much debate and conferring with the various entities that prepared the reports we are relying upon to make our projections. This was not a simple process, yet the conclusions we reached were acceptable to the group and we feel as they accurately project, to the best of our abilities, the demands for agriculture across the state. However, future agricultural water demand will also be affected by several factors that have not been considered in this project, primarily because of time and resource constraints. Commodity prices, advances in water conservation technology, the timing and location of urban growth and urban growth patterns, and other factors will have an effect on future agricultural water demand in this state.

I would like to begin by clarifying a few of our assumptions to begin with while others will be noted at the end of the report. Most of the data we had to work with was assembled by groundwater basin. Our report will be presented by county, thereby removing any misinterpreting of the Ag Sub work. Converting this data from a basin analysis to a county presentation is not simple, in fact there has been liberties taken in determining the correct assignment of a demand from the basin to the county presentation. The resulting document that you receive, although not rocket science, has been determined to be acceptable to the Ag Sub.

In reporting on the Ag demands for the state of Arizona we have chosen to break up our presentation of data into three categories: AMA or Active Management Area; Non-AMA or Non Active Management Area and the Yuma and Lower Gila Basin area.

Non-AMA areas of Arizona

This area of the State comprises many counties which have very little Ag land comparatively speaking. However, the Ag land that exists in these areas has been in active production for many generations. Also, this land will continue to be farmed into the future without much interruption and very little infringement by Municipal or Industrial growth. For example, the Willcox basin within Cochise County has historically farmed the same amount of ground in terms of acres farmed. The limiting factor has been, and will always be, the accessibility to groundwater. The potential for this land to be developed exists, but we feel that any growth in this county that does occur on agriculture properties will provide for the water used on that parcel to be used on a different parcel in order to benefit an adjacent property. In other words, any Ag land removed from production for development will provide the ability to apply the water used here to another parcel. The Willcox area has a unique problem when it comes to water availability: This area is isolated from other non-basin inflows; it is an island in the water world within the State of Arizona.

In our evaluation of the Verde Valley area, we took the position that the Ag demand there was also going to not increase, nor decrease over time. Much of this area is in the horse farm category of 1-5 acre parcels that the landowner has acquired a right to water use, and this demand will not vary over time.

In general, we are proposing that the Non-AMA portions of the State of Arizona, outside of Yuma County, will be flat-lined in the demand for Ag water for all three projections. The 25, 50 and 100 year demand numbers for each county will be the same as they are for the test year, 2006.

Yuma and Lower Gila Basin (Yuma County)

In determining the need to carve this area out of the mass and present it separately from the Non-AMA areas, the inconsistencies within the data pools was a major contributing factor. The USGS data and the DWR data were inconsistent in the reporting of the historical use and when analyzing this information it was determined that the best case scenario required that we present Yuma County as a separate demand component within the Ag report.

The reporting of the demands within this area has been questioned, and answers have been provided so that the Ag Sub is comfortable with our report. Many questions were presented regarding the collecting of the data in the Lower Gila basin due to what appeared as a lack of use/demand for the Wellton Mohawk area. Most of the water use data appeared to come from the upper end of the Lower Gila Basin. When this was questioned and then reviewed, the resulting responses were satisfactorily assigned in the correct area of Yuma County for our purposes.

The data assembled from the Yuma Basin also appeared to be misstated and was reviewed with the appropriate agencies. After reviewing this data with DWR, the Ag Sub determined that this area was in need of being addressed in conjunction with the Wellton Mohawk area.

Considering all the information gathered, taking into the corrections in the interpretation of this data and looking at past growth as a means to determine future growth; the Ag Subcommittee has reached the conclusion that in forecasting the Ag demands for both the Lower Gila AND the Yuma Basin (Yuma County) that a gradual decline in total water demands over the next 50 years of 7% of the total annual delivery for 2006 should be reflected with the resulting number being displayed each year and specifically for year 25 (2036). Beyond 2062, the total demand should be flat-lined each year.

Active Management Area's (AMA's)

Phoenix – There has been much work on this subject matter in each of the 3 AMA Management Plans. The 4th Management Plan is scheduled to start data analysis this summer with a report proposed sometime in 2012, unfortunately not soon enough for inclusion in this report.

The 3rd Management Plan reflected the impacts of the economic boom the State of Arizona was experiencing in the mid '90's. This boom never fully materialized and as a result the projections that were sure to occur never fully materialized. Now we are faced with many years of recovery that may lead back to a scheduled growth that mirrors the planned growth rate in the 3rd Management Plan.

How far off is this scenario is anyone's guess. What we do know is that the Maricopa Realtors are strongly suggesting that the current economic conditions indicate that at the earliest we are looking at is 2015 for Maricopa Realty to return back to any resemblance of earlier sales of homes. I have had this discussion with DWR and have reached an accord that the Ag projections for Maricopa County, thus the Phoenix AMA, will in essence slide out to 2015 before we begin any rate of decline in the number of acres used in Ag and therefore see any reduction in the demand for Ag water.

So, for the purposes of the Ag Sub report, the Phoenix AMA will reflect a flat-line demand from now until 2015. Beginning with 2015 the Phoenix AMA water demand will begin a decline similar to that projected by the Mid-Range analysis of the DWR data and resemble the rate of decline in the 3rd Management Plan. This decline will bottom out at 75,000 acres, at whatever period in time it occurs. A corresponding demand rate, as determined by the 2006 demand to acre ratio, shall be applied to these 75,000 acres for the demand rate through the rest of the 100 years.

Pinal - There has been much work on this subject matter in each of the 3 AMA Management Plans. The 4th Management Plan is scheduled to start data analysis this summer with a report proposed sometime in 2012, unfortunately not soon enough for inclusion in this report.

The 3rd Management Plan reflected the impacts of the economic boom the State of Arizona was experiencing in the mid '90's. This boom never fully materialized and as a result the projections that were sure to occur never fully materialized. Now we are faced with many years of recovery that may lead back to a scheduled growth that mirrors the planned growth rate in the 3rd Management Plan.

How far off is this scenario is anyone's guess. What we do know is that the current economic conditions mirror those in Maricopa County and as such the feeling is that the turn-around may not be felt in Pinal County until 2018. To reflect this projected growth slide I discussed the possibility of sliding any reduction in Ag acres until 2018 with DWR and they were open to this thought process as well.

Therefore, in this Ag Sub report, before we begin any rate of decline in the number of acres used in Ag and any reduction in the demand for Ag water, we will show a flat-line demand from 2011 through 2018 in the Pinal AMA. Beginning with 2018 the Pinal AMA water demand will begin a decline similar to that projected by the Mid-Range analysis of the DWR data and resemble the rate of decline in the 3rd Management Plan. This decline will bottom out at 100,000 acres, at whatever period in time it occurs. A corresponding demand rate, as determined by the 2006 demand to acre ratio, shall be applied to the 100,000 acres for the resulting demand rate through the rest of the 100 years.

There are assumptions and/or clarification that were applied to various basins and, as such, to the counties as well. The following assumptions/clarifications were made:

1 – Indian Ag use is not discussed, nor reflected in this work. All Ag numbers are reflective of demands for Ag water off any reservation.

2 – Demand for Ag is just that, demand for water without inference that any particular source of water is being used. This determination will be made in our next analysis, Supply of Ag water.

3 – Non AMA Ag is not restricted to the acreage that was in existence at any given time. Thus the ability for Ag, in some basins, to move water from one Ag parcel to another; without violating any rules or regulations.

RESULTS

The results for the agricultural demand projections developed using the methodology described are displayed in Table 1. Tables that show the 2006 test year (baseline demand) and the Colorado River Basin Supply and Demand Study values that were used to project water demands for the Phoenix, Pinal and Tucson AMAs are provided in the Appendix.

Table 1. Projected Agricultural Water Demand by Basin through 2110

BASIN_NAME	YEAR 2035	YEAR 2060	YEAR 2110
AGUA FRIA	1,800	1,800	1,800
ARAVAIPA CANYON	1,000	1,000	1,000
BIG SANDY	0	0	0
BILL WILLIAMS	2,700	2,700	2,700
BONITA CREEK	0	0	0
BUTLER VALLEY	14,500	14,500	14,500
CIENEGA CREEK	500	500	500
COCONINO PLATEAU	0	0	0
DETRITAL VALLEY	0	0	0
DONNELLY WASH	0	0	0
DOUGLAS	48,000	48,000	48,000
DRIPPING SPRINGS WASH	0	0	0
DUNCAN VALLEY	7,200	7,200	7,200
GILA BEND	351,500	351,500	351,500
GRAND WASH	0	0	0
HARQUAHALA INA	135,500	135,500	135,500
HUALAPAI VALLEY	0	0	0
KANAB PLATEAU	1,100	1,100	1,100
LAKE HAVASU	0	0	0
LAKE MOHAVE	89,000	89,000	89,000
LITTLE COLORADO RIVER PLATEAU	39,250	39,250	39,250
LOWER GILA	481,535	464,070	464,070
LOWER SAN PEDRO	3,700	3,700	3,700
MCMULLEN VALLEY	71,000	71,000	71,000
MEADVIEW	0	0	0
MORENCI	0	0	0
PARIA	0	0	0
PARKER	643,396	643,396	643,396
PEACH SPRINGS	0		
PHOENIX AMA	307,926	147,045	147,045
PINAL AMA	590,540	418,152	418,152
PRESCOTT AMA	1,329	1,329	1,329
RANEGRAS PLAIN	29,000	29,000	29,000
SACRAMENTO VALLEY	0	0	0
SAFFORD	179,500	179,500	179,500
SALT RIVER	6,900	6,900	6,900
SAN BERNARDINO VALLEY	0	0	0
SAN RAFAEL	0	0	0
SAN SIMON WASH	500	500	500
SANTA CRUZ AMA	11,233	11,233	11,233
SHIVWITS PLATEAU	0	0	0
TIGER WASH		0	
TONTO CREEK	1,500	1,500	1,500
TUCSON AMA	66,242	56,723	56,723
UPPER HASSAYAMPA	0	0	0
UPPER SAN PEDRO	8,800	8,800	8,800
VERDE RIVER	23,700	23,700	23,700
VIRGIN RIVER	1,000	1,000	1,000
WESTERN MEXICAN DRAINAGE	0	0	0
WILLCOX	166,000	166,000	166,000
YUMA	782,615	754,230	754,230
STATEWIDE	**4,068,466**	**3,679,827**	**3,679,827**

APPENDIX

BASIN_NAME	2006 Agricultural Water Demands (acre-feet)							
	CAP	CAP (GSF)	GW	Reclaimed	Reclaimed (GSF)	Recovered Reclaimed	SW	Total
AGUA FRIA	0	0	1,800	0	0	0	0	1,800
ARAVAIPA CANYON	0	0	500	0	0	0	500	1,000
BIG SANDY	0	0	0	0	0	0	0	0
BILL WILLIAMS	0	0	2,700	0	0	0	0	2,700
BONITA CREEK	0	0	0	0	0	0	0	0
BUTLER VALLEY	0	0	14,500	0	0	0	0	14,500
CIENEGA CREEK	0	0	500	0	0	0	0	500
COCONINO PLATEAU	0	0	0	0	0	0	0	0
DETRITAL VALLEY	0	0	0	0	0	0	0	0
DONNELLY WASH	0	0	0	0	0	0	0	0
DOUGLAS	0	0	48,000	0	0	0	0	48,000
DRIPPING SPRINGS WASH	0	0	0	0	0	0	0	0
DUNCAN VALLEY	0	0	7,200	0	0	0	0	7,200
GILA BEND	0	0	289,000	0	0	0	62,500	351,500
GRAND WASH	0	0	0	0	0	0	0	0
HARQUAHALA INA	0	0	65,500	0	0	0	70,000	135,500
HUALAPAI VALLEY	0	0	0	0	0	0	0	0
KANAB PLATEAU	0	0	1,100	0	0	0	0	1,100
LAKE HAVASU	0	0	0	0	0	0	0	0
LAKE MOHAVE	0	0	29,500	0	0	0	59,500	89,000
LITTLE COLORADO RIVER PLATEAU	0	0	8,700	11,300	0	0	19,250	39,250
LOWER GILA	0	0	115,000	0	0	0	384,000	499,000
LOWER SAN PEDRO	0	0	3,200	0	0	0	500	3,700
MCMULLEN VALLEY	0	0	71,000	0	0	0	0	71,000
MEADVIEW	0	0	0	0	0	0	0	0
MORENCI	0	0	0	0	0	0	0	0
PARIA	0	0	0	0	0	0	0	0
PARKER	0	0	500	896	0	0	642,000	643,396
PEACH SPRINGS	0	0	0	0	0	0	0	0
PHOENIX AMA	56,305	104,640	271,498	30,550	42,509	0	224,523	730,025
PINAL AMA	261,598	139,616	327,702	2,325	0	0	88,653	819,894
PRESCOTT AMA	0	0	2,065	0	0	782	0	2,847
RANEGRAS PLAIN	0	0	29,000	0	0	0	0	29,000
SACRAMENTO VALLEY	0	0	0	0	0	0	0	0
SAFFORD	0	0	80,500	0	0	0	99,000	179,500
SALT RIVER	0	0	500	0	0	0	6,400	6,900
SAN BERNARDINO VALLEY	0	0	0	0	0	0	0	0
SAN RAFAEL	0	0	0	0	0	0	0	0
SAN SIMON WASH	0	0	500	0	0	0	0	500
SANTA CRUZ AMA	0	0	10,704	0	0	0	0	10,704
SHIVWITS PLATEAU	0	0	0	0	0	0	0	0
TIGER WASH	0	0	0	0	0	0	0	0
TONTO CREEK	0	0	500	0	0	0	1,000	1,500
TUCSON AMA	5,450	18,794	63,511	0	0	0	0	87,755
UPPER HASSAYAMPA	0	0	0	0	0	0	0	0
UPPER SAN PEDRO	0	0	4,500	0	0	0	4,300	8,800
VERDE RIVER	0	0	9,900	0	0	0	13,800	23,700
VIRGIN RIVER	0	0	500	0	0	0	500	1,000
WESTERN MEXICAN DRAINAGE	0	0	0	0	0	0	0	0
WILLCOX	0	0	166,000	0	0	0	0	166,000
YUMA	0	0	102,000	0	0	0	709,000	811,000
STATEWIDE	**323,353**	**263,050**	**1,728,080**	**45,071**	**42,509**	**782**	**2,385,426**	**4,788,270**

Colorado River Basin Water Supply and Demand Study			
Arizona Demand Study			
Projected Agricultural Use			
Year	Phoenix AMA - Revised	Pinal AMA - Revised	Tucson AMA - Revised
2010	685,185	856,239	85,871
2011	663,810	853,470	84,803
2012	643,012	850,689	83,757
2013	622,759	847,898	82,732
2014	603,025	845,094	81,727
2015	583,784	842,279	80,742
2016	565,010	834,441	79,776
2017	546,684	819,480	78,828
2018	528,782	804,454	77,898
2019	511,287	789,365	76,984
2020	494,180	774,209	76,087
2021	477,985	758,985	75,196
2022	462,122	743,695	74,322
2023	446,580	728,337	73,462
2024	431,345	712,908	72,616
2025	416,405	697,409	71,784
2026	404,114	684,963	71,159
2027	392,169	672,957	70,551
2028	380,546	661,380	69,957
2029	369,231	650,207	69,379
2030	358,207	639,413	68,817
2031	347,558	628,979	68,271
2032	337,213	618,899	67,740
2033	327,164	609,144	67,225
2034	317,404	599,698	66,726
2035	307,926	590,540	66,242
2036	298,724	581,652	65,772
2037	289,791	573,010	65,316
2038	281,122	564,614	64,873
2039	272,711	556,456	64,442
2040	264,553	548,509	64,023
2041	256,644	540,759	63,614
2042	248,979	533,198	63,215
2043	241,555	525,805	62,826
2044	234,366	518,557	62,444
2045	227,409	511,432	62,066
2046	220,682	504,427	61,694
2047	214,179	497,558	61,329
2048	207,899	490,789	60,968
2049	201,839	484,099	60,607
2050	195,996	477,499	60,247
2051	190,367	470,967	59,887
2052	184,950	464,498	59,529
2053	179,744	458,096	59,171
2054	174,745	451,745	58,814
2055	169,795	445,888	58,458
2056	164,965	440,034	58,105
2057	160,280	434,336	57,755
2058	155,734	428,792	57,408
2059	151,324	423,398	57,064
2060	147,045	418,152	56,723

APPENDIX 3

WRDC INDUSTRIAL DEMAND SUBCOMMITTEE REPORT

WRDC Industrial Demand Subcommittee Report

By: Ron Doba, Northern Arizona Municipal Water Users Association, rdoba@cox.net

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INTRODUCTION

The Industrial Subcommittee was formed as a subcommittee of the Water Supply and Demand Committee to prepare industrial water demand assumptions. Tasks identified in the Water Resources Development Commission Workplan include the following:

- Develop economic development and growth methodologies with county and other economic development experts and review existing development plans and strategies with appropriate staff.
- Develop demand assumptions based on current or new technology.
- Develop a methodology to predict sand and gravel and industrial golf course demand based on population or other approach.

Current industrial water demand and future projections were to be identified for the mining, sand and gravel, dairy, feedlot, power, turf, and other industries. Future projections were to be made for the next 25-year (2035), 50-year (2060), and 100-year (2110) periods and incorporated into the report from the Water Supply and Demand Committee.

METHODS

The Industrial Subcommittee determined it could best complete its tasks by breaking the group into subsectors made up of experts representing each subsector. The subsectors included mining, power, turf, and the sand and gravel industry. The Arizona Department of Water Resources (ADWR) defines dairies and feedlots as industrial users. However, the group determined better assumptions could be made by the Agricultural Subcommittee for these two subsectors. Efforts to increase subsector participation included reaching out to: the Arizona Mining Association (mining); Arizona Rock Products Association (sand and gravel); Arizona Public Service, Tucson Electric Power and Salt River Project (electric power generation and solar development); and the Arizona Golf Industry Association (turf). The assumptions and water demand projections for dairies and feedlots included in this report were provided to the Industrial Subcommittee by the Agricultural Subcommittee. The group reviewed baseline data provided by ADWR which included, with a few exceptions, water that is self-served (not provided by a municipal provider) and is not used for an agricultural purpose. Some subsectors initially projected water demands for low, medium, and high development. Later it was determined that only low and high projections would be used by the Water Supply and Demand Committee for the purposes of their report and the projections were adjusted accordingly. In the final projections an additional category called “other industrial” was created, which included industries such as paper mills and certain, large non-residential water users within the Active Management Areas (i.e. Intel) and accounted for approximately 30,000 AF of current statewide water use. The methodology used by each subsector to determine future water demand projections is discussed separately for each subsector.

Baseline Data

Baseline data was provided by ADWR for industrial water demands outside AMAs for the period of 1991-2009 and inside AMAs from 1985-2006. Baseline data from outside the AMAs came primarily from the USGS. Water users outside AMAs are not required to report their water use so in some cases the water usage amounts are estimates. AMA baseline data came primarily from the Annual Withdrawal and Use Reports submitted each year to ADWR. Generally, the Industrial Subcommittee decided to use the 2006 industrial water demands for baseline demands because it was the most recent year data was available for both areas. The exception was the power subsector working group that chose to develop a 2010 power plant water baseline demand (using Population Committee forecasts) for use as a starting place for 2035, 2060 and 2110 projections. Baseline data used for the industrial sector can be found in the Appendix.

Mining Subsector

The Arizona mining subsector produces different global commodities that are not based on local population or economic conditions within Arizona. Each commodity has its own separate market dynamics that do not uniformly reflect global economic conditions. The industry is cyclical and subject to a high degree of volatility that makes it hard to make long range projections of mine activity and associated water use. As a result of this condition, long-term water demand projections looking at 25, 50 and 100 year timelines should be considered highly speculative and subject to future change.

Differences in local climate, geography, production rates, and mineralization types can vary significantly between operations and can influence water demand and conservation potential. Because there is no uniform constant for judging future water demand within the mining industry as a whole, each mining company provided their best current estimates of future demand for each of their Arizona operations and matched those with the basin locations of use. Each company provided a best guess as to the possible low, mid and high range of projected future water demand. In some instances, mines may divert water from one basin or county into another to supply operations. The group determined it would report water demand for the basin in which the water was actually used. Projected demands may also include some commingling of possible future remedial pumping requirements. Due to the uncertain nature of how this water would be recovered and subsequently used (either for mining or other purposes), the group felt that the projected demand for any remedial pumping should be assumed to remain a mining demand within the basin where the related facilities are located.

With minor exceptions, the mining demand projections assume constant demand ranges over the three (25, 50, 100 year) projection timelines because it is not currently possible to predict the timing and duration of future mine expansions. No standardized assumptions were made about water use rates or conservation efficiencies because of the distinct geographic nature of each mine operation.

Power Subsector

The power subsector working group chose to use a simple approach for determining future power plant water consumption that could be linked to the Population Committee’s forecasts. Key statistics utilized include energy production per capita and electric power plant water consumption per unit of energy. Total projected energy production was based on Energy Administration Information data from 2008 and adjusted for 2010. Electric power plant water consumption per unit of energy was based on an average of Arizona Public Service, Salt River Project and Tucson Electric Power values for the years 2000-2009. The percentage of total 2010 Arizona power plant water consumption that occurs in each county and groundwater basin was calculated and some accounting for solar projects in western Arizona (based on pending BLM right of way applications) was factored into the development of projections for 2035, 2060 and 2110. High and low forecasts were developed based on the following two scenarios:

Scenario A

Lower Power Plant Consumption Forecast

Modest Increase: Energy Production Per Person

Significant Decrease: Power Plant Water Consumption Per Unit of Energy

	Target Year	Energy Production Per Person		Power Plant Water Consumption Per Unit of Energy	
1	2035	• Energy Production in Arizona is strongly correlated with energy consumption in Arizona • Energy efficiency and renewable energy requirements, plus demand management advancements result in a need for fewer power plants that consume water • While advancements in new/other consumer uses of electricity do not occur, electric vehicle load becomes significant • Power plants are built for consumers in other states • The offsetting effects of these factors are such that there is no change in energy production per person in this time frame	0%	• Energy efficiency and renewable energy requirements reduce power plant water consumption • Some older power plants retire • All new power plants utilize dry or hybrid cooling technologies	-20%
2	2060	• Increased reliance on electric vehicles • Advancements in new/other consumer uses of electricity occur	+5%	• Same as 2035 plus • Climate concerns drive power plant water conservation	-10%
3	2110	• Increased reliance on electric vehicles	+3%	• Same as 2035 plus • Climate concerns drive power plant water conservation	-20%

Scenario B

Higher Power Plant Water Consumption Forecast

Sustained Increase: Energy Production Per Person

Delayed Decrease: Power Plant Water Consumption Per Unit of Energy

	Target Year	Energy Production Per Person		Power Plant Water Consumption Per Unit of Energy	
1	2035	• Other states become increasingly parochial about use of state resources – Arizona entities withdraw from out-of-state power plants and replace those resources inside Arizona • Relative to today, more power plants are located in Arizona to meet electric needs in other states • Energy production in Arizona is strongly correlated with energy consumption in Arizona • Advancements in known technologies serve to increase energy production intensity (e.g. electric vehicles, high speed electric trains) • Innovation continues – advancements in "unknown" technologies serve to increase energy production intensity • U.S. Economy improves – a greater number of people demand more energy intensive appliances and devices	+10%	• Some new power plants utilize dry or hybrid cooling technologies • Increased power plants in Arizona result in increased water consumption • Electric vehicle and high speed electric train advancements prompt the need for more base loaded electric generating capability (higher power plant water consumption per unit of energy than intermediate or peaking resources) • The offsetting effects of these factors are such that there is no change in power plant water consumption per unit of energy in this time frame	0%
2	2060	• Same as 2035	+10%	• Significant power plant retirements occur • A majority of new power plants utilize dry or hybrid cooling technologies	-10%
3	2110	• Same as 2035	+10%	• Same as 2060	-20%

± % change equals percent change relative to the prior target year

The power subsector chose to round the population numbers used within their equation to determine projected water demands. Subsequent to the report from the power subsector, the Water Supply and Demand Committee compared the results from the various subcommittees with the Central Arizona Water Demand Model developed by Peter Culp for the Phoenix, Tucson and Pinal AMAs. The model used the same methodology to calculate the power demand as the subsector, except that the population numbers within the equation were the actual projections instead of the rounded projections. The model was selected to provide the final demand and supply numbers for the Phoenix, Tucson and Pinal AMAs, resulting in a small difference (<1,000 AF) in the power subsector water demand numbers shown in the final Water Supply and Demand Committee report. The tables included in this report show the water demand projections developed by the subcommittee, not the model.

Turf Subsector

The turf subsector group projected water use for golf courses not being supplied water by municipalities. They anticipated that beyond the first few years following construction of new golf courses that they will use 80% effluent water, 10% surface water and 10% groundwater. Similar to other industrial subsectors, the turf subsector decided to base water projections on population data. Using Maricopa County data, total rounds of golf per 18-hole equivalent were calculated for 2010 (7,500,000) and divided by the 2009 population estimate (4,023,000) to arrive at 1.86 rounds per capita. An adjustment factor was applied for reduced disposable income and lifestyle changes as follows:

Year	Adjustment Factor	Adjusted Baseline
2010	1.00	1.86
2035	0.70	1.30
2060	0.50	0.93
2110	0.40	0.74

Using the mid population estimates from the population committee and assuming an average of 65,000 rounds per year per 18-hole golf course is required for sustainability (industry standard) the following two scenarios were presented:

Scenario 1 (low)

Per capita rounds decrease significantly over time

Golf course sustainability at 65,000 rounds per year

Statistic	2010	2035	2060	2110	2110
Population	6,628,757	10,453,870	13,252,013	18,322,751	18,322,751
Rounds Played per Capita	1.86	1.30	0.93	0.74	0.74
Projected Rounds	12,329,488	13,610,939	12,324,372	13,632,127	13,632,127
Sustainable Golf Courses	189.7	209.4	265.4	209.7	209.7
Water Consumption (Acre Feet)	87,129	100,164	129,118	117,040	117,040

Scenario 2 (high)

Steady decrease in per capita rounds over time

Golf course sustainability at 45,000 rounds per year

Statistic	2010	2035	2060	2110	2110
Population	6,628,757	10,453,870	13,252,013	18,322,751	18,322,751
Rounds Played per Capita	1.86	1.49	1.30	1.12	1.12
Projected Rounds	12,329,488	15,576,267	17,227,617	20,521,481	20,521,481
Sustainable Golf Courses	274.0	346.1	382.8	456.0	315.7
Water Consumption (Acre Feet)	87,129	115,441	129,765	154,115	154,116

New golf courses and associated water demands were distributed to groundwater basins based on urban areas and areas anticipated to become urban areas.

Sand and Gravel Subsector

Water use projections were developed for all 51 groundwater basins within the State of Arizona based on relationships established between historical population, historical and recent rock production volumes and recent rock production related water use. Because water use data was more available from producers within the AMAs, the relationship used to establish the projections were developed based on data provided by producers within the AMAs. Population growth and construction activity were determined the main drivers of sand and gravel use. The subsector group provided high, mid and low range water use projections due to the sub-category reflecting significant variability in the amount of water required to produce one ton of material. For example ready mix concrete production typically requires more water use than aggregate mining. These activities were grouped together for the purpose of this report. The low-range projection assumes that a larger proportion of low water use rock production activities occur. The mid-range projection assumes that the present water use requirements driven by regulatory requirements such as dust control remain relatively constant through 2110. The high-range production assumes that a larger proportion of high water use rock production activities occur in the future than at present. The high, mid and low range values are 300, 212 and 125 gallons of water per ton of material produced. The subsector group understands the Water Supply and Demand Committee will only use the low and high demand numbers in its report. The relationship of 13 tons per person was multiplied by population projections provided by the Water Supply and Demand Committee for the years 2035, 2060 and 2110 for each groundwater basin. The result was then multiplied times the high, mid and low range water use values to obtain population correlated rock production water use for each basin. Only the high and low values are shown in this report.

Dairies

Dairy water demand projections were calculated by the Agriculture Subcommittee and provided to the Industrial Subcommittee for this report. According to data from the United Dairymen of Arizona (UDA) existing dairy use is 105 gallons per cow per day. Increased cow population is 2 cows per 100 people in determining the increase in cow population. The location of dairies is expected to change in the next 25, 50 and 100 years as a result of residential development. Dairy population is projected to reduce to zero within the next ten years in Maricopa County while the dairy population in Pinal County is projected to increase over the next 5 years. With population as the driver for dairies, water demand is projected to increase accordingly over the next 100 years. Dairy water demand projections are shown on Table 1.

Table 1. Projected Dairy Demands by Basin

BASIN_NAME	2001	2002	2003	2004	2005	2001-2005 Average Dairy Water Demand (acre-feet)	2006 Dairy Water Demand (acre-feet)	2010	2035	2060	2110
						GW	GW				
DUNCAN VALLEY	92.5	92.5	92.5	92.5	92.5	93	93	93	93	93	93
GILA BEND	0	0	108.1	172.9	172.9	91	173	724	5,281	13,814	23,782
KANAB PLATEAU	27.1	27.1	27.1	27.1	27.1	27	27	27	27	27	27
LITTLE COLORADO RIVER PLATEAU	19.5	19.5	19.5	19.5	19.5	20	20	20	20	20	20
LOWER GILA	152.1	246.2	246.2	246.2	246.2	227	246	724	5,281	13,814	23,782
PHOENIX AMA	11720.99	12569.32	12143.91	11642.89	10567.8	11,729	10,080	7,500	0	0	0
PINAL AMA	2630	3259	4679	5980	7584	4,826	8,400	10,980	18,480	8,000	0
SACRAMENTO VALLEY	75.7	75.7	75.7	75.7	75.7	76	76	76	76	76	76
TUCSON AMA	125.98	131.6	114.24	88.1	123.62	117	110	110	0	0	0
UPPER HASSAYAMPA	786.4	786.4	786.4	786.4	786.4	786	786	786	786	786	786
UPPER SAN PEDRO	42.17	42.17	42.17	42.17	42.17	42	42	42	42	42	42
WILLCOX	0	0	0	583.7	583.7	233	584	584	584	584	584
Statewide						**18,267**	**20,637**	21,665	30,669	37,255	49,191

Feedlots

Feedlot water demand projections were calculated by the Agriculture Subcommittee and provided to the Industrial Subcommittee for this report. The subcommittee decided to flat line feedlot water use for the next 100 years with the exception of the addition of a large pig feeder that is planned for the Lower Gila Basin in about 10 years (2020). The new pig feeder is projected to include 300,000 pigs at 10 gallons per pig per day. Feedlot water demands are shown in Table 2.

Table 2. Projected Feedlot Demands by Basin

BASIN_NAME	2001-2005 Average Feedlot Water Demand (acre-feet)	2006 Feedlot Water Demand (acre-feet)	2010	2035	2060	2110
	GW	GW				
KANAB PLATEAU	0.15	0.15	0.15	0.15	0.15	0.15
LITTLE COLORADO RIVER PLATEAU	526	539.15	539	539	539	539
LOWER GILA	3,421	3,420.90	3,421	6,781	6,781	6,781
PHOENIX AMA	132	58.01	58	58	58	58
PINAL AMA	2,353	3,033	3,033	3,033	3,033	3,033
WILLCOX	130	130.40	130	130	130	130
Statewide	**6,562**	**7,181.61**	7,181.15	10,541.15	10,541.15	10,541.15

Other Industrial Water Demand

The “Other Industrial Water Demand” category includes demands not associated with power plants, mining, sand and gravel, turf facilities, feedlots and dairies. Examples could include water demands from paper mills and/or computer chip manufacturing facilities. After compiling the water demands and associated populations for corresponding years it was determined a correlation did not exist between the other industrial water demands and the population number associated with the year the demand occurred. Two different methods were employed to estimate future water demands for this category. First, it was determined that treating the annual demand as a random variable suggested the demand figures were normally distributed and by using statistical analysis, determines an approximate maximum water demand of 35,310 AF/year. Second, total manufacturing/industrial employment for 2005 in three counties (estimated by MAG, PAG, and CAAG) was compared to the average other industrial water demand for 2001-2005 to arrive at a water demand per subsector employee.

Using a projected manufacturing/industrial employment for 2030 of 713,174, water demand was estimated at 39,943 AF using 50 gallons per day per employee. The subcommittee recommendation for the three AMA Other Industrial Demand category is to increase the demand linearly from the 15,210 AF in 2006 to 40,000 AF in 2030 and then hold constant at 40,000 AF/year thereafter.

RESULTS

The results for the industrial water demand projections developed using the methodology described are di played in Table 3. Detailed tables that include individual subsector demand projections are provided in the Appendix.

Table 3. Projected Industrial Water Demand by Basin through 2110

BASIN NAME	2035 Low Range Census Split	2035 High Range Census Split	2060 Low Range Census Split	2060 High Range Census Split	2110 Low Range Census Split	2110 High Range Census Split	2110 Low Range Area Split	2110 High Range Area Split
AGUA FRIA	83	200	100	240	138	332	8,972	4,472
ARAVAIPA CANYON	1	1	1	2	1	2	5	11
BIG SANDY	13	31	16	39	22	54	82	198
BILL WILLIAMS	10,034	30,082	10,039	30,094	10,055	30,131	10,409	30,443
BONITA CREEK	0	0	0	0	0	1	11	25
BUTLER VALLEY	0	0	0	0	0	0	0	0
CIENEGA CREEK	337	589	346	609	363	651	354	630
COCONINO PLATEAU	75	179	90	215	124	298	143	344
DETRITAL VALLEY	14	33	17	41	24	57	32	76
DONNELLY WASH	0	0	0	0	39	95	39	95
DOUGLAS	209	711	248	804	342	1,030	325	989
DRIPPING SPRINGS WASH	1	3	1	3	2	4	46	110
DUNCAN VALLEY	322	348	325	355	333	374	335	379
GILA BEND	24,440	31,564	37,320	47,419	50,791	64,762	55,333	66,769
GRAND WASH	0	0	0	0	0	0	3	7
HARQUAHALA INA	925	1,165	1,663	2,091	2,222	2,801	2,566	3,087
HUALAPAI VALLEY	324	989	403	1,177	557	1,547	507	1,428
KANAB PLATEAU	90	177	105	215	135	286	150	323
LAKE HAVASU	541	1,510	687	1,861	1,243	2,731	1,236	2,716
LAKE MOHAVE	15,462	21,593	18,596	26,859	21,080	32,744	21,031	32,546
LITTLE COLORADO RIVER PLATEAU	120,446	161,794	141,244	198,669	157,091	237,016	157,079	236,981
LOWER GILA	13,458	31,904	23,058	41,788	33,852	52,831	35,830	53,794
LOWER SAN PEDRO	14,311	30,450	14,505	30,598	14,566	30,746	14,593	31,050
MCMULLEN VALLEY	39	93	47	112	63	152	93	223
MEADVIEW	8	20	10	25	14	34	2	6
MORENCI	12,099	48,132	12,102	48,141	12,113	48,166	12,117	48,177
PARIA	9,335	12,840	11,175	16,100	12,670	19,497	12,667	19,489
PARKER	5,965	7,735	10,307	13,195	13,597	17,387	13,591	17,372
PEACH SPRINGS	316	338	319	345	326	363	362	448
PHOENIX AMA	276,128	388,554	326,663	460,183	353,944	559,149	336,329	549,134
PINAL AMA	49,537	71,635	49,293	72,933	41,915	74,744	41,874	76,700
PRESCOTT AMA	2,541	4,155	2,986	4,806	3,484	6,210	3,319	5,694
RANEGRAS PLAIN	5	13	7	16	8	20	6	15
SACRAMENTO VALLEY	12,602	18,663	13,654	20,455	14,545	22,578	14,557	22,605
SAFFORD	5,667	28,008	5,703	28,095	5,810	28,352	5,808	28,348
SALT RIVER	27,798	44,188	27,900	44,383	28,039	44,708	28,094	44,841
SAN BERNARDINO VALLEY	0	1	1	1	1	2	17	41
SAN RAFAEL	1	2	1	3	1	3	6	15
SAN SIMON WASH	53	127	67	160	92	221	100	239
SANTA CRUZ AMA	1,962	2,756	2,484	3,093	2,652	3,861	2,660	3,913
SHIVWITS PLATEAU	0	0	0	0	0	0	24	57
TIGER WASH	0	0	0	0	0	0	16	38
TONTO CREEK	97	444	121	501	167	612	231	1,004
TUCSON AMA	58,987	106,239	63,210	112,113	65,587	123,775	67,195	123,694
UPPER HASSAYAMPA	892	1,041	917	1,101	968	1,222	846	929
UPPER SAN PEDRO	4,502	15,494	4,798	15,825	5,080	16,830	5,066	16,772
VERDE RIVER	4,860	9,385	5,616	9,906	5,970	11,460	6,021	11,757
VIRGIN RIVER	907	941	914	959	926	989	888	896
WESTERN MEXICAN DRAINAGE	0	0	0	1	0	1	4	9
WILLCOX	7,753	10,366	9,077	12,719	10,179	15,227	10,170	15,204
YUMA	5,251	8,193	6,349	10,040	7,574	12,782	7,560	12,745
STATEWIDE	688,391	1,092,688	802,486	1,258,290	878,706	1,466,837	878,706	1,466,837

APPENDIX

INDUSTRIAL SECTOR BASELINE WATER DEMAND TABLE

BASIN NAME	2006 Baseline							
	INDUSTRIAL							TOTAL
	Mining	Rock Products	Dairy	Feedlots	Power Plants[1]	Turf	Other Industrial	
AGUA FRIA	0	2	0	0	0	0	0	**2**
ARAVAIPA CANYON	0	0	0	0	0	0	0	**0**
BIG SANDY	14,717	40	0	0	0	0	0	**14,757**
BILL WILLIAMS	200	0	0	0	0	0	0	**200**
BONITA CREEK	0	0	0	0	0	0	0	**0**
BUTLER VALLEY	0	0	0	0	0	0	0	**0**
CIENEGA CREEK	0	1	0	0	0	0	0	**1**
COCONINO PLATEAU	0	0	0	0	0	0	0	**0**
DETRITAL VALLEY	0	0	0	0	0	0	0	**0**
DONNELLY WASH	0	0	0	0	0	0	0	**0**
DOUGLAS	0	0	0	0	0	0	0	**0**
DRIPPING SPRINGS WASH	0	0	0	0	0	0	0	**0**
DUNCAN VALLEY	0	0	93	0	0	211	0	**304**
GILA BEND	0	0	173	0	5,400	0	0	**5,573**
GRAND WASH	0	0	0	0	0	0	0	**0**
HARQUAHALA INA	0	0	0	0	1,107	0	0	**1,107**
HUALAPAI VALLEY	0	9	0	0	0	0	0	**9**
KANAB PLATEAU	0	0	27	0	0	0	0	**27**
LAKE HAVASU	0	60	0	0	0	0	0	**60**
LAKE MOHAVE	0	77	0	0	4,000	882	0	**4,959**
LITTLE COLORADO RIVER PLATEAU	1,201	331	20	539	63,200	1,716	11,766	**78,773**
LOWER GILA	0	0	246	3,421	0	0	0	**3,667**
LOWER SAN PEDRO	17,544	423	0	0	0	211	0	**18,177**
MCMULLEN VALLEY	0	0	0	0	0	0	0	**0**
MEADVIEW	0	0	0	0	0	0	0	**0**
MORENCI	8,109	0	0	0	0	75	0	**8,184**
PARIA	0	0	0	0	0	0	0	**0**
PARKER	0	0	0	0	0	0	0	**0**
PEACH SPRINGS	0	1	0	0	0	0	0	**1**
PHOENIX AMA	0	10,401	10,080	58	69,585	60,632	10,624	**161,381**
PINAL AMA	0	1,199	8,400	3,033	96	6,286	1,229	**20,243**
PRESCOTT AMA	0	126	0	0	0	793	567	**1,486**
RANEGRAS PLAIN	0	0	0	0	0	0	0	**0**
SACRAMENTO VALLEY	90	0	76	0	1,300	0	0	**1,465**
SAFFORD	44	192	0	0	0	423	0	**658**
SALT RIVER	15,448	395	0	0	0	211	0	**16,054**
SAN BERNARDINO VALLEY	0	0	0	0	0	0	0	**0**
SAN RAFAEL	0	0	0	0	0	0	0	**0**
SAN SIMON WASH	0	0	0	0	0	0	0	**0**
SANTA CRUZ AMA	0	195	0	0	0	1,482	98	**1,774**
SHIVWITS PLATEAU	0	0	0	0	0	0	0	**0**
TIGER WASH	0	0	0	0	0	0	0	**0**
TONTO CREEK	0	0	0	0	0	0	0	**0**
TUCSON AMA	34,905	3,807	110	0	2,656	8,249	3,357	**53,084**
UPPER HASSAYAMPA	0	0	786	0	0	0	0	**786**
UPPER SAN PEDRO	0	75	42	0	0	1,552	288	**1,957**
VERDE RIVER	0	1,180	0	0	0	3,087	0	**4,267**
VIRGIN RIVER	0	0	0	0	0	882	0	**882**
WESTERN MEXICAN DRAINAGE	0	0	0	0	0	0	0	**0**
WILLCOX	0	0	584	130	6,200	0	0	**6,914**
YUMA	0	238	0	0	658	441	1,178	**2,515**
STATEWIDE	**92,256**	**18,750**	**20,637**	**7,182**	**154,202**	**87,132**	**29,108**	**409,266**

[1] The power subsector believes 230,000 AF water demand had actually occurred by 2010. ADWR has indicated the 2006 water demand may be 16,000 AF less than actual.

INDUSTRIAL SECTOR SUMMARY WATER DEMAND PROJECTION TABLES

(Note: Small differences between table values may result from rounding)

BASIN NAME	2035 - WATER DEMAND PROJECTIONS (LOW RANGE - CENSUS)							
	INDUSTRIAL							TOTAL
	Mining	Rock Products	Dairy	Feedlots	Power Plants	Turf	Other Industrial	
AGUA FRIA	0	83	0	0	0	0	0	**83**
ARAVAIPA CANYON	0	1	0	0	0	0	0	**1**
BIG SANDY	0	13	0	0	0	0	0	**13**
BILL WILLIAMS	10,000	34	0	0	0	0	0	**10,034**
BONITA CREEK	0	0	0	0	0	0	0	**0**
BUTLER VALLEY	0	0	0	0	0	0	0	**0**
CIENEGA CREEK	300	37	0	0	0	0	0	**337**
COCONINO PLATEAU	0	75	0	0	0	0	0	**75**
DETRITAL VALLEY	0	14	0	0	0	0	0	**14**
DONNELLY WASH	0	0	0	0	0	0	0	**0**
DOUGLAS	0	208	0	0	1	0	0	**209**
DRIPPING SPRINGS WASH	0	1	0	0	0	0	0	**1**
DUNCAN VALLEY	0	18	93	0	0	211	0	**322**
GILA BEND	0	57	5,281	0	19,102	0	0	**24,440**
GRAND WASH	0	0	0	0	0	0	0	**0**
HARQUAHALA INA	0	7	0	0	918	0	0	**925**
HUALAPAI VALLEY	0	324	0	0	0	0	0	**324**
KANAB PLATEAU	0	63	27	0	0	0	0	**90**
LAKE HAVASU	0	541	0	0	0	0	0	**541**
LAKE MOHAVE	0	483	0	0	14,097	882	0	**15,462**
LITTLE COLORADO RIVER PLATEAU	1,500	1,871	20	539	103,034	1,716	11,766	**120,446**
LOWER GILA	0	83	5,281	6,781	1,313	0	0	**13,458**
LOWER SAN PEDRO	14,000	100	0	0	0	211	0	**14,311**
MCMULLEN VALLEY	0	39	0	0	0	0	0	**39**
MEADVIEW	0	8	0	0	0	0	0	**8**
MORENCI	12,000	24	0	0	0	75	0	**12,099**
PARIA	0	3	0	0	9,332	0	0	**9,335**
PARKER	300	102	0	0	5,563	0	0	**5,965**
PEACH SPRINGS	300	16	0	0	0	0	0	**316**
PHOENIX AMA	15,000	32,135	0	58	127,311	67,147	34,476	**276,128**
PINAL AMA	4,000	3,366	18,480	3,033	4,153	12,658	3,847	**49,537**
PRESCOTT AMA	0	1,056	0	0	16	902	567	**2,541**
RANEGRAS PLAIN	0	5	0	0	0	0	0	**5**
SACRAMENTO VALLEY	8,000	180	76	0	4,346	0	0	**12,602**
SAFFORD	5,000	244	0	0	0	423	0	**5,667**
SALT RIVER	27,000	167	0	0	420	211	0	**27,798**
SAN BERNARDINO VALLEY	0	0	0	0	0	0	0	**0**
SAN RAFAEL	0	1	0	0	0	0	0	**1**
SAN SIMON WASH	0	53	0	0	0	0	0	**53**
SANTA CRUZ AMA	0	344	0	0	38	1,482	98	**1,962**
SHIVWITS PLATEAU	0	0	0	0	0	0	0	**0**
TIGER WASH	0	0	0	0	0	0	0	**0**
TONTO CREEK	0	97	0	0	0	0	0	**97**
TUCSON AMA	39,000	7,136	0	0	2,925	8,249	1,677	**58,987**
UPPER HASSAYAMPA	0	106	786	0	0	0	0	**892**
UPPER SAN PEDRO	2,000	620	42	0	0	1,552	288	**4,502**
VERDE RIVER	1,000	773	0	0	0	3,087	0	**4,860**
VIRGIN RIVER	0	25	0	0	0	882	0	**907**
WESTERN MEXICAN DRAINAGE	0	0	0	0	0	0	0	**0**
WILLCOX	300	83	584	130	6,656	0	0	**7,753**
YUMA	0	1,536	0	0	2,061	476	1,178	**5,251**
STATEWIDE	**139,700**	**52,133**	**30,670**	**10,541**	**301,286**	**100,164**	**53,897**	**688,391**

BASIN NAME	2060 - WATER DEMAND PROJECTIONS (LOW RANGE - CENSUS)							
	INDUSTRIAL							TOTAL
	Mining	Rock Products	Dairy	Feedlots	Power Plants	Turf	Other Industrial	
AGUA FRIA	0	100	0	0	0	0	0	**100**
ARAVAIPA CANYON	0	1	0	0	0	0	0	**1**
BIG SANDY	0	16	0	0	0	0	0	**16**
BILL WILLIAMS	10,000	39	0	0	0	0	0	**10,039**
BONITA CREEK	0	0	0	0	0	0	0	**0**
BUTLER VALLEY	0	0	0	0	0	0	0	**0**
CIENEGA CREEK	300	46	0	0	0	0	0	**346**
COCONINO PLATEAU	0	90	0	0	0	0	0	**90**
DETRITAL VALLEY	0	17	0	0	0	0	0	**17**
DONNELLY WASH	0	0	0	0	0	0	0	**0**
DOUGLAS	0	246	0	0	2	0	0	**248**
DRIPPING SPRINGS WASH	0	1	0	0	0	0	0	**1**
DUNCAN VALLEY	0	21	93	0	0	211	0	**325**
GILA BEND	0	71	13,814	0	23,435	0	0	**37,320**
GRAND WASH	0	0	0	0	0	0	0	**0**
HARQUAHALA INA	0	11	0	0	1,652	0	0	**1,663**
HUALAPAI VALLEY	0	403	0	0	0	0	0	**403**
KANAB PLATEAU	0	78	27	0	0	0	0	**105**
LAKE HAVASU	0	687	0	0	0	0	0	**687**
LAKE MOHAVE	0	594	0	0	16,874	1,128	0	**18,596**
LITTLE COLORADO RIVER PLATEAU	1,500	2,216	20	539	123,332	1,870	11,766	**141,244**
LOWER GILA	0	99	13,814	6,781	2,364	0	0	**23,058**
LOWER SAN PEDRO	14,000	161	0	0	0	343	0	**14,505**
MCMULLEN VALLEY	0	47	0	0	0	0	0	**47**
MEADVIEW	0	10	0	0	0	0	0	**10**
MORENCI	12,000	27	0	0	0	75	0	**12,102**
PARIA	0	4	0	0	11,171	0	0	**11,175**
PARKER	300	113	0	0	9,894	0	0	**10,307**
PEACH SPRINGS	300	19	0	0	0	0	0	**319**
PHOENIX AMA	15,000	40,375	0	58	152,391	84,364	34,476	**326,663**
PINAL AMA	4,000	5,344	8,000	3,033	4,972	20,097	3,847	**49,293**
PRESCOTT AMA	0	1,295	0	0	19	1,105	567	**2,986**
RANEGRAS PLAIN	0	7	0	0	0	0	0	**7**
SACRAMENTO VALLEY	8,000	227	76	0	5,351	0	0	**13,654**
SAFFORD	5,000	280	0	0	0	423	0	**5,703**
SALT RIVER	27,000	187	0	0	502	211	0	**27,900**
SAN BERNARDINO VALLEY	0	1	0	0	0	0	0	**1**
SAN RAFAEL	0	1	0	0	0	0	0	**1**
SAN SIMON WASH	0	67	0	0	0	0	0	**67**
SANTA CRUZ AMA	0	423	0	0	46	1,917	98	**2,484**
SHIVWITS PLATEAU	0	0	0	0	0	0	0	**0**
TIGER WASH	0	0	0	0	0	0	0	**0**
TONTO CREEK	0	121	0	0	0	0	0	**121**
TUCSON AMA	39,000	8,840	0	0	3,502	10,191	1,677	**63,210**
UPPER HASSAYAMPA	0	131	786	0	0	0	0	**917**
UPPER SAN PEDRO	2,000	735	42	0	0	1,734	288	**4,798**
VERDE RIVER	1,000	925	0	0	0	3,691	0	**5,616**
VIRGIN RIVER	0	32	0	0	0	882	0	**914**
WESTERN MEXICAN DRAINAGE	0	0	0	0	0	0	0	**0**
WILLCOX	300	96	584	130	7,967	0	0	**9,077**
YUMA	0	1,882	0	0	2,705	584	1,178	**6,349**
STATEWIDE	**139,700**	**66,087**	**37,256**	**10,541**	**366,179**	**128,826**	**53,897**	**802,486**

BASIN NAME	2110 - WATER DEMAND PROJECTIONS (LOW RANGE - CENSUS)							
	INDUSTRIAL							TOTAL
	Mining	Rock Products	Dairy	Feedlots	Power Plants	Turf	Other Industrial	
AGUA FRIA	0	138	0	0	0	0	0	**138**
ARAVAIPA CANYON	0	1	0	0	0	0	0	**1**
BIG SANDY	0	22	0	0	0	0	0	**22**
BILL WILLIAMS	10,000	55	0	0	0	0	0	**10,055**
BONITA CREEK	0	0	0	0	0	0	0	**0**
BUTLER VALLEY	0	0	0	0	0	0	0	**0**
CIENEGA CREEK	300	63	0	0	0	0	0	**363**
COCONINO PLATEAU	0	124	0	0	0	0	0	**124**
DETRITAL VALLEY	0	24	0	0	0	0	0	**24**
DONNELLY WASH	0	39	0	0	0	0	0	**39**
DOUGLAS	0	340	0	0	2	0	0	**342**
DRIPPING SPRINGS WASH	0	2	0	0	0	0	0	**2**
DUNCAN VALLEY	0	29	93	0	0	211	0	**333**
GILA BEND	0	99	23,782	0	26,910	0	0	**50,791**
GRAND WASH	0	0	0	0	0	0	0	**0**
HARQUAHALA INA	0	20	0	0	2,202	0	0	**2,222**
HUALAPAI VALLEY	0	557	0	0	0	0	0	**557**
KANAB PLATEAU	0	108	27	0	0	0	0	**135**
LAKE HAVASU	0	951	0	0	0	292	0	**1,243**
LAKE MOHAVE	0	821	0	0	19,131	1,128	0	**21,080**
LITTLE COLORADO RIVER PLATEAU	0	3,065	20	539	139,831	1,870	11,766	**157,091**
LOWER GILA	0	137	23,782	6,781	3,152	0	0	**33,852**
LOWER SAN PEDRO	14,000	223	0	0	0	343	0	**14,566**
MCMULLEN VALLEY	0	63	0	0	0	0	0	**63**
MEADVIEW	0	14	0	0	0	0	0	**14**
MORENCI	12,000	38	0	0	0	75	0	**12,113**
PARIA	0	5	0	0	12,665	0	0	**12,670**
PARKER	300	153	0	0	13,144	0	0	**13,597**
PEACH SPRINGS	300	26	0	0	0	0	0	**326**
PHOENIX AMA	15,000	55,705	0	58	172,777	75,927	34,476	**353,944**
PINAL AMA	4,000	7,310	0	3,033	5,637	18,087	3,847	**41,915**
PRESCOTT AMA	0	1,790	0	0	22	1,105	567	**3,484**
RANEGRAS PLAIN	0	8	0	0	0	0	0	**8**
SACRAMENTO VALLEY	8,000	314	76	0	6,155	0	0	**14,545**
SAFFORD	5,000	387	0	0	0	423	0	**5,810**
SALT RIVER	27,000	259	0	0	569	211	0	**28,039**
SAN BERNARDINO VALLEY	0	1	0	0	0	0	0	**1**
SAN RAFAEL	0	1	0	0	0	0	0	**1**
SAN SIMON WASH	0	92	0	0	0	0	0	**92**
SANTA CRUZ AMA	0	585	0	0	52	1,917	98	**2,652**
SHIVWITS PLATEAU	0	0	0	0	0	0	0	**0**
TIGER WASH	0	0	0	0	0	0	0	**0**
TONTO CREEK	0	167	0	0	0	0	0	**167**
TUCSON AMA	39,000	12,381	0	0	3,970	8,560	1,677	**65,587**
UPPER HASSAYAMPA	0	182	786	0	0	0	0	**968**
UPPER SAN PEDRO	2,000	1,016	42	0	0	1,734	288	**5,080**
VERDE RIVER	1,000	1,279	0	0	0	3,691	0	**5,970**
VIRGIN RIVER	0	44	0	0	0	882	0	**926**
WESTERN MEXICAN DRAINAGE	0	0	0	0	0	0	0	**0**
WILLCOX	300	132	584	130	9,033	0	0	**10,179**
YUMA	0	2,603	0	0	3,209	584	1,178	**7,574**
STATEWIDE	**138,200**	**91,374**	**49,192**	**10,541**	**418,461**	**117,040**	**53,897**	**878,706**

BASIN NAME	2110 - WATER DEMAND PROJECTIONS (LOW RANGE - AREA SPLIT)							
	INDUSTRIAL							TOTAL
	Mining	Rock Products	Dairy	Feedlots	Power Plants	Turf	Other Industrial	
AGUA FRIA	0	1,863	0	0	0	7,109	0	**8,972**
ARAVAIPA CANYON	0	5	0	0	0	0	0	**5**
BIG SANDY	0	82	0	0	0	0	0	**82**
BILL WILLIAMS	10,000	184	0	0	0	225	0	**10,409**
BONITA CREEK	0	11	0	0	0	0	0	**11**
BUTLER VALLEY	0	0	0	0	0	0	0	**0**
CIENEGA CREEK	300	54	0	0	0	0	0	**354**
COCONINO PLATEAU	0	143	0	0	0	0	0	**143**
DETRITAL VALLEY	0	32	0	0	0	0	0	**32**
DONNELLY WASH	0	39	0	0	0	0	0	**39**
DOUGLAS	0	323	0	0	2	0	0	**325**
DRIPPING SPRINGS WASH	0	46	0	0	0	0	0	**46**
DUNCAN VALLEY	0	31	93	0	0	211	0	**335**
GILA BEND	0	935	23,782	0	26,910	3,706	0	**55,333**
GRAND WASH	0	3	0	0	0	0	0	**3**
HARQUAHALA INA	0	139	0	0	2,202	225	0	**2,566**
HUALAPAI VALLEY	0	507	0	0	0	0	0	**507**
KANAB PLATEAU	0	123	27	0	0	0	0	**150**
LAKE HAVASU	0	944	0	0	0	292	0	**1,236**
LAKE MOHAVE	0	772	0	0	19,131	1,128	0	**21,031**
LITTLE COLORADO RIVER PLATEAU	0	3,052	20	539	139,831	1,870	11,766	**157,079**
LOWER GILA	0	538	23,782	6,781	3,152	1,577	0	**35,830**
LOWER SAN PEDRO	14,000	250	0	0	0	343	0	**14,593**
MCMULLEN VALLEY	0	93	0	0	0	0	0	**93**
MEADVIEW	0	2	0	0	0	0	0	**2**
MORENCI	12,000	42	0	0	0	75	0	**12,117**
PARIA	0	2	0	0	12,665	0	0	**12,667**
PARKER	300	147	0	0	13,144	0	0	**13,591**
PEACH SPRINGS	300	62	0	0	0	0	0	**362**
PHOENIX AMA	15,000	52,565	0	58	172,777	61,454	34,476	**336,329**
PINAL AMA	4,000	7,270	0	3,033	5,637	18,087	3,847	**41,874**
PRESCOTT AMA	0	1,625	0	0	22	1,105	567	**3,319**
RANEGRAS PLAIN	0	6	0	0	0	0	0	**6**
SACRAMENTO VALLEY	8,000	326	76	0	6,155	0	0	**14,557**
SAFFORD	5,000	385	0	0	0	423	0	**5,808**
SALT RIVER	27,000	314	0	0	569	211	0	**28,094**
SAN BERNARDINO VALLEY	0	17	0	0	0	0	0	**17**
SAN RAFAEL	0	6	0	0	0	0	0	**6**
SAN SIMON WASH	0	100	0	0	0	0	0	**100**
SANTA CRUZ AMA	0	593	0	0	52	1,917	98	**2,660**
SHIVWITS PLATEAU	0	24	0	0	0	0	0	**24**
TIGER WASH	0	16	0	0	0	0	0	**16**
TONTO CREEK	0	231	0	0	0	0	0	**231**
TUCSON AMA	39,000	12,357	0	0	3,970	10,191	1,677	**67,195**
UPPER HASSAYAMPA	0	60	786	0	0	0	0	**846**
UPPER SAN PEDRO	2,000	1,003	42	0	0	1,734	288	**5,066**
VERDE RIVER	1,000	1,330	0	0	0	3,691	0	**6,021**
VIRGIN RIVER	0	6	0	0	0	882	0	**888**
WESTERN MEXICAN DRAINAGE	0	4	0	0	0	0	0	**4**
WILLCOX	300	123	584	130	9,033	0	0	**10,170**
YUMA	0	2,589	0	0	3,209	584	1,178	**7,560**
STATEWIDE	**138,200**	**91,374**	**49,192**	**10,541**	**418,461**	**117,040**	**53,897**	**878,706**

BASIN NAME	2035 - WATER DEMAND PROJECTIONS (HIGH RANGE - CENSUS)							
	INDUSTRIAL							TOTAL
	Mining	Rock Products	Dairy	Feedlots	Power Plants	Turf	Other Industrial	
AGUA FRIA	0	200	0	0	0	0	0	**200**
ARAVAIPA CANYON	0	1	0	0	0	0	0	**1**
BIG SANDY	0	31	0	0	0	0	0	**31**
BILL WILLIAMS	30,000	82	0	0	0	0	0	**30,082**
BONITA CREEK	0	0	0	0	0	0	0	**0**
BUTLER VALLEY	0	0	0	0	0	0	0	**0**
CIENEGA CREEK	500	89	0	0	0	0	0	**589**
COCONINO PLATEAU	0	179	0	0	0	0	0	**179**
DETRITAL VALLEY	0	33	0	0	0	0	0	**33**
DONNELLY WASH	0	0	0	0	0	0	0	**0**
DOUGLAS	0	498	0	0	2	211	0	**711**
DRIPPING SPRINGS WASH	0	3	0	0	0	0	0	**3**
DUNCAN VALLEY	0	44	93	0	0	211	0	**348**
GILA BEND	0	136	5,281	0	26,147	0	0	**31,564**
GRAND WASH	0	0	0	0	0	0	0	**0**
HARQUAHALA INA	0	18	0	0	1,147	0	0	**1,165**
HUALAPAI VALLEY	0	778	0	0	0	211	0	**989**
KANAB PLATEAU	0	150	27	0	0	0	0	**177**
LAKE HAVASU	0	1,299	0	0	0	211	0	**1,510**
LAKE MOHAVE	0	1,160	0	0	19,383	1,050	0	**21,593**
LITTLE COLORADO RIVER PLATEAU	1,500	4,490	20	539	141,672	1,806	11,766	**161,794**
LOWER GILA	18,000	200	5,281	6,781	1,642	0	0	**31,904**
LOWER SAN PEDRO	30,000	239	0	0	0	211	0	**30,450**
MCMULLEN VALLEY	0	93	0	0	0	0	0	**93**
MEADVIEW	0	20	0	0	0	0	0	**20**
MORENCI	48,000	57	0	0	0	75	0	**48,132**
PARIA	0	8	0	0	12,832	0	0	**12,840**
PARKER	300	245	0	0	6,979	211	0	**7,735**
PEACH SPRINGS	300	38	0	0	0	0	0	**338**
PHOENIX AMA	25,000	77,125	0	58	175,052	76,843	34,476	**388,554**
PINAL AMA	18,000	8,078	18,480	3,033	5,711	14,486	3,847	**71,635**
PRESCOTT AMA	0	2,535	0	0	22	1,032	567	**4,155**
RANEGRAS PLAIN	0	13	0	0	0	0	0	**13**
SACRAMENTO VALLEY	12,000	432	76	0	5,944	211	0	**18,663**
SAFFORD	27,000	585	0	0	0	423	0	**28,008**
SALT RIVER	43,000	400	0	0	577	211	0	**44,188**
SAN BERNARDINO VALLEY	0	1	0	0	0	0	0	**1**
SAN RAFAEL	0	2	0	0	0	0	0	**2**
SAN SIMON WASH	0	127	0	0	0	0	0	**127**
SANTA CRUZ AMA	0	824	0	0	52	1,781	98	**2,756**
SHIVWITS PLATEAU	0	0	0	0	0	0	0	**0**
TIGER WASH	0	0	0	0	0	0	0	**0**
TONTO CREEK	0	233	0	0	0	211	0	**444**
TUCSON AMA	74,000	17,126	0	0	4,022	9,414	1,677	**106,239**
UPPER HASSAYAMPA	0	255	786	0	0	0	0	**1,041**
UPPER SAN PEDRO	12,000	1,489	42	0	0	1,675	288	**15,494**
VERDE RIVER	4,000	1,855	0	0	0	3,530	0	**9,385**
VIRGIN RIVER	0	59	0	0	0	882	0	**941**
WESTERN MEXICAN DRAINAGE	0	0	0	0	0	0	0	**0**
WILLCOX	300	200	584	130	9,152	0	0	**10,366**
YUMA	0	3,686	0	0	2,784	545	1,178	**8,193**
STATEWIDE	**343,900**	**125,119**	**30,670**	**10,541**	**413,120**	**115,441**	**53,897**	**1,092,688**

BASIN NAME	2060 - WATER DEMAND PROJECTIONS (HIGH RANGE - CENSUS)							
	INDUSTRIAL							TOTAL
	Mining	Rock Products	Dairy	Feedlots	Power Plants	Turf	Other Industrial	
AGUA FRIA	0	240	0	0	0	0	0	**240**
ARAVAIPA CANYON	0	2	0	0	0	0	0	**2**
BIG SANDY	0	39	0	0	0	0	0	**39**
BILL WILLIAMS	30,000	94	0	0	0	0	0	**30,094**
BONITA CREEK	0	0	0	0	0	0	0	**0**
BUTLER VALLEY	0	0	0	0	0	0	0	**0**
CIENEGA CREEK	500	109	0	0	0	0	0	**609**
COCONINO PLATEAU	0	215	0	0	0	0	0	**215**
DETRITAL VALLEY	0	41	0	0	0	0	0	**41**
DONNELLY WASH	0	0	0	0	0	0	0	**0**
DOUGLAS	0	590	0	0	3	211	0	**804**
DRIPPING SPRINGS WASH	0	3	0	0	0	0	0	**3**
DUNCAN VALLEY	0	51	93	0	0	211	0	**355**
GILA BEND	0	171	13,814	0	33,434	0	0	**47,419**
GRAND WASH	0	0	0	0	0	0	0	**0**
HARQUAHALA INA	0	26	0	0	2,065	0	0	**2,091**
HUALAPAI VALLEY	0	966	0	0	0	211	0	**1,177**
KANAB PLATEAU	0	188	27	0	0	0	0	**215**
LAKE HAVASU	0	1,650	0	0	0	211	0	**1,861**
LAKE MOHAVE	0	1,426	0	0	24,307	1,126	0	**26,859**
LITTLE COLORADO RIVER PLATEAU	1,500	5,319	20	539	177,657	1,867	11,766	**198,669**
LOWER GILA	18,000	238	13,814	6,781	2,955	0	0	**41,788**
LOWER SAN PEDRO	30,000	387	0	0	0	211	0	**30,598**
MCMULLEN VALLEY	0	112	0	0	0	0	0	**112**
MEADVIEW	0	25	0	0	0	0	0	**25**
MORENCI	48,000	66	0	0	0	75	0	**48,141**
PARIA	0	9	0	0	16,091	0	0	**16,100**
PARKER	300	272	0	0	12,412	211	0	**13,195**
PEACH SPRINGS	300	45	0	0	0	0	0	**345**
PHOENIX AMA	25,000	96,899	0	58	219,516	84,234	34,476	**460,183**
PINAL AMA	18,000	12,826	8,000	3,033	7,161	20,066	3,847	**72,933**
PRESCOTT AMA	0	3,107	0	0	28	1,103	567	**4,806**
RANEGRAS PLAIN	0	16	0	0	0	0	0	**16**
SACRAMENTO VALLEY	12,000	545	76	0	7,623	211	0	**20,455**
SAFFORD	27,000	672	0	0	0	423	0	**28,095**
SALT RIVER	43,000	449	0	0	723	211	0	**44,383**
SAN BERNARDINO VALLEY	0	1	0	0	0	0	0	**1**
SAN RAFAEL	0	3	0	0	0	0	0	**3**
SAN SIMON WASH	0	160	0	0	0	0	0	**160**
SANTA CRUZ AMA	0	1,015	0	0	66	1,914	98	**3,093**
SHIVWITS PLATEAU	0	0	0	0	0	0	0	**0**
TIGER WASH	0	0	0	0	0	0	0	**0**
TONTO CREEK	0	290	0	0	0	211	0	**501**
TUCSON AMA	74,000	21,217	0	0	5,044	10,175	1,677	**112,113**
UPPER HASSAYAMPA	0	315	786	0	0	0	0	**1,101**
UPPER SAN PEDRO	12,000	1,764	42	0	0	1,731	288	**15,825**
VERDE RIVER	4,000	2,220	0	0	0	3,686	0	**9,906**
VIRGIN RIVER	0	77	0	0	0	882	0	**959**
WESTERN MEXICAN DRAINAGE	0	1	0	0	0	0	0	**1**
WILLCOX	300	229	584	130	11,476	0	0	**12,719**
YUMA	0	4,518	0	0	3,761	583	1,178	**10,040**
STATEWIDE	**343,900**	**158,609**	**37,256**	**10,541**	**524,322**	**129,765**	**53,897**	**1,258,290**

BASIN NAME	2110 - WATER DEMAND PROJECTIONS HIGH RANGE - CENSUS)							
	INDUSTRIAL							TOTAL
	Mining	Rock Products	Dairy	Feedlots	Power Plants	Turf	Other Industrial	
AGUA FRIA	0	332	0	0	0	0	0	**332**
ARAVAIPA CANYON	0	2	0	0	0	0	0	**2**
BIG SANDY	0	54	0	0	0	0	0	**54**
BILL WILLIAMS	30,000	131	0	0	0	0	0	**30,131**
BONITA CREEK	0	1	0	0	0	0	0	**1**
BUTLER VALLEY	0	0	0	0	0	0	0	**0**
CIENEGA CREEK	500	151	0	0	0	0	0	**651**
COCONINO PLATEAU	0	298	0	0	0	0	0	**298**
DETRITAL VALLEY	0	57	0	0	0	0	0	**57**
DONNELLY WASH	0	95	0	0	0	0	0	**95**
DOUGLAS	0	816	0	0	3	211	0	**1,030**
DRIPPING SPRINGS WASH	0	4	0	0	0	0	0	**4**
DUNCAN VALLEY	0	70	93	0	0	211	0	**374**
GILA BEND	0	237	23,782	0	40,743	0	0	**64,762**
GRAND WASH	0	0	0	0	0	0	0	**0**
HARQUAHALA INA	0	48	0	0	2,753	0	0	**2,801**
HUALAPAI VALLEY	0	1,336	0	0	0	211	0	**1,547**
KANAB PLATEAU	0	259	27	0	0	0	0	**286**
LAKE HAVASU	0	2,281	0	0	0	450	0	**2,731**
LAKE MOHAVE	0	1,972	0	0	29,431	1,341	0	**32,744**
LITTLE COLORADO RIVER PLATEAU	0	7,355	20	539	215,112	2,225	11,766	**237,016**
LOWER GILA	18,000	328	23,782	6,781	3,940	0	0	**52,831**
LOWER SAN PEDRO	30,000	535	0	0	0	211	0	**30,746**
MCMULLEN VALLEY	0	152	0	0	0	0	0	**152**
MEADVIEW	0	34	0	0	0	0	0	**34**
MORENCI	48,000	91	0	0	0	75	0	**48,166**
PARIA	0	13	0	0	19,484	0	0	**19,497**
PARKER	300	368	0	0	16,508	211	0	**17,387**
PEACH SPRINGS	300	63	0	0	0	0	0	**363**
PHOENIX AMA	25,000	133,693	0	58	265,795	100,127	34,476	**559,149**
PINAL AMA	18,000	17,545	0	3,033	8,671	23,648	3,847	**74,744**
PRESCOTT AMA	0	4,296	0	0	33	1,314	567	**6,210**
RANEGRAS PLAIN	0	20	0	0	0	0	0	**20**
SACRAMENTO VALLEY	12,000	754	76	0	9,298	450	0	**22,578**
SAFFORD	27,000	929	0	0	0	423	0	**28,352**
SALT RIVER	43,000	621	0	0	876	211	0	**44,708**
SAN BERNARDINO VALLEY	0	2	0	0	0	0	0	**2**
SAN RAFAEL	0	3	0	0	0	0	0	**3**
SAN SIMON WASH	0	221	0	0	0	0	0	**221**
SANTA CRUZ AMA	0	1,404	0	0	80	2,280	98	**3,861**
SHIVWITS PLATEAU	0	0	0	0	0	0	0	**0**
TIGER WASH	0	0	0	0	0	0	0	**0**
TONTO CREEK	0	401	0	0	0	211	0	**612**
TUCSON AMA	74,000	29,714	0	0	6,107	12,277	1,677	**123,775**
UPPER HASSAYAMPA	0	436	786	0	0	0	0	**1,222**
UPPER SAN PEDRO	12,000	2,439	42	0	0	2,062	288	**16,830**
VERDE RIVER	4,000	3,069	0	0	0	4,390	0	**11,460**
VIRGIN RIVER	0	107	0	0	0	882	0	**989**
WESTERN MEXICAN DRAINAGE	0	1	0	0	0	0	0	**1**
WILLCOX	300	317	584	130	13,896	0	0	**15,227**
YUMA	0	6,246	0	0	4,663	695	1,178	**12,782**
STATEWIDE	**342,400**	**219,299**	**49,192**	**10,541**	**637,393**	**154,115**	**53,897**	**1,466,837**

BASIN NAME	2110 - WATER DEMAND PROJECTIONS (HIGH RANGE - AREA SPLIT)							
	INDUSTRIAL							TOTAL
	Mining	Rock Products	Dairy	Feedlots	Power Plants	Turf	Other Industrial	
AGUA FRIA	0	4,472	0	0	0	0	0	**4,472**
ARAVAIPA CANYON	0	11	0	0	0	0	0	**11**
BIG SANDY	0	198	0	0	0	0	0	**198**
BILL WILLIAMS	30,000	443	0	0	0	0	0	**30,443**
BONITA CREEK	0	25	0	0	0	0	0	**25**
BUTLER VALLEY	0	0	0	0	0	0	0	**0**
CIENEGA CREEK	500	130	0	0	0	0	0	**630**
COCONINO PLATEAU	0	344	0	0	0	0	0	**344**
DETRITAL VALLEY	0	76	0	0	0	0	0	**76**
DONNELLY WASH	0	95	0	0	0	0	0	**95**
DOUGLAS	0	775	0	0	3	211	0	**989**
DRIPPING SPRINGS WASH	0	110	0	0	0	0	0	**110**
DUNCAN VALLEY	0	75	93	0	0	211	0	**379**
GILA BEND	0	2,244	23,782	0	40,743	0	0	**66,769**
GRAND WASH	0	7	0	0	0	0	0	**7**
HARQUAHALA INA	0	334	0	0	2,753	0	0	**3,087**
HUALAPAI VALLEY	0	1,217	0	0	0	211	0	**1,428**
KANAB PLATEAU	0	296	27	0	0	0	0	**323**
LAKE HAVASU	0	2,266	0	0	0	450	0	**2,716**
LAKE MOHAVE	0	1,854	0	0	29,431	1,261	0	**32,546**
LITTLE COLORADO RIVER PLATEAU	0	7,326	20	539	215,112	2,219	11,766	**236,981**
LOWER GILA	18,000	1,291	23,782	6,781	3,940	0	0	**53,794**
LOWER SAN PEDRO	30,000	600	0	0	0	450	0	**31,050**
MCMULLEN VALLEY	0	223	0	0	0	0	0	**223**
MEADVIEW	0	6	0	0	0	0	0	**6**
MORENCI	48,000	102	0	0	0	75	0	**48,177**
PARIA	0	5	0	0	19,484	0	0	**19,489**
PARKER	300	353	0	0	16,508	211	0	**17,372**
PEACH SPRINGS	300	148	0	0	0	0	0	**448**
PHOENIX AMA	25,000	126,155	0	58	265,795	97,650	34,476	**549,134**
PINAL AMA	18,000	17,447	0	3,033	8,671	25,702	3,847	**76,700**
PRESCOTT AMA	0	3,900	0	0	33	1,193	567	**5,694**
RANEGRAS PLAIN	0	15	0	0	0	0	0	**15**
SACRAMENTO VALLEY	12,000	781	76	0	9,298	450	0	**22,605**
SAFFORD	27,000	925	0	0	0	423	0	**28,348**
SALT RIVER	43,000	754	0	0	876	211	0	**44,841**
SAN BERNARDINO VALLEY	0	41	0	0	0	0	0	**41**
SAN RAFAEL	0	15	0	0	0	0	0	**15**
SAN SIMON WASH	0	239	0	0	0	0	0	**239**
SANTA CRUZ AMA	0	1,423	0	0	80	2,311	98	**3,913**
SHIVWITS PLATEAU	0	57	0	0	0	0	0	**57**
TIGER WASH	0	38	0	0	0	0	0	**38**
TONTO CREEK	0	554	0	0	0	450	0	**1,004**
TUCSON AMA	74,000	29,657	0	0	6,107	12,253	1,677	**123,694**
UPPER HASSAYAMPA	0	143	786	0	0	0	0	**929**
UPPER SAN PEDRO	12,000	2,407	42	0	0	2,035	288	**16,772**
VERDE RIVER	4,000	3,192	0	0	0	4,565	0	**11,757**
VIRGIN RIVER	0	14	0	0	0	882	0	**896**
WESTERN MEXICAN DRAINAGE	0	9	0	0	0	0	0	**9**
WILLCOX	300	294	584	130	13,896	0	0	**15,204**
YUMA	0	6,213	0	0	4,663	691	1,178	**12,745**
STATEWIDE	**342,400**	**219,299**	**49,192**	**10,541**	**637,393**	**154,116**	**53,897**	**1,466,837**

COMMITTEE MEMBERS/AFFILLIATION

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Val Danos, Arizona Municipal Water Users Association

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APPENDIX 4

MUNICIPAL DEMAND SUBCOMITTEE REPORT

WRDC Municipal Demand Subcommittee Report

By: Christine Nunez, City of Surprise, email: Christine.Nunez@surpriseaz.gov

Stu Spaulding, Town of Taylor, email: stuspaulding@cableone.net

INTRODUCTION

The Municipal Demand Subcommittee was tasked with providing the following information to the Water Supply and Demand Committee: (1) current municipal demand (2010) by basin with the term "municipal" meaning water (groundwater, surface water or effluent) for people including water delivered for non-residential uses by water providers and domestic use from wells; (2) 25-year municipal demand by basin; (3) 50-year municipal demand by basin; and (4) 100-year municipal demand.

METHODS

Baseline Data

The municipal demand subcommittee had two potential sources of data to utilize for developing baseline municipal demand outside the Active Management Areas (AMA): (1) annual reports filed by Community Water Systems (CWS); and (2) water demand information found within the Arizona Water Atlas (Atlas). The earliest year information is available based on CWS annual reports is 2006 and the last year of data published in the Arizona Water Atlas was 2005. Baseline municipal demand inside the AMAs was available from the Draft Demand and Supply Assessments (Assessment) being compiled for each AMA. Although the final draft Assessments have not been published for all AMAs, historical data for each AMA (through 2006) had been published.

The subcommittee decided that a gross gallons per capita per day (GPCD) value would be calculated for each basin. This was not a unanimous decision of the subcommittee, but was a majority decision. The gross GPCD would be calculated using total municipal demand and total population. The subcommittee recognized that more extensive GPCD information was available within the AMAs, however, it was decided that the GPCD calculation would be done the same way for both AMA and non-AMA basins.

For the non-AMA areas, subcommittee members analyzed the two available data sets and concluded that the 2005 data from the Atlas would be the best source for obtaining baseline municipal demand and population data to develop GPCD values. Municipal population and demand data for 2005 was obtained from the Assessments. Baseline data for both non-AMA and AMA basins and the gross GPCD calculated from that data is presented in Table 1.

Table 1. Baseline Demand, Population and Gallons per capita per Day (GPCD) Data

Basin	2005 Demand (AF)	2005 Population	2005 GPCD
Agua Fria	1,800	10,389	155
Aravaipa Canyon	14	140	89
Big Sandy	271	1,423	170
Bill Williams	1,250	5,482	204
Bonita Creek[1,2]	No data	23	140
Butler Valley	3	15	179
Cienega Creek	600	4,880	110
Coconino Plateau	1,170	11,525	91
Detrital Valley	309	2,142	129
Donnelly Wash	19	185	92
Douglas Basin	5,300	28,911	164
Douglas INA[3]	-	-	164
Dripping Springs Wash	11	186	53
Duncan Valley	550	3,683	133
Gila Bend	750	6,415	104
Grand Wash	2	15	119
Harquahala INA	128	780	147
Hualapai Valley	9,100	40,539	200
Joseph City INA[4]	-	-	139
Kanab Plateau[5]	2,500	8,077	276
Lake Havasu	16,070	56,192	255
Lake Mohave	21,920	58,404	335
Little Colorado River Plateau	42,800	274,386	139
Lower Gila	2,020	12,594	143
Lower San Pedro	2,750	18,710	131
McMullen Valley	500	3,991	112
Meadview	145	1,000	129
Morenci	2,200	5,066	388
Paria	120	547	196
Parker	4,520	17,137	235
Peach Springs	350	2,228	140
Phoenix AMA[6]	1,060,995	3,650,464	260
Pinal AMA[6]	30,485	136,130	200
Prescott AMA[6]	17,550	112,641	139
Ranegras Plain	350	978	319
Sacramento Valley	2,300	22,192	183[7]
Safford	7,300	45,110	144
Salt River	4,320	30,299	127
San Bernardino Valley	19	74	229

Basin	2005 Demand (AF)	2005 Popu-lation	2005 GPCD
San Rafael	22	158	124
San Simon Wash	1,000	7,119	125
Santa Cruz AMA[6]	8,500	47,424	160
Shivwits Plateau	2	12	149
Tiger Wash	2	5	357
Tonto Creek	2,700	9,032	267
Tucson AMA[6]	185,769	952,670	174
Upper Hassayampa	2,500	11,414	196
Upper San Pedro	18,480	87,671	188
Verde River	16,560	101,898	145
Virgin River	300	1,860	144
Western Mexican Drainage	6	38	141
Willcox	3,160	13,862	204
Yuma	44,960	181,600	221

[1]Bonita Creek demand is so small that there was no 2005 Atlas demand value. A GPCD value of 140 was selected by the subcommittee.

[2] Water withdrawn in this basin is transported to the Safford Basin and is counted there.

[3] In the Atlas, Douglas and the Douglas INA are combined.

[4] In the Atlas, the Joseph City INA and the Little Colorado River Plateau are combined.

[5] Any deliveries from Utah for municipal use are not included in demand.

[6] AMA population and demand data obtained from Assessment.

[7] GPCD value adjusted due to transfer nature of water/ pattern of water use in Kingman area.

The 2005 Atlas municipal demand data included groundwater, surface water and effluent and included Indian populations and demands, where applicable. The methodology utilized in the Atlas to derive the demand and population data can be found in the Atlas and in Tadayon (2004).

The 2005 data obtained from the Assessment historical templates includes municipal demand met by groundwater, surface water and effluent supplies, and also includes Indian populations and demands, where applicable. The methodology utilized in deriving the Assessment data is described in each individual AMA Assessment. The footnotes to Table 1 describe any unique data issues that were encountered. The issue regarding the Sacramento Basin GPCD is further described in Appendix A to this report.

Projecting Future Municipal Demand

The subcommittee recognized that forecasting municipal, or any other demand, over a 100-year time period is not a simple endeavor. There are many uncertainties and very few variables that can be evaluated with any degree of confidence. The subcommittee discussed the innumerable factors that could impact municipal demand in the future, including but not limited to, the following: water conservation; growth patterns in rural versus more urban areas; conversion of rural areas to areas with more urban characteristics; changing patterns of effluent utilization; structural efficiency improvements; and changes in residential versus the non-residential component of municipal demand. Although the subcommittee recognized that a "one-size-fits-all" approach may be problematic, it was the only one reasonable to be used within the time constraints of this study. Consequently, the subcommittee decided that all basins would be treated equally with respect to the assumptions utilized to project future municipal demand.

The analysis method that was selected is not a substitute, and is not intended to be a substitute, for a water provider based analysis that could take into account the following significant variables: present and projected land use; population demographics; future economic and industrial development; weather patterns and climate; and socioeconomic factors. Additionally, the results that are derived from this analysis are not intended to be used for any regulatory purposes. Any use of them in that manner would be contrary to the intent of the subcommittee.

The subcommittee considered two different demand constrained projections, however, subcommittee members had a number of issues with the results. Consequently, the subcommittee decided to simply apply the 2005 GPCDs against the mid-range population projection into the future with no modification. For the period 2010-2060, the mid-range Census-Split population projections were used for this purpose. For the period 2060-2110, the mid-range Census-Split was used but an alternative where the 2060-2110 demand based on the mid-range Area-Split population was also developed.

RESULTS

The results for the municipal demand projections developed using the methodology described above are displayed in Table 2.

Table 2. Projected Municipal Demand by Basin through 2110

Basin	2035 Demand (AF)	2060 Demand (AF)	2110[1] Demand (AF)	2110[2] Demand (AF)
Agua Fria	2,888	3,471	4,800	64,732
Aravaipa Canyon	12	14	19	93
Big Sandy	496	619	856	3,149
Bill Williams	1,564	1,790	2,505	8,431
Bonita Creek	5	6	8	332
Butler Valley	0	0	0	0
Cienega Creek	918	1,123	1,552	1,341
Coconino Plateau	1,521	1,827	2,526	2,919
Detrital Valley	397	494	682	919
Donnelly Wash	0	0	811	811
Douglas Basin	668	766	1,059	1,593
Douglas INA	6,964	8,276	11,443	10,280
Dripping Springs Wash	14	16	22	542
Duncan Valley	546	635	878	942
Gila Bend	1,332	1,672	2,312	21,922
Grand Wash	0	0	0	77
Harquahala INA	245	354	652	4,576
Hualapai Valley	14,595	18,122	25,056	22,824
Joseph City INA	210	221	305	185
Kanab Plateau	3,885	4,852	6,708	7,651
Lake Havasu	31,036	39,425	54,511	54,153

Basin	2035 Demand (AF)	2060 Demand (AF)	2110[1] Demand (AF)	2110[2] Demand (AF)
Lake Mohave	36,384	44,715	61,825	58,124
Little Colorado River Plateau	58,523	69,327	95,854	95,477
Lower Gila	2,676	3,184	4,402	17,301
Lower San Pedro	2,937	4,756	6,576	7,372
McMullen Valley	970	1,173	1,588	2,339
Meadview	243	302	417	68
Morenci	2,051	2,378	3,288	3,683
Paria	148	167	231	83
Parker	5,391	5,993	8,111	7,788
Peach Springs	494	597	825	1,945
Phoenix AMA	1,876,700	2,357,875	3,253,190	3,069,776
Pinal AMA	151,212	240,081	328,407	326,579
Prescott AMA	32,994	40,447	55,923	50,774
Ranegras Plain	392	482	595	441
Sacramento Valley	7,403	9,342	12,917	13,382
Safford	7,914	9,085	12,561	12,503
Salt River	4,762	5,347	7,394	8,977
San Bernardino Valley	25	27	37	889
San Rafael	25	29	41	170
San Simon Wash	1,489	1,873	2,590	2,805
Santa Cruz AMA	12,347	15,204	21,022	21,314
Shivwits Plateau	2	3	4	796
Tiger Wash	0	0	0	1,269
Tonto Creek	5,821	7,235	10,003	13,836
Tucson AMA	278,695	345,271	483,537	482,607
Upper Hassayampa	4,659	5,768	7,975	2,616
Upper San Pedro	26,226	31,062	42,947	42,386
Verde River	25,190	30,143	41,677	43,336
Virgin River	798	1,039	1,437	195
Western Mexican Drainage	6	8	11	119
Willcox	3,816	4,366	6,037	5,601
Yuma	76,244	93,451	129,209	128,514
STATEWIDE TOTAL	**2,693,625**	**3,414,190**	**4,717,032**	**4,630,352**

[1] Projected demand using the Census-Split Methodology

[2] Projected demand using the Area-Split Methodology

CONCLUSIONS

The Municipal Demand Subcommittee recognizes that time and resources impacted their ability to incorporate other factors that could impact future municipal demand into the projections. To that end, the subcommittee developed a list of bin items. The items listed in the bin are either items that may have provided more refined results had there been information or time available, or recommendations that the subcommittee makes for future areas of research. The bin items are as follows:

1. Additional information regarding tribal populations and tribal demands
2. Effluent use, variability, increasing use in certain areas
3. Need to obtain more accurate, reliable, real-time data for non-AMA areas
4. Development of a database to input new data into
5. Effects of conservation on both existing and new populations
6. Analysis of CWS data and annual reports

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APPENDIX 5

WRDC WATER SUPPLY SUBCOMMITTEE REPORT

WRDC Supply Subcommittee Report

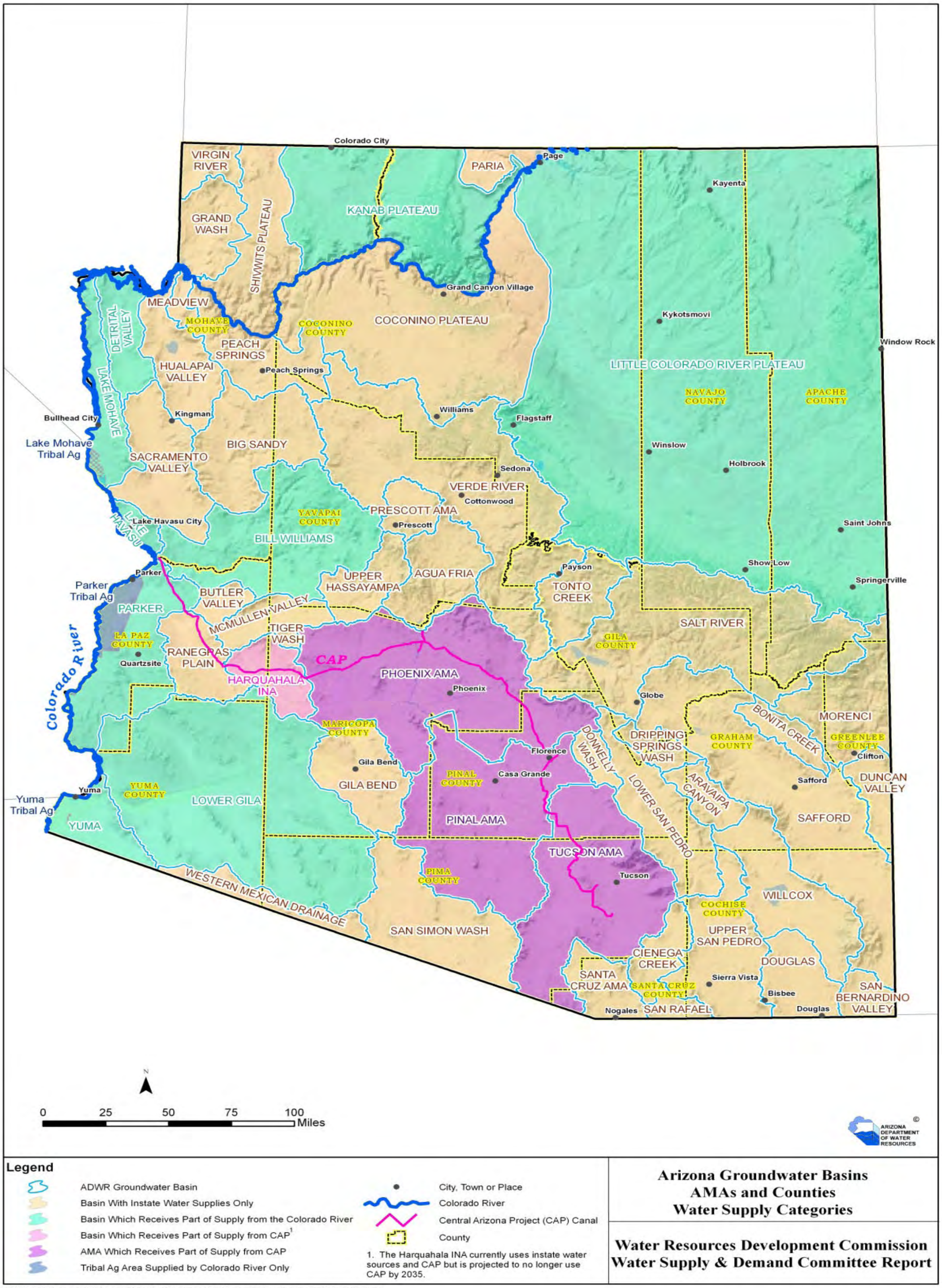
Introduction

The Supply Subcommittee's objective was to provide water supply data to the Water Supply and Demand Committee for the years 2035, 2060 and 2110 for groundwater basins and the Active Management Areas (AMAs). The Supply Subcommittee's task was determining the volume of a baseline supply representing recent conditions that is anticipated to be available in the future. A baseline water supply was determined based on the four categories of water currently available including: (1) Groundwater; (2) Instate Surface Water Diversions; (3) Effluent; and (4) Colorado River and Central Arizona Project (CAP) water. The methodology and assumptions used to determine the volume of each category of water for the baseline conditions and years 2035, 2060, and 2110 are provided.

Baseline Supply For Future Projection

The Baseline Supply for Future Projection dataset was developed to show the baseline supply for Arizona by sources of water by groundwater basin or AMA. The sources of water include groundwater, instate surface water diversions, effluent, Colorado River and CAP. The values were taken from the Arizona Water Atlas outside the AMAs. Values within the AMAs came from the AMA Assessments. Non-AMA Groundwater Basins, the Santa Cruz and Prescott AMA and the Phoenix, Pinal and Tucson AMAs were addressed separately. Since some basins utilize only instate supplies while others use Colorado River or CAP supplies, the basins/AMAs are often grouped in the presentation of supply and demand information by these supply categories. Figure 1 depicts these supply categories as they pertain to the groundwater basins and AMAs. The supply was equivalent to the demand in the baseline condition. In general, the baseline supply was determined by identifying the sources of water used to meet the demand in the baseline condition using the best available data.

Non-AMA Groundwater Basins: The Arizona Water Atlas provided the volume of groundwater, surface water and effluent necessary to meet agriculture, municipal, and industrial demands for the baseline condition. However, the volume of Colorado River Water used to meet demands in those basins where entitlements exist was included in the surface water and/or groundwater values in the Arizona Water Atlas. The Colorado River Water supply was treated as a separate supply in this analysis to provide a more accurate representation of the water supply within Arizona. Therefore; individual contract holders' reported diversions, return flows and consumptive use volumes were reviewed to determine how much of the demand was supplied by water from the Colorado River. Corresponding adjustments were made to the groundwater and instate surface water supplies.



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Phoenix, Pinal and Tucson Active Management Areas (AMAs): The AMA assessments provided the volume of groundwater, surface water, effluent and CAP water necessary to meet agriculture, municipal, and industrial demands for the baseline condition in the Phoenix, Pinal, and Tucson AMAs. The Groundwater In-Lieu reported in the assessments is actually CAP water applied to agriculture to save groundwater for which a portion of it is considered to replenish the aquifer and create storage credits. Tribal demands in the Phoenix, Pinal and Tucson AMAs include agriculture, municipal and industrial. Those demands were separated out into their sectors to assure that Tribal supplies are available for only Tribal demands. Due to the complexity of allocating water supplies within the Phoenix, Pinal and Tucson AMAs, the subcommittee decided to use the Central Arizona Model (CAM). The CAM has the capability to project available surface water, groundwater, effluent and other supply categories based on existing regulations and priorities. It models multiple interrelationships between supply, demand and storage categories to incorporate category-specific restrictions on water use and availability, express demands on CAP pools and project demand for new imported supplies. It can account for earned storage credits, distribute CAP through the major AMAs based on Colorado River assumptions, and insure that Tribal supplies are used exclusively for Tribal demands. The CAM also provided tribal agricultural demand projections within the major AMAs. Therefore, the CAM was used to determine future available supplies within the major AMAs.

Due to the complex accounting and assumptions involved, earned storage credits in the AMA's, stored for non-AMA users, were not included in the supply calculations for the basins where stored.

Groundwater: The values used are from 2006 Atlas data which represented the most complete data set with the exception of the Municipal sector where the 2005 Atlas data set was considered the best available data. Where applicable, a mixture of 2005/2006 data are provided due to the Municipal Subcommittee's choice of 2005 as their baseline year. The subcommittee assumed that the groundwater supply available in the baseline condition will be available in the years 2035, 2060, and 2110 (See Table 1) outside AMAs. In the AMAs, the CAM produced a low and high groundwater supply that corresponded to the low and high industrial demands, however if that value exceeded the baseline volume, the baseline volume was used in this analysis. If the CAM groundwater value was less than the volume of groundwater currently developed, the CAM value was used to incorporate anticipated restrictions on groundwater usage in the AMAs due to the complex regulatory framework. Development of additional groundwater supply is addressed in the unmet demand analysis.

Table 1. Baseline Groundwater Available in the Future (Acre-Feet)

BASIN_NAME	GW (c. 2006)
AGUA FRIA	3,602
ARAVAIPA CANYON	514
BIG SANDY	15,028
BILL WILLIAMS	3,251
BONITA CREEK	0
BUTLER VALLEY	14,503
CIENEGA CREEK	1,101
COCONINO PLATEAU	500
DETRITAL VALLEY	159
DONNELLY WASH	19
DOUGLAS	53,300
DRIPPING SPRINGS WASH	11
DUNCAN VALLEY	8,054
GILA BEND	295,323
GRAND WASH	2
HARQUAHALA INA	66,178
HUALAPAI VALLEY	9,109
KANAB PLATEAU	2,799
LAKE HAVASU	47
LAKE MOHAVE	2,007
LITTLE COLORADO RIVER PLATEAU	95,812
LOWER GILA	110,296
LOWER SAN PEDRO	23,677
MCMULLEN VALLEY	71,500
MEADVIEW	145
MORENCI	9,126
PARIA	120
PARKER	1,787
PEACH SPRINGS	351
PHOENIX AMA	673,754
PINAL AMA	431,290
PRESCOTT AMA	17,679
RANEGRAS PLAIN	29,350
SACRAMENTO VALLEY	3,765
SAFFORD	87,958
SALT RIVER	12,611
SAN BERNARDINO VALLEY	19
SAN RAFAEL	22
SAN SIMON WASH	1,500
SANTA CRUZ AMA	20,980
SHIVWITS PLATEAU	2
TIGER WASH	2
TONTO CREEK	3,000
TUCSON AMA	216,997
UPPER HASSAYAMPA	3,286
UPPER SAN PEDRO	23,957
VERDE RIVER	28,549
VIRGIN RIVER	1,585
WESTERN MEXICAN DRAINAGE	6
WILLCOX	175,714
YUMA	108,570
STATEWIDE	**2,628,916**

1. Non-AMA data from 2006/2005 Atlas

2. AMA 2006 Groundwater demand from AMA Assessments (includes all demands identified as “Groundwater”)

Instate Surface Water Diversion: The baseline instate surface water diversions for future projection represents average diversions from 2001-2006 in the non-AMA basins. Due to the variability inherent in instate surface water diversions, an average value provides a better representation of future availability. The subcommittee decided that the baseline instate surface water diversions should be reduced by 5% in 2035 and 10% in 2060 and 2010 to accommodate for potential stress to surface water diversions due to drought and/or potential climate change (See Table 2). In the AMAs, the instate surface water supplies from the CAM were used in this analysis. Development of additional instate surface water supply is addressed in the unmet demand analysis.

Table 2. Instate Surface Diversions (Baseline Year, 2035, 2060 and 2110 in Acre-Feet)

	BASIN NAME	Baseline For Projection 1: 2001-2006 Six Year Ave		
		Baseline	2035 (-5%)	2060+ (-10%)
Instate Water Supplies Only	AGUA FRIA	0	0	0
	ARAVAIPA CANYON	500	475	450
	BIG SANDY	0	0	0
	BONITA CREEK	0	0	0
	BUTLER VALLEY	0	0	0
	CIENEGA CREEK	0	0	0
	COCONINO PLATEAU	358	340	323
	DONNELLY WASH	0	0	0
	DOUGLAS	0	0	0
	DRIPPING SPRINGS WASH	0	0	0
	DUNCAN VALLEY	9,900	9,405	8,910
	GILA BEND	55,417	52,646	49,875
	GRAND WASH	0	0	0
	HUALAPAI VALLEY	0	0	0
	LOWER SAN PEDRO	833	792	750
	MCMULLEN VALLEY	0	0	0
	MEADVIEW	0	0	0
	MORENCI	1,627	1,545	1,464
	PARIA	0	0	0
	PEACH SPRINGS	0	0	0
	PRESCOTT AMA	2,067	1,963	1,860
	RANEGRAS PLAIN	0	0	0
	SACRAMENTO VALLEY	0	0	0
	SAFFORD	74,183	70,474	66,765
	SALT RIVER	12,011	11,410	10,810
	SAN BERNARDINO VALLEY	0	0	0
	SAN RAFAEL	0	0	0
	SAN SIMON WASH	0	0	0
	SANTA CRUZ AMA	0	0	0
	SHIVWITS PLATEAU	0	0	0
	TIGER WASH	0	0	0
	TONTO CREEK	1,000	950	900
	UPPER HASSAYAMPA	0	0	0
	UPPER SAN PEDRO	4,450	4,228	4,005
	VERDE RIVER	16,494	15,669	14,845
	VIRGIN RIVER	1,618	1,537	1,457
	WESTERN MEXICAN DRAINAGE	0	0	0
	WILLCOX	150	143	135
Basins Which Receive Part of their Supply from the Colorado River or CAP		Baseline For Projection 1: 2001-2006 Six Year Ave		
		Baseline	2035 (-5%)	2060+ (-10%)
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	14,717	13,981	13,246
Instate + CR Lower Mainstem	BILL WILLIAMS	500	475	450
	DETRITAL VALLEY	50	48	45
	KANAB PLATEAU	800	760	720
	LAKE HAVASU	0	0	0
	LAKE MOHAVE	0	0	0
	Lake Mohave (Tribal Ag)	0	0	0
	LOWER GILA	473	450	426
	PARKER	0	0	0
	Parker (Tribal Ag)	0	0	0
	YUMA	973	924	875
	Yuma (Tribal Ag)	0	0	0
Instate + CAP	HARQUAHALA INA	0	0	0
	Major Active Management Areas (AMAs)	Baseline	2035 (CAM)	2060+ (CAM)
	PHOENIX AMA	727,402	702,362	665,395
	PINAL AMA	73,830	66,443	62,946
	TUCSON AMA	506	466	441
STATEWIDE		999,860	957,486	907,092

Effluent: The baseline effluent for future availability represents the total amount of effluent generated in 2006. The amount of effluent generated is greater than the amount of effluent used in 2006. However, the subcommittee assumed the amount of effluent generated in 2006 will used in the years 2035, 2060, and 2110 (see Table 3). Development of additional effluent supply is addressed in the unmet demand analysis.

Table 3. Baseline Effluent Available for Future in Acre-Feet

ARIZONA EFFLUENT GENERATION AND USE (c. 2006)[1]

BASIN	VOLUME GENERATED (acre-feet)	DIRECT USE[2] (acre-feet)			STORAGE AT PERMITTED RECHARGE FACILITY[3] (acre-feet)	DELIVERY TO CREATED WETLAND[4] (acre-feet)	DISCHARGED[5] (acre-feet)	EFFLUENT DOMINATED STREAM MILES[8]
		Municipal	Industrial	Agriculture				
Agua Fria	30	NR	NR	NR	NR	NR	30	
Aravaipa Canyon	NR	NR	NR	NR	NR	NR	NR	
Big Sandy	NR	NR	NR	NR	NR	NR	NR	
Bill Williams	200	NR	200	NR	NR	NR	NR	
Bonita Creek	NR	NR	NR	NR	NR	NR	NR	
Butler Valley	NR	NR	NR	NR	NR	NR	NR	
Cienega Creek	100	NR	NR	NR	NR	NR	100	0.16
Coconino Plateau	1,700	273	NR	NR[6]	NR	NR	1,427	7.68
Detrital Valley	NR[7]	NR	NR	NR	NR	NR	NR	
Donnelly Wash	NR	NR	NR	NR	NR	NR	NR	
Douglas	1,400	NR	NR	NR	NR	NR	1,400	3.88
Dripping Springs	NR	NR	NR	NR	NR	NR	NR	
Duncan Valley	50	NR	NR	NR	NR	NR	45	
Gila Bend	800	NR	NR	NR	NR	NR	800	2.15
Grand Wash	NR	NR	NR	NR	NR	NR	NR	
Harquahala	NR	NR	NR	NR	NR	NR	NR	
Hualapai Valley	1,800	NR	NR	NR	NR	NR	1,800	
Kanab Plateau	500	NR	NR	NR[6]	NR	NR	500	4.87
Lake Havasu	3,400	2,433	NR	NR	NR	NR	967	
Lake Mohave	3,100	715	NR	NR	NR	NR	2,385	
Little Colorado River	36,100	3,600	NR	11,300	NR	2,700	18,500	43.01
Lower Gila	300	NR	NR	NR	NR	NR	300	
Lower San Pedro	700	145	NR	NR	NR	NR	555	3.54
McMullen Valley	NR[7]	NR	NR	NR	NR	NR	NR	
Meadview	NR	NR	NR	NR	NR	NR	NR	
Morenci	200	NR	NR[6]	NR	NR	NR	200	
Paria	NR	NR	NR	NR	NR	NR	NR	
Parker	2,100	220	NR	896	NR	NR	984	
Peach Springs	100	NR	NR	NR	NR	NR	100	
Phoenix AMA	315,000	40,639	80,000	73,009	13,100	1,350	106,902	81.74
Pinal AMA	6,900	800	1,700	2,300	600	0	1,500	23.85
Prescott AMA	6,900	1,900	0	800	3,600	0	600	6.54
Ranegras Plain	NR	NR	NR	NR	NR	NR	NR	
Sacramento Valley	300	NR	NR	NR	NR	NR	300	1.86
Safford	2,600	500	NR	NR[6]	NR	NR	2,100	5.59
Salt River	2,600	NR[6]	NR	NR[6]	NR	NR	2,600	4.72
San Bernardino Valley	NR	NR	NR	NR	NR	NR	NR	
San Rafael	NR	NR	NR	NR	NR	NR	NR	
San Simon Wash	400	NR	NR	NR	NR	NR	400	
Santa Cruz AMA	16,311	0	0	0	0	0	16,311	47.93
Shivwits Plateau	NR	NR	NR	NR	NR	NR	NR	
Tiger Wash	NR	NR	NR	NR	NR	NR	NR	
Tonto Creek	500	200	NR	NR	300	NR	NR	
Tucson AMA	74,235	15,947	900	0	16,700	0	40,688	56.95
Upper Hassayampa	600	NR	NR	NR	NR	NR	600	
Upper San Pedro	5,300	830	NR	NR	2,000	NR	2,470	12.18
Verde River	6,200	980	NR	NR[6]	NR	426	4,794	11.99
Virgin River	10	NR	NR	NR	NR	NR	10	
Western Mexican Drainage	NR	NR	NR	NR	NR	NR	NR	
Willcox	500	211	NR	NR	NR	NR	289	
Yuma	13,500	460	NR	NR[6]	NR	NR	13,040	
State Total	**504,436**	**69,853**	**82,800**	**88,305**	**36,300**	**4,476**	**222,697**	**318.64**

Notes and Sources:

1. Only those facilities with reported effluent generation are listed; the largest facilities typically report and are included here. Data from Volumes 2-8 of the Arizona Water Atlas.

2. The 200 af of industrial use in the Bill Williams Basin is estimated for the Bagdad Mine. Based on the GRIC 2008 annual report, an additional 10,686 af of effluent (through exchange) was used on the reservation in the Phoenix AMA. This additional use is not included here.

3. Amount delivered to managed facilities minus annual recovery, evaporation and cut to the aquifer. The Fort Huachuca recharge facility in the Upper San Pedro River Basin and the Green Valley Park Lakes recharge facility in the Tonto Creek Basin are not permitted facilities, but the estimated volume recharged by these two facilities is listed.

4. Created wetlands are accessible to the public and not permitted as a recharge facility.

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

6. Demand reportedly exists, however, the amount is unknown.

7. Treatment facilities located in the basin, however, the volume generated is unknown.

8. A composite of the NEMO GIS Dataset 2008-2009 and Arizona Water Atlas (2009-2010).

9. The majority of the Phoenix AMA discharge is from the 91st Avenue WWTP. A portion of the discharge is diverted downstream of the plant as contract effluent, and most of the remainder is diverted for irrigation pursuant to surface water rights. Of note, as of 2011, approximately 20,000 af/yr is now being delivered to the expanded Tres Rios Wetlands at the 91st Ave WWTP.

Colorado River Water:

The Colorado River Compact of 1922 divided the waters of the Colorado River between the Upper Colorado and Lower Colorado River Basins. Each Basin was allocated 7.5 million acre-feet. In 1928, the Boulder Canyon Project Act (which authorized the construction of Hoover Dam) divided the Lower Basin's allocation among the Lower Basin States of Arizona, California, and Nevada. The Act gave 2.8 million acre-feet to Arizona, 300,000 acre-feet to Nevada, and the remainder – 4.4 million acre-feet - to California. These amounts are summarized below:

California:	4.4 million acre-feet
Arizona:	2.8 million acre-feet
Nevada:	0.3 million acre-feet
Total:	7.5 million acre-feet

These amounts represent each state's basic annual apportionment and are based on consumptive use.[1]

Under Section 5 of the Boulder Canyon Project Act, a contract with the United States Secretary of the Interior (Secretary) is required for diversion and use of Colorado River water. Since 1980, the Secretary consults with the Arizona Department of Water Resources (ADWR) before making any final decision on a contract. With the exception of the Central Arizona Project (CAP), all other contracts in Arizona quantify the amount of water which can be used, either in terms of a maximum diversion amount, the amount of water required to irrigate a given amount of land (beneficial uses), or consumptive use.

The Secretary has adopted a priority system for delivering Arizona's apportionment. The priorities are listed below:

First Priority: Satisfaction of Present Perfected Rights as defined and provided for in the Arizona v. California Decree (2006 Consolidated).

Second Priority: Satisfaction of Federal Reservations and Perfected Rights established or effective prior to September 30, 1968.

Third Priority: Satisfaction of entitlements pursuant to contracts between the United States and water users in the State of Arizona executed on or before September 30, 1968.

1 The term consumptive use means diversion minus return flows. The definition is found in the decree: Supreme Court of the United States, State of Arizona v. State of California, No. 8 Orig. Entered March 27, 2006, 547 US 150 (2006 Consolidated).

Fourth Priority: Satisfaction of entitlements pursuant to: (i) contracts, Secretarial Reservations, and other arrangements between the United States and water users in Arizona entered into or established subsequent to September 30, 1968, for use on Federal, State, or privately owned lands in Arizona (for a total quantity of 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 Water Conservation District for the delivery of mainstem water for the Central Arizona Project (CAP), including use of mainstem water on Indian lands.

Entitlements having a fourth priority as defined in (i) and (ii) are considered coequal.

Fifth Priority: Satisfaction of entitlements to any unused Arizona entitlement.

Sixth Priority: Satisfaction of entitlements to surplus apportionment water.

In a normal year, the CAP is entitled to divert the remainder of Arizona's 2.8 million acre-feet apportionment, after water is provided to the first through third priority rights and contracts, and mainstem fourth priority contracts (the same priority as the CAP). In general, it is assumed that the non-CAP related contractual entitlements will eventually be fully used.

Colorado River Demand Assumptions:

In order for the Water Supply and Demand Work Group to estimate the Colorado River water supply available in 2035, 2060, and 2110, the Work Group has made assumptions regarding the future demands for several water use sectors. These assumptions are discussed below.

Municipal and Industrial (M & I) Demands: M & I mainstem contractor demand is projected to increase in the future. It has been assumed that in the future M & I contractors will fully use their entitlements.

Agricultural Water Supply: Based on the projections made by the Agricultural Demand Subcommittee, it has been assumed that mainstem agricultural demands will not increase in the future. For the Lake Mohave, Havasu, and Parker groundwater basins, the agricultural demand is assumed by constant based on the 2001- 2005 average demand. For the Lower Gila and Yuma Basins, 2001-2005 average agricultural demand is projected to decrease by 7% by 2060 and remain constant thereafter.

Based on the above agricultural demand assumptions, Colorado River water that is not used by mainstem agriculture contractors may be available for:

1. Future mainstem M & I demand;
2. Diversion by the CAP; and/or
3. For any other water user.

For any transfers, ADWR would require compliance with its transfer policy and the water user would also have to contract with the Secretary.

Tribal Water Supply: It is assumed that in the future mainstem Tribal users will fully use their entitlements.

Environmental Water Supply: There are three wildlife refuges that have entitlements use Colorado River water. They are the Havasu, Cibola and Imperial National Wildlife Refuges (NWRs). The Cibola NWR was established by a public land order, while the Havasu and Imperial NWRS were established by executive orders. Entitlements for the refuges were either established by Secretarial reservation, quantified in the Arizona v. California Decree, or both. It is assumed that the NWRs will fully use their entitlements.

The subcommittee decided that both a Normal and Shortage years were possible in the future. Therefore; both Normal and Shortage years' supplies are provided in the baseline condition and in the future. However, it was decided to only evaluate the first tier shortage because it has the highest probability of occurring. The values for the Colorado River and CAP represent the volume of water that is diverted to meet Arizona's Colorado River full allocation for both Normal and Shortage years. Normal Colorado River Supply Available when the elevation of Lake Mead is between 1,075-1,145 feet. In this case CAP and Priority Four can use their full entitlements. The first tier shortage of Colorado River Supply available occurs when the elevation of Lake Mead is between 1,050-1,075 feet. In this case CAP and Priority Four consumptive use entitlements are reduced by a total of 320,000 acre-feet. ADWR assumes that the CAP would take 90% of the cut (288,000 acre-feet) and the mainstem basins with Priority Four contracts would take the remaining 10% of the cut (32,000). Table 4 shows the Colorado River/CAP supply for the baseline and for years 2035, 2060, and 2110 for both Normal and Shortage years.

Central Arizona Project (CAP)

The volume of Colorado River water available for diversion to CAP off the mainstem was calculated as the remainder of Arizona's 2.8 MAF apportionment after subtracting mainstem uses. A 5% system loss is applied to account for evaporation and transmission losses within the CAP system, with the remaining volume distributed among the Phoenix, Pinal and Tucson AMAs using the CAM; following projected buildout schedules for the various CAP subcontracts, the CAM allocates available CAP water among the various CAP "pools" according to the priority system that applies within the CAP and current rules governing the allocation of excess water. Based on these same rules, it was assumed that the Harquahala INA (which lies outside the three AMAs but currently receives CAP water for agricultural use) would no longer receive any CAP water by 2035 (CAP's agricultural contracts will expire prior to that time). Where available CAP water was insufficient to support model projected AMA demands, the CAM reported this unsatisfied need as unmet demand in the AMA. Generally speaking, 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users or as determined by the Arizona-Nevada Shortage Agreement during times of shortages.

Additional water may be available to CAP's AMA and/or non-AMA users if water is reallocated from current mainstem uses and wheeled via the CAP pursuant to CAP's contract with the Secretary; however, no such water was assumed to be available for purposes of calculating unmet demand in the AMA.

Table 4. Colorado River/CAP Supply for Baseline year and 2035, 2060, and 2010 in Acre-Feet

	BASIN	Baseline Supply For Projection Purposes				2035				2060 & 2110			
		Diversion		Consumptive Use		Diversion		Consumptive Use		Diversion		Consumptive Use	
		Normal Year	Shortage Year	Normal Year	Shortage Year	Normal Year	Shortage Year	Normal Year	Shortage Year	Normal Year	Shortage Year	Normal Year	Shortage Year
Available Supply For Cultural Demand Projections	BILL WILLIAMS	654	464	417	299	654	464	417	299	654	464	417	299
	DETRITAL VALLEY	150	150	150	150	150	150	150	150	150	150	150	150
	KANAB PLATEAU	70	50	45	32	70	50	45	32	70	50	45	32
	LAKE HAVASU	37,010	26,528	23,432	16,796	37,010	26,528	23,432	16,796	37,010	26,528	23,432	16,796
	LAKE MOHAVE	72,242	51,887	47,689	34,285	72,242	51,887	47,689	34,285	72,242	51,887	47,689	34,285
	Lake Mohave (Tribal Ag)	103,535	103,535	55,965	55,965	103,535	103,535	55,965	55,965	103,535	103,535	55,965	55,965
	LOWER GILA[1]	400,825	400,617	260,780	260,645	386,822	386,614	251,670	251,534	372,818	372,611	242,559	242,424
	PARKER	36,581	26,992	26,782	19,378	36,581	26,992	26,782	19,378	36,581	26,992	26,782	19,378
	Parker (Tribal Ag)	666,680	665,468	376,655	375,971	666,680	665,468	376,655	375,971	666,680	665,468	376,655	375,971
	YUMA[1]	806,498	803,175	481,403	479,086	781,255	778,041	466,498	464,252	756,013	752,907	451,593	449,417
	Yuma (Tribal Ag)	17,197	17,197	12,404	12,404	17,197	17,197	12,404	12,404	17,197	17,197	12,404	12,404
	Central Arizona Project (CAP) Supply Range[2,3]	1,281,770 to 1,403,887	1,008,170 to 1,128,998	1,281,770 to 1,403,887	1,008,170 to 1,128,998	1,281,770 to 1,427,903	1,008,170 to 1,152,943	1,281,770 to 1,427,903	1008170 to 1152943	1,281,770 to 1,451,918	1,008,170 to 1,176,889	1,281,770 to 1,451,918	1,008,170 to 1,176,889
	Total CR/CAP Supplies to Meet Cultural Demands	**3,545,328**	**3,225,063**	**2,689,609**	**2,384,009**	**3,530,098**	**3,209,871**	**2,689,609**	**2,384,009**	**3,514,867**	**3,194,679**	**2,689,609**	**2,384,009**
Not Available For Cultural Demand Projections	Environmental	104,339	104,339	42,930	42,930	104,339	104,339	42,930	42,930	104,339	104,339	42,930	42,930
	CAP 5% SYSTEM LOSS	67,462	53,062	67,462	53,062	67,462	53,062	67,462	53,062	67,462	53,062	67,462	53,062
	Total Supply NOT Available For Cultural Demand Projections	**171,801**	**157,401**	**110,391**	**95,991**	**171,801**	**157,401**	**110,391**	**95,991**	**171,801**	**157,401**	**110,391**	**95,991**
Total Full Use of Colorado River		**3,717,129**	**3,382,463**	**2,800,000**	**2,480,000**	**3,701,899**	**3,367,271**	**2,800,000**	**2,480,000**	**3,686,668**	**3,352,079**	**2,800,000**	**2,480,000**

1. Non-Indian Agriculture is projected to decline by 7 % by 2060 in Yuma and Lower Gila basins, therefore the supply was adjusted down for future years, rolling over to the additional water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.

2. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use. It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.

3. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.

Note: In a Normal Year (Lake Mead Elevation between 1,075 And 1,145), AZ CU Entitlements = 2.8MAF, AZ use =2.8MAF, Balance available equals zero. In a First Tier Shortage Year (Lake Mead Elevation between 1,050 and 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available equals zero. Arizona will always use its full apportionment.

Results: Tables 5 through 9 show the supply for all categories of water for the baseline conditions, 2035, 2060, 2110 (Census), and 2110 (Area Split) respectively.

Table 5. Baseline Supply For Projection Purposes

	BASIN NAME	Baseline Supply for Projection Purposes[1]					
		Instate				Colorado River/CAP	Total Supply
		GW (c. 2006)	Instate SW (2001-2006 Avg. Diversions)	Effluent (Generated c. 2006)	Total Instate Supply		
Instate Water Supplies Only	AGUA FRIA	3,602	0	30	**3,632**	NA	**3,632**
	ARAVAIPA CANYON	514	500	0	**989**	NA	**989**
	BIG SANDY	15,028	0	0	**15,028**	NA	**15,028**
	BONITA CREEK	0	0	0	**0**	NA	**0**
	BUTLER VALLEY	14,503	0	0	**14,503**	NA	**14,503**
	CIENEGA CREEK	1,101	0	100	**1,201**	NA	**1,201**
	COCONINO PLATEAU	500	358	1,700	**2,540**	NA	**2,540**
	DONNELLY WASH	19	0	0	**19**	NA	**19**
	DOUGLAS	53,300	0	1,400	**54,700**	NA	**54,700**
	DRIPPING SPRINGS WASH	11	0	0	**11**	NA	**11**
	DUNCAN VALLEY	8,054	9,900	50	**17,509**	NA	**17,509**
	GILA BEND	295,323	55,417	800	**348,769**	NA	**348,769**
	GRAND WASH	2	0	0	**2**	NA	**2**
	HUALAPAI VALLEY	9,109	0	1,800	**10,909**	NA	**10,909**
	LOWER SAN PEDRO	23,677	833	700	**25,169**	NA	**25,169**
	MCMULLEN VALLEY	71,500	0	0	**71,500**	NA	**71,500**
	MEADVIEW	145	0	0	**145**	NA	**145**
	MORENCI	9,126	1,627	200	**10,871**	NA	**10,871**
	PARIA	120	0	0	**120**	NA	**120**
	PEACH SPRINGS	351	0	100	**451**	NA	**451**
	PRESCOTT AMA	17,679	2,067	6,900	**26,542**	NA	**26,542**
	RANEGRAS PLAIN	29,350	0	0	**29,350**	NA	**29,350**
	SACRAMENTO VALLEY	3,765	0	300	**4,065**	NA	**4,065**
	SAFFORD	87,958	74,183	2,600	**161,032**	NA	**161,032**
	SALT RIVER	12,611	12,011	2,600	**26,621**	NA	**26,621**
	SAN BERNARDINO VALLEY	19	0	0	**19**	NA	**19**
	SAN RAFAEL	22	0	0	**22**	NA	**22**
	SAN SIMON WASH	1,500	0	400	**1,900**	NA	**1,900**
	SANTA CRUZ AMA	20,980	0	16,311	**37,291**	NA	**37,291**
	SHIVWITS PLATEAU	2	0	0	**2**	NA	**2**
	TIGER WASH	2	0	0	**2**	NA	**2**
	TONTO CREEK	3,000	1,000	500	**4,450**	NA	**4,450**
	UPPER HASSAYAMPA	3,286	0	600	**3,886**	NA	**3,886**
	UPPER SAN PEDRO	23,957	4,450	5,300	**33,484**	NA	**33,484**
	VERDE RIVER	28,549	16,494	6,200	**50,418**	NA	**50,418**
	VIRGIN RIVER	1,585	1,618	10	**3,132**	NA	**3,132**
	WESTERN MEXICAN DRAINAGE	6	0	0	**6**	NA	**6**
	WILLCOX	175,714	150	500	**176,357**	NA	**176,357**

Table 5. Baseline Supply For Projection Purposes (Cont.)

Basins Which Receive Part of Supply from the Colorado River or CAP		Baseline Supply for Projection Purposes[1]											
		Instate				Colorado River/CAP Diversions		Total Supply		Colorado River Expected Return Flow		Colorado River Consumptive Use	
		GW (c. 2006)	Instate SW (2001-2006 Avg. Diversions)	Effluent (Generated c. 2006)	Total Instate Supply	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	95,813	14,717	36,100	146,630	51,782	51,782	198,412	198,412	1,782	1,782	50,000	50,000
Instate + CR Lower Mainstem	BILL WILLIAMS	3,251	500	200	3,951	654	464	4,604	4,415	237	0	417	299
	DETRITAL VALLEY	159	50	0	209	150	150	359	359	0	0	150	150
	KANAB PLATEAU	2,799	800	500	4,099	70	50	4,169	4,149	25	0	45	32
	LAKE HAVASU	47	0	3,400	3,447	37,010	26,528	40,457	29,975	13,578	0	23,432	16,796
	LAKE MOHAVE	2,007	0	3,100	5,107	72,242	51,887	77,349	56,995	24,553	89	47,689	34,285
	Lake Mohave (Tribal Ag)	0	0	0	0	103,535	103,535	103,535	103,535	47,570	47,570	55,965	55,965
	LOWER GILA	110,296	473	300	111,070	400,825	400,617	511,894	511,687	140,045	139,790	260,780	260,645
	PARKER	1,787	0	2,100	3,887	36,581	26,992	40,468	30,879	9,799	348	26,782	19,378
	Parker (Tribal Ag)	0	0	0	0	666,680	665,468	666,680	665,468	290,025	288,164	376,655	375,971
	YUMA	108,570	973	13,500	123,042	806,498	803,175	929,540	926,217	325,095	320,786	481,403	479,086
	Yuma (Tribal Ag)	0	0	0	0	17,197	17,197	17,197	17,197	4,793	4,793	12,404	12,404
	HARQUAHALA INA	66,178	0	0	66,178	0	0	66,178	66,178	0	0	0	0
Instate + CAP	Major Active Management Areas (AMAs)	GW (c. 2006)	Instate SW (CAM)	Effluent (Generated c. 2006)	Total Instate Supply	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]	Normal Year[2]	Shortage Year[3]
	PHOENIX AMA	673,755	727,402	315,000	1,693,083	895,395	703,579	2,588,479	2,396,662	0	0	895,395	703,579
	PINAL AMA	431,290	73,830	6,900	506,639	166,269	116,073	672,908	622,712	0	0	166,269	116,073
	TUCSON AMA	216,996	506	74,235	291,721	220,106	188,519	511,827	480,240	0	0	220,106	188,519
						122,117	120,828	122,117	120,828	0	0	122,117	120,828
		Central Arizona Project (CAP) Supply Range[4,5]				1,281,770 to 1,403,887	1,008,170 to 1,128,998	1,281,770 to 1,403,887	1,008,170 to 1,128,998	0	0.00	1,281,770 to 1,403,887	1,008,170 to 1,128,998
		Colorado Mainstem Environmental (Not Available For Cultural Supply)				104,339	104,339	0	0	61,409	61,409	42,930	42,930
		CAP System Loss = -5% of Diversion (Not Available For Supply)				67,462	53,062	0	0	0	0	67,462	53,062
	STATEWIDE	2,628,917	999,860	504,436	4,104,742	3,768,911	3,434,245	7,701,852	7,381,586	918,911	864,732	2,850,000	2,530,000

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. The Baseline Supply for Projection Purposes represents currently developed supplies that are available today and throughout the study period to meet both baseline and, if applicable, future demand.
This value will be adjusted in the future scenarios to simulate reductions in water supply due to climate change and other stressors.
2. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
3. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet.
Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.
4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use.
It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary.
Increased values in future yars correspond to decreased values in the Yuma and Lower Gila Basins based on a projected 7% decrease in non-Indian agriculture demand.
6. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.

Note: In a Normal Year (Lake Mead Elevation between 1,075 And 1,145), AZ CU Entitlements = 2.8MAF, AZ use =2.8MAF, Balance available equals zero.

In a First Tier Shortage Year (Lake Mead Elevation between 1,050 and 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available equals zero. Arizona will always use its full apportionment.

Table 6. 2035 Supply

	BASIN NAME	2035 Supply					
		Instate				Colorado River/CAP	Total Supply
		GW (c. 2006)	Instate SW (2001-2006 Avg. Diversions - 5%)	Effluent (Generated c. 2006)	Total Instate Supply		
Instate Water Supplies Only	AGUA FRIA	3,602	0	30	**3,632**	NA	**3,632**
	ARAVAIPA CANYON	514	475	0	**989**	NA	**989**
	BIG SANDY	15,028	0	0	**15,028**	NA	**15,028**
	BONITA CREEK	0	0	0	**0**	NA	**0**
	BUTLER VALLEY	14,503	0	0	**14,503**	NA	**14,503**
	CIENEGA CREEK	1,101	0	100	**1,201**	NA	**1,201**
	COCONINO PLATEAU	500	340	1,700	**2,540**	NA	**2,540**
	DONNELLY WASH	19	0	0	**19**	NA	**19**
	DOUGLAS	53,300	0	1,400	**54,700**	NA	**54,700**
	DRIPPING SPRINGS WASH	11	0	0	**11**	NA	**11**
	DUNCAN VALLEY	8,054	9,405	50	**17,509**	NA	**17,509**
	GILA BEND	295,323	52,646	800	**348,769**	NA	**348,769**
	GRAND WASH	2	0	0	**2**	NA	**2**
	HUALAPAI VALLEY	9,109	0	1,800	**10,909**	NA	**10,909**
	LOWER SAN PEDRO	23,677	792	700	**25,169**	NA	**25,169**
	MCMULLEN VALLEY	71,500	0	0	**71,500**	NA	**71,500**
	MEADVIEW	145	0	0	**145**	NA	**145**
	MORENCI	9,126	1,545	200	**10,871**	NA	**10,871**
	PARIA	120	0	0	**120**	NA	**120**
	PEACH SPRINGS	351	0	100	**451**	NA	**451**
	PRESCOTT AMA	17,679	1,963	6,900	**26,542**	NA	**26,542**
	RANEGRAS PLAIN	29,350	0	0	**29,350**	NA	**29,350**
	SACRAMENTO VALLEY	3,765	0	300	**4,065**	NA	**4,065**
	SAFFORD	87,958	70,474	2,600	**161,032**	NA	**161,032**
	SALT RIVER	12,611	11,410	2,600	**26,621**	NA	**26,621**
	SAN BERNARDINO VALLEY	19	0	0	**19**	NA	**19**
	SAN RAFAEL	22	0	0	**22**	NA	**22**
	SAN SIMON WASH	1,500	0	400	**1,900**	NA	**1,900**
	SANTA CRUZ AMA	20,980	0	16,311	**37,291**	NA	**37,291**
	SHIVWITS PLATEAU	2	0	0	**2**	NA	**2**
	TIGER WASH	2	0	0	**2**	NA	**2**
	TONTO CREEK	3,000	950	500	**4,450**	NA	**4,450**
	UPPER HASSAYAMPA	3,286	0	600	**3,886**	NA	**3,886**
	UPPER SAN PEDRO	23,957	4,228	5,300	**33,484**	NA	**33,484**
	VERDE RIVER	28,549	15,669	6,200	**50,418**	NA	**50,418**
	VIRGIN RIVER	1,585	1,537	10	**3,132**	NA	**3,132**
	WESTERN MEXICAN DRAINAGE	6	0	0	**6**	NA	**6**
	WILLCOX	175,714	143	500	**176,357**	NA	**176,357**

Table 6. 2035 Supply (Cont)

Basins Which Receive Part of Supply from the Colorado River or CAP		2035 Supply – Instate: GW (c. 2006)		Instate SW (2001-2006 Avg. Diversions - 5%)	Effluent (Generated c. 2006)	Total Instate Supply		Colorado River/CAP Diversions: Normal Year[1]	Colorado River/CAP Diversions: Shortage Year[2]	Total Supply: Normal Year[1]		Total Supply: Shortage Year[2]		Colorado River Expected Return Flow: Normal Year[1]	Colorado River Expected Return Flow: Shortage Year[2]	Colorado River Consumptive Use: Normal Year[1]	Colorado River Consumptive Use: Shortage Year[2]
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	95,813		13,981	36,100	**145,894**		49,193	49,193	**195,087**		**195,087**		1,693	1,693	47,500	47,500
Instate + CR Lower Mainstem	BILL WILLIAMS	3,251		475	200	**3,926**		654	464	**4,579**		**4,390**		237	165	417	299
	DETRITAL VALLEY	159		48	0	**207**		150	150	**357**		**357**		0	0	150	150
	KANAB PLATEAU	2,799		760	500	**4,059**		70	50	**4,129**		**4,109**		25	18	45	32
	LAKE HAVASU	47		0	3,400	**3,447**		37,010	26,528	**40,457**		**29,975**		13,578	9,732	23,432	16,796
	LAKE MOHAVE	2,007		0	3,100	**5,107**		72,242	51,887	**77,349**		**56,995**		24,553	17,603	47,689	34,285
	Lake Mohave (Tribal Ag)	0		0	0	**0**		103,535	103,535	**103,535**		**103,535**		47,570	47,570	55,965	55,965
	LOWER GILA	110,296		450	300	**111,046**		386,822	386,614	**497,868**		**497,660**		135,152	135,080	251,670	251,534
	PARKER	1,787		0	2,100	**3,887**		36,581	26,992	**40,468**		**30,879**		9,799	7,614	26,782	19,378
	Parker (Tribal Ag)	0		0	0	**0**		666,680	665,468	**666,680**		**665,468**		290,025	289,498	376,655	375,971
	YUMA	108,570		924	13,500	**122,994**		781,255	778,041	**904,249**		**901,035**		314,757	313,789	466,498	464,252
	Yuma (Tribal Ag)	0		0	0	**0**		17,197	17,197	**17,197**		**17,197**		4,793	4,793	12,404	12,404
	HARQUAHALA INA	66,178		0	0	**66,178**		0	0	**66,178**		**66,178**		0	0	0	0
Instate + CAP	**Major Active Management Areas (AMAs)**	**GW Low[3]**	**GW High[3]**	**Instate SW (CAM)**	**Effluent (Generated c. 2006)**	**Low**	**High**	**Normal Year[1]**	**Shortage Year[2]**	**Low**	**High**	**Low**	**High**	**Normal Year[1]**	**Shortage Year[2]**	**Normal Year[1]**	**Shortage Year[2]**
	PHOENIX AMA	645,174	673,755	702,362	315,000	**1,662,536**	**1,691,116**	895,395	703,579	**2,557,931**	**2,586,512**	**2,366,114**	**2,394,695**	0	0	895,395	703,579
	PINAL AMA	431,290	431,290	66,443	6,900	**504,633**	**504,633**	166,269	116,073	**670,902**	**670,902**	**620,706**	**620,706**	0	0	166,269	116,073
	TUCSON AMA	158,223	196,258	466	74,235	**232,924**	**270,958**	220,106	188,519	**453,030**	**491,064**	**421,442**	**459,477**	0	0	220,106	188,519
								146,132	144,773	**146,132**	**146,132**	**144,773**	**144,773**	0	0	146,132	144,773
		Central Arizona Project (CAP) Supply Range[4,5]						1,281,770 to 1,427,903	1,008,170 to 1,152,943	**1,281,770 to 1,427,903**	**1,281,770 to 1,427,903**	**1,008,170 to 1,152,943**	**1,008,170 to 1,152,943**	0	0	1,281,770 to 1,427,903	1,008,170 to 1,152,943
		Colorado Mainstem Environmental (Not Available For Cultural Supply)						104,339	104,339	**0**	**0**	**0**	**0**	61,409	61,409	42,930	42,930
		CAP System Loss = -5% of Diversion (Not Available For Supply)						67,462	53,062	**0**	**0**	**0**	**0**	0	0	67,462	53,062
	STATEWIDE	**2,541,563**	**2,608,178**	**957,486**	**504,436**	**4,003,485**	**4,070,100**	**3,751,091**	**3,416,464**	**7,582,776**	**7,649,391**	**7,262,549**	**7,329,163**	**903,591**	**888,964**	**2,847,500**	**2,527,500**

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet. Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.
3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.
4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use. It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary. Increased values in future years correspond to decreased values in the Yuma and Lower Gila basins based on a projected 7% decrease in non-Indian agriculture demand.
6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.

Note: In a Normal Year (Lake Mead Elevation = 1,075 to 1,145), AZ CU Entitlements = 2.8MAF, AZ use = 2.8MAF, Balance available = zero.
In a First Tier Shortage Year (Lake Mead Elevation = 1,050 to 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available = zero. Arizona will always use its full apportionment.

Table 7. 2060 Supply

	BASIN NAME	2060 Supply					
		Instate				Colorado River/CAP	Total Supply
		GW (c. 2006)	Instate SW (2001-2006 Avg. Diversions -10%)	Effluent (Generated c. 2006)	Total Instate Supply		
Instate Water Supplies Only	AGUA FRIA	3,602	0	30	**3,632**	NA	**3,632**
	ARAVAIPA CANYON	514	450	0	**964**	NA	**964**
	BIG SANDY	15,028	0	0	**15,028**	NA	**15,028**
	BONITA CREEK	0	0	0	**0**	NA	**0**
	BUTLER VALLEY	14,503	0	0	**14,503**	NA	**14,503**
	CIENEGA CREEK	1,101	0	100	**1,201**	NA	**1,201**
	COCONINO PLATEAU	500	323	1,700	**2,523**	NA	**2,523**
	DONNELLY WASH	19	0	0	**19**	NA	**19**
	DOUGLAS	53,300	0	1,400	**54,700**	NA	**54,700**
	DRIPPING SPRINGS WASH	11	0	0	**11**	NA	**11**
	DUNCAN VALLEY	8,054	8,910	50	**17,014**	NA	**17,014**
	GILA BEND	295,323	49,875	800	**345,998**	NA	**345,998**
	GRAND WASH	2	0	0	**2**	NA	**2**
	HUALAPAI VALLEY	9,109	0	1,800	**10,909**	NA	**10,909**
	LOWER SAN PEDRO	23,677	750	700	**25,127**	NA	**25,127**
	MCMULLEN VALLEY	71,500	0	0	**71,500**	NA	**71,500**
	MEADVIEW	145	0	0	**145**	NA	**145**
	MORENCI	9,126	1,464	200	**10,790**	NA	**10,790**
	PARIA	120	0	0	**120**	NA	**120**
	PEACH SPRINGS	351	0	100	**451**	NA	**451**
	PRESCOTT AMA	17,679	1,860	6,900	**26,438**	NA	**26,438**
	RANEGRAS PLAIN	29,350	0	0	**29,350**	NA	**29,350**
	SACRAMENTO VALLEY	3,765	0	300	**4,065**	NA	**4,065**
	SAFFORD	87,958	66,765	2,600	**157,323**	NA	**157,323**
	SALT RIVER	12,611	10,810	2,600	**26,021**	NA	**26,021**
	SAN BERNARDINO VALLEY	19	0	0	**19**	NA	**19**
	SAN RAFAEL	22	0	0	**22**	NA	**22**
	SAN SIMON WASH	1,500	0	400	**1,900**	NA	**1,900**
	SANTA CRUZ AMA	20,980	0	16,311	**37,291**	NA	**37,291**
	SHIVWITS PLATEAU	2	0	0	**2**	NA	**2**
	TIGER WASH	2	0	0	**2**	NA	**2**
	TONTO CREEK	3,000	900	500	**4,400**	NA	**4,400**
	UPPER HASSAYAMPA	3,286	0	600	**3,886**	NA	**3,886**
	UPPER SAN PEDRO	23,957	4,005	5,300	**33,262**	NA	**33,262**
	VERDE RIVER	28,549	14,845	6,200	**49,593**	NA	**49,593**
	VIRGIN RIVER	1,585	1,457	10	**3,052**	NA	**3,052**
	WESTERN MEXICAN DRAINAGE	6	0	0	**6**	NA	**6**
	WILLCOX	175,714	135	500	**176,349**	NA	**176,349**

Table 7. 2060 Supply (Cont.)

Basins Which Receive Part of Supply from the Colorado River or CAP		2060 Supply: Instate – GW (c. 2006)		Instate SW (2001-2006 Avg. Diversions - 10%)	Effluent (Generated c. 2006)	Total Instate Supply		Colorado River/CAP Diversions		Total Supply				Colorado River Expected Return Flow		Colorado River Consumptive Use	
								Normal Year[1]	Shortage Year[2]	Normal Year[1]		Shortage Year[2]		Normal Year[1]	Shortage Year[2]	Normal Year[1]	Shortage Year[2]
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	95,813		13,246	36,100	**145,158**		46,604	46,604	**191,762**		**191,762**		1,604	1,604	45,000	45,000
Instate + CR Lower Mainstem	BILL WILLIAMS	3,251		450	200	**3,901**		654	464	**4,554**		**4,365**		237	165	417	299
	DETRITAL VALLEY	159		45	0	**204**		150	150	**354**		**354**		0	0	150	150
	KANAB PLATEAU	2,799		720	500	**4,019**		70	50	**4,089**		**4,069**		25	18	45	32
	LAKE HAVASU	47		0	3,400	**3,447**		37,010	26,528	**40,457**		**29,975**		13,578	9,732	23,432	16,796
	LAKE MOHAVE	2,007		0	3,100	**5,107**		72,242	51,887	**77,349**		**56,995**		24,553	17,603	47,689	34,285
	Lake Mohave (Tribal Ag)	0		0	0	**0**		103,535	103,535	**103,535**		**103,535**		47,570	47,570	55,965	55,965
	LOWER GILA	110,296		426	300	**111,022**		372,818	372,611	**483,841**		**483,633**		130,259	130,187	242,559	242,424
	PARKER	1,787		0	2,100	**3,887**		36,581	26,992	**40,468**		**30,879**		9,799	7,614	26,782	19,378
	Parker (Tribal Ag)	0		0	0	**0**		666,680	665,468	**666,680**		**665,468**		290,025	289,498	376,655	375,971
	YUMA	108,570		875	13,500	**122,945**		756,013	752,907	**878,958**		**875,852**		304,419	303,490	451,593	449,417
	Yuma (Tribal Ag)	0		0	0	**0**		17,197	17,197	**17,197**		**17,197**		4,793	4,793	12,404	12,404
	HARQUAHALA INA	66,178		0	0	**66,178**		0	0	**66,178**		**66,178**		0	0	0	0
Instate + CAP	Major Active Management Areas (AMAs)	GW Low[3]	GW High[3]	Instate SW (CAM)	Effluent (Generated c. 2006)	Low	High	Normal Year[1]	Shortage Year[2]	Low	High	Low	High	Normal Year[1]	Shortage Year[2]	Normal Year[1]	Shortage Year[2]
	PHOENIX AMA	540,665	673,755	665,395	315,000	**1,521,060**	**1,654,150**	895,395	703,579	**2,416,455**	**2,549,545**	**2,224,638**	**2,357,729**	0	0	895,395	703,579
	PINAL AMA	431,290	431,290	62,946	6,900	**501,136**	**501,136**	166,269	116,073	**667,405**	**667,405**	**617,209**	**617,209**	0	0	166,269	116,073
	TUCSON AMA	161,039	200,402	441	74,235	**235,715**	**275,078**	220,106	188,519	**455,821**	**495,184**	**424,234**	**463,596**	0	0	220,106	188,519
								170,148	168,718	**170,148**	**170,148**	**168,718**	**168,718**	0	0	170,148	168,718
		Central Arizona Project (CAP) Supply Range[4,5]						1,281,770 to 1,451,918	1,008,170 to 1,176,889	**1,281,770 to 1,451,918**	**1,281,770 to 1,451,918**	**1,008,170 to 1,176,889**	**1,008,170 to 1,176,889**	0	0	1,281,770 to 1,451,918	1,008,170 to 1,176,889
		Colorado Mainstem Environmental (Not Available For Cultural Supply)						104,339	104,339	**0**	**0**	**0**	**0**	61,409	61,409	42,930	42,930
		CAP System Loss = -5% of Diversion (Not Available For Supply)						67,462	53,062	**0**	**0**	**0**	**0**	0	0	67,462	53,062
	STATEWIDE	**2,439,869**	**2,612,322**	**907,092**	**504,436**	**3,851,397**	**4,023,850**	**3,733,272**	**3,398,683**	**7,412,868**	**7,585,321**	**7,092,679**	**7,265,132**	**888,271**	**873,683**	**2,845,000**	**2,525,000**

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet. Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.
3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.
4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use. It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary. Increased values in future years correspond to decreased values in the Yuma and Lower Gila basins based on a projected 7% decrease in non-Indian agriculture demand.
6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.

Note: In a Normal Year (Lake Mead Elevation = 1,075 to 1,145), AZ CU Entitlements = 2.8MAF, AZ use = 2.8MAF, Balance available = zero.
In a First Tier Shortage Year (Lake Mead Elevation = 1,050 to 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available = zero. Arizona will always use its full apportionment.

Table 8. 2110 Supply (Census)

	BASIN NAME	2110 Supply (Census)					
		Instate				Colorado River/CAP	Total Supply
		GW (c. 2006)	Instate SW (2001-2006 Avg. Diversions -10%)	Effluent (Generated c. 2006)	Total Instate Supply		
Instate Water Supplies Only	AGUA FRIA	3,602	0	30	**3,632**	NA	**3,632**
	ARAVAIPA CANYON	514	450	0	**964**	NA	**964**
	BIG SANDY	15,028	0	0	**15,028**	NA	**15,028**
	BONITA CREEK	0	0	0	**0**	NA	**0**
	BUTLER VALLEY	14,503	0	0	**14,503**	NA	**14,503**
	CIENEGA CREEK	1,101	0	100	**1,201**	NA	**1,201**
	COCONINO PLATEAU	500	323	1,700	**2,523**	NA	**2,523**
	DONNELLY WASH	19	0	0	**19**	NA	**19**
	DOUGLAS	53,300	0	1,400	**54,700**	NA	**54,700**
	DRIPPING SPRINGS WASH	11	0	0	**11**	NA	**11**
	DUNCAN VALLEY	8,054	8,910	50	**17,014**	NA	**17,014**
	GILA BEND	295,323	49,875	800	**345,998**	NA	**345,998**
	GRAND WASH	2	0	0	**2**	NA	**2**
	HUALAPAI VALLEY	9,109	0	1,800	**10,909**	NA	**10,909**
	LOWER SAN PEDRO	23,677	750	700	**25,127**	NA	**25,127**
	MCMULLEN VALLEY	71,500	0	0	**71,500**	NA	**71,500**
	MEADVIEW	145	0	0	**145**	NA	**145**
	MORENCI	9,126	1,464	200	**10,790**	NA	**10,790**
	PARIA	120	0	0	**120**	NA	**120**
	PEACH SPRINGS	351	0	100	**451**	NA	**451**
	PRESCOTT AMA	17,679	1,860	6,900	**26,438**	NA	**26,438**
	RANEGRAS PLAIN	29,350	0	0	**29,350**	NA	**29,350**
	SACRAMENTO VALLEY	3,765	0	300	**4,065**	NA	**4,065**
	SAFFORD	87,958	66,765	2,600	**157,323**	NA	**157,323**
	SALT RIVER	12,611	10,810	2,600	**26,021**	NA	**26,021**
	SAN BERNARDINO VALLEY	19	0	0	**19**	NA	**19**
	SAN RAFAEL	22	0	0	**22**	NA	**22**
	SAN SIMON WASH	1,500	0	400	**1,900**	NA	**1,900**
	SANTA CRUZ AMA	20,980	0	16,311	**37,291**	NA	**37,291**
	SHIVWITS PLATEAU	2	0	0	**2**	NA	**2**
	TIGER WASH	2	0	0	**2**	NA	**2**
	TONTO CREEK	3,000	900	500	**4,400**	NA	**4,400**
	UPPER HASSAYAMPA	3,286	0	600	**3,886**	NA	**3,886**
	UPPER SAN PEDRO	23,957	4,005	5,300	**33,262**	NA	**33,262**
	VERDE RIVER	28,549	14,845	6,200	**49,593**	NA	**49,593**
	VIRGIN RIVER	1,585	1,457	10	**3,052**	NA	**3,052**
	WESTERN MEXICAN DRAINAGE	6	0	0	**6**	NA	**6**
	WILLCOX	175,714	135	500	**176,349**	NA	**176,349**

Table 8. 2110 Supply (Census, Cont.)

Basins Which Receive Part of Supply from the Colorado River or CAP		2110 Supply (Census)															
		Instate						Colorado River/CAP Diversions		Total Supply				Colorado River Expected Return Flow		Colorado River Consumptive Use	
		GW (c. 2006)		Instate SW (2001-2006 Avg. Diversions - 10%)	Effluent (Generated c. 2006)	Total Instate Supply		Normal Year[1]	Shortage Year[2]	Normal Year[1]		Shortage Year[2]		Normal Year[1]	Shortage Year[2]	Normal Year[1]	Shortage Year[2]
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	95,813		13,246	36,100	**145,158**		46,604	46,604	**191,762**		**191,762**		1,604	1,604	45,000	45,000
Instate + CR Lower Mainstem	BILL WILLIAMS	3,251		450	200	**3,901**		654	464	**4,554**		**4,365**		237	165	417	299
	DETRITAL VALLEY	159		45	0	**204**		150	150	**354**		**354**		0	0	150	150
	KANAB PLATEAU	2,799		720	500	**4,019**		70	50	**4,089**		**4,069**		25	18	45	32
	LAKE HAVASU	47		0	3,400	**3,447**		37,010	26,528	**40,457**		**29,975**		13,578	9,732	23,432	16,796
	LAKE MOHAVE	2,007		0	3,100	**5,107**		72,242	51,887	**77,349**		**56,995**		24,553	17,603	47,689	34,285
	Lake Mohave (Tribal Ag)	0		0	0	**0**		103,535	103,535	**103,535**		**103,535**		47,570	47,570	55,965	55,965
	LOWER GILA	110,296		426	300	**111,022**		372,818	372,611	**483,841**		**483,633**		130,259	130,187	242,559	242,424
	PARKER	1,787		0	2,100	**3,887**		36,581	26,992	**40,468**		**30,879**		9,799	7,614	26,782	19,378
	Parker (Tribal Ag)	0		0	0	**0**		666,680	665,468	**666,680**		**665,468**		290,025	289,498	376,655	375,971
	YUMA	108,570		875	13,500	**122,945**		756,013	752,907	**878,958**		**875,852**		304,419	303,490	451,593	449,417
	Yuma (Tribal Ag)	0		0	0	**0**		17,197	17,197	**17,197**		**17,197**		4,793	4,793	12,404	12,404
	HARQUAHALA INA	66,178		0	0	**66,178**		0	0	**66,178**		**66,178**		0	0	0	0
Instate + CAP	Major Active Management Areas (AMAs)	GW Low[3]	GW High[3]	Instate SW (CAM)	Effluent (Generated c. 2006)	Low	High	Normal Year[1]	Shortage Year[2]	Low	High	Low	High	Normal Year[1]	Shortage Year[2]	Normal Year[1]	Shortage Year[2]
	PHOENIX AMA	608,306	673,755	665,395	315,000	**1,588,701**	**1,654,150**	895,395	703,579	**2,484,097**	**2,549,545**	**2,292,280**	**2,357,729**	0	0	895,395	703,579
	PINAL AMA	431,290	431,290	62,946	6,900	**501,136**	**501,136**	166,269	116,073	**667,405**	**667,405**	**617,209**	**617,209**	0	0	166,269	116,073
	TUCSON AMA	191,144	237,987	441	74,235	**265,820**	**312,663**	220,106	188,519	**485,926**	**532,769**	**454,339**	**501,182**	0	0	220,106	188,519
								170,148	168,718	**170,148**	**170,148**	**168,718**	**168,718**	0	0	170,148	168,718
		Central Arizona Project (CAP) Supply Range[4,5]						1,281,770 to 1,451,918	1,008,170 to 1,176,889	**1,281,770 to 1,451,918**	**1,281,770 to 1,451,918**	**1,008,170 to 1,176,889**	**1,008,170 to 1,176,889**	0	0	1,281,770 to 1,451,918	1,008,170 to 1,176,889
		Colorado Mainstem Environmental (Not Available For Cultural Supply)						104,339	104,339	**0**	**0**	**0**	**0**	61,409	61,409	42,930	42,930
		CAP System Loss = -5% of Diversion (Not Available For Supply)						67,462	53,062	**0**	**0**	**0**	**0**	0	0	67,462	53,062
	STATEWIDE	**2,537,616**	**2,649,908**	**907,092**	**504,436**	**3,949,144**	**4,061,436**	**3,733,272**	**3,398,683**	**7,510,616**	**7,622,907**	**7,190,426**	**7,302,718**	**888,271**	**873,683**	**2,845,000**	**2,525,000**

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet. Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.
3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.
4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use. It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary. Increased values in future years correspond to decreased values in the Yuma and Lower Gila basins based on a projected 7% decrease in non-Indian agriculture demand.
6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.

Note: In a Normal Year (Lake Mead Elevation = 1,075 to 1,145), AZ CU Entitlements = 2.8MAF, AZ use = 2.8MAF, Balance available = zero.
In a First Tier Shortage Year (Lake Mead Elevation = 1,050 to 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available = zero. Arizona will always use its full apportionment.

Table 9. 2110 Supply (Area Split)

	BASIN NAME	2110 Supply (Area Split)					
		Instate				Colorado River/CAP	Total Supply
		GW (c. 2006)	Instate SW (2001-2006 Avg. Diversions -10%)	Effluent (Generated c. 2006)	Total Instate Supply		
Instate Water Supplies Only	AGUA FRIA	3,602	0	30	**3,632**	NA	**3,632**
	ARAVAIPA CANYON	514	450	0	**964**	NA	**964**
	BIG SANDY	15,028	0	0	**15,028**	NA	**15,028**
	BONITA CREEK	0	0	0	**0**	NA	**0**
	BUTLER VALLEY	14,503	0	0	**14,503**	NA	**14,503**
	CIENEGA CREEK	1,101	0	100	**1,201**	NA	**1,201**
	COCONINO PLATEAU	500	323	1,700	**2,523**	NA	**2,523**
	DONNELLY WASH	19	0	0	**19**	NA	**19**
	DOUGLAS	53,300	0	1,400	**54,700**	NA	**54,700**
	DRIPPING SPRINGS WASH	11	0	0	**11**	NA	**11**
	DUNCAN VALLEY	8,054	8,910	50	**17,014**	NA	**17,014**
	GILA BEND	295,323	49,875	800	**345,998**	NA	**345,998**
	GRAND WASH	2	0	0	**2**	NA	**2**
	HUALAPAI VALLEY	9,109	0	1,800	**10,909**	NA	**10,909**
	LOWER SAN PEDRO	23,677	750	700	**25,127**	NA	**25,127**
	MCMULLEN VALLEY	71,500	0	0	**71,500**	NA	**71,500**
	MEADVIEW	145	0	0	**145**	NA	**145**
	MORENCI	9,126	1,464	200	**10,790**	NA	**10,790**
	PARIA	120	0	0	**120**	NA	**120**
	PEACH SPRINGS	351	0	100	**451**	NA	**451**
	PRESCOTT AMA	17,679	1,860	6,900	**26,438**	NA	**26,438**
	RANEGRAS PLAIN	29,350	0	0	**29,350**	NA	**29,350**
	SACRAMENTO VALLEY	3,765	0	300	**4,065**	NA	**4,065**
	SAFFORD	87,958	66,765	2,600	**157,323**	NA	**157,323**
	SALT RIVER	12,611	10,810	2,600	**26,021**	NA	**26,021**
	SAN BERNARDINO VALLEY	19	0	0	**19**	NA	**19**
	SAN RAFAEL	22	0	0	**22**	NA	**22**
	SAN SIMON WASH	1,500	0	400	**1,900**	NA	**1,900**
	SANTA CRUZ AMA	20,980	0	16,311	**37,291**	NA	**37,291**
	SHIVWITS PLATEAU	2	0	0	**2**	NA	**2**
	TIGER WASH	2	0	0	**2**	NA	**2**
	TONTO CREEK	3,000	900	500	**4,400**	NA	**4,400**
	UPPER HASSAYAMPA	3,286	0	600	**3,886**	NA	**3,886**
	UPPER SAN PEDRO	23,957	4,005	5,300	**33,262**	NA	**33,262**
	VERDE RIVER	28,549	14,845	6,200	**49,593**	NA	**49,593**
	VIRGIN RIVER	1,585	1,457	10	**3,052**	NA	**3,052**
	WESTERN MEXICAN DRAINAGE	6	0	0	**6**	NA	**6**
	WILLCOX	175,714	135	500	**176,349**	NA	**176,349**

Table 9. 2110 Supply (Area Split Cont.)

Basins Which Receive Part of Supply from the Colorado River or CAP		Instate: GW (c. 2006)		Instate: Instate SW (2001-2006 Avg. Diversions - 10%)	Instate: Effluent (Generated c. 2006)	Total Instate Supply		Colorado River/CAP Diversions: Normal Year[1]	Colorado River/CAP Diversions: Shortage Year[2]	Total Supply: Normal Year[1]		Total Supply: Shortage Year[2]		Colorado River Expected Return Flow: Normal Year[1]	Colorado River Expected Return Flow: Shortage Year[2]	Colorado River Consumptive Use: Normal Year[1]	Colorado River Consumptive Use: Shortage Year[2]
Instate + CR Upper	LITTLE COLORADO RIVER PLATEAU	95,813		13,246	36,100	**145,158**		46,604	46,604	**191,762**		**191,762**		1,604	1,604	45,000	45,000
Instate + CR Lower Mainstem	BILL WILLIAMS	3,251		450	200	**3,901**		654	464	**4,554**		**4,365**		237	165	417	299
	DETRITAL VALLEY	159		45	0	**204**		150	150	**354**		**354**		0	0	150	150
	KANAB PLATEAU	2,799		720	500	**4,019**		70	50	**4,089**		**4,069**		25	18	45	32
	LAKE HAVASU	47		0	3,400	**3,447**		37,010	26,528	**40,457**		**29,975**		13,578	9,732	23,432	16,796
	LAKE MOHAVE	2,007		0	3,100	**5,107**		72,242	51,887	**77,349**		**56,995**		24,553	17,603	47,689	34,285
	Lake Mohave (Tribal Ag)	0		0	0	**0**		103,535	103,535	**103,535**		**103,535**		47,570	47,570	55,965	55,965
	LOWER GILA	110,296		426	300	**111,022**		372,818	372,611	**483,841**		**483,633**		130,259	130,187	242,559	242,424
	PARKER	1,787		0	2,100	**3,887**		36,581	26,992	**40,468**		**30,879**		9,799	7,614	26,782	19,378
	Parker (Tribal Ag)	0		0	0	**0**		666,680	665,468	**666,680**		**665,468**		290,025	289,498	376,655	375,971
	YUMA	108,570		875	13,500	**122,945**		756,013	752,907	**878,958**		**875,852**		304,419	303,490	451,593	449,417
	Yuma (Tribal Ag)	0		0	0	**0**		17,197	17,197	**17,197**		**17,197**		4,793	4,793	12,404	12,404
	HARQUAHALA INA	66,178		0	0	**66,178**		0	0	**66,178**		**66,178**		0	0	0	0
Instate + CAP	**Major Active Management Areas (AMAs)**	**GW Low[3]**	**GW High[3]**	**Instate SW (CAM)**	**Effluent (Generated c. 2006)**	**Low**	**High**	**Normal Year[1]**	**Shortage Year[2]**	**Low**	**High**	**Low**	**High**	**Normal Year[1]**	**Shortage Year[2]**	**Normal Year[1]**	**Shortage Year[2]**
	PHOENIX AMA	590,160	673,755	665,395	315,000	**1,570,555**	**1,654,150**	895,395	703,579	**2,465,951**	**2,549,545**	**2,274,134**	**2,357,729**	0	0	895,395	703,579
	PINAL AMA	431,290	431,290	62,946	6,900	**501,136**	**501,136**	166,269	116,073	**667,405**	**667,405**	**617,209**	**617,209**	0	0	166,269	116,073
	TUCSON AMA	192,310	237,794	441	74,235	**266,986**	**312,470**	220,106	188,519	**487,092**	**532,576**	**455,504**	**500,988**	0	0	220,106	188,519
								170,148	168,718	**170,148**	**170,148**	**168,718**	**168,718**	0	0	170,148	168,718
		Central Arizona Project (CAP) Supply Range[4,5]						1,281,770 to 1,451,918	1,008,170 to 1,176,889	**1,281,770 to 1,451,918**	**1,281,770 to 1,451,918**	**1,008,170 to 1,176,889**	**1,008,170 to 1,176,889**	0	0	1,281,770 to 1,451,918	1,008,170 to 1,176,889
		Colorado Mainstem Environmental (Not Available For Cultural Supply)						104,339	104,339	**0**	**0**	**0**	**0**	61,409	61,409	42,930	42,930
		CAP System Loss = -5% of Diversion (Not Available For Supply)						67,462	53,062	**0**	**0**	**0**	**0**	0	0	67,462	53,062
	STATEWIDE	**2,520,635**	**2,649,714**	**907,092**	**504,436**	**3,932,163**	**4,061,242**	**3,733,272**	**3,398,683**	**7,493,634**	**7,622,714**	**7,173,445**	**7,302,524**	**888,271**	**873,683**	**2,845,000**	**2,525,000**

GW = groundwater
CR = Mainstem Colorado River Water
CAP = Central Arizona Project
Instate SW = Other Surface Water
Effluent = reclaimed water

1. Normal Colorado River Supply Available when the Elevation of Lake Mead = 1,075-1,145. In this case CAP and Priority 4 can use their full entitlements.
2. The first tier shortage of Colorado River Supply available when the Elevation of Lake Mead = 1,050-1,075. In this case CAP and Priority 4 consumptive use entitlements are reduced by a total of 320,000 acre-feet. Of that 90% is reduced from the CAP and 10% from Priority 4 Mainstem Users.
3. In the AMAs, a low and high groundwater supply corresponds with low and high industrial demands. If CAM GW Supply > Baseline (c. 2006), the GW Supply is = Baseline (c.2006). If CAM GW Supply < Baseline (c. 2006), the GW Supply = CAM GW Supply.
4. The first CAP value in the range represents the portion of Arizona's Lower Basin Colorado River Supply that is projected to be available after full on-river use of entitlements occurs. This value includes a 5% system loss expected from the point of diversion and the place of use. It is divided into the Phoenix, Pinal and Tucson AMAs for planning purposes in the Supply Vs. Demand tabulation and unmet demand analysis.
5. The second CAP value in the range represents the addition of water contracted to mainstem contract holders currently utilized by CAP pursuant to CAP's contract with the Secretary. Increased values in future years correspond to decreased values in the Yuma and Lower Gila basins based on a projected 7% decrease in non-Indian agriculture demand.
6. Positive values for (supply – demand) for Colorado River basins would be available for use by CAP or other Colorado River water users. No water would be left unused in the basin.

Note: In a Normal Year (Lake Mead Elevation = 1,075 to 1,145), AZ CU Entitlements = 2.8MAF, AZ use = 2.8MAF, Balance available = zero.
In a First Tier Shortage Year (Lake Mead Elevation = 1,050 to 1,075), AZ CU Entitlements = 2.48MAF, AZ use = 2.48MAF, Balance available = zero. Arizona will always use its full apportionment.

APPENDIX 6

WRDC TRIBAL WORKING GROUP REPORT

The Future of Water Resources in Arizona:

A Tribal Report

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The Future of Water Resources in Arizona:

A Tribal Report

"We have made water an insignificant part of our lives.

Unless we get back to respect the water as a giver of life,

the water problems will continue."

Vincent Randall, Tribal Leader, Yavapai-Apache Nation

Invocation, ITCA Water Round Table, November, 2007

INTRODUCTION

Water is a life-giving resource for all residents of Arizona. As the first people of this land, Indian people have known this longer than anyone else. For tribes, water is not only a material resource; it is prized for its spiritual value as well.

Indian tribes understand the importance of water. Over many centuries, they have seen its scarcity often -- scarcity resulting from acts of nature and from acts of man. Severe drought has destroyed many tribal communities. Upstream diversions and the withdrawal of groundwater from the land underneath tribal homelands have triggered famine and hardship.

Tribes are a major force with respect to water resource issues. Tribes hold rights to several million acre-feet of surface water and groundwater, rights which nearly always enjoy an earlier priority date than the rights of others to the same resource.

The more than 1.9 million acre-feet in currently quantified and perfected water rights, entitlements and claims listed later in this report are just the most visible of these rights. A number of tribes have yet to quantify their rights through litigation or settlement negotiations. Some tribes have settlements for only a portion of their lands. Other tribes have settlements that confirm rights to amounts of water, including groundwater, which may not be assigned a "quantified" number. In addition, as development occurs over the next 100 years, tribes, like others, may seek additional supplies necessary for tribal communities to grow.

The tables in this report and those elsewhere in the Commission's work focus on numbers, numbers based on the best projections that many experts could develop. However, it is important to understand that these numbers don't tell the complete story, particularly when it comes to the extent of tribal water rights.

Resolving imbalances between future water needs and future water supplies must include tribes as full and equal partners on a local, regional and statewide basis. A precondition of tribal collaboration is that all parties recognize that all the water to which tribes have rights is to be regarded as just that -- tribal water and not water which other parties can assume will be available for their use. This principle prevails whether or not tribal rights are currently quantified and whether or not the use of tribal water may currently be leased to others.

Tribes have been active and willing partners in resolving water issues. Negotiations over the settlement of tribal claims customarily involve scores of other users. The successful conclusion of those negotiations has brought certainty to everyone as to what water they can legitimately claim, now and in the future.

In addition, tribes have worked together over the years with state agencies, local governments and private developers on joint projects to enable Arizona to grow, to protect the environment and to make the most efficient use of the scarce water resources within the state.

METHODS

The Origin and History of Tribal Water Rights

Tribal rights to water flow from a number of sources. These include:

- Aboriginal rights
- Treaty rights
- Federal reserved rights
- Rights confirmed in court decrees
- Rights confirmed in federal or state legislation, including legislation ratifying or amending tribal water settlements
- Rights established by administrative action
- Contract rights

Tribes occupied this land and enjoyed the use of water from time immemorial. The right of tribes to use water is one of a bundle of vested property rights included in full beneficial title to their lands. These rights are associated with the use of water resources that traverse, underlie and border tribal lands. These rights are not judicially created, but are pre-existing vested property rights that have been effectively confirmed by judicial, legislative and executive action on the part of the government of the United States and the government of the state of Arizona.

Tribes have long asserted their water rights, drawing on their aboriginal and treaty rights and on a US Supreme Court opinion in a case involving the use of the Milk River in north central Montana. In that landmark case, *Winters v. US*, 207 U.S. 564 (1908), the court found that when the federal government creates an Indian reservation it implicitly reserves the right to use a sufficient amount of water to fulfill the purposes of the reservation.

This doctrine of federal reserved water rights for reservation areas was reaffirmed in a number of subsequent court decrees. For the tribes with land in Arizona, the 1963 decision of the US Supreme Court in the case of *Arizona v. California* is particularly important.

In its initial decision in that case, the high court said:

> "It is impossible to believe that when Congress created the great Colorado River Indian Reservation and when the Executive Department of this Nation created the other reservations they were unaware that most of the lands were of the desert kind - hot, scorching sands - and that water from the river would be essential to the life of the Indian people and to the animals they hunted and the crops they raised."

The Court went on to assert that it would follow the decision in the *Winters* case, saying "We follow it now and agree that the United States did reserve the water rights for the Indians effective as of the time the Indian Reservations were created."

The protection extended to tribal water by the federal reserved water rights doctrine has been reaffirmed by the Arizona Supreme Court, notably in decisions regarding issues raised in the Gila River general stream adjudication.

Indian water law, like water law generally, initially evolved around situations related to the rights to surface water. In Arizona, surface water is an essential part of the total water resources. At the same time, groundwater plays an equally or even more important role in many parts of the state.

Although in Arizona there are significant legal distinctions between them, the courts have found that groundwater rights, like surface water rights, are part of a tribe's federal reserved water rights. The Arizona Supreme Court confirmed in 1999 that "federal reserved rights extend to groundwater to the extent groundwater is necessary to accomplish the purpose of a reservation." (See *In Re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 195 Ariz. 411, 989 P.2d 739 (1999).)

Initially, tribal water rights were commonly confirmed and quantified through litigation. As time went on, precedents grew and the fundamental principles of tribal water rights became better understood.

Starting in 1978, a number of the tribes in Arizona whose water rights had not previously been quantified acted to establish their water rights through negotiated settlements. Often taking many years to conclude, these settlements were developed in accordance with two well-established legal standards.

One, used in the *Arizona v. California* decision, considers the amount of "practicably irrigable acreage" on the reservation and quantifies tribal water rights on this basis.

The other takes into account the water required for the establishment of a "permanent tribal homeland," that includes, but is not limited to, current and future water necessary for domestic, commercial, industrial, agricultural, cultural and religious purposes. The Arizona Supreme Court has confirmed this standard for quantifying tribal water rights as the water necessary to maintain a tribe in its permanent tribal homeland. (See *In Re the General Adjudication of All Rights to Use Water in the Gila River System and Source*, 201 Ariz. 307, 35 P.3d 68 (2001).)

Special Characteristics of Tribal Water Rights

Under the *Winters* doctrine, federal reserved water rights involving tribes have a number of distinctive aspects to them.

The rights are considered as having been established as of the date the federal government created the reservation involved. This means that tribal rights are nearly always senior to those of most other current users of the same water resource.

The rights cannot be forfeited by non-use, as can rights held under state law according to the principle of "prior appropriation."

Although the scope of these rights is often quantified as being the amount of water necessary to support the "practically irrigable acreage" on a reservation, the rights, once quantified, can be used for non-agricultural purposes. The courts have also established the need for tribal water to support permanent tribal homelands as an additional measure of the scope of tribal water rights.

Consistent with the idea of permanent tribal homelands, the rights involve the future needs of a reservation, not just present needs.

Along with the right to use water on-reservation, tribes also have the right to lease their water off-reservation.

However, tribal water settlements confirmed by Congress frequently stipulate the circumstances under which tribes can lease or use water off-reservation. This is generally the situation in Arizona, where use and leasing provisions vary from settlement to settlement.

As permitted by law, tribes may lease the use of water to which they hold rights. Tribes may also exchange water to which they hold rights for a different supply. These situations are particularly common among tribes with entitlements to Central Arizona Project (CAP) water. Leases are negotiated only with the consent of the tribal government involved. The leaseholders are subject to the terms and conditions of the lease.

It is important to note that tribes cannot sell or permanently relinquish their water rights without the explicit consent of Congress.

RESULTS AND DISCUSSION

Currently Quantified Tribal Water Rights

Data showing the currently quantified tribal water rights and entitlements is provided in Table 1., "Summary of Currently Quantified Tribal Water Rights & Entitlements," in the Appendix.

The summary is derived from information on the public record. Three principal sources were used:

The tabulations produced by the US Bureau of Reclamation showing the holders of priority rights to the Arizona apportionment of water from the mainstem of the Lower Colorado River. The tabulations were obtained from the Web site for BOR's Lower Colorado Region, http://www.usbr.gov/lc/ and carry a 2010 date.

The portion of the Central Arizona Project Subcontracting Report dated April 1, 2011 covering CAP Indian Contracts, obtained from CAP's Web site, http://cap-az.com/Operations/Allocations.aspx.

Copies of settlement legislation and related documents for the various tribal water settlements ratified by the US Congress involving tribal land within Arizona.

Tribal leaders and their representatives also provided supporting information for the Fort McDowell Yavapai Nation, the Navajo Nation, the Pascua Yaqui Tribe, the San Carlos Apache Tribe, the Tohono O'odham Nation and the Yavapai-Apache Nation.

The amounts in the "All Other Quantified/Claimed Sources" column include amounts of in-state surface water, groundwater and effluent that are shown in the settlements. In the cases of the Pascua Yaqui Tribe and Yavapai-Apache Nation, the amounts include those listed in the Statement of Claimant submitted by the US on behalf of these tribes, or by the tribe itself in the Gila River general stream adjudication.

It should be noted, however, that for tribes that have not yet quantified their water rights through litigation or negotiation, the tribe's Statement of Claimant may be amended in the pending Arizona general stream adjudications. Since the initial claims were submitted in the 1980's, the Arizona Supreme Court has established clearer standards for the water required to fulfill the "permanent tribal homeland" purposes. Therefore, such claims may be amended in the future, and the numbers presented cannot be completely relied upon as a final statement of projected tribal demands.

The amounts shown in Table 1. for mainstem Colorado River water represent amounts from the Arizona apportionment of water from the River. The Colorado River Indian Tribes, Fort Mojave Indian Tribe, Navajo Nation and Quechan Indian Tribe also have rights to Colorado River water apportioned to other states. These amounts are not shown in this table. In the case of the Navajo Nation, its rights include potential rights to

50,000 acre-feet of water apportioned to Arizona from the Upper Basin.

The rights and entitlements belong to tribes for their tribal land. The terms of the decrees or settlements involved do not divide the water by groundwater basins or by county areas.

Tribal Water Rights Not Currently Quantified

The currently quantified tribal water rights add up to a substantial portion of the water resources in Arizona. Equally important and too easily forgotten are the tribal water rights that are not currently quantified.

Simply because there are no final numbers attached to them does not mean that these rights are any less real or that this water is available for the use of others without tribal consent.

There are eleven federally recognized tribal governments with land in Arizona whose rights have yet to be fully adjudicated or quantified through settlements. The tribes are:

- Havasupai Tribe
- Hopi Tribe
- Hualapai Tribe
- Kaibab Band of Paiute Indians
- Navajo Nation
- Pascua Yaqui Tribe
- San Carlos Apache Tribe
- San Juan Southern Paiute Tribe
- Tohono O'odham Nation
- Tonto Apache Tribe
- Yavapai-Apache Nation

The current settlements and entitlements of the Hopi Tribe, the San Carlos Apache Tribe and the Tohono O'odham Nation do not cover all portions of their reservations or all of their claims.

The White Mountain Apache Tribe has a settlement that has been incorporated into enacted federal legislation, but is not yet completely final.

As noted earlier, both federal and state court decisions have clearly affirmed tribal rights to groundwater. The amount of this water has not been quantified except in a limited number of cases.

The total amount involved is significant. Tribal land covers 28% of all land within the state of Arizona. Groundwater is commonly used for domestic, commercial, agricultural and other purposes. This means that such water is necessary to accomplish the purposes for which the reservations were created -- a key legal test of the tribal right to groundwater.

Future Tribal Demand

The work of the Water Resources Development Commission is focused on future water needs -- needs extending 25, 50 and 100 years into the future. The needs over this time frame of each water-using sector have been estimated as accurately as possible.

Tribal communities, like other communities, are likely to need additional water in the future. Moreover, there are a number of factors unique to tribal lands that make the prediction of future needs particularly difficult. Several of these arise from the deep attachment of tribal people to their homelands.

In the municipal sector, tribal needs can be expected to increase as a result of natural population growth. Tribal members living in off-reservation areas may return to their homelands as development efforts produce additional employment opportunities, improved education and better medical care. In those reservation communities where homes do not currently have safe drinking water piped into the house, future hook-ups to municipal water systems are likely to increase per capita daily use to levels that more closely resemble those in off-reservation communities.

In the agricultural sector, reservations still have opportunities to put additional land into cultivation. This will require water, with some needs met by water included in current settlements and other needs that may arise in the future requiring additional water.

In the industrial and enterprise sector, reservations have potential in many areas. These include exciting opportunities in renewable power, wind in some places, solar in others. Growth in tourism also calls for facilities that need water.

Some tribes are struggling to improve the viability of their communities by adding additional land badly needed for both residential and economic development.

Even though negotiated settlements try to look far into the future in determining the extent of tribal water needs, they have been and, in all probability, will continue to be subject to revision as previously unforeseen circumstances arise.

Any analysis of tribal water needs must fully consider the totality of water rights not currently quantified, together with the likelihood of future needs to support permanent tribal homelands.

The Navajo Nation has completed an extensive study of its future water needs. The Western Navajo Hopi Water Supply Needs, Alternatives and Impacts report projects water needs by sector and community at ten-year intervals from the year 2010 through 2100. Those needs for the Arizona portion of the reservation have been provided to the Water Resources Development Commission and are shown in Table 2 of this report. They illustrate the increase in projected use attributable to population growth, economic development and other factors.

Additional Considerations

Tribal water needs have sometimes been projected using data that has not been supplied or verified by tribes, data that is out of date or incomplete and data that is not consistent with the intent of tribes to use the full amounts of water to which they have rights.

The most complete inventory of water data in the state of Arizona is the Arizona Water Atlas. Tribal water use is discussed in a number of the volumes of the Atlas. However, tribes were not contacted individually in collecting the information used, nor were they asked to confirm the data that was used. The Atlas does not take tribal water rights into account.

The gap between the amount of tribal water use estimated in the Atlas and the amount to which tribes have currently quantified rights is significant. The various volumes of the Atlas show tribal water use at less than 380,000 acre-feet for the AMA Planning Area. In contrast, tribes in that Planning Area have rights to nearly 980,000 acre-feet of water. The Arizona Water Atlas should not be used by the Commission to project tribal water needs.

Similarly, existing "build out" schedules and computer models are inappropriate for use in projecting tribal water needs. These schedules do not always reflect the full amounts of water to which tribes have currently quantified rights. Nor do they reflect the amounts of water to which tribes have rights that are yet to be quantified.

Projections based on data in the Arizona Water Atlas or on "build out" schedules have the unfortunate effect of mistakenly implying that water to which tribes have rights may be available for use by others without tribal consent.

Tribal Collaboration in Water Resource Development Projects

Tribes have been strong and constructive partners in projects developing water resources for non-tribal as well as tribal communities.

As noted early in this report, the willingness of tribes to negotiate water settlements has benefitted everyone in the state. Negotiated settlements provide certainty and remove the cloud over water used by others that was previously a result of tribal claims. In every case, the amounts agreed to have been less -- sometimes a great deal less -- than the amounts which might have been achieved in court based on aboriginal rights, treaty rights and the doctrine of federal reserved rights.

Tribal willingness to work as full partners with others in putting water to good use for the benefit of all Arizonans is long-standing and continues to this day. The following are simply a few of the many examples of this tribal collaboration.

The city of Phoenix has operated a water treatment facility on the banks of the Salt River for nearly 50 years. That land is leased for that use by the Salt River Pima-Maricopa Indian Community. Treated water from that facility is conveyed across the Community in a pipeline delivering water to households in the city.

Following the passage of the first federal tribal water settlement legislation in 1978, the Ak-Chin Indian Community negotiated an agreement to lease a relatively small portion of its water to the Del Webb corporation. Del Webb needed water to build what became the Anthem community north of Phoenix. The terms of the lease provided water for the growth of a non-Indian community, while enabling the tribe to receive compensation for water not needed in the near future on its reservation.

Tribes throughout Arizona were the first to care for the environment. Riparian restoration is a prominent goal for tribes that still have water flowing across their lands. A major project has now come to fruition in southwest Arizona, thanks to a partnership between the Quechan Indian Tribe, the City of Yuma and the Yuma Crossing National Heritage Area. The reservation side of the project includes the newly opened Anya Nitz Pak (Sunrise Point) Park, complete with an Elder Village to educate local youth about traditional Quechan life ways. The Yuma side of the project includes the Yuma East Wetlands park and trail.

Tribes join with other communities and with the state in looking forward to opportunities for collaboration as full partners on future water development projects that serve all Arizona residents.

CONCLUSIONS

Indian tribes have prior and paramount rights to the use of a very substantial amount of the water resources allocated to or within the state of Arizona. Some of these rights have been quantified; some remain to be quantified. All water covered by these rights must be included in any baseline estimate of water resources or any projection of future water demands.

Water to which tribes have federal reserved or other rights, whether quantified or not, cannot be considered as water available to other users, now or in the future.

Tribes, as sovereign nations, must be given the opportunity, independent representation and ability to become fully involved as equal partners in the development of future water legislation as well as studies, research and projections involving water resources in the state of Arizona.

Table 1. Summary of Currently Quantified Tribal Water Rights & Entitlements*

(volumes presented in acre-feet)

Tribe	Arizona Apportionment Colorado River Mainstem	Central Arizona Project	All Other Quantified/ Claimed Sources	Total of Amounts Shown
Ak-Chin Indian Community	50,000	25,000		**75,000**
Cocopah Tribe	10,847			**10,847**
Colorado River Indian Tribes	662,402			**662,402**
Fort McDowell Yavapai Nation		18,233	18,117	**36,350**
Fort Mojave Indian Tribe	103,535			**103,535**
Gila River Indian Community		328,800	324,700	**653,500**
Havasupai Tribe	Water rights not currently quantified, no adjudication pending			
Hopi Tribe	6,028			**6,028**
Hualapai Tribe	Water rights not currently quantified, no adjudication pending			
Kaibab Band of Paiute Indians	Water rights not currently quantified, no adjudication pending			
Navajo Nation - Upper Colorado River Basin (AZ apportion 50,000 af) (see NN water demands - Table 2)	Water rights not currently quantified, no adjudication pending			
Navajo Nation - Lower Colorado River Basin (see NN water demands - Table 2)	Water rights not currently quantified, negotiations pending Pending	Pending		**Pending**
Navajo Nation - Little Colorado River Basin	Water rights not currently quantified, adjudication pending Negotiations pending			
Pascua Yaqui Tribe ** ***		500	3,520	**4,020**
Pueblo of Zuni			7,000	**7,000**
Quechan Indian Tribe	6,350			**6,350**
Salt River Pima-Maricopa Indian Community	22,000	13,300	87,100	**122,400**
San Carlos Apache Tribe (partial water settlement)		64,145	13,300	**77,445**
San Juan Southern Paiute	Water rights not currently quantified, no adjudication pending			
Tohono O'odham Nation (partial water settlement)		74,000	13,200	**87,200**
Tonto Apache Tribe **		128		**128**
White Mountain Apache Tribe		25,000	27,000	**52,000**
Yavapai-Apache Nation ** ***		1,200	6,848	**8,048**
Yavapai-Prescott Tribe		500	1,000	**1,500**
Totals	**861,162**	**550,806**	**501,785**	**1,913,753**

*** Some data may be approximate.**

**** Data for Pascua Yaqui Tribe, Tonto Apache Tribe and Yavapai-Apache Nation include CAP entitlements.**

***** Data for Pascua Yaqui Tribe and Yavapai-Apache Nation include water claims.**

Table 2. (June 16,2011)

Navajo Nation Water Demands (AFA)

YEAR	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
DCM	14,988	24,524	34,767	48,253	61,647	76,851	95,534	118,759	147,630	183,520
INDUSTRIAL (footnote 1)	53,923	54,923	62,923	60,864	60,945	60,970	60,970	60,970	60,970	60,970
AGRICULTURAL_IRRIGATION	41,347	41,347	41,747	50,688	57,863	64,734	72,634	80,017	82,608	84,834
MISCELLANEOUS	6,618	6,618	7,018	7,091	7,563	7,636	8,508	8,581	9,381	9,381
TOTAL	**116,876**	**127,412**	**146,455**	**166,896**	**188,018**	**210,191**	**237,646**	**268,327**	**300,589**	**338,705**

Coconino Plateau	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
DCM	425	674	929	1,261	1,569	1,912	2,339	2,871	3,531	4,352
INDUSTRIAL	0	0	0	0	0	0	0	0	0	0
AGRICULTURAL_IRRIGATION	0	0	0	0	0	0	0	0	0	0
MISCELLANEOUS	0	0	0	0	0	0	0	0	0	0
CP subtotal	**425**	**674**	**929**	**1,261**	**1,569**	**1,912**	**2,339**	**2,871**	**3,531**	**4,352**

LCR Plateau	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
DCM	14,563	23,850	33,838	46,992	60,078	74,939	93,195	115,888	144,099	179,168
INDUSTRIAL	53,923	54,923	62,923	60,864	60,945	60,970	60,970	60,970	60,970	60,970
AGRICULTURAL_IRRIGATION	41,347	41,347	41,747	50,688	57,863	64,734	72,634	80,017	82,608	84,834
MISCELLANEOUS	6,618	6,618	7,018	7,091	7,563	7,636	8,508	8,581	9,381	9,381
LCR subtotal	**116,451**	**126,738**	**145,526**	**165,635**	**186,449**	**208,279**	**235,307**	**265,456**	**297,058**	**334,353**

HDR Engineering Inc., Western-Navajo Hopi Water Supply Needs, Alternatives, and Impacts, Volume 2, Task 4.1, May 2003

Table 9: Estimate of Annual Navajo M&I Demand (Acre-Feet), Midrange Rates of Population Growth,

Assuming Growth Towards Population Centers, and Ramped-Up Water Usage.

1. Industrial includes Navajo Generating Station use of 34,100 AFA added to the HDR data for LCR Plateau

APPENDIX 7

COMMITTEE MEMBERS/AFFILIATION

COMMITTEE MEMBERS/AFFILIATION

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Adam Miller/ City of Phoenix

Alan Dulaney/City of Peoria

Amelia Homewytewa/Gila river Indian Community

Bas Aja/Arizona Cattle Feeders Association

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Bill Wells/Bureau of Land Management

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Brenda Burman/The Nature Conservancy

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Brian Munson/ASARCO

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Cheryl Lombard/The Nature Conservancy

Chip Howard/Turf Science

Chip Sherrill/Mohave County

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Christine Dawe/United States Forest Service

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Colette Moore/City of Mesa

Cynthia Chandley/Snell and Wilmer

Cynthia Stefanovic/Arizona State Land Department

Dave Slick/Salt River Project

David Gomez (Supervisor)/Greenlee County

Dean Mair/Collie Canyon

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Jeff Johnson/Town of Taylor

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John Sellers/Yavapai Regional Capital

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Reland Kane/Tucson Electric Power

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Wally Wilson/City of Tucson

Yvonne Pearson/Greenlee County

Water Resources Development Commission
Finance Working Group
Report

Working Group Chair:
David Snider, Pinal County Supervisor
August 2011

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INTRODUCTION

In 2010, the Arizona Legislature passed H.B. 2661, which created the Water Resources Development Commission for the purpose of assessing the current and future water needs of Arizona. As a part of this effort the WRDC created four working groups to address specific objectives associated with the assessment. One of those four groups was the Finance Work Group. The Finance Work Group has been tasked with identifying potential mechanisms to finance the acquisition of water supplies and the infrastructure necessary to treat or deliver the projected needed water identified.

OBJECTIVE

The Water Resources Development Commission (WRDC) assigned the following objective with its associated tasks to the Finance Work Group (FWG):

Objective 1

Identify potential mechanisms to finance the acquisition of water supplies and infrastructure necessary to treat or deliver the identified water supplies. Associated with Objective 1 are four tasks that will be addressed in this report. The four tasks are as follows:

1. For the water supplies identified that could be developed within or imported into each basin region, identify the infrastructure required considering any technical issues identified.
2. Develop cost estimates for the required infrastructure.
3. Identify potential financing mechanisms based upon differing cost estimates.
4. Prepare summary of findings of recommendation including needed studies and research by May 31, 2011.

RESULTS

Task 1: For water supplies identified that could be developed within or imported into each basin region, identify the infrastructure required considering any technical issues identified.

The following Table (Table 1) was developed by the Water Supply and Demand Work Group where it was labeled Table 17 and entitled "Additional Water Supplies That May Potentially Be Developed." It identifies potential sources of supply to be considered for development and the potential infrastructure component requirements associated with each potential source of supply.

Table 1. Additional Water Supplies That May Potentially Be Developed

Potential Source of Supply	Potential Issues	Potential Infrastructure Requirements
Conservation	Costs	Lining or Relining Canals, Greywater systems, water use and monitoring equipment, water savings devices and equipment
Groundwater (Within Basin)	Available GW in Storage Current GW Basin Overdraft Aquifer heterogeneity/productivity Water Quality Land Subsidence and Earth Fissures GW/SW Impacts Colorado River Accounting Surface Impacts Environmental Tribal Rights and Claims Groundwater Right and Well Drilling Rules Costs to Drill Wells and to Pump, Treat and Transport Groundwater	Wells Pipelines Storage Facilities Treatment Facilities
Groundwater (Import)	Same as Above Plus Inter-basin GW Transfer Restrictions	Same as Above
Surface water (In-state)	Physical Availability of SW Physical Availability of New Dam and Reservoir Sites Costs to Construct and Operate New SW Diversion and Transport Infrastructure Water Quality Environmental Costs to Treat SW SW Rights (Acquisition) Tribal Rights and Claims	Dams Diversion Works Pipelines Canals Treatment Facilities
Surface water (Colorado River)	Physical Availability of CR Water Water Quality Costs to Treat CR Water Environmental Tribal Rights and Claims Colorado River Entitlements (Acquisition)	Diversion Works Pipelines Canals Treatment Facilities
CAP	Physical Availability of CAP Water Proximity to CAP Canal Tribal Rights and Claims Costs to Treat CAP Water Priorities in Times of Shortage	Diversion Works Pipelines Canals Treatment Facilities
Effluent	Water Quality Treatment and transport costs	Sewer systems Lift stations Pipelines WWTPs
Other Supplies:		
Mine Drainage	GW/SW Impacts Water Quality Treatment and transport costs	Same as for GW
Agricultural Drainage	GW/SW Impacts Water Quality Treatment and transport costs	Same as for GW
Desalination/Ocean Water	International and Interstate Water Transfer Issues Infrastructure and Treatment Costs Ownership of Water Availability of Electric Power	Desalination Plants Pipelines Brine Disposal Systems
Desalination/Brackish Water	Costs Federal Regulations Availability of Electric Power	Desalination Plants Pipelines Brine Disposal Systems
Weather Modification	Technical Feasibility Cost	Ground based Silver Iodide Generators

Task 2: Develop cost estimates for the required infrastructure.

For infrastructure components identified in Table 1, a range of cost estimates associated with each infrastructure component has been developed and has been included in Table 2. The variability in the range of costs is associated with size and capacity of infrastructure required to facilitate the transfer, treatment and delivery of water. Pipe materials and placement constitute the majority of costs for water conveyance systems, approximately 60% to 70% of the total cost of the system. The remaining 30% to 40% will usually cover all other associated features; pumping plants, pressure reducing stations, vaults, sectionalizing valves, electric power, O&M roads, etc. The acquisition of the identified potential supplies will increase the total cost of water development projects over and above the cost of infrastructure.

In addition to the individual infrastructure components, the FWG also identified seven potential infrastructure projects to use as examples for what the potential range in costs for large regional water supply infrastructure projects might be. The specific costs of these projects and others that may be developed in other areas of the state will vary based on the requirements of each individual project. The seven examples of potential water supply projects were developed as part of water supply appraisal studies (Appraisal Study) conducted by the Bureau of Reclamation working in conjunction with the Arizona Department of Water Resources (ADWR) and local watershed partnerships. (See Appendix A, Table 1 for a listing of water supply projects previously identified.)

As part of the State's Rural Watershed Initiative Program, instituted in 1999, ADWR has actively pursued completing Appraisal Studies with the Bureau of Reclamation (BOR) and watershed partnerships in areas where additional water supplies were presumed to be needed to meet projected new demands or to supplement local water supplies that are over used (Figure 1). Currently, all water demands are being met, but in some cases the water supplies are being used at an unsustainable rate.

Examples of the over-use of groundwater can be found in some of the State's Active Management Areas (AMAs), which were created specifically to reduce the historical overdraft of groundwater to meet local demands, and in areas that have environmental preservation goals such as the Sierra Vista Subwatershed of the Upper San Pedro Groundwater Basin. Although significant progress has been made to reduce the overdraft of groundwater in the five AMAs groundwater overdraft is still occurring. In the example of the Sierra Vista Subwatershed there is estimated to be around 20 million acre-feet of groundwater in storage and the current overdraft of the groundwater system from pumping and from natural withdrawals resulting from evapotranspiration is estimated to be around 6,000 acre-feet per year (AFY). This volume of overdraft seems rather insignificant in comparison to the volume of groundwater in storage, but continued overdraft of the groundwater system will eventually lower the elevation of the groundwater to a point where it will eventually impact the base flows in the San Pedro River.

The watershed/regions where the water supply appraisal studies (Appraisal Study) have been completed are the Coconino Plateau, the Mogollon Highlands, and the Sierra Vista Subwatershed of the Upper San Pedro groundwater basin. A fourth Appraisal Study is currently being conducted in the Verde River Watershed and is due to be complete by the end of 2011. The following Figure 1 identifies the watershed/regions where Appraisal Studies have been completed or are in the process of being completed.

An Appraisal Study is very similar in scope to the WRDC's current statewide water supply and demand assessment effort, except that an Appraisal Study focuses on a specific watershed/region for a shorter time period. The objectives of an Appraisal Study are to: 1) identify the current and projected water supplies and demands for a watershed/region over a 50 year time frame, 2) determine whether or not an unmet water demand is projected to occur over the 50 year time frame, 3) determine if there is at least one potential alternative solution to address any projected unmet water demands, 4) develop cost estimates for the required infrastructure for each alternative solution identified, and 5) determine if there is a nexus between the federal government and the identified alternative solution(s) to warrant a feasibility study being conducted.

In the three Appraisal Studies completed thus far a total of 18 alternative water supply projects were initially identified to meet the projected unmet water demands of the three areas. The sources of water identified to be developed for the 18 alternatives included intra-basin groundwater of good quality, brackish groundwater, groundwater within inactive mining districts, groundwater in adjoining groundwater basins, Colorado River water, local surface water, and enhanced recharge through storm water capture. The 18 alternatives were reduced to seven after a thorough evaluation based on the following four criteria: acceptability, effectiveness, efficiency, and completeness. The completion of a feasibility study conducted by the BOR of all seven alternative water supply projects has been recommended by the local watershed partnerships.

The volume of water proposed to be developed for each of the seven alternative water supply projects ranges from 1,800 to 30,000 AFY. The sources of water proposed to be developed were Colorado River water, intra-basin groundwater, groundwater from inactive mining districts, and enhanced recharge from storm water capture. Two of the seven alternative water supply projects if developed would have to be supplemented by an additional project in order to meet the total projected unmet water demands for the watershed/region over a 50 year time frame. (See Appendix A, Table 1 for a description of the alternative water supply projects that were identified and recommended in the Appraisal Studies. See Appendix A, Figures 1 thru 6 for maps of the of the six alternative water supply projects identified and recommended in the Appraisal Studies.)

Table 2. Cost Estimates for Infrastructure Components

Infrastructure Components	Cost Estimate
Lining or Relining Canals	$31 per square yard (assumes 3.5 inch thick concrete)
Wells	10" diam well, 6-inch casing, 250 feet deep - $120 per foot, MR* 16" diam well, 10-inch casing, 1000 feet deep - $85/foot, MSR* 18" diam well, 10-inch casing, 1200 feet deep - $267/foot MSSL 20" diam well, 16-inch casing, 500 feet deep $286/foot, MSR
Pipelines (PVC - 125 psi to 300 psi)	3 inch - $18 per foot 24 inch - $200 per foot 48 inch - $580 per foot
Excavation of Trenches for Placement of Pipelines for Conveyance of Water or Wastewater	Common materials (trench with light equipment) - $4/cubic yard Soft rock (excavator or rock trencher required, some dozer ripping) - $20/cubic yard Hard rock (Blasting required) - $60/cubic yard
Storage Facilities (steel tanks)	Less than 400,000 gallons - $1/gallon 400,000 to 1,000,000 gallons - $0.85/gallon 1,000,000 gallons and greater - $0.70/gallon
Treatment Facilities (conventional)	Capacity (million gallons/day) — Capital Cost ($ Millions) 1.5 — $3.18 1.0 — $4.45 2.0 — $5.90 1.02 — $8.90 1.59 — $12.71 1.54 — $15.44 91.30 — $46.31
Treatment Facilities (membrane filter)**	Capacity (million gallons/day) — Capital Cost ($ Millions) 20 — $39 40 — $59 60 — $77 80 — $97
Dams	No cost estimate available
Canals	
Sewer Systems	Highly variable and dependent upon size and complexity of system. Pipeline and excavation costs previously identified can be used to estimate costs.
Recharge Facilities	20,000 AFY - $ 8.50 Million 40,000 AFY - $12.22 Million 60,000 AFY - $16.78 Million
Desalination Plants***	91.5 MGD plant - $125.97 Million to $155.56 Million 150 MGD plant - $183.46 Million to $210.81 Million
Brine Disposal Systems***	Costs vary based on the size and type of disposal system, which include: discharge to oceans, deep well injection, evaporation ponds, brackish wetlands, etc. For the 91.5 MGD plant identified above the estimated cost for disposal ranged from $47 Million to $266 Million
Silver Iodide Land Based Generators	$10,000 to $50,000+ per generator

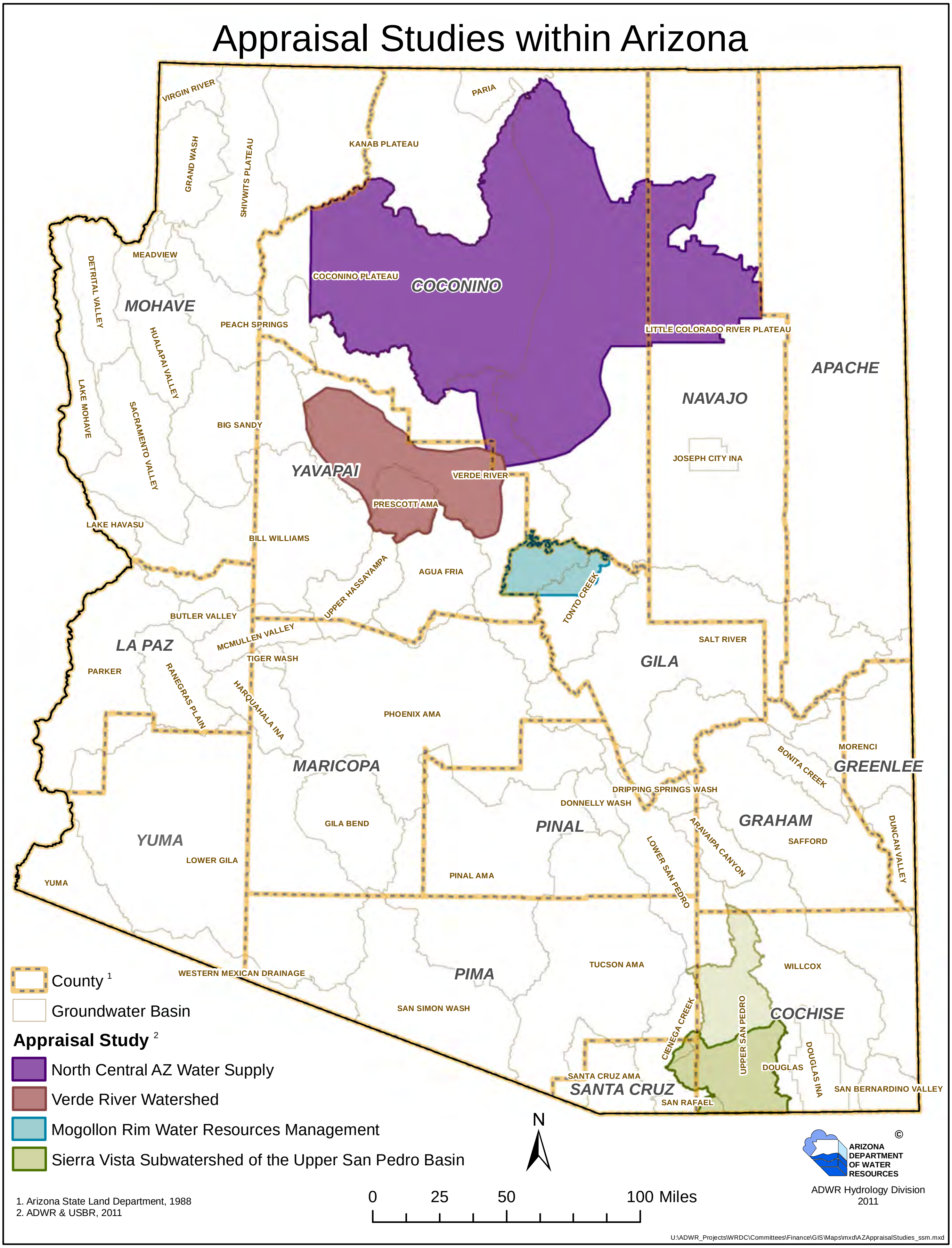
Appraisal level cost estimates for components were developed by the Bureau of Reclamation 2011 (See Appendix A for Summary of Unit Costs for Typical Water Conveyance and Treatment Systems, August 11, 2011).

* MR = moderate rock; MSR = moderately soft rock; MSSL = moderately soft sandstone and limestone

** Both treatment costs adjusted to ENR CCI 9080 (July 2011). Membrane costs have been escalated from 2006 costs.

***"Reverse Osmosis Treatment of Central Arizona Project Water", Appraisal Evaluation, Bureau of Reclamation January, 2004

Figure 1. Location of Appraisal Studies conducted within Arizona



A detailed cost estimate was developed for all but one of the seven alternative projects that included capital construction and O&M costs. The total estimated cost of construction in 2006 dollars ranged from a low of $34 million to a high of about $650 million. The estimated total cost for construction of each of the seven projects is presented in Table 3. For each alternative water supply project, the estimated cost per acre-foot and cost per 1000 gallons were also determined by dividing the total annual project costs by the annual volume of water proposed to be delivered in acre-feet and gallons. The total annual project cost was based on the present worth value in 2006 dollars. For the Coconino Plateau alternatives, the present worth value was based on a 50 year project life and an interest rate of 5.125 percent. For the Sierra Vista Subwatershed alternatives, the present worth value was based on a 20 year project life and an interest rate of 4 percent. The project's total present worth included estimated O&M and energy costs. The estimated cost per acre-foot and per 1000 gallons for each project is presented in Table 4.

Table 3. Estimated Capital Construction Costs in 2006 Dollars

	Coconino Plateau			Mogollon Highlands	Sierra Vista Subwatershed		
	Alternative 1 (million)	Alternative 2 (million)	Alternative 3 (million)	Alternative 1 (million)	Alternative 1 (million)	Alternative 2 (million)	Alternative 3 (million)
Capital Construction Costs	$471,000	$621,000	$650,000	$33,862	$41,600	$193,070	NA

Table 4. Estimated Annual Cost for Treatment and Delivery of Water in 2006 Dollars

	Coconino Plateau			Mogollon Highlands	Sierra Vista Subwatershed		
	Alternative 1	Alternative 2	Alternative 3	Alternative 1	Alternative 1	Alternative 2	Alternative 3
Cost per Acre-Ft	$1,479	$2,116	$2,265	$1,799	*$1,635 & $2,397	$1,233	$2,675
Cost per 1000 Gals.	$4.54	$6.50	$6.95	$5.52	*$5.02 & $7.36	$3.78	$8.23

* Range of cost based on the development 2,600 and 1,800 AFY

(See Appendix A, Table 2 for an example of a detailed listing of the specific infrastructure components associated with the Coconino Plateau Alternative 1 water supply project and the estimated cost of each infrastructure component. See Appendix A, Table 3 for a listing of the Total Project Worth, including the projected O&M costs for the three Alternatives identified for the Coconino Plateau Appraisal Study.)

In addition to the seven alternative water supply projects identified in Tables 3 and 4 active planning and supply acquisition has been occurring to transport groundwater from the Big Chino sub-basin area to cities within the Prescott AMA. The estimated cost of a proposed pipeline to deliver 8,068 AFY of groundwater from the Big Chino Sub-basin to the cities of Prescott and Prescott Valley is about $170 million. (See Appendix A, Figure 7 for a map of the proposed project.) There have also been some preliminary discussions of extending any pipeline that might be built to supply water to Flagstaff from Lake Powell into the Verde Valley and to the Prescott AMA cities. Preliminary appraisal cost estimates for a pipeline from Lake Powell to the Verde Valley and tri-cities areas capable of delivering up to 78,000 AFY to the communities on the Coconino Plateau, the tri-cities area in the Prescott AMA and the communities in the Verde Valley is more than $1.2 billion. The estimated cost of $1.2 billion does not include the cost of the water supply, which has yet to be identified. The Water Supply and Demand Work Group has identified other areas of the State, both inside and outside of AMAs, where future water supply development projects may be needed to meet the projected demands.

Other long-term projects that have been informally discussed or considered and may eventually be evaluated in more detail include the development of desalination plants along the coasts of California and Mexico (see Appendix B for an example of a desalination project in Mexico). In both cases the water developed by the project would most likely involve a water exchange in order to minimize the costs that would be associated with projects of this type. It is estimated that any project of this size and scope would cost several billion dollars.

Even a cursory analysis of the costs of developing water supplies makes it clear that future water supply projects are going to be extremely expensive. The costs of developing water supply projects will vary based on a number of factors, including the region's geography and size of water needs, as well as the amount and types of infrastructure expansion or development that is required. Water supply development costs may additionally include treatment and distribution infrastructure.

As an example, within the CAP service area, in the short-term, the largest cost may be associated with the cost of acquiring additional supplies due to the presence of the CAP transmission system. Projected long-term demands, however, may require modifications to and/or the expansion of the current CAP transmission system to increase the capacity and/or to accommodate other areas within the three county CAP service area. A study on the feasibility of expanding the CAP aqueduct from the Colorado River to the Salt-Gila pumping plant prepared as part of the ADD Water process in 2009 estimated that expanding the aqueduct to 3,600 CFS would cost $230 million. The development of alternative supplies that could potentially involve interstate or international exchanges will also require the construction of treatment and transmission facilities outside of the State to acquire the additional supplies through exchanges. Both of these types of efforts are going to be extremely expensive. The FWG received in-depth presentations on water desalination concept projects, as well as on methods that have the potential to augment the supply of Colorado River water.

Outside of the three county CAP service area the costs of developing water supply projects will include both the acquisition costs and the cost of treatment and distribution infrastructure. These projects, too, are likely to be costly. While lower elevations and dense populations make water infrastructure development more cost effective on a per capita basis in central Arizona the low-density population and generally higher elevation in most of Arizona (outside of the three CAP-served counties) increases delivery costs and means that those higher costs are shared by a smaller population.

Table 5 presents a comparison of cost ratios for water development projects discussed above.

Table 5. Project Cost Comparison Ratios

	Central Arizona Project	Big Chino Water Ranch	Coconino Alt. #3	Sierra Vista Alt. 2	Mogollon Highlands	CAP ADD Water Canal Expansion
People in Service Area at Time of Financing	2,130,000 (1980)	79,000	100,000	73,000	15,500	4,568,657 (2010)
Total Project Cost	$3.65 Billion	$170 Million	$650 Million	$193 Million	$34 Million	$230 Million
Total Volume Delivered (af)	1,500,000	8,068	28,000	20,000	3,000	300,000
Cost/person	$1,713	$2,162	$6,500	$2,645	$2,194	$50.34
Cost/acre-foot	$2,433	$21,070	$23,214	$9,654	$11,333	$766.66
Volume per person (af)	0.7	0.1	0.28	0.27	0.19	0.065

Task 3: Identify potential financing mechanisms based upon differing cost estimates.

The cost estimates for developing long-term supplies to meet the projected demands vary widely. For those water providers that can continue to drill a new well to meet their increasing demands, the cost of drilling a water supply well can range in cost from several hundred thousand dollars to several million dollars depending on the size and depth of the well being constructed. Traditional forms of financing available to municipalities and private water providers such as revenue bonds, government obligation bonds, impact fees, standard bank loans and others have been and will continue to be adequate for continuing to develop new wells.

However, for those communities that may experience unacceptable impacts from an increase in pumping groundwater; the strategy of simply drilling another well may eventually not be an option. For these communities an alternative solution will most likely involve the importation of a long-term renewable water supply. Such a supply would then be used in conjunction with the currently available local supplies to meet the projected long-term demands. The importation of water to areas outside of the CAP service area will require the construction, operation and maintenance of very costly infrastructure. For this reason, the development of solutions outside of the CAP service area will probably have to be regional in scope, which generally is much more cost effective in the long-term and addresses demands for the entire region.

In the past many of the larger water supply development projects, like the Central Arizona Project (CAP) canal, which cost about $3.6 billion to construct, included financing or funding assistance from the federal government. In the example of the CAP, about $1.65 billion will be repaid to the federal government by the users. It appears to the FWG that federal financial assistance for future projects is very limited.

With regional water supply projects ranging in cost from $34 million to more than $1 billion, many water users may have difficulty financing these sorts of projects independently through traditional funding and financing mechanisms currently available to them. This leaves the funding and financing of water supply projects up to an individual or a group of water providers, both public and private to identify creative solutions.

Some of the traditional forms of funding for water supply infrastructure projects include revenue bonds whose repayment is linked to project-generated cash flow, general obligation bonds of a political entity, general funds of political entities, or loans from the Water Infrastructure Finance Authority (WIFA). A comparison of the traditional sources is presented in the following Table 6.

Table 6. Comparison of Financing Sources

Revenue Bonds	General Obligation Bonds	Other Sources
• Relies on revenues from a specific project • Higher cost than GO bonds, but after-tax cost no higher • Projects can be sized properly and built rapidly • May potentially impact municipality's credit rating • Can't be used for new project development financing due to need for regular bond payments and no revenues generated during development stage. For an expansion of an existing project where revenues are currently being generated this may be an option	• Relies on taxes • Needs public approval of new taxes. • May potentially impact the credit rating and borrowing capability of the municipality • Revenue generation dictated by the amount of taxes • Can be used for project development normally done by the government entity • Cost of GOs fluctuates with the economy and the financial rating of the issuer and as a result may not always be available or economically feasible	• U.S. Government or state government loans. This source currently very limited if even available. Generally comes with a 50 year repayment provision and are subject to Congressional approvals • BOR funds. Like previously stated these funds are in short supply and are subject to annual appropriations, which can result in delays or the downsizing of a project • WIFA financing – limited to water and wastewater treatment projects. • Water Supply Development Revolving Fund overseen by WIFA – This fund has yet to be funded, but could be a viable source if funded • Private/Public Partnerships - Relies on cash flow from a specific project, after-tax cost equal to municipal bond cost, but requires source of development equity to conduct engineering and due diligence.

Water Supply Development Revolving Fund (WSDRF)

The Water Supply Development Revolving Fund was established in 2007 with the enactment of H.B. 2692 (see Appendix C for copy of H.B. 2692). For more than two years leading up to the enactment of the H.B. 2692, the Statewide Water Advisory Group (SWAG) met to develop recommendations for addressing identified water resource issues of concern. One of the recommendations identified by SWAG was the establishment of a water resource development fund. The purpose of the WSDRF is to provide a revolving fund, administered by the Water Infrastructure Finance Authority (WIFA), which can provide low cost loans to water providers for the acquisition of water supplies and development of water infrastructure.

The authorizing legislation identified six sources of revenue for the WSDRF including:

1. Monies received from the issuance of water supply development bonds.
2. Monies appropriated by the legislature.
3. Monies received for water supply development purposes from the United States government.
4. Monies received from water providers as loan payments, interest and penalties.
5. Interest and other income received from investing monies in the fund.
6. Gifts, grants and donations received for water supply development from any public or private source.

To date the WSDRF has not been funded. If the WSDRF is to be a primary viable source of financing for the acquisition and development of water supply projects, one or more sources of dedicated funding will have to be established. It should be pointed out that currently there are some restrictions on which water providers are eligible to obtain funding from the WSDRF, which may need to be addressed (see Appendix C, A.R.S. § 49-1273(A), A.R.S. § 49-1273(C), A.R.S. § 42-5301).

So how much money is required to make the WSDRF viable source of financing for water supply infrastructure projects and from what source or sources can revenues be utilized by the WSDRF? The Executive Director of WIFA in 2007 made a presentation to SWAG about the Drinking Water and Clean Water revolving loan programs for water and wastewater treatment projects. In that presentation she explained that it took about eight to ten years to accrue enough revenue (> $100 million) to make meaningful loans to meet the needs of the local water providers throughout the State for infrastructure improvements and upgrades. The majority of initial funding to establish these two funds came from the U.S. Environmental Protection Agency (EPA) beginning in the early 1990's. There were also some state appropriations that went into the building of these two funds. In addition to the interest earned on outstanding loans, WIFA's Drinking Water and Clean Water revolving fund programs remain dependent on annual federal revenues from the EPA.

This funding source has now grown in size to where in 2010 a total of more than $200 million in loans were provided from the Clean Water Revolving Fund and $130 million from the Drinking Water Revolving Fund, for a total of $330 million. As of the end of FY 2010 a little more than $ 1 billion in revolving fund loans were outstanding for the two programs. These funds are used exclusively to assist communities fund the construction and improvement of municipal water and wastewater treatment plants to comply with water and wastewater quality requirements. It is important to note that these two revolving funds benefit from an annual infusion of cash from the Federal government averaging between $27 million and $29 million.

The experiences of WIFA indicate that a secure, dependable revenue source will be needed for many years to make WSDRF a viable source of financing for water supply development projects. The completion of the WRDC statewide assessment, the Appraisal Studies, the Water Atlas and other efforts are the first steps in developing estimates for the needed size of the WSDRF.

Conducting a needs survey similar to what WIFA does every four years for its two revolving funds has been suggested, but unlike that survey most communities have yet to identify a sustainable source of water for which a project could be developed. Many communities have always assumed their next source of water will entail the development of another well, which for many will be sufficient for many years into the future. For those communities, however, that may experience unacceptable impacts from the increase in groundwater pumping; drilling a new well doesn't create new water. Because of the Appraisal Study efforts, the Water Atlas effort, and the current efforts of the WRDC many communities are just now starting to realize the standard solution of drilling a new well to increase supplies is not likely to work long-term and are beginning to seek alternatives to ensure the long-term availability of their supplies. Even without a comprehensive statewide effort to identify specific water supply infrastructure projects that may be needed, it is reasonable to assume that within the next five to twenty-five years, significant funding will be required to assist water providers and governments meet their long-term dependable water supply needs if the WSDRF is to be a viable source of financing for these types of projects.

With the WSDRF already in place, but with no funding, four conceptual principles have been identified related to selecting potential sources of revenue for that fund and for use in direct funding of water projects.

- **Dependability and Predictability –** The revenue source must be dependable and predictable over a long period of time. This principle is necessary to allow the fund to increase with modest investments over time, be available for projects that will be proposed in the twenty-year or longer time frame, and to create a capacity for revenue bonding. Also, income from these revenue sources should not be subject to large fluctuations so that bonding agencies and communities that are planning water supply projects can be reasonably assured that predicted revenue will be available to meet financial commitments.
- **Adequate Funding –** The revenue sources must generate enough funding so that within 7 to 10 years significant revolving fund loans may be made.
- **Mix of Revenue Sources –** A mix of revenue sources is preferred to keep the size of payments from any source or economic sector low and reasonable. A mix of revenue sources also allows the burden of payment to be spread more equitably. The mix of revenue may include some sources of funds that are broadly based across all sectors, and some sources from parties that will be directly eligible to use or benefit from the fund.

- **Beneficiaries need to contribute –** As closely as possible, a part of the mix of taxes or fees needs to be tied to the benefit received. Several considerations need to be made regarding this principle. The beneficiaries of the projects will eventually pay for the use of the fund because the WSDRF is a revolving fund. Those who help contribute to the creation of the fund may benefit in the future. By continually having funds available for loans over time, a great number of water providers across the state will potentially benefit in the long run. Even where specific water providers may not directly benefit, the citizens of the state may collectively benefit if the fund provides for the development of secure water supplies for other communities. This principle will require consideration of how the benefits and costs might be balanced between regions and economic sectors based on the anticipated requests to access the Water Supply Development Revolving Fund for revolving loans.

Potential Funding and Financing Options

Federal Grants and Loans

Some funding may be available in the future from the Federal Government for water supply related infrastructure, but it is expected that this funding source will be extremely limited. The Federal Government has been gradually reducing its support for reclamation and water supply projects for some time, and is focusing what funding is available on loan guarantees, on programs that provide low-cost loans, and on research and small pilot projects. Some discussion has taken place recently in Washington about a new national infrastructure bank, but again it is likely that assistance will take the form of low-cost loans (e.g. financing mechanisms) rather than outright funding contributions. It is conceivable that some Federal funding could be provided for initial revolving fund initiatives and/or initial cost analysis and project design work. Some funding of water supply efforts may be available for new projects that involve Indian communities or military facilities. However, with the current fiscal situation at the national level, it is highly unlikely that significant Federal funding will be available for major water supply projects anywhere in Arizona.

Advantages:

- *Long history of Federal funding and financing of water supply projects.*
- *Long history of Federal involvement with assessment, design, construction and management of major water supply projects including SRP and CAP.*
- *Often only funding source available for specific users like Indian Communities, military bases, and national forest or park facilities.*
- *Funding may be available at start of project for seed money (initial assessment, design, etc.).*
- *Once granted, funding is usually dependable.*

Disadvantages:

- *Funding availability is extremely limited due to fiscal situation of Federal Government.*
- *Can take decades to obtain necessary approvals and votes.*
- *Majority of funding does not come from benefited parties.*
- *Costs to pursue may be significant*
- *May incur significant at-risk compliance costs to go through agency/regulatory approvals necessary to access federal monies*

General State-Wide Taxes

Appropriations from the General Fund

Appropriations from the general fund are arguably based on the broadest set of revenues including sales and income taxes. The competition for appropriations from the general fund is also very wide and diverse. In addition, the appropriations from the general fund are subject to cyclical swings related to general swings in the economy. Any single appropriation, especially if it is not encumbered for high priority annual expenditures, is subject to suspension or reappropriation to other legislative priorities. On the other hand, H.B. 2692 specifically authorized appropriations as a source of generating revenues for the Water Supply Development Revolving Fund from the legislature and as such appropriations may be an option. There is some precedent for these types of appropriations, for example, some State general funds have been appropriated to the WIFA revolving funds. Outside of Arizona, the State of Colorado reports that a general appropriation of $10 million was used to start a revolving water development fund and the legislature from time to time has appropriated a small part the revenue from the State Severance Tax Trust Fund to this fund.

Advantages:

- *Central funding source would benefit from economies of scale.*
- *Funding would be based on a diverse range of revenue sources (e.g. income taxes, sales taxes, etc.) instead of only one funding source.*

Disadvantages:

- *Current and future economic climate may impact availability.*
- *Majority of funding does not come directly from benefiting parties.*
- *Communities that already have adequate water supplies that they have funded partially or entirely using their own resources will likely oppose significant State-wide taxes to fund specific existing and future water consumers.*
- *If a fund is populated by appropriated monies, it may be subject to budget sweeps.*

State-Wide Specific Taxes Associated With Water Consumption, Water Infrastructure or Groundwater Use

Bottled Water Tax

According to statistics published in an article entitled "Bottled Water 2004: U.S. and International Statistics and Development" in the April/May 2005 Bottled Water Reporter, the average American consumes about 90.5 liters of bottled water annually in the U.S. This equates to approximately 153 twenty ounce bottles per person annually. Imposing a tax of two to five cents per bottle has the potential to generate between $20 million and $50 million annually. This type of tax is dependable and predictable and is generated statewide by consumers of water. Assigning a tax to a product that funds the development of additional supplies should be more saleable to the consumer. The impact on the individual user who consumes the average 153 bottles of water annually is also minimal with the average impact ranging from about $3 to $8 annually.

Advantages:

- *The tax rate could be very small and may not change economic behavior.*
- *The revenue source may be relatively dependable in the short and medium terms, but a long-term transition away from bottled water to other beverages could have a significant negative impact on total receipts in the long-term.*

Disadvantages:

- *Majority of revenues does not come from the benefiting parties.*
- *No nexus between tax and infrastructure to be funded, unless the product is sourced in Arizona.*
- *Revenues may be small compared to size of needed water projects unless per-bottle tax is high.*
- *May require 2/3 supermajority or public vote for enactment.*

Transaction Privilege Tax

A transaction privilege tax is used by the state to collect taxes on the operation of a business. This type of tax is currently used to provide partial support to the Arizona Water Quality Assurance Revolving Fund (WQARF) that is used to remediate polluted groundwater. The fee that is deposited to the WQARF fund is assessed on the sale of water by municipal utilities. It generally taxes all municipal water users at a rate of $0.0065 per one thousand gallons of water delivered. Payment of the fee is to the Department of Revenue. Enforcement and compliance is by that agency as part of its overall mission.

A transaction privilege tax does meet the criteria for being dependable and predictable and has the potential to generate significant revenues statewide. As an example, imposing a transaction privilege tax of $0.05 per thousand gallons on the sale of water by municipal and private water providers has the capability to generate $24 million annually. The impact on the individual family of four with a total monthly use of 10,000 gallons would be about $0.50 per month.

There are several drawbacks to the implementation of a transaction privilege tax: 1) it is a tax and as such there will be tremendous opposition to this sort of option, and 2) it only generates revenues from those individuals who are served water by municipal and private water providers. Individuals served water by a private domestic well would be exempt from this tax. With more than 115,000 private domestic wells in Arizona this has the potential for being an issue.

Advantages:

- *Would provide a dependable revenue source because water rate receipts tend to fluctuate less than sales tax, impact fee, or other revenues dependent on the business cycle.*
- *Statewide base for funding source.*

Disadvantages:

- *Majority of funding does not come from the benefiting parties, and in some cases parties that benefit the most pay nothing.*
- *No nexus between tax and infrastructure to be funded.*
- *Funding source would be small unless tax rate is high.*
- *May require 2/3 supermajority or election for enactment.*

New or Existing Well Fees

Another revenue source to consider is an impact fee on applications to drill new wells as well as an annual fee for existing wells. Concern has been raised in previous forums about dry lot subdivisions or lot splits and the impact of the proliferation of wells associated with this type of development. If water development impact fees are assessed on proposed subdivisions, there might be a concern that the impact fee could create an incentive for the proliferation of lot splits and associated wells. An impact fee on the application to drill a new well might provide a disincentive to this type of land sales and subsequent development. A modest annual fee assessed on all active wells might substitute or be used in conjunction with a well impact fee and would minimize the issue of the exemption from a transaction privilege tax if it were implemented.

The potential revenue generating capability of a well impact fee imposed upon both new and existing wells is modest by comparison to some of the other revenue generating sources. If a $50 impact fee on new wells was imposed as well as a $10 annual fee on existing wells, the potential annual revenue generating capability based upon 3,000 new wells annually and 150,000 existing wells is about $1.65 million. One of the primary issues associated with this option, other than opposition from the well owners directly, is the logistics for who and how a well impact fee could be collected.

Advantages:

- *May provide a relatively dependable revenue source, if applied annually to existing wells.*
- *Reliance on new well applications for revenues would result in fluctuation corresponding to changes in the business cycle and real estate markets.*
- *Statewide geographic base for funding source, if it includes existing wells.*

Disadvantages:

- *Depending on type of water supply projects, majority of funding does not come from the benefiting parties, and in some cases parties that benefit the most pay nothing.*
- *Depending on type of water supply projects, no nexus between tax and infrastructure to be funded.*
- *May have equity imbalance if all well types are assessed the same fee.*

State-Wide New Development Tax

In 2003, a study group called the Arizona Water Policy Forum recommended that $500 per lot be assessed to support a revolving loan fund for water supply planning, acquisition and projects.

Since this charge would be arbitrarily calculated and there would be no nexus between actual demand for services and the facilities constructed with the revenues, this fee would be a tax rather than an impact fee. Presumably revenues from the tax would be put into dedicated accounts that could only be used for major water supply projects that benefit parts of the state that currently have inadequate water resources. The potential annual revenue generating capability from an impact fee is about $3 million annually based upon a $500 impact fee per lot and 500 lots per month.

Advantages:

- *Revenue levels would be somewhat tied to demands placed on water supply systems and new infrastructure (e.g. high growth – high revenues; slow growth-limited revenues)*
- *Wide geographic base for funding source.*
- *Depending on amount of fee, amount of revenue could be significant.*

Disadvantages:

- *Potential inequitable double taxation, if the development already pays a similar resource acquisition charge to a service provider.*
- *Majority of funding does not come from the benefiting parties, and in some cases parties that benefit the most pay nothing.*
- *No nexus between tax and infrastructure to be funded.*
- *Revenue source is very vulnerable to major downturns in economy that result in fall in number of building permits sought.*

Specific Area Impact Fees

County, City and Town Development Impact Fees

Many cities and counties assess impact fees on new construction to help pay for water, sewer, transportation and other services or infrastructure costs that are necessary to support new development. These fees vary by city and may be several thousands of dollars per lot. This type of revenue source would be prone to significant fluctuations in the total revenues generated. Although the number of housing starts has declined dramatically in the last three years, Arizona has a demonstrated long-term growth trend, and impact fee revenues in the long run should match necessary infrastructure expenditures. The Arizona Water Policy Forum emphasized that the growth occurring throughout Arizona will require new, dependable water supplies to ensure a secure long-term future for the State and its regions.

Assessing a fee on new development for the purposes of acquiring and developing new water supplies is consistent with the concept of providing benefit to the primary payer and is dependable and predictable. Within AMAs, the need will most likely be new development in undeveloped areas outside of the service areas of those water providers with Designations of Assured Water Supplies. It is expected that smaller towns throughout Arizona will also need new water supplies. These areas would be expected to be the primary beneficiaries of the Water Supply Development Revolving Fund over the life of the fund. Because any water providers will potentially have the opportunity to apply for a loan from the Water Supply Development Revolving Fund, charging impact fees on new development to build the loan fund into an adequate size would seem to be a general benefit for persons buying property. The collection of a fee could be facilitated by a city, town or county through the permitting process.

Impact fees are charged under the police power and are not taxes, and thus can only be charged to cover the capital cost of new facilities required to serve new development. Eligible costs include design, construction, construction management and financing expenditures, and fees must be aligned to costs. Second, the new statute is very restrictive about the use of fees, especially with regard to the amount of time that can be used for a planning period, so fees have to be collected for projects that can be built and completed in a ten to fifteen year time frame, but changes to the statute could be proposed to better accommodate large water supply projects that would necessarily require very long planning horizons. Third, impact fee revenues are collected at the time when building permits or site plans are issued, so revenues tend to rise and fall with development activity, creating certain benefits and certain problems. When capital investments tend to be relatively incremental in nature, the revenue and expenditure situation is relatively synchronized, so road and smaller transmission main projects only need to be constructed (and paid for) when impact fee revenues are strong because of residential and commercial construction. When capital investments are very large and one-time in nature -- as in the case of major water supply projects -- impact fees can be viewed by the investment community as an unreliable revenue source. For example, it can be difficult to issue bonds worth hundreds of millions of dollars to fund a treatment plant or water supply canal that will take decades to pay off, when bond investors know that a downturn in the economy during that time could eliminate new development and shut off new impact fee revenues, jeopardizing interest and principal payments to bondholders. As a result, borrowing for very large capital projects such as canals or treatment plants must usually be backed by utility water rates, municipal property taxes or federal guarantees even if the anticipated funding source will be impact fees or a similar revenue source

The imposition of development impact fees by cities and towns is subject to modifications by the State Legislature as happened in the 2011 legislative session. It should be pointed out that statutes and court decisions require impact fees to bear a proportionate relationship to the impacts of the new development. Impact fees are collected when building permits or site plan approvals are obtained, and are generally paid by home builders or developers. These fees are generally included in the cost of new development along with design, construction, utility and other permit fees. While at least some of the fee is passed on to new residents and businesses in the form of higher prices or lease rates, in certain land markets the impact fee will be partially absorbed by land owners that have to sell properties for less.

Advantages:

- *Revenue levels would be somewhat tied to demands placed on water supply systems and new infrastructure (e.g. high growth – high revenues; slow growth-limited revenues).*
- *Depending on costs of projects, amount of revenue could be significant because developments must pay entire proportion of project costs at time of building permit.*
- *Very close nexus between impact fee and infrastructure costs.*
- *All funding comes from benefiting parties.*
- *Fees can be set by city, town or county governing bodies – no need for establishment of new districts and associated votes of property owners.*

Disadvantages:

- *State legislation may have to be amended to allow for very long term-time horizons for infrastructure construction and fee collection (e.g. twenty years +)*
- *Relatively narrow base for revenue production, depending on location of project.*
- *Revenue source is very vulnerable to major downturns in economy that result in fall in number of building permits sought.*
- *Only new development (including additional or larger meters) can be charged impact fees – existing water users cannot be charged.*
- *Some sort of trigger like a building permit, drilling permit, or new meter service is needed to collect impact fees.*

Specific Area Taxes, Assessments, Levies or Volumetric Charges

Community Facility District, Improvement District or Other Special District Assessments and Charges

In Arizona special districts can be established to facilitate the collection of revenues to fund various types of infrastructure, if a certain percentage of property owners in the affected area vote to establish new districts. Regular improvement districts are routinely used by municipalities to establish revenue sources from relatively small geographic areas to pay for specific infrastructure improvements like streets and water mains. In these situations, the municipality usually utilizes its own borrowing capacity and ratings to issue bonds to pay for the facilities, and then charges an annual assessment to benefiting properties to fund the principal and interest on the bonds. Community facility districts (CFD) are far more complicated and powerful tools, and involve the establishment of a separate entity that in some ways resembles a mini-municipality that can levy charges, issue debt and construct and maintain infrastructure. CFDs are almost always proposed by one or more very large property owners or developers that are willing to use their own land as collateral against any bonds that are issued by the CFD. While the strict requirements for property owner approval often make the establishment of CFDs difficult to implement, once established these districts have a great deal of flexibility in choosing how the funding of infrastructure will take place. One-time assessments can be levied on home builders and commercial developers as development takes place, in the same manner of impact fees, or assessments can be required annually in the same way as municipal property taxes. CFDs have been successfully used in a number of municipalities in Arizona to hundreds of millions of dollars worth of water, wastewater and street infrastructure, but the establishment of these districts has been heavily concentrated in the western part of Metropolitan Phoenix in cities like Goodyear and Surprise.

Conceptually, special districts like community facility districts might turn out to be powerful tools in the funding of water supply projects in all parts of the State, but it is likely that special enabling legislation would be required to deal with the special requirements associated with large geography districts that would serve large areas and have many property owners. The state legislature produced special legislation to deal specifically with the establishment of improvement districts to place large power lines underground (A.R.S. 48-620), a relatively obscure infrastructure category, so it would not be unreasonable to assume that the legislature could pass a statute to enable and regulate the creation of specialized districts to fund, finance and construct large water supply infrastructure. Such a statute might potentially allow for multiple revenue sources (volume rates, property assessments, impact-fee-like levies, etc.), special opt-out provisions for property owners that decide to not use the new water resources provided, and for more flexible public-private partnerships, including the establishment of new private or public entities to manage large water projects.

Advantages:

- *Revenue levels would be somewhat tied to demands placed on water supply systems and new infrastructure (e.g. high growth – high revenues; slow growth-limited revenues)*
- *Depending on costs of projects, amount of revenue could be significant because developments must pay entire proportion of project costs at time of building permit.*
- *Assessments could be charged over time if a financing vehicle (e.g. CFD bonds) is available, lessening impact on home builders, developers, home buyers, and new businesses.*
- *Very close nexus between charges and assessments, and infrastructure and financing costs.*
- *All funding comes from benefiting parties.*
- *All properties within boundaries of special districts can be required to pay assessments and fees.*
- *Fees can be established for some operating and maintenance costs as well as initial capital costs.*

Disadvantages:

- *Existing enabling legislation may be too restrictive for some water supply projects.*
- *Relatively narrow base (geographic) for revenue production.*
- *Revenue source is very vulnerable to major downturns in economy that result in fall in number of building permits sought, if assessments are paid at building permit stage.*
- *If assessments are paid annually initial tax base may be too low to pay off interest and principal, if development proceeds slower than anticipated.*
- *Special districts are very difficult to form when property ownership is fragmented or when property owners are unfamiliar with uses of special districts.*
- *Property owners are often required to collectively put up property as collateral for infrastructure loans.*

Public or Private Utility Hook Up and Volumetric Charges

An obvious funding source that will not be discussed in detail would be municipal and private water utilities that would charge customers hook-up fees and rates based on the volume of water used. This type of funding source has been widely used in communities across Arizona for many decades. Funding occurs as new customers are enrolled and then water is used and customers are billed.

Advantages:

- *Depending on costs of projects, amount of revenue could be moderate initially because developments must pay part of project costs at time of hook up fee and then rest off over time through water rates.*

- *Water rates could be charged over time if a financing vehicle (e.g. utility bonds) is available, lessening impact on home builders, developers, home buyers, and new businesses.*
- *Very close nexus between charges and assessments, and infrastructure and financing costs.*
- *All funding comes from benefiting parties.*
- *All properties using services of water providers can be required to pay hook-up fees and volume-based water rates.*
- *Water rates can be established to include all operating and maintenance costs as well as initial capital costs.*
- *Revenue source is not as vulnerable in major downturns in economy because water rate revenue is less susceptible to volatile economic and real estate market forces.*

Disadvantages:

- *Revenue levels would tend to lag new water supply infrastructure expenditures because development would occur and then majority of costs would be paid off as water is used over time.*
- *Relatively narrow base for revenue production, depending on size of utility.*
- *Water utilities can be difficult and expensive to establish and/or expand, and a considerable amount of capital costs must be incurred.*
- *Rate payers often fight increases in water rates that are tied to new infrastructure to provide additional water resources.*
- *In some cases, increasing rates to pay for new infrastructure will result in reduced demand by, and lower revenues from, existing customers making future demand and revenue difficult to project.*

Local/Regional Ad Valorem (Property) Taxes

Property taxes have been used to finance water projects in many places. As an example, within Arizona, the Central Arizona Project (CAP) has the authority to levy a tax of ten cents per one hundred dollars valuation within Maricopa, Pinal and Pima Counties for the purposes of repayment of the project costs to the federal government and operation and maintenance of the district. At this time, the full amount of the tax authorization is not being assessed because other revenue sources are sufficient to cover annual operating costs and debt services. The CAP is also authorized to collect four cents per hundred dollars valuation in the three counties to assist the Arizona Water Banking Authority (AWBA) with the acquisition, recharge and long-term storage of Colorado River water. Entities that reside outside of the three counties may purchase CAP water, but they must pay in-lieu ad valorem taxes equivalent to the annual tax assessment levied upon property in the three counties. In this way, the tax is “exportable” to entities from other counties or states that participate in interstate banking activities. For example, the Southern Nevada Water Authority (SNWA) participates with the AWBA to recharge water in Arizona. The SNWA must pay the in-lieu tax equivalent to the ad valorem taxes of the CAP.

Ad valorem taxes are dependable and predictable because, unlike sales taxes, they are not as subject to annual swings in the economy. When used by special districts such as the CAP, the beneficiaries of the district services generally are those that pay.

At four cents per one-hundred dollars valuation, the taxes collected to recharge water in Pinal and Pima County have not been an adequate source of revenue. As a result, the lack of sufficient revenues from the ad valorem tax has limited some of the AWBA activities in those counties. In the case of the Water Supply Development Revolving Fund, the direct beneficiaries of the fund will be water providers. Based upon the political climate, it is highly unlikely that an Ad Valorem tax could be successfully passed.

Advantages:

- *Assessments are charged over time, deferring costs for home builders, developers, home buyers, and new businesses.*
- *Partial nexus between charges and assessments, and infrastructure and financing costs.*
- *Funding largely comes from benefiting parties.*
- *All properties within boundaries of special districts can be required to pay assessments.*
- *Revenue source is less volatile than other taxes, but still subject to economic downturns (decreasing property values).*
- *Revenue could be significant if high enough taxes are charged.*

Disadvantages:

- *Ad valorem taxes tend to all rely heavily on commercial and industrial uses that may or may not use much water.*
- *Relatively narrow base for revenue production, depending on local/regional tax rolls; some areas of the state have very low valuations and may not be viable for additional property taxation.*
- *May require an election.*

Water Withdrawal Fee

Within Active Management Areas, groundwater right holders must remit an annual withdrawal fee on each acre-foot of water pumped (see Table 7). In 1980, the Groundwater Management Code authorized the following fees to be collected. Up to one dollar per acre foot could be collected to support one half of the administration of the water code. This fee is remitted to the general fund. Up to two dollars could be assessed in the AMAs for water conservation assistance, supply augmentation, monitoring and assessment. Up to two dollars per acre-foot can be assessed after January 2006 to purchase and retire irrigation grandfather rights (IGFR retirement).

In 1997, the fee structure changed in the Phoenix, Pinal, and Tucson AMAs to collect funds to operate the AWBA programs. Two dollars and fifty cents per acre-foot was authorized to partially fund the AWBA through 2017. In 2007, this fee was made permanent to provide sufficient revenue to meet AWBA obligations for firming water supplies allocated to Arizona Tribes under the Arizona Water Rights Settlement Act. The 2007 amendments also authorize the Pinal AMA fee to be used to replenish groundwater withdrawals near the Gila River Indian Community southern boundary.

With regards to dependability, the withdrawal fees vary somewhat with water use and have been reduced as groundwater use has declined. The revenue from the fees has been fairly easy to predict from year to year.

The authorized amount of the fees has not been changed since 1980. As a result, the administration fees have not been adequate to cover one-half of the administration costs of the groundwater code. In contrast, the Conservation and Augmentation fee has been adequate for the purposes of conservation assistance. The conservation assistance programs are tailored to fit within the revenue constraints. The fee supporting the AWBA has not been adequate in the Tucson and Pinal AMAs. There is general agreement that the IGFR Retirement fee was never adequate for the intended purpose.

The conservation, augmentation and AWBA fees have to be used in the AMA where collected. For the most part, the citizens who benefit from the programs are paying for the program. Extending a withdrawal fee to areas outside of AMAs is problematic in that there is not an equivalent program for the monitoring, reporting and enforcement of groundwater withdrawals. All community water systems are now required to annually report withdrawals throughout the State and it may be possible through this program to add requirements for payment of withdrawal fees, but this would only capture the withdrawals by the community water systems and would miss the large industrial users. Private domestic well owners would also be exempt from this fee. Because the Water Supply Development Revolving Fund is intended to service the water providers, any withdrawal fee collected for this purpose would be tied directly to the benefit of the fund. To generate enough revenue to create a source of funding for the Water Supply Development Revolving Fund, the fee would have to be higher than that for the AMAs (see Table 7 for a listing of AMA fees authorized and assessed).

Table 7. The Fees Assessed for the AMAs in 2008

Groundwater Withdrawal Fee	Phoenix AMA	Tucson AMA	Pinal AMA	Prescott AMA	Santa Cruz AMA
Administration					
Authorized	$1	$1	$1	$1	$1
Assessed	$1	$1	$1	$1	$1
AWBA					
Authorized	$2.50	$2.50	$2.50	$0	$0
Assessed	$2.50	$2.50	$2.50	--	--
Conservation					
Authorized	$.50	$.50	$.50	$2.00	$2.00
Assessed	$.50	$.50	$.50	$1.00	$2.00
IGFR Retirement					
Authorized	$2.00	$2.00	$2.00	$2.00	$2.00
Assessed	$0	$0	$0	$0	$0

Advantages:

- *Fees are charged over time, deferring costs for home builders, developers, home buyers, and new businesses.*
- *Close nexus between charges made for water withdrawals, and infrastructure and financing costs associated with water supply projects that could provide water for groundwater recharge or domestic use by customers previously depleting groundwater.*
- *Would provide a relatively dependable revenue source.*

Disadvantages:

- *Not a significant source of funding at lower assessment levels.*
- *Would require significant changes to statute to allow the withdrawal fees to be used for this new purpose.*

Tables 8 and 9 present the projected revenue generating capability of these five revenue generating sources at the low and high ranges presented for 10, 25, 50 and 100 years. Both tables incorporate a 3% return on investment rate for loans made from the fund for water supply projects.

Table 8. Projected Potential Revenue Generating at the Low Rates

Revenue Source	10 Years (2021)	25 Years (2036)	50 Years (2061)	100 Years (2111)
Bottled Water Tax (2¢ per bottle)	$239 million	$759 million	$2.3 billion	$12.6 billion
Transaction Privilege Tax (5¢ per 1000 gallons)	$285 million	$907 million	$2.8 billion	$15 billion
*Impact Fees	$18 million	$56 million	$174 million	$938 million
**New & Existing Well Fees	$19 million	$62 million	$192 million	$1 billion
***General Fund Appropriation	$118 million	$376 million	$1.2 billion	$6.3 billion
Total	$679 million	$2.1 billion	$6.7 billion	$34.8 billion

*$250 per lot at 6000 lots annually

**$50 per new well & $10 for existing well

***Assumes $10 million annual general fund appropriation

Table 9. Projected Potential Revenue Generating at the High Rates

Revenue Source	10 Years (2021)	25 Years (2036)	50 Years (2061)	100 Years (2111)
Bottled Water Tax (5¢ per bottle)	$596 million	$1.9 billion	$5.9 billion	$31.6 billion
Transaction Privilege Tax (10¢ per 1000 gallons)	$570 million	$1.8 billion	$5.6 billion	$30.2 billion
*Impact Fees	$35 million	$113 million	$349 million	$1.9 billion
**New & Existing Well Fees	$39 million	$124 million	$383 million	$2 billion
***General Fund Appropriation	$118 million	$376 million	$1.2 billion	$6.3 billion
Total	$1.9 billion	$4.5 billion	$13.4 billion	$73 billion

*$500 per lot at 6000 lots annually

**$100 per new well & $20 for existing well

***Assumes $10 million annual general fund appropriation

Potential Financing Options

- Federal loans, federal loan guarantees used in conjunction with private lending or state/local/district bond issuance and federal agency debt issued specifically to finance infrastructure provision at the state and local level (e.g. possible national infrastructure bank).
- State loans, state revolving funds that serve as infrastructure banks, and state loan guarantees used in conjunction with private lending or local/district bond issuance.
- Municipal debt in the form of bonds, or in loans to municipalities from private lenders, including debt issued directly by municipal water utilities and debt issued by municipalities to finance water improvement districts.
- Special district debt in form of bonds or in loans to districts from private lenders, including bonds issued by community facility districts with private property being used as collateral.
- Private water utility or other corporate and private-sector debt, including short-term paper, bonds, or borrowing from investment banks, commercial banks or private sources.

In the future it is likely that more mix and match of funding and financing mechanisms will take place. For example, a possible approach to funding/financing water supply projects in northern or southern Arizona might be to fund new projects using special district assessments, water resource impact fees and private/municipal utility water rates, but to finance those projects partially using federal or state loan guarantees and/or federal or state revolving funds like the existing State Water Supply Development Revolving Fund or the proposed federal infrastructure bank. These opportunities for combined approaches should be considered.

Private Public Partnerships (PPPs)

The private/public partnership is another way to finance large water supply infrastructure projects that would be separate from the Water Supply Development Revolving Fund, but funds from the Water Supply Development Revolving Fund could be used as seed money or development equity money for a PPP project.

Public/private partnership is a term used increasingly loosely in the U.S. for any joint private/public activities (infrastructure or otherwise) that encompasses both groups, including design/build projects with limited risk-sharing or limited private control/cost containment, or non-project activities with cost-sharing elements. For purposes of this discussion, a specific type of PPP, "Infrastructure Project Finance," would be more exact, in that it refers only to the development of water supplies and infrastructure through an agreement between the public and private sectors that:

- Combines project elements into a single purpose entity whose cash flows will repay the principal and interest required to build and operate the project
- Clearly defines the separate roles of the public and private sector by means of a joint venture contract that is specific to the project and its special requirements
- Assigns appropriate risks to each group
- Predominantly uses private funds and companies to finance, build and often operate projects, but with some public sector assets at risk

One of the reasons for the growing interest in PPPs is due to current economic conditions. If municipalities, due to their level of indebtedness, are no longer in a position to directly finance expensive water development projects, PPPs may be an option. Although bonding capacity may be available, the additional debt of water development projects is projected to be many times higher than typical. Even if a community is able to fund an expensive water development project, its bond rating and capacity may potentially be reduced and other community infrastructure services are likely to suffer (roads, parks, etc). Some communities struggle to provide the up-front financing to conduct project planning and design. Based on current economic trends it doesn't appear likely that this scenario will turn around anytime soon and for this reason the PPP may increasingly become a more viable solution for funding the anticipated large water supply infrastructure projects that are greater than $50 million in cost. The $50 million cost level, although not cast in stone, appears to be the minimum size project that the private sector will consider.

Perhaps one of the biggest advantages of the PPP option is that it can significantly reduce the amount of up-front capital required by the public sector. Industry analysts presented to the FWG that there is a tremendous amount of private capital available for "shovel-ready" projects, but few water supply projects utilizing the PPP option have been pursued thus far.

Under the PPP option, government would only be required to provide the necessary development equity to allow the private sector to fund initial design and due diligence, and the development equity is fully reimbursable upon initiating the construction of the project. The key project selection criteria required for approval by the private sector are: sufficient economic and financial viability on the part of the benefiting parties and the political will to back the project. Returns on these investments tend to be above the norm for infrastructure investments and the major risk to reimbursement of the development equity capital is that the project does not proceed in a timely manner.

Properly conceived/designed PPPs are really joint venture agreements between the public and private sectors. Generally, the private sector leads the project design, due diligence, economic, financial, and engineering analyses, providing financing, construction, operation, and long-term maintenance. Government defines the needed project outputs and can provide project elements it has risk sharing with, such as necessary permits, land acquisition, and right of ways (if applicable). PPPs are not a panacea for financing infrastructure but rather a tool with some potential advantages over traditional procurement methods.

Because of the foresight, sacrifice, and perseverance of early leaders at the local, State, and Federal level, Arizona's residents have sufficient water supplies to sustain their current and projected water demands for the near future. Farmers and ranchers in the Salt River Valley joined together in the early 1900s to create the Salt River Valley Water Users Association (SRP) and pledged their lands as collateral to receive federal loans to have Roosevelt Dam constructed. The completion of the Central Arizona Project came as a result of Arizonans from all walks of life working together for decades to gain access to the state's share of Colorado River water. In the future, Arizona's population is projected to increase from its current level of about 6.6 million to more than 18 million over the next 100 years and its sustainable water supplies are limited. Just as early leaders had the foresight to plan for future water supplies, Arizona's current leaders must begin identifying solutions and allocating funds to plan, acquire and develop additional water resources to ensure a sufficient supply of water is available for Arizona's future.

SUMMARY AND RECOMMENDATION

The FWG met more than five times since the beginning of the year and heard presentations from public and private industry leaders. They shared their experiences and expertise in project financing. The committee also discussed the many current and potential mechanisms to finance projects or create revenue streams that might assist in the development of future water supply projects. It also discussed a proposal for a cooperative governance and finance of regional projects. The result of these discussions, as reflected in this report, is an inventory of options that are available for evaluation by decision makers at the state and local levels.

The FWG understands that the costs associated with the development of infrastructure and the acquisition of water for delivery are enormous and will become exponentially larger as time passes. Therefore, the FWG recommends that the Commission examine these funding sources and financing mechanisms, including the water resources development fund, to determine what options will best enable water users throughout the State to meet their future water needs taking into consideration the political, fiscal, legal, and hydrological ramifications for the State and for the individual water users.

MEMBERS OF THE FINANCE WORKING GROUP:

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APPENDIX A
TABLES AND FIGURES

Table 1 – Potential Water Supply Projects Previously Identified in Other Studies

Watershed/Region	Water Supply Project Description	Quantity of Water Associated With Each Project
Coconino Plateau	**Alternative 1** • Delivers water from Lake Powell to Cameron to serve the City of Page and the communities and villages located on the western Navajo Nation and Hopi reservation, • Flagstaff receives C-aquifer groundwater from a well field to be developed approximately 35 miles east of Flagstaff, • Williams receives Redwall/Muav (RM) aquifer groundwater developed near the City, and • Grand Canyon National Park and the City of Tusayan would receive water from the Bright Angel Creek infiltration gallery located at Phantom Ranch.	28,000 AFY
	Alternative 2 • Delivers water from Lake Powell to serve the City of Page, the communities and villages located on the western Navajo Nation and Hopi reservation, and the City of Flagstaff, • Williams receives RM-aquifer groundwater developed near the City, and • Grand Canyon National Park and the City of Tusayan would receive water the Bright Angel Creek infiltration gallery located at Phantom Ranch.	28,000 AFY
	Alternative 3 • Delivers water from Lake Powell to serve the City of Page, the communities and villages located on the western Navajo Nation and Hopi reservation, the cities of Flagstaff, Williams and Tusayan, and the Grand Canyon National Park.	28,000 AFY
Mogollon Highlands	**Alternative 1** • Delivers water from C.C. Cragin Reservoir to supply the City of Payson.	3,000 AFY
Sierra Vista Subwatershed of the Upper San Pedro groundwater basin	**Alternative 1** • Delivers groundwater from the Copper Queen mine after treatment to Fort Huachuca, the Cities of Sierra Vista, Bisbee, Naco and to recharge excess water to maintain flows of the San Pedro River	1,800 AFY to 2,600 AFY
	Alternative 2 • Delivers water from the terminus of the CAP canal to Fort Huachuca and the city of Sierra Vista, and to recharge water into the basin to offset current pumping.	30,000 AFY
	Alternative 3 • Development of an urban runoff collection and recharge system	1,800 AFY

Summary of Unit Costs for Typical Water Conveyance and Treatment Systems

August 11, 2011

The unit costs shown below are provided at the request of Mr. Tom Whitmer, ADWR. These figures should be considered appropriate only for appraisal level estimates to develop order-of-magnitude cost estimates, and comparisons of alternatives. Final engineering cost estimates need to consider, at a minimum, actual specified materials, site specific conditions, locality adjustments, quantities, pricing indexes, economic conditions, materials availability, and construction methods. Most of the unit costs provided below are based on actual contracted prices.

Figures listed below are April 2011 prices.

1. Lining or Relining Canals – Assume 3.5-inch thick concrete = $31/square yard

2. Pipe - Pipe materials and placement constitute the majority of costs for water conveyance systems, approximately 60% to 70% of the total cost of the system. The remaining 30% to 40% will usually cover all other associated features; pumping plants, pressure reducing stations, vaults, sectionalizing valves, electric power, O&M roads, etc. Operation and maintenance is not covered in this document because operating costs are largely dependent on lift and water volume.

Unit costs shown below are for PVC pipe with nominal pressure ratings of 125 psi. Thicker walled PVC pipe can be rated for pressures up to 300 psi. Wall thickness increases the unit cost, so a mid-range pressure pipe was selected for this summary. Standard PVC pipe sizes are shown.

The unit costs below include pipe materials, common excavation, bedding, pipe placement, backfill, and appurtenances. Excavation costs are discussed in more detail below.

Steel pipe costs do not vary considerably from PVC, but cathodic protection is usually required for steel pipe.

PVC sizes (in)	Unit Cost ($/foot)
3	18
4	30
6	50
8	60
10	80
12	105
14	120
16	135
18	150
20	165
24	200
30	290
36	380
42	480
48	580

3. Pipeline trench excavation – Excavation costs can vary significantly depending on geology. Three categories are provided, with equipment becoming more specialized as the excavation becomes more difficult.

Common materials (trench with light equipment) - $4/cubic yard

Soft rock (excavator or rock trencher required, some dozer ripping) - $20/cubic yard

Hard rock (Blasting required) - $60/cubic yard

4. Wells – Costs for drilling wells are dependent on geology, depth, diameter of well, casing requirements, and equipment and methods. The unit costs provided are associated with specific projects, so important factors of the work are listed. Casing, gravel packing, and concrete well pad costs are included. Costs for pumps, piping, and electrical equipment are not included.

20-inch diam well, 16-inch casing, 500 feet deep, moderately soft rock - $286/foot

18-inch diam well, 10-inch casing, 1,200 feet deep, moderately soft sandstone and limestone - $267/foot

16-inch diam well, 10-inch casing, 1,000 feet deep, moderately soft rock - $85/foot

10-inch diam well, 6-inch casing, 250 feet deep, moderate rock - $120

5. Steel Water Storage Tanks – Dependent on steel prices

Less than 400,000 gallons - $1/gallon

400,000 to 1,000,000 gallons - $0.85/gallon

1,000,000 gallons and greater - $0.70/gallon

6. Water Treatment Plants

Conventional Water Treatment Plant Capital Cost

Plant Capacity (million gallons per day) (mgd)	**Capital Cost ($Millions)**	**Cost/capacity ($M/mgd)**
0.50	3.18	6.33
0.75	3.81	5.06
1.0	4.45	4.64
2.0	5.90	2.84
2.74	7.17	2.62
4.11	7.99	1.95
5.02	8.90	1.77
9.59	12.71	1.33
20.54	15.44	0.75
27.39	18.16	0.66
42.23	25.88	0.61
47.93	28.15	0.59
91.30	46.31	0.51

Membrane Water Treatment Plant Capital Cost

Plant Capacity (million gallons per day) (mgd)	Capital Cost ($Millions)	Cost/capacity ($M/mgd)
20	39	1.95
40	59	1.47
60	77	1.28
80	97	1.21

Both costs adjusted to ENR CCI 9080 (July 2011).

Costs do not include land acquisition, design or administrative costs. Membrane costs have been escalated from 2006 costs. Current technology and project delivery methods could affect these unit costs.

Table 2 - Coconino Plateau Water Supply Alternative 1 Estimated Cost Worksheet

Coconino Plateau Alternative 1: *Lake Powell Source to Cameron plus Bitter Springs Spur*				**Sheet 1 of 2**
Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Intakes				
330 foot inclined bore	3	Each	$595,000	$1,785,000
30 inch boreholes with 18 inch casing and	990	Lin Ft	Included in item above	
12 inch Carrier Pipe	990	Lin Ft	Included in item above	
Submersible pump/motor, 3600	3	Each	Included in item above	
Forebay Tank, 10 ft Dia. X 20 Ft High Concrete				
11 regulated	11	Each	$60,000	$660,000
Total Concrete	88	CY	Included in item above	
Total Steel, Reinforcement	38,500	LB	Included in item above	
Pumping Plants				
22.51 CFS, 440 Ft Head	5	Each	$1,150,000	$5,750,000
22.51 CFS, 387 Ft Head	1	LS	$1,150,000	$1,150,000
22.51 CFS, 153 Ft Head	1	LS	$670,000	$670,000
17.42 CFS, 400 Ft Head	1	LS	$920,000	$920,000
17.42 CFS, 82 Ft Head	1	LS	$430,000	$430,000
1.38 CFS, 400 Ft Head	1	LS	$180,000	$180,000
1.38 CFS, 305 Ft Head	1	LS	$160,000	$160,000
Air Chamber, Tank, Steel Spherical 20 FT Dia, 10				
11 required, Total Weight	671,000	LBS	$4.50	$3,019,500
Excavation Rock (assuming 60%)	978,000	CY	$10.00	$9,780,000
Excavation	652,000	CY	$4.00	$2,608,000
Backfill	1,166,000	CY	$4.50	$5,247,000
Embedment to O.D. +3", assumed commercial	384,000	CY	$30.00	$11,520,000
Furnishing and installing the following diameters				
of steel pipe (all 500 ft. head class)				
30" .1875" Thick, 63 lb/ft	356,347	Ft	$131,000	$46,681,457
24" .1466" Thick 40 lb/ft	57,341	Ft	$87,000	$4,988,667
10" .1345" Thick 14.77 lb/ft	74,659	Ft	$39,000	$2,911,701
8" .1345" Thick 11.89 lb/ft	39,600	Ft	$35,000	$1,386,000
6" .1345" Thick 9.01 lb/ft	96,760	Ft	$28,000	$2,708,440
	624,677			
SUBTOTAL OF THIS SHEET				$102,555,765

Table 2 - Coconino Plateau Water Supply Alternative 1 Estimated Cost Worksheet - Continued

Coconino Plateau Alternative 1: *Lake Powell Source to Cameron plus Bitter Springs Spur*				**Sheet 2 of 2**
Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Storage Tanks, Steel				
Coppermine, 100 ft Dia. X 25 ft. High	1	LS	$700,000	$700,000
Bodaway Gap, 200 ft. Dia. X 20 ft. High	1	LS	$2,200,000	$2,200,000
Tuba City/Moenkopi, 500 ft. Dia. X 25 ft High	1	LS	$13,000,000	$13,000,000
Cameron, 200 ft. Dia. X 20 ft. High	1	LS	$2,200,000	$2,200,000
Pressure Reducing Station				
In-line PRV, 30 inch Dia.	3	Each	$80,000	$240,000
Designing, furnishing, and erecting	3	Each	$60,000	$180,000
One Steel tank -				
Height: 10 feet				
Diameter: 20 feet				
Power Lines	118	Miles	$200,000	$23,600,000
SCADA Control Systems				
(Approx. 1% of construction cost)				
SUBTOTAL THIS SHEET				$47,950,000
SUBTOTAL ALL SHEETS				$150,505,765
Mobilization @5%				$7,500,000
SUBTOTAL WITH MOBILIZATION				$158,005,765
Unlisted items @ 15%				$21,994,235
Contract Cost				$180,000,000
Contingencies @ 25%				$50,000,000
TOTAL CONSTRUCTION FIELD COST				**$230,000,000**

Table 2 - Coconino Plateau Water Supply Alternative 1 Estimated Cost Worksheet - Continued

Coconino Plateau Alternative 1: *Two Guns Well Field and 35 Mile Pipeline to supply C-Aquifer Water to Flagstaff*				**Sheet 1 of 2**
Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Well Field Gathering System				
24" PVC Pipe DR 25 C905	5,280	Lin Ft	$83	$438,240
18" PVC Pipe DR 25 C905	10,560	Lin Ft	$55	$580,800
14" PVC Pipe DR 25 C905	5,280	Lin Ft	$35	$184,800
12" PVC Pipe DR 25 C905	15,840	Lin Ft	$26	$411,840
10" PVC Pipe DR 25 C905	31,680	Lin Ft	$19	$601,920
8" PVC Pipe DR 25 C905	31,680	Lin Ft	$14	$443,520
6" PVC Pipe DR 25 C905	31,680	Lin Ft	$12	$380,160
Storage Tank, Steel 500 ft. Dia X 38 ft High	1	LS	$17,500,000	$17,500,000
(8,835,729 cubic feet)				
Wells With Pumps				
12 Wells – 1200 ft deep				
150 hp submersible pumps 500 gpm	26	EA	$360,000	$9,360,000
Wellfield:				
Excavation, Rock (assuming 80%)	126,120	CY	$10	$1,261,200
Excavation	84,080	CY	$4	$336,320
Backfill	176,244	CY	$4.50	$793,098
Embedment to O.D.+3", assume commercial	30,132	CY	$30	$903,960
Forebay Tank, 10 Ft. Dia. X 20 Ft High, Concrete				
5 required	5	EA	$60,000	$300,000
Total Concrete	50	CY	Included in Item Above	
Total Steel, Reinforecement	17,500	LB	Included in Item Above	
Pumping Plants:				
28.43 CFS, 400 Ft Head	4	EA	$1,400,000	$5,600,000
28.43 CFS, 42 Ft Head	1	EA	$520,000	$520,000
Air Chamber, Tank, Steel Spherical, 20 Ft. Dia.				
5 Required, Total Weight	305,000	LB	$4.50	$1,372,500
SUBTOTAL OF THIS SHEET				**$40,988,358**

Table 2 - Coconino Plateau Water Supply Alternative 1 Estimated Cost Worksheet - Continued

Coconino Plateau Alternative 1: *Two Guns Well Field and 35 Mile Pipeline to supply C-Aquifer Water to Flagstaff*				**Sheet 2 of 2**
Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Pipeline:				
Excavation, Rock (assuming 100%)	701,000	CY	$10	$7, 010,000
Backfill	449,000	CY	$4.50	$2,020,500
Embedment to O.D. +3”, assumed commercial	202,000	CY	$30	$6,060,000
Furnishing and installing the following diameters				
of steel pipe (all 500 ft head class)				
38”, 25”, Thick, 100 lb/ft	184,694	Ft	$202	$37,308,188
Power Lines	35	Miles	$200,000	$7,000,000
SCADA/Control Systems				
(3% of Construction Costs)	1	LS	$3,010,000	$3,010,000
Corrosion Monitoring	1	LS	$1,030,000	$1,030,000
(1% of construction costs)				
Subtotal This Sheet				$63,438,688
Subtotal All Sheets				$104,427,046
Mobilization @5%				$5,200,000
Subtotal w/ Mobilization				$109,627,046
Unlisted @ 15%				$15,372,954
Contract Cost				$125,000,000
Contingencies @ 25%				$35,000,000
TOTAL CONSTRUCTED FIELD COSTS				**$160,000,000**

Table 2 - Coconino Plateau Water Supply Alternative 1 Estimated Cost Worksheet - Continued

Coconino Plateau Alternative 1: Development of R-Aquifer Wellfield to Supply groundwater to Williams				**Sheet 1 of 1**
Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Well Field Gathering System				
10" PVC Pipe DR 25 C905	5,280	Lin Ft	$19	$100,320
8" PVC Pipe DR 25 C905	10,560	Lin Ft	$14	$147,840
6" PVC Pipe DR 25 C905	10,560	Lin Ft	$12	$126,440
4" PVC Pipe DR 25 C905	31,680	Lin Ft	$8	$253,440
Storage Tank, Steel 200 ft. Dia. X 28 Ft High	1	LS	$2,200,000	$2,200,000
(863,136 cubic ft, 2—ft dia X 28 ft High)				
Wells with Pumps				
12" wells – 4000 ft deep (use $5,000,000 per well)				
150 Hp Submersible Pumps 250 gpm	6	EA	$5,000,000	$30,000,000
Excavation, Rock (assuming 60%)	25,200	CY	$10	$252,000
Excation	16,800	CY	$4	$67,200
Backfill	38,000	CY	$4.50	$171,000
Embedment to O.D.+3", assume commercial	3,000	CY	$30	$90,000
Power Lines	6	Miles	$200,000	$1,200,000
Corrosion Monitoring	1	LS	$1,030,000	$1,030,000
(1% of construction costs)				
SCADA Control Systems				
(3% of Construction Cost)	1	LS	$1,040,000	$1,040,000
Subtotal All Sheets				$35,648,520
Mobilization @ 5%				$1,800,000
Subtotal w/ Mobilization				$37,446,520
Unlisted items @ 15%				$5,551,480
Contract Cost				$43,000,000
Contingencies @ 25%				$11,000,000
TOTAL CONSTRUCTED FIELD COSTS				**$54,000,000**

Table 2 - Coconino Plateau Water Supply Alternative 1 Estimated Cost Worksheet - Continued

Coconino Plateau Alternative 1: Development of Bright Angel Creek infiltration gallery and pipeline to serve Grand Canyon National Park and Tusayan				**Sheet 1 of 2**
Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
Excavation Pipeline	1,858	CY	$190	$353,020
Assume 100% rock, trail 5 ft wide (cover 3' over pipe				
Backfill, Pipeline	1,752	CY	$130	$227,760
Backfill, Select, Pipeline	96	CY	$880	$84,480
Excavation Power Cable	574	CY	$640	$367,670
Backfill, Select Power Cable	546	CY	$1,000	$546,000
Pipe, Steel				
12B100, t=0 1345, 17.64lb/ft	1,500	FT	$100	$150,000
4B200, t=0, 6.14 lb/ft	4,000	FT	$35	$140,000
Power Cable – medium voltage 5Kv line	15,500	FT	$30	$465,000
Installed in pipe trench and along existing pipe				
Trench depth = 2 ft & width=6", select backfill	38,000	CY	$4.50	$171,000
Pumping Plant	1	LS	$1,800,000	$1,800,000
Concrete = 100 CY				
Excavation = 1,130 CY				
Backfill, compacted = 785 CY				
2 pumps 1=3.36 cfs, H=4938 ft				
Infiltration Gallery	1	LS	$700,000	$700,000
36D25 concrete pipe				
Concrete = 10 CY				
Uniformly graded gravel = 90 CY				
Excavation = 290 CY				
Backfill, Compacted = 50 CY				
Riprap = 165 CY				
Conventional Treatment Plant at South Rim	1	LS	$5,000,000	$5,000,000
Treatment Plant Package at Phantom Ranch	1	LS	$50,000	$50,000
Q = 14,000/ day				
Tank, Storage, Concrete	1	LS	$130,000	$!30,000
(65,000 gal. 23' High, 22' dia)				
SUBTOTAL THIS SHEET				**$10,013,620**

Table 2 - Coconino Plateau Water Supply Alternative 1 Estimated Cost Worksheet - Continued

Coconino Plateau Alternative 1: Development of Bright Angel Creek infiltration gallery and pipeline to serve Grand Canyon National Park and Tusayan				**Sheet 2 of 2**
Description	**Quantity**	**Unit**	**Unit Price**	**Amount**
SCADA Control Systems Pipeline	1	LS	$360,000	$360,000
(3% of construction cost)				
Power Lines	7	MI	$200,000	$1,400,000
Corrosion Monitoring	1	LS	$140,000	$140,000
(1% of construction cost)				
Grand Canyon To Tusayan				
Forebay Tank, 10 Ft Dia. X 20 Ft High Concrete				
1 Required	1	Each	$60,000	$60,000
Total Concrete	8	CY	Included in item Above	
Total Steel, Reinforcement			Included in item Above	
Pumping Plants				
1.17 CFS, 284 FT Head	1	LS	$150,000	$150,000
Air Chamber, Tank, Steel, Spherical 20FT Dia. 10				$171,000
1 required, Total Weight	61,000	LBS	$4.50	$274,500
Excavation, Rock (assuming 60%)	25,800	CY	$10	$258,000
Excavation	17,200	CY	$4	$68,800
Backfill	39,000	CY	$4.50	$175,000
Embedment to O.C.+3" native material	4,000	CY	$30	$120,000
Furnishing and installing the following diameters				
Of steel pipe (all 500 ft Head class):				
6", .1345" Thick, 9.01 lb/ft	34,400	FT	$28	$963,200
Subtotal This Sheet				$3,970,000
Subtotal All sheets				$13,983,620
Mobilization @ 35% (Helicopter influenced)				$4,900,000
Subtotal w/Mobilization				$18,883,620
Unlisted Items @ 15%				$3,116,380
Contract Cost				$22,000,000
Contingencies @ 25%				$5,000,000
TOTAL CONSTRUCTION FIELD COSTS				**$27,000,000**

Table 3 – Projected Total Present Worth for Coconino Plateau Alternatives 1, 2 and 3

Item	Alternative 1	Alternative 2	Alternative 3
Total Field Construction Cost	$471,000,000	$621,000,000	$650,000,000
Pumping plants annual O&M	$1,051,973	$1,658,346	$2,023,994
Pumping plants annual energy	$3,029,771	$63,94,839	$7,276,020
Pipelines annual O&M	$480,000	$1,425,000	$1,660,000
Total annual O&M & energy	$4,561,744	$9,478,185	$10,960,014
Present worth O&M	$81,695,948	$169,744,140	$196,282,110
Project total present worth	$553,000,000	$791,000,000	$846,000,000

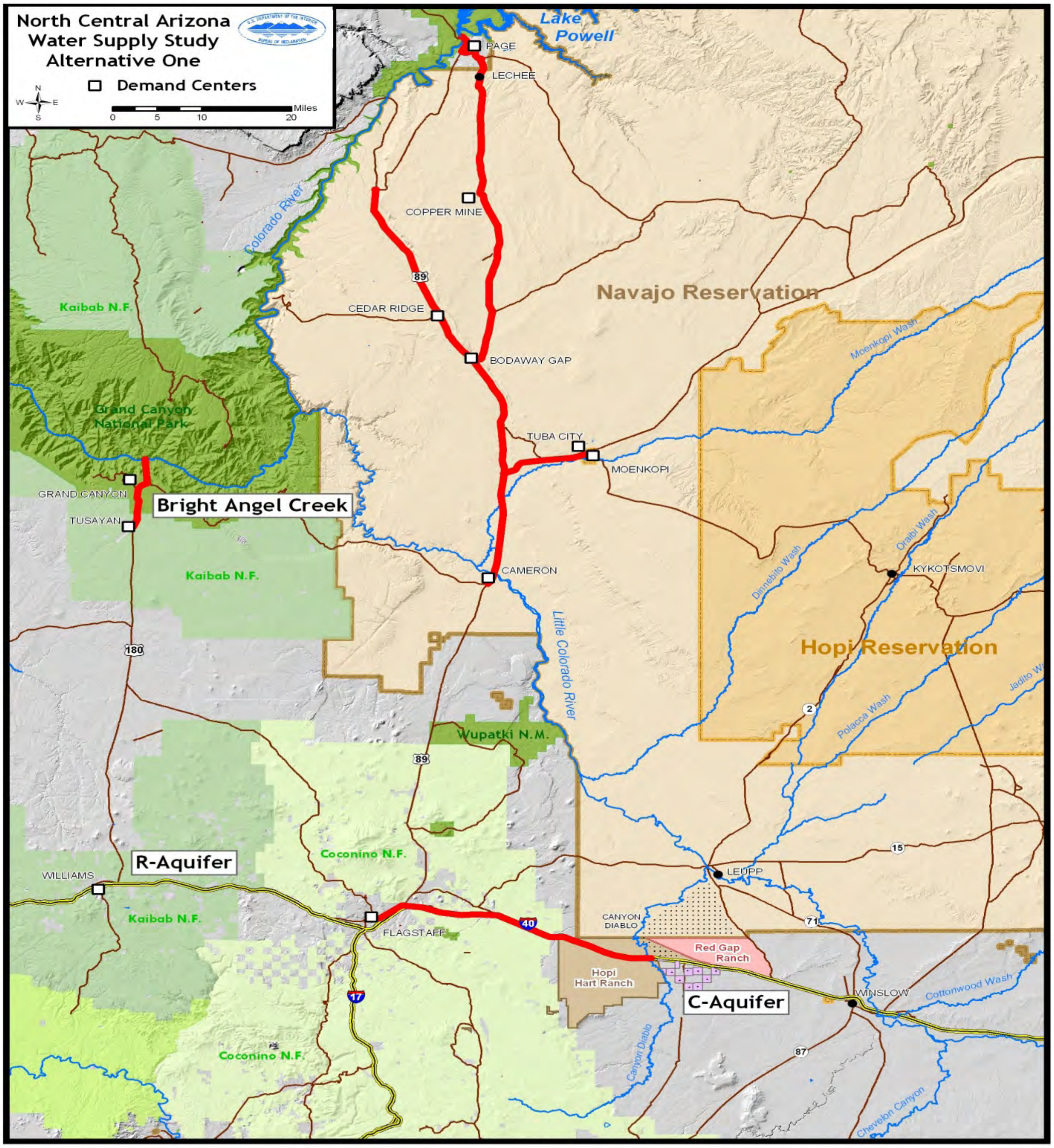


Figure 1. Coconino Plateau Alternative 1: City of Page, Hopi, Navajo Demand Center – supplied Colorado River water via Lake Powell pipeline; Flagstaff Demand Center – supplied via pipeline from C-Aquifer pipeline; Williams Demand Center – supplied from local R-M Aquifer wells; Grand Canyon/Tusayan Demand Center – supplied from Roaring Springs via pipeline diverting from Phantom Ranch infiltration gallery.

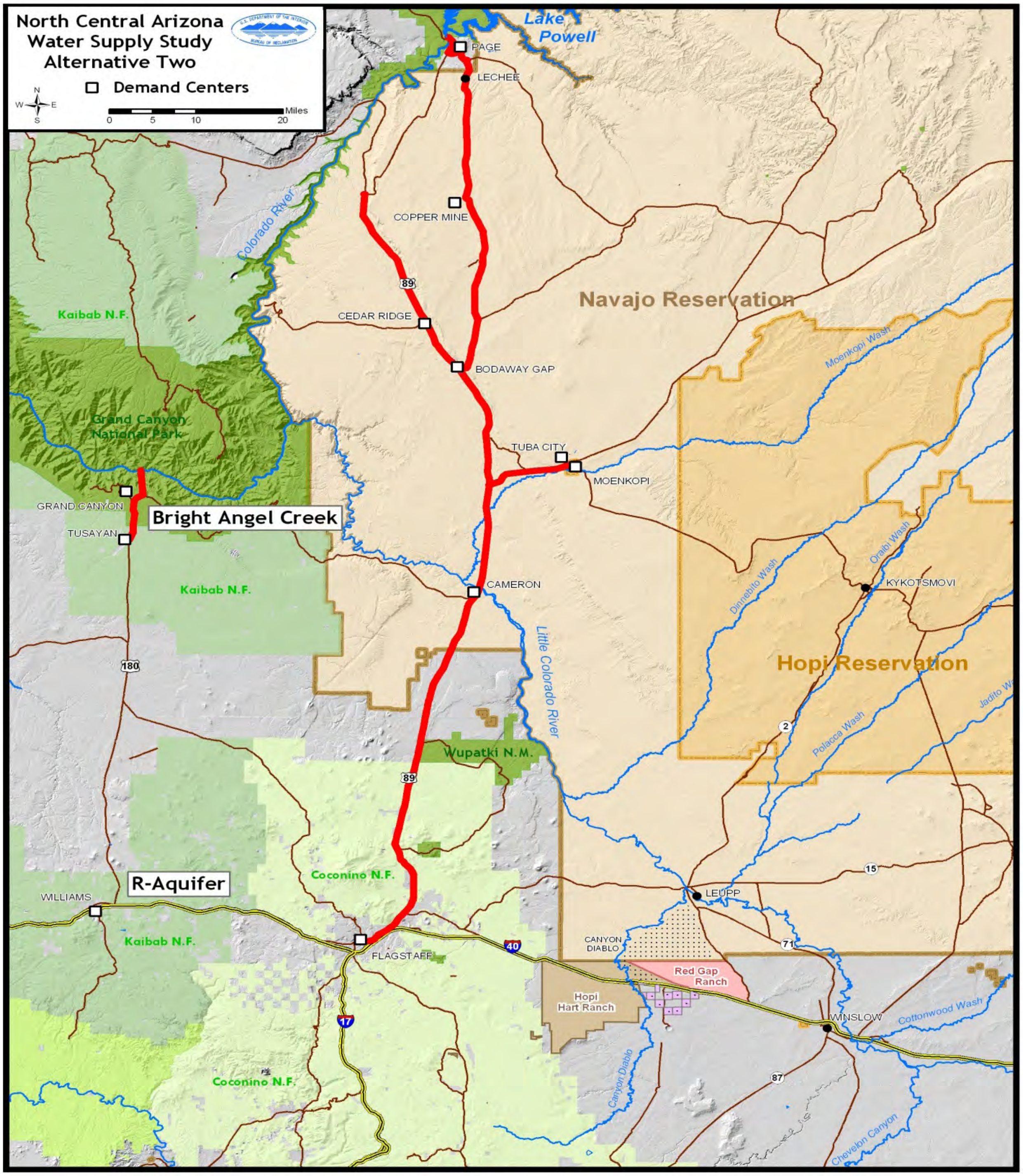


Figure 2. Coconino Plateau Alternative 2: Page, Hopi, Navajo, Flagstaff Demand Centers – supplied Colorado River water via Lake Powell pipeline; Williams Demand Center – supplied from local RM Aquifer wells; Grand Canyon/Tusayan Demand Center – supplied from Roaring Springs via pipeline diverting from Phantom Ranch infiltration gallery.

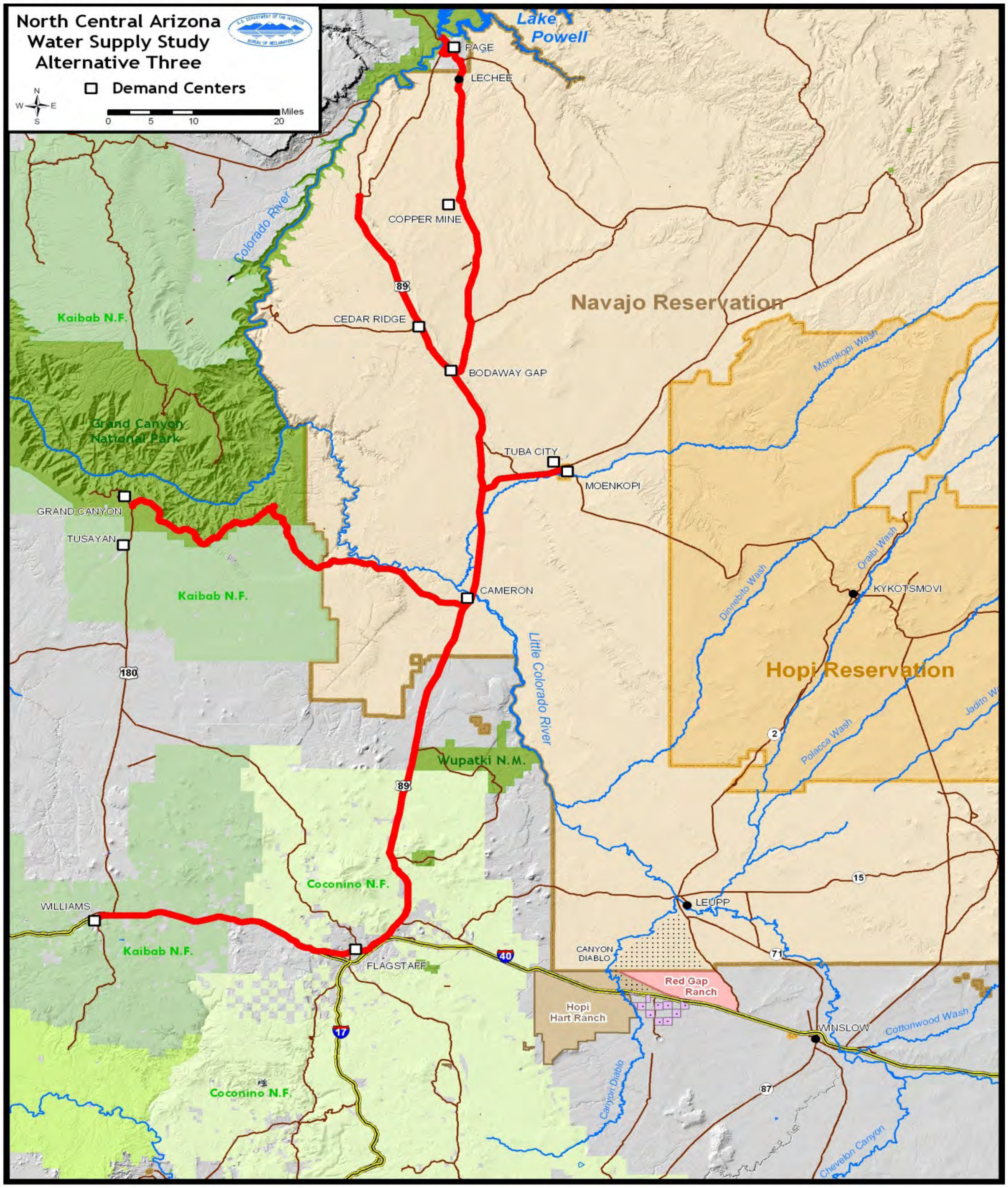


Figure 3. Coconino Plateau Alternative 3: Page, Hopi, Navajo, Flagstaff, Williams, Grand Canyon, and Tusayan Demand Centers – supplied Colorado River water via Lake Powell pipeline.

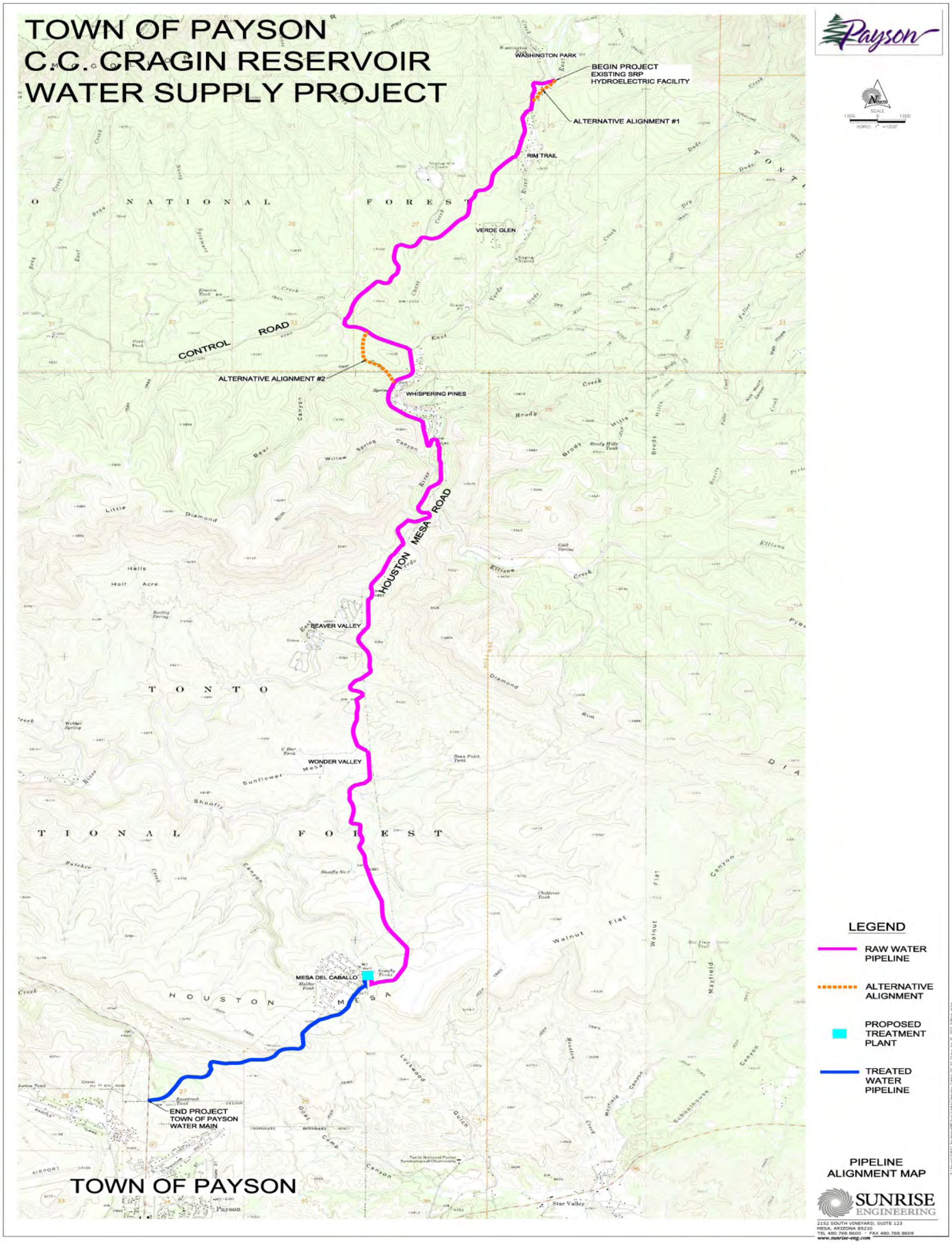
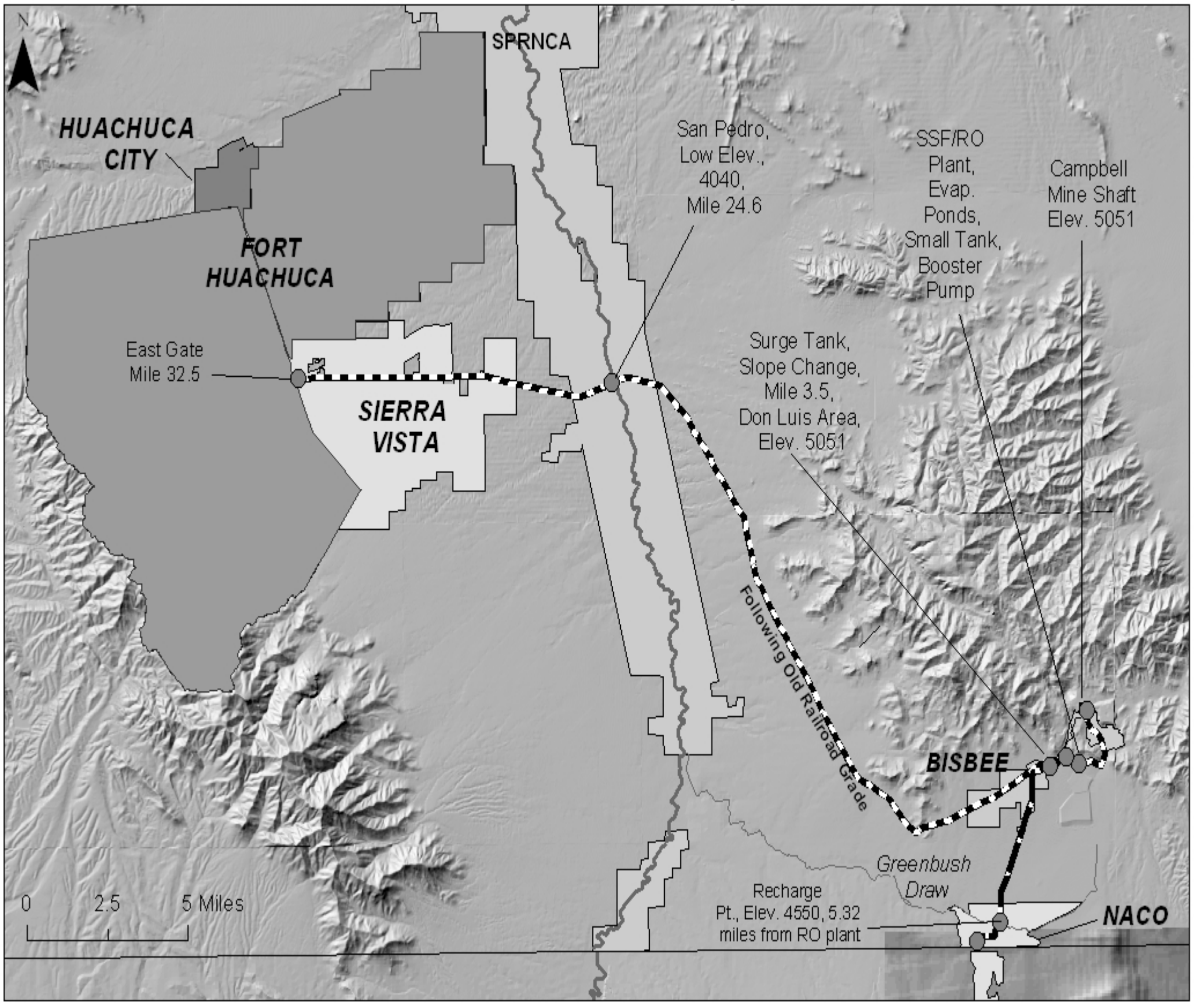


Figure 4. Mogollon Highlands Alternative: Town of Payson supplied water via pipeline from the C.C. Cragin Reservoir.

Appraisal Level Location of CQM to Ft. Huachuca/Sierra Vista and CQM to Bisbee/Naco Pipelines



U.S. Bureau of Reclamation, Tucson Field Office, updated 7/26/2006

Figure 5. Sierra Vista Subwatershed Alternative 1: A portion of the water demands of Bisbee, Naco, Sierra Vista and/or Fort Huachuca supplied by a pipeline from the Copper Queen Mine as well as recharged back into aquifer to support the baseflows of the San Pedro River.

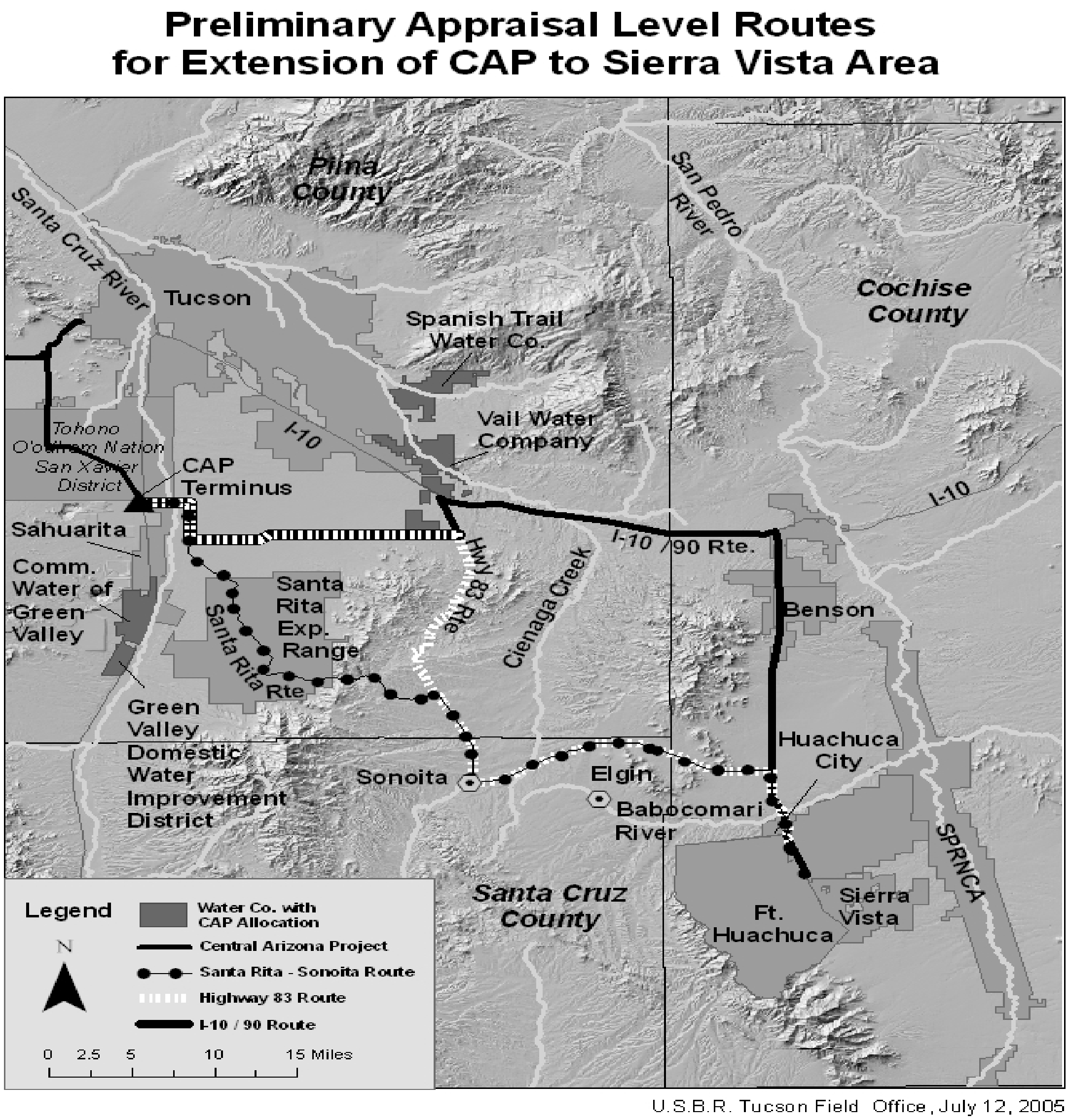


Figure 6. Sierra Vista Subwatershed Alternative 2: Three potential pipeline routings for pipeline to serve water to Sierra Vista, Fort Huachuca and to also recharge into the basin. The preferred pipeline routing is the I-10/Rte.90 alignment.

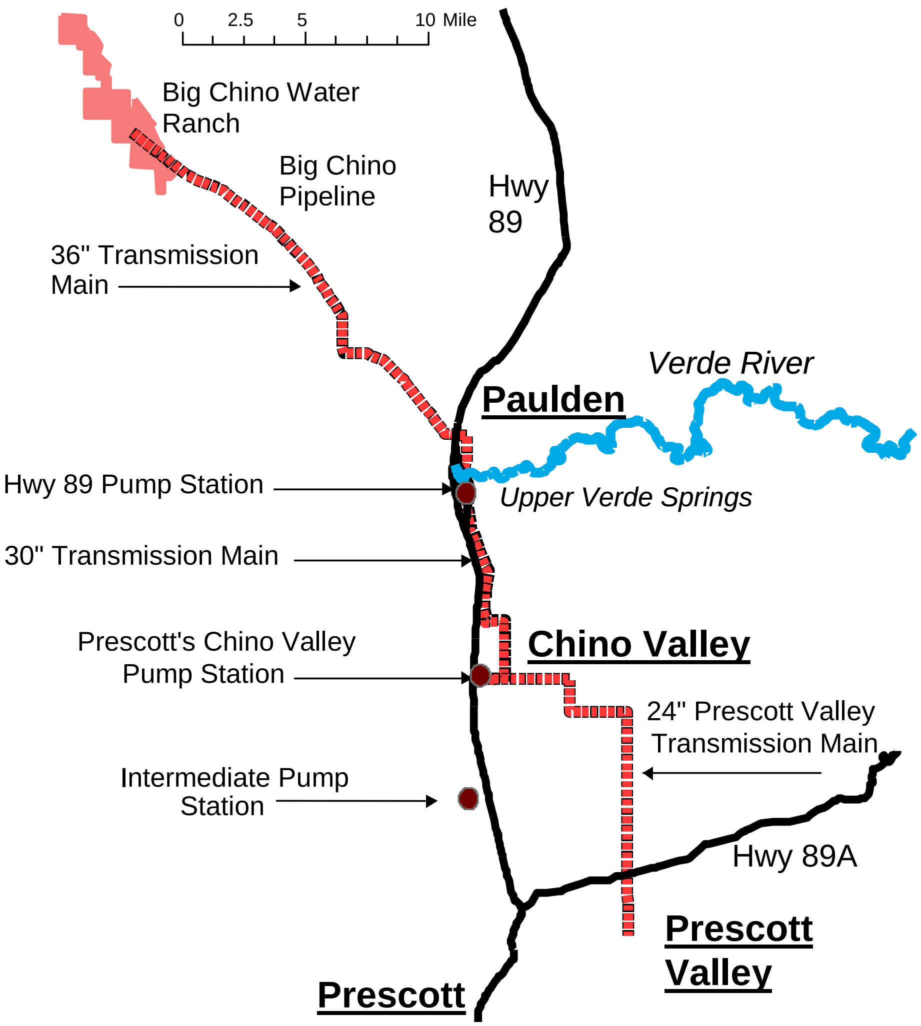


FIGURE 7. Proposed Big Chino Pipeline to Deliver Groundwater to the cities of Prescott and Prescott Valley

PROJECT ELEMENTS:

9 wells and 2 - 1MG reservoirs

23 miles 36" gravity pipeline from BCWR to new Highway 89 Pump Station (PS

Highway 89 PS 7 pumps, 17 MGD capacity

7 miles 30" pipeline to CVWPF

Reconstructed CVWPF PS 11 pumps, 23 MGD capacity, 1 additional 5MG reservoir

15 miles 24" pressurized pipeline from CVWPF to Prescott Valley

Intermediate Pump Station - 5 pumps, 31 MGD capacity, 3 - 3MG reservoirs (separately budgeted project)

APPENDIX B
STUDIES

BEYOND THE COLORADO RIVER: IS AN INTERNATIONAL WATER AUGMENTATION CONSORTIUM IN ARIZONA'S FUTURE?

Karl Kohlhoff* & David Roberts**

I. INTRODUCTION

In his book *Beyond the Hundredth Meridian*, Wallace Stegner wrote, "Water is the true wealth in a dry land; without it, land is worthless or nearly so."[1] In Arizona, water is the state's lifeblood, allowing people, crops, wildlife, and industry to thrive, even in a desert. In order to obtain the highest return on its value, however, the use of water must be carefully and thoughtfully planned, developed, and managed. Current residents of Arizona are the beneficiaries of the state's past leaders who had the vision to plan for, invest in, develop, and manage, the water resources we depend on today.

Arizona's burgeoning population is reaping the benefits of work by visionaries like George Maxwell, Governor Sidney Osborne, and Senator Carl Hayden, whose pioneering efforts in the first half of the twentieth century, and earlier, allowed this desert state to flourish.[2] George Maxwell's efforts led to the

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* P.E., B.C.E.E., HDR Engineering. This Article is a revised version of a paper originally presented at the Water Law and Policy Conference hosted by the University of Arizona James E. Rogers College of Law in Tucson, Arizona, on October 6–7, 2006. Articles from the Conference are collected in this symposium issue, Volume 49 Number 2, of the *Arizona Law Review*. For further information about the data and models presented in this Article, please contact the Authors at karl.kohlhoff@hdrinc.com and dave.roberts@srpnet.com.

** Manager, Water Rights & Contracts Department, Salt River Project.

1. WALLACE STEGNER, BEYOND THE HUNDREDTH MERIDIAN 226 (Houghton Mifflin 1954).

2. *See generally* JACK AUGUST, VISION IN THE DESERT: CARL HAYDEN AND HYDROPOLITICS IN THE AMERICAN SOUTHWEST (1999); DONALD J. PISANI, TO RECLAIM A DIVIDED WEST: WATER, LAW, AND PUBLIC POLICY 1848–1902 (1992); Charles A. Esser, *Second Session Opened*, ARIZ. REPUBLIC, June 19, 1947; Charles A. Esser, *Two Water Bills Filed with Solons: Enforcement Control Plans Offered For Consideration*, ARIZ. REPUBLIC, Jan. 23, 1948; *Groundwater Code Before Lawmakers*, ARIZ. TIMES, Jan. 22, 1948; *Osborn's Water Bill*, ARIZ. TIMES, Jan. 22, 1948; *Revised Groundwater Code Given to Solons for Study*, ARIZ. REPUBLIC, Mar. 5, 1948; *Sweeping Powers Asked in Ground Water Bill*,

formation of the 1902 Reclamation Act, which provided the means to develop the source of funds to finance the construction of Theodore Roosevelt Dam and to develop the Salt River Project. Governor Osborne had the foresight in the 1940s to recognize and begin the debate over the importance of protecting Arizona's groundwater supply from excessive pumping. Senator Hayden spent much of his long career of public service securing funding for the Central Arizona Project ("CAP")—the water supply that sustains much of the current population growth in central Arizona.

Because of the foresight of these leaders, and others, Arizona's residents have sufficient water supplies to sustain their current and projected water demands for the near future. However, Arizona's population is growing at a tremendous rate and its sustainable water supplies are limited. Further, there is a growing interest in protecting and enhancing Arizona's unique natural environment that, in many places, is dependent on the availability of water. In order to continue to provide sufficient water supplies for its citizens without negatively impacting Arizona's ecosystems, leaders must begin allocating funds to plan and develop additional water resources for the future.

In this paper, the Authors review the historic, current, and future trends in Arizona's population growth and water use, and assess whether the state's current water supplies are adequate to serve its citizens in the future. The analysis indicates that in the majority of the state's most populous areas—Cochise, Coconino, Gila, Maricopa, Mohave, Pima, Pinal, and Yavapai counties—the current available renewable water supplies are not sufficient to sustain the projected population and preserve the distinctive natural environment in the future.

Because additional municipal water supplies will be needed in the future, the Authors evaluate several options for augmenting the state's water supplies and recommend an approach to initiate planning the development of such supplemental supplies. A review of these options suggests that Arizona will need to go beyond the Colorado River for its next water supply. The most viable option for Arizona appears to be development of an international water augmentation consortium with Mexico. The consortium would seek to develop a new freshwater supply for both Arizona and Mexico created through the desalination of ocean water from the Gulf of California.

Developing a water augmentation consortium with Mexico will be a monumental undertaking, not unlike the twentieth-century development of water supplies currently used by the United States and Mexico from the Colorado River. Creating the consortium and the necessary freshwater supplies will require the same farsighted leadership Arizona has benefited from in the development of its past water supplies. Arizona will need a visionary to champion this cause and to inspire the state's political, business, scientific, and engineering leaders. This multifaceted collaboration is essential to develop the necessary relationships with Mexico, the research and development of technologies to support implementation of a large-scale desalination project, and a plan to manage the financing,

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PHOENIX GAZETTE, Jan. 22, 1948; Bill Turnbow, *Legislators, Gov. Osborn Agree on Call: For Second Time State Water Code Will Be Subject*, PHOENIX GAZETTE, Mar. 5, 1948.

construction, and operation of the infrastructure needed to create and deliver the freshwater.

II. TRENDS IN ARIZONA'S POPULATION

For the last half of the twentieth century, Arizona was one of the fastest growing states in the country. Since 1950, Arizona's population has grown by nearly 600%, more than six times the United States growth rate for the same period (Figure 1). In 1950, the population of Phoenix was slightly more than 100,000. In the most recent census, Phoenix was home to more than 1,300,000 people.[3] Nine Arizona cities and towns now have a population greater than 100,000 people.[4]

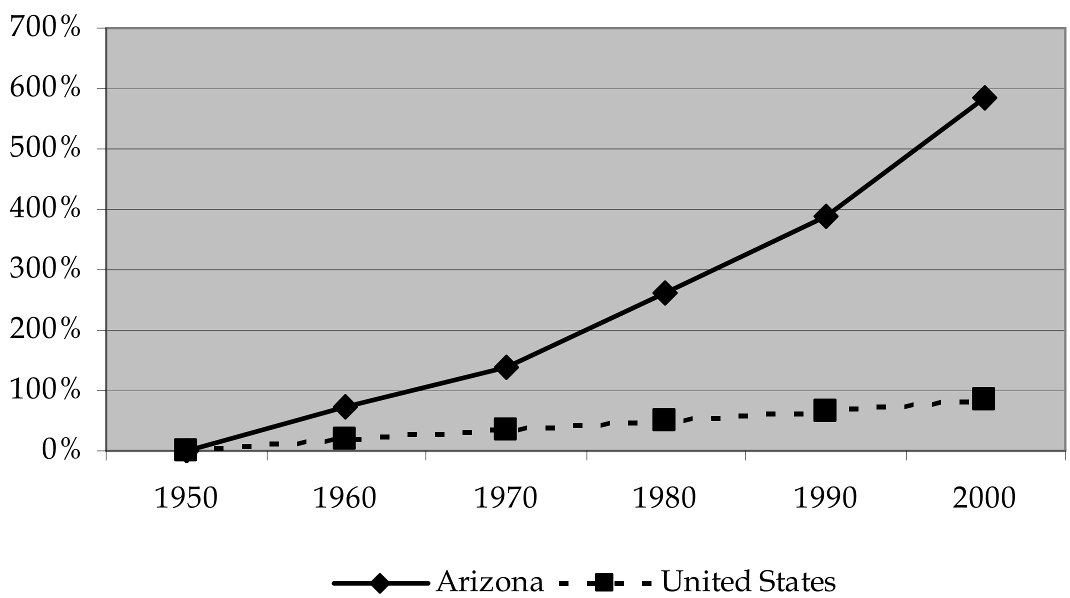

Figure 1. Population growth by percent in Arizona and the United States from 1950 to 2000.

Since 2000, Arizona's population boom has further escalated. In the last six years the state has gained nearly 1,000,000 new residents; its population has now surpassed 6,000,000. Some cities have experienced triple digit growth during this period: Maricopa (561%), Sahuarita (332%), El Mirage (289%), Queen Creek (268%), Surprise (154%), Buckeye (147%) and Goodyear (118%). Phoenix is now the sixth largest city in the United States; Tucson is ranked 32nd.[5] Geographically,

3. U.S. CENSUS BUREAU, GCT-PH1. POPULATION, HOUSING UNITS, AREA, AND DENSITY, *available at* http://factfinder.census.gov/servlet/GCTSubjectShowTablesServlet?_lang=en&_ts=193343158694 (select "GCT-PH1. Population, Housing Units, Area, and Density: 2000") (last visited Mar. 30, 2007).

4. *Id.*

5. U.S. CENSUS BUREAU, TABLE 1: ANNUAL ESTIMATES OF THE POPULATION FOR INCORPORATED PLACES OVER 100,000, RANKED BY JULY 1, 2005 POPULATION: APRIL 1, 2000 TO JULY 1, 2005 (2006), *available at* http://www.census.gov/popest/cities/SUB-EST2005.html (follow "Excel" hyperlink after title of report).

80.9% (4,985,544) of Arizona's current population resides in Maricopa, Pima, and Pinal counties ("Three County Area").[6] The next three most populous counties (Yavapai, Yuma, and Mohave) together comprise 9.5% (588,604) of Arizona's population.

Demographic experts forecast that Arizona's explosive growth will continue. The Arizona Department of Economic Security projects that Arizona will surpass the 10,000,000 mark in 2028 and reach over 13,300,000 by 2055.[7] By that time researchers predict that Phoenix and Tucson will have merged, and that the corridor from Prescott south to the Mexican border, including Sierra Vista, will grow into a megapolitan or "super-sized" metropolitan area, referred to as the Arizona Sun Corridor.[8] In 2055 Pinal County is expected to have quadrupled in population to more than 1,100,000 people, while the population in four other counties is projected to double (Maricopa, Mohave, Yavapai and Yuma). The Three County Area is expected to become home to 83.3% (11,112,290) of the state's population. Yavapai, Yuma and Mohave counties will continue to be the next most populous counties, but their proportion of the state's population is expected to drop slightly to 9%.

Still other researchers have projected that Arizona could grow to more than 18,000,000 people by 2100.[9] The population is expected to follow the same geographical patterns, although Pinal County is predicted to replace Pima County as the state's second most populous county (Table 1).

6. U.S. CENSUS BUREAU, TABLE 1: ANNUAL ESTIMATES OF THE POPULATION FOR COUNTIES OF ARIZONA: APRIL 1, 2000 TO JULY 1, 2006 (2007), *available at* http://www.census.gov/popest/counties/CO-EST2006-01.html (follow "Excel" hyperlink under "Arizona").

7. ARIZ. DEP'T OF ECON. SEC., ARIZONA POPULATION PROJECTIONS 2006–2055 tbl.1 (2006), *available at* http://www.workforce.az.gov/?PAGEID=67&SUBID=138 (follow "excel" hyperlink after "Arizona State and County Projections 2006–2055: State of Arizona"). These projections may actually underestimate the number of persons that reside and use water in Arizona as they do not take into account (1) seasonal residents whose principal place of residence is in another state, and (2) undocumented residents who live in Arizona but are not permanent residents.

8. Catherine Reagor, *When Phoenix, Tucson Merge*, ARIZ. REPUBLIC, Apr. 9, 2006, at 1A.

9. Jim Holway, Peter Newell, and Terri Sue Rossi, Water and Growth: Future Water Supplies for Central Arizona 4 tbl.1 (June 13, 2006) (unpublished manuscript, on file with Global Institute of Sustainability, Arizona State University), *available at* http://sustainability.asu.edu/gios/waterworkshop.htm (follow "pdf" hyperlink after article title).

County	2020[10]	2040[11]	2060[12]	2080[13]	2100[14]
Apache	86,533	99,190	109,163	119,023	128,883
Cochise	169,717	201,179	225,372	249,936	274,500
Coconino	159,345	186,871	208,076	228,492	248,908
Gila	64,396	74,195	82,750	91,488	100,226
Graham	41,119	47,623	51,544	55,072	58,600
Greenlee	8,189	8,611	9,614	10,682	11,750
La Paz	25,487	29,715	32,382	35,180	37,978
Maricopa	5,276,074	7,009,664	8,209,097	9,347,117	10,485,137
Mohave	281,668	367,952	434,082	500,416	566,750
Navajo	147,045	180,054	204,644	229,022	253,400
Pima	1,271,912	1,585,983	1,831,622	2,075,670	2,319,718
Pinal	609,720	1,081,737	1,529,581	1,979,551	2,429,521
Santa Cruz	61,658	78,526	90,776	102,882	114,988
Yavapai	305,343	390,954	446,814	502,466	558,118
Yuma	271,361	351,299	403,258	454,280	505,302
Total	**8,779,567**	**11,693,553**	**13,868,772**	**15,981,274**	**18,093,776**

Table 1. Projected population by county in Arizona.

III. TRENDS IN ARIZONA'S WATER SUPPLY AND USE

Although Arizona has experienced explosive population growth, sound water management policies have enabled the state to provide adequate water supplies for new residents, while at the same time reducing the state's dependence on groundwater. Figure 2 shows the percentage of total water use from groundwater withdrawals and surface water diversions in Arizona from 1950 to 2000.

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10. ARIZ. DEP'T OF ECON. SEC., ARIZONA POPULATION PROJECTIONS 2006–2055 summary tbl. (2006), *available at* http://www.workforce.az.gov/?PAGEID=67&SUBID=138 (follow "excel" hyperlink after "Summary Population Projections 2006–2055: Projections for State and Counties").
11 *Id.*
12. Holway et al., *supra* note 9, at 4 tbl.1.
13. *Id.*
14. *Id.*

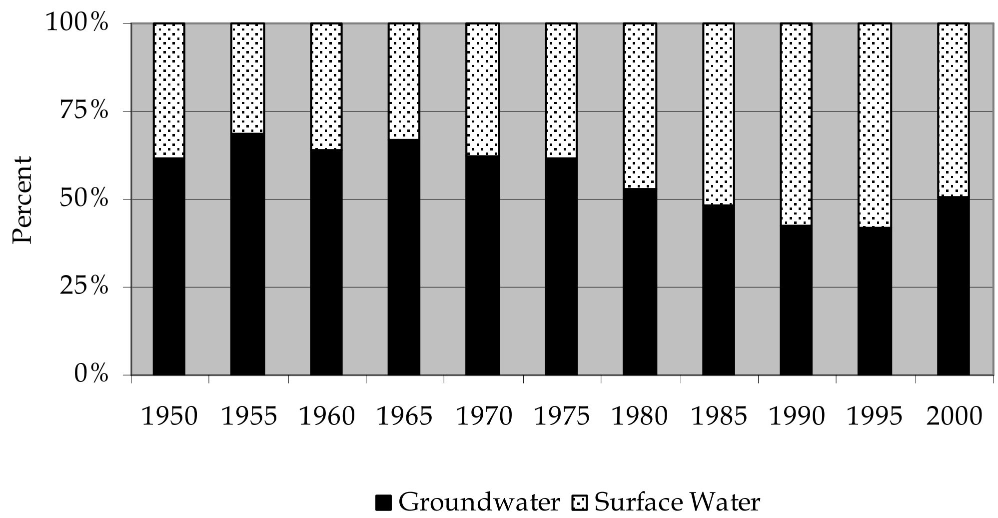

Figure 2. Percentage of total water use from groundwater withdrawals and surface water diversions in Arizona from 1950 to 2000.[15]

From the 1950s until the mid-1980s Arizona relied on groundwater for the majority of its water. During this period the rate of groundwater pumped from underground aquifers far exceeded their recharge, and water levels in wells throughout central Arizona decreased sharply. In addition to the significant loss of the groundwater supply, negative effects such as land subsidence and earth fissuring began to occur as a result of the over pumping. The state's past overuse of its groundwater system still impacts Arizona today.[16]

Recognizing that the continued overuse of groundwater supplies was not sustainable, Arizona's political leaders and water users agreed in 1980 to limit the use of groundwater in the state's most affected groundwater basins. The passage of the 1980 Groundwater Code ("Code")[17] also improved Arizona's prospects for receiving federal funding to complete the CAP. Largely as a result of the Code's limitations on groundwater use, the water use trend reversed in 1985. This new trend continues today, due in large part to the success of both the Code and CAP.[18] By the end of 2005, CAP had delivered nearly 20,000,000 acre-feet of Colorado River water into central and southern Arizona.

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15. A.D. KONIECZKI & J.A. HEILMAN, U.S. DEP'T OF THE INTERIOR, WATER-USE TRENDS IN THE DESERT SOUTHWEST—1950–2000, SCIENTIFIC INVESTIGATIONS REPORT 2004-5148, at 12 tbl.A (2004).

16. Lisa Nicita, *Governor Approves Bill to Identify, Map Fissures*, ARIZ. REPUBLIC, June 22, 2006, Chandler Republic, at 9; Lisa Nicita, *ADOT to Remedy Large Fissure on Route for Freeway*, ARIZ. REPUBLIC, July 17, 2006, Valley & State, at 1.

17. Groundwater Management Act, 1980 Ariz. Sess. Laws 4th Spec. Sess., ch. 1, § 86 (codified at ARIZ. REV. STAT. ANN. §§ 45-401 to -704 (2006)).

18. Since 1998, Arizona has been experiencing a nearly statewide drought that has temporarily caused the withdrawals of groundwater to exceed the diversions of surface water. This is reflected in the 2000 data. *See supra* Figure 2.

In addition to the changes in the source of water used in the state, there has also been a shift in how water is used. Figure 3 illustrates the growth in municipal and industrial uses as a result of the significant population growth in the state, and the decline in agricultural uses of water from 1950 to 2000. In 1950, agriculture used 97% of the state's water. In 2000, agricultural use comprised 80%, while the municipal and industrial sectors used 16% and 3%, respectively.[19]

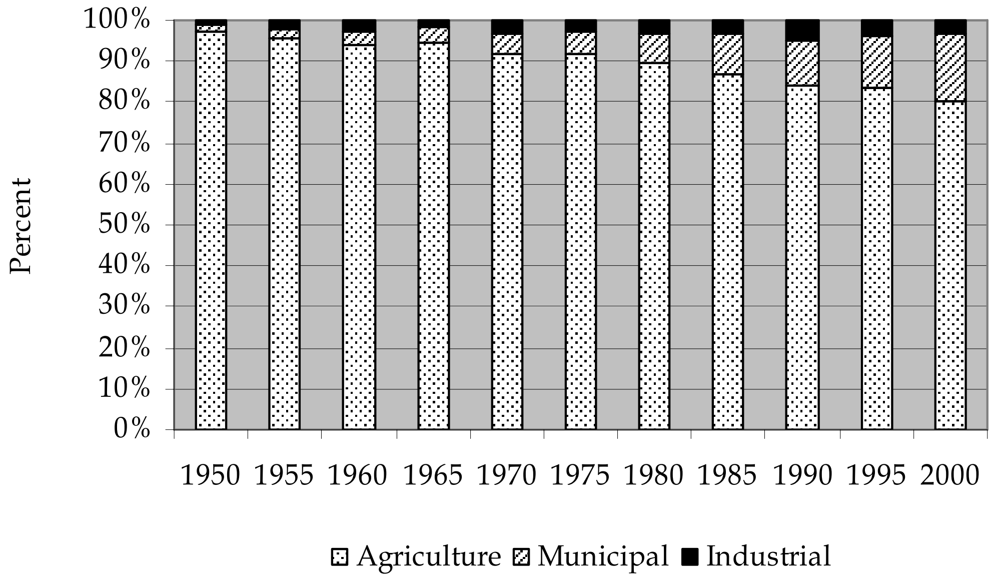

Figure 3. Percentage of water use by sector in Arizona from 1950 to 2000.

The most recent estimate by the Arizona Department of Water Resources puts the state's water use at 7,826,600 acre-feet per year (Table 2).[20]

19. KONIECZKI & HEILMAN, *supra* note 15, at 9 tbl.2.

20. ARIZ. DEP'T OF WATER RES., 1 ARIZONA WATER ATLAS: INTRODUCTION, at 19 tbl.1-2 (2006) (draft).

Water Use Sector	Source of Supply and Amount of Water Used (acre-feet)				
	Groundwater[21]	**In-State Surface Water**	**Colorado River Water**	**Reclaimed Water**	**Total**
Agriculture	2,594,500	898,000	2,275,000	74,600	**5,822,100**
Municipal	662,600	418,200	421,900	94,000	**1,596,700**
Industrial	317,500	66,700	1,800	21,200	**407,200**
Total	**3,574,600**	**1,382,900**	**2,698,700**[22]	**189,800**	**7,826,000**

Table 2. Estimated water use by sector and water source in Arizona in 2003.

As noted earlier, the overall use of surface water continues to exceed the overall use of groundwater. Water use in the municipal sector now comprises 20% of the state's water use, while agricultural use represents 74%.

IV. ARIZONA'S CURRENT WATER SUPPLIES

Currently, Arizona's water supply is derived from four sources: (1) surface water from in-state rivers—the Gila River system and its tributaries (Salt, Verde, Santa Cruz, San Pedro, Agua Fria and Hassayampa), the Little Colorado River system, and the Bill Williams River system; (2) surface water from the Colorado River; (3) groundwater; and (4) effluent or reclaimed water.

The long-term average annual supply of surface water from Arizona's in-state rivers is estimated to be about 1,700,000 acre-feet. The vast majority of this water is either diverted and used directly from Arizona's rivers each year or is stored in reservoirs, e.g., Roosevelt Lake, San Carlos Lake, Bartlett Lake, etc., for use in subsequent years. Currently, on average, about 65% of the water that is diverted or stored each year is used for agricultural purposes and 30% is used for municipal purposes. The remaining 5% is used for industrial purposes. Additionally, about 150,000 acre-feet per year are used on Indian reservations. The vast majority of this water is used for agricultural purposes.

Arizona is entitled to use 2,800,000 acre-feet of water from the Colorado River each year.[23] This water has been allocated among various water users under several different priorities. Water users along the mainstem of the Colorado River are projected to consume about 1,300,000 acre-feet. The majority of this

21. Includes pumping for drainage purposes. The majority of the drainage pumping in Arizona (approximately 250,000 acre-feet per year) is associated with agricultural water uses along the Colorado River and is reflected in the figures for agricultural groundwater use.

22. Does not include approximately 400,000 acre-feet of CAP water recharged in central Arizona.

23. 43 U.S.C. § 617c(a) (2000).

entitlement carries the highest priority; however, approximately 150,000 acre-feet shares the most junior priority with CAP (see below). Agriculture uses about 90% of the mainstem Colorado River supply. About 800,000 acre-feet of the agricultural water is diverted for use on Indian reservations.

The remaining 1,500,000 acre-feet of Arizona's Colorado River water supplies are allocated to the CAP.[24] The CAP entitlement is further allocated among non-Indian and Indian water users. The vast majority of the non-Indian CAP supplies are allocated to municipal and industrial uses and, pending approval of the Gila River Indian Community Water Rights Settlement Agreement, total 747,276 acre-feet. The Indian CAP allocation is 667,724 acre-feet. Of the total Indian allocation, 154,000 acre-feet has been leased to municipal water providers on a long-term basis.[25] The entire CAP entitlement (plus the 150,000 acre-foot mainstem allocations—see above) is currently regarded as the most junior Colorado River supply among the seven states who share its supply, and is therefore less likely to be fully available during periods of extended drought in the Colorado River Basin.[26]

Arizona's groundwater supply is highly variable and, in certain areas (Active Management Areas or "AMAs"), highly regulated. In the central and southern areas of the state (Phoenix, Pinal, and Tucson AMAs) the groundwater supply is quite extensive; however, its use is limited by the requirements of the Code.[27] Northeast Arizona (most of Apache and Navajo counties and parts of Coconino County) also contains significant groundwater reserves. In some parts of the state, groundwater is interconnected with surface water (areas adjacent to perennial and intermittent streams in the Gila, San Pedro, Salt, Verde, Santa Cruz, Bill Williams, Hassayampa, and lower Colorado River watersheds). Consequently, the use of groundwater in these areas may be limited in the future, depending on the actual availability of groundwater and the quantity of stream flow available to surface water users, because most uses of water withdrawn from wells near streams are junior in priority to uses initiated by direct diversion from streams. In still other areas of the state, groundwater is contained in hard rock aquifers and is often difficult to extract in large volumes on a sustained basis. These areas include Payson, Pine, Strawberry, Williams, and Flagstaff.

Reclaimed water is produced from the wastewater (effluent) derived from the use of water by people. Currently, it estimated that about 479,000 acre-feet of effluent is produced each year in Arizona. Effluent is treated (reclaimed water) and

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24. The actual quantity of CAP water that has been allocated for delivery is 1,415,000 acre-feet. The remaining 85,000 acre-feet is lost through evaporation and seepage during delivery in the CAP aqueduct.

25. *See* Holway et al., *supra* note 9, at 17, 22 tbl.5.

26. 43 U.S.C. § 1521(b).

27. Under the assured water supply rules, however, there are several types of authorizations to pump groundwater that are considered renewable for purposes of groundwater regulation: (1) Pre-rules groundwater (about 75,000 acre-feet/year); (2) Incidental recharge (4% of municipal demand); (3) Allowable groundwater use (about 80,000 acre-feet/year); and, (4) AMA water farms/imported groundwater (estimated to be about 123,000 acre-feet/year). See Holway et al., *supra* note 9, for a more detailed explanation of these renewable groundwater supplies.

is reused for a variety of purposes, most of which are agricultural or industrial. As the state continues to grow in population, the amount of reclaimed water produced for future uses will increase. It is expected that over time the percentage of effluent reclaimed for future use will increase as the infrastructure to deliver reclaimed water expands into new urban development areas.

V. ARIZONA'S FUTURE: MUNICIPAL WATER DEMANDS AND AVAILABLE RENEWABLE WATER SUPPLIES[28]

Given the state's projected population growth, one of the most significant issues for Arizona to address will be whether the state has sufficient water supplies to sustain its projected municipal water demands. Determining whether Arizona's water supplies are sufficient for the future requires an assessment of the future municipal water demands and the amount of water available to supply these demands.[29]

For purposes of this analysis, we use the population projections in Table 1 (2020 to 2100) and the current representative gallons-per-capita-per-day (GPCD) rates of water providers in each county to estimate future municipal water demands. As previously noted, these population projections likely underestimate the total population using water in Arizona because seasonal and undocumented residents are not included in the state's population projections.[30] Table 2 shows the projected water demands in the municipal sector for each county in 2020, 2040, 2060, 2080, and 2100. Municipal water demand in Arizona is expected to increase by nearly 300%, from 1,596,700 acre-feet today to 4,195,512 acre-feet in 2100.

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28. For purposes of this analysis, municipal water demand includes self-supplied domestic uses.

29. For purposes of this analysis, we assume that municipal water demands will be met mostly from renewable water supplies—surface water, renewable groundwater, and reclaimed water, and not mined groundwater. Renewable groundwater is groundwater that is replenished from natural and artificial recharge over a long-term period and is available for use without depleting the overall groundwater supply or discharge to springs and streams. Mined groundwater is groundwater that is not renewable over a long-term period and results in long-term depletions to the overall groundwater supply and discharge to springs and streams.

30. *See supra* note 7.

County	Est'd GPCD	Projected Municipal Demand				
		2020	2040	2060	2080	2100
Apache	150	14,539	16,666	18,342	19,998	21,655
Cochise	175	33,269	39,436	44,179	48,994	53,809
Coconino	150	26,773	31,398	34,961	38,392	41,822
Gila	150	10,820	12,466	13,904	15,372	16,840
Graham	175	8,060	9,335	10,104	10,795	11,487
Greenlee	150	1,376	1,447	1,615	1,795	1,974
La Paz	220	6,281	7,323	7,980	8,669	9,359
Maricopa	220	1,300,192	1,727,403	2,022,981	2,303,425	2,583,870
Mohave	220	69,412	90,675	106,972	123,318	139,665
Navajo	150	24,707	30,253	34,385	38,481	42,577
Pima	175	249,327	310,893	359,044	406,884	454,723
Pinal	200	136,595	242,340	342,670	443,476	544,283
Santa Cruz	175	12,087	15,393	17,794	20,167	22,541
Yavapai	175	59,855	76,637	87,587	98,496	109,405
Yuma	250	75,991	98,376	112,927	127,215	141,503
Total		**2,029,283**	**2,710,042**	**3,215,444**	**3,705,478**	**4,195,512**

Table 3. Projected municipal water demands by County from 2020 to 2100.

There are several approaches that could be used to derive an estimate of the quantity of renewable water supplies available to supply future municipal water demands. One approach would be to assume that all of the renewable water supplies in Arizona could be used to serve municipal uses. Under this statewide demand versus supply approach, the task would then be as simple as adding up all the supplies described previously and then comparing them to the projected municipal water demand. Table 4 presents these data. With this approach, the projections suggest that Arizona could easily supply its municipal water demands well into the future.

Water Source	Quantity (acre-feet)				
	2020	2040	2060	2080	2100
In-State Surface Water	1,700,000	1,700,000	1,700,000	1,700,000	1,700,000
Colorado River Water	2,715,000	2,715,000	2,715,000	2,715,000	2,715,000
Groundwater[31]	281,171	363,402	406,618	426,219	445,820
Reclaimed Water[32]	152,196	203,253	482,317	555,822	629,327
Total Renewable Water Supplies	**4,848,367**	**4,981,655**	**5,303,935**	**5,397,041**	**5,490,147**
Projected Municipal Water Demands	**2,029,283**	**2,710,042**	**3,215,444**	**3,705,478**	**4,195,512**
Surplus (Deficit)	**2,819,084**	**2,271,613**	**2,088,491**	**1,691,563**	**1,294,635**

Table 4. Estimated total quantity of renewable water supplies in Arizona by water source and projected municipal water demands. These estimates assume that all renewable supplies are available for use in the municipal sector.

However, for several reasons, this type of approach is not realistic. First, a "statewide" analysis of water supply and demand does not consider the geographic variability of the legal entitlements to water supplies available to different parts of the state. While water users have, on occasion, managed to work out arrangements to exchange water supplies in one area of the state for water supplies in another area, the number and size of these exchanges is generally limited by (1) the available supply at the point where the exchange takes place, (2) water rights interests of third parties, and (3) environmental concerns. Consequently, a statewide approach masks the actual legal and physical availability of water to supply future municipal uses in different areas of the state.

Second, this approach fails to consider that the amount of precipitation and runoff from the state's watersheds and from the Colorado River Basin does not provide an average supply of renewable water every year. While the state is fortunate to have a number of large reservoirs to capture water in above average years of runoff, research shows that drought periods can be extensive enough in both length and magnitude to easily deplete the reservoir supplies.[33] Groundwater

31. Includes incidental recharge from municipal use (4% of municipal water demand), and AMA renewable groundwater. *See supra* note 27.

32. Assumes 30% of projected municipal demand will be available as effluent. In 2020 and 2040, we assume 25% of the effluent will be reclaimed and reused for drinking water purposes and after 2040, we assume 50% will be reclaimed and reused for drinking water purposes.

33. *See* KATHERINE K. HIRSCHBOECK & DAVID M. MEKO, A TREE-RING BASED ASSESSMENT OF SYNCHRONOUS EXTREME STREAMFLOW EPISODES IN THE UPPER COLORADO & SALT–VERDE–TONTO RIVER BASINS 17 (2005), *available at*

is a good short-term backup supply, but it can easily be shortsightedly overused, as Arizona history has demonstrated. Accordingly, projecting the quantity of renewable water to serve future municipal uses must take into account the variability in the availability of surface water supplies.

A third shortcoming of this approach is that it does not consider that much of Arizona's renewable water supplies are used for agricultural purposes in areas of the state that are not projected to grow significantly in population over the next 100 years. The expectation of being able to transfer agricultural water from rural communities to other areas of the state that are predicted to grow significantly in population must take into account the long-established legal, economic, and cultural interests of those who depend on that water, and the political, institutional, geographical, and physical constraints associated with such proposed transfers.

For example, in the upper Gila River watershed (Graham and Greenlee counties) there is a significant supply of surface water from the Gila River (approximately 125,000 acre-feet) that is currently used by farmers in the Safford and Duncan Valleys. This quantity of water is much greater than the combined long-term projected municipal water demand in Graham and Greenlee counties (2100: approximately 13,400 acre-feet). If the entire municipal demand in these two counties in 2100 came from the Gila River, the farmers would still have entitlements to approximately 110,000 acre-feet. Legally, culturally, economically, and institutionally this water belongs to the upper Gila River farmers, the surrounding communities, and its businesses. Because of these factors, it is likely that any attempt to transfer this water to another watershed to serve municipal uses would be strenuously resisted by many upper Gila River watershed interests. Additionally, the Gila River Indian Community and the San Carlos Irrigation District would likewise resist the proposed transfer because the water users of both of these entities share an interest in the Gila River water for the San Carlos Irrigation Project.

Consequently, while "on paper" there appears to be approximately 110,000 acre-feet of surface water from the upper Gila River watershed available to serve municipal water uses somewhere in the state in the future, because of the factors discussed above, this water will likely remain in the watershed for use by farmers and others.

A more reasoned approach to assess whether Arizona has sufficient renewable water supplies to serve its projected municipal water demand would be to identify the renewable water supplies that could reasonably be considered available for future use in the municipal sector. These supplies would include (1) supplies currently used for municipal purposes (surface water, reclaimed water and renewable groundwater), (2) supplies that are under contract but are not currently being fully used for municipal purposes, e.g. CAP water, and (3) supplies that are currently utilized for other purposes but could reasonably be considered for conversion or transfer to municipal uses taking into account the legal, economic,

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http://fp.arizona.edu/kkh/SRP/
Final.Report/Final.Final.Report.pdf.

cultural, institutional, political, geographical, and physical constraints associated with such changes in use.

To determine this amount of water, however, it is necessary to make certain assumptions about (1) the allocation and management of water in Arizona and how it affects the availability of various water sources that are, or could be, used to serve municipal uses, and (2) future uses of water for municipal, agricultural, industrial and fish and wildlife uses in Arizona. These assumptions are described below.

A. Water Allocation and Management Assumptions

1. The water user requirements and water management goals applicable to the groundwater basins regulated by the Groundwater Code will remain in place. Accordingly, municipal water providers in the AMAs will be required to continue to secure renewable water supplies for new urban developments.

2. The Arizona Water Settlements Act of 2004 will become effective. Accordingly, the Final Decision of CAP Water Reallocation will become effective.[34]

3. Arizona's in-state surface water supplies will be declared fully appropriated and will be adjudicated to those with existing decreed rights and those who lawfully initiated rights to use water under state and federal law. Surface water rights associated with non-Indian agricultural uses will eventually be converted to (1) municipal use as agricultural lands urbanize or (2) fish and wildlife uses. However, some transfers to new locations to serve municipal uses in the watershed of origin will take place in rural areas. Indian entitlements to in-state surface water will be used on their reservations in accordance with settlement agreements.

4. The Arizona Supreme Court's order regarding subflow will be implemented in the General Stream Adjudications.[35]

5. The water supplies set forth in the settlement agreements for the Ak-Chin, Ft. McDowell, Salt River, San Carlos, Yavapai-Prescott, Gila River, Tohono O'odham, Zuni, and Quechan Tribes, and the decreed entitlements of the Colorado River, Fort Mojave, and Cocopah Tribes will be sufficient to supply the water uses contemplated on their respective reservations. Accordingly, these Indian Tribes will not need additional water supplies prior to 2100.

6. Indian Tribes legally authorized to lease allocations of Colorado River water will continue to lease more, but not all, of their allocations.

B. Water Use Assumptions

1. Given the expected population increases in Arizona, the use of water in the municipal sector will continue to increase. Municipal water providers outside

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34. Central Arizona Project (CAP), Arizona; Water Allocations, 71 Fed. Reg. 50,449-02, 50,449–52 (Aug. 25, 2006).

35. *In re* Gen. Adjudication of All Rights to Use Water in the Gila River Sys. & Source (*Gila IV*), 9 P.3d 1069 (Ariz. 2000).

AMAs currently overlying and dependent on groundwater supplies that are (1) interconnected with surface water or (2) from hard rock aquifers will move toward acquiring legal entitlements to renewable water supplies. Municipal water providers outside AMAs in regions where sufficient groundwater reserves exist, including sufficient natural recharge to the groundwater system, will continue to use groundwater as their primary supply.

2. Overall, agricultural use will continue to decline, although there will be an increase in agricultural use on Indian Reservations as Indian communities begin to use water supplies obtained in their settlement agreements. In some parts of the state—Yuma, La Paz, Graham, and Cochise counties—new non-Indian agricultural land may be developed. However, these new uses will be relatively small and will be supplied by groundwater and, accordingly, will not compete with the municipal sector for renewable water supplies.

3. Self-supplied industrial uses will increase at a modest rate; however, all major industrial users will be supplied by groundwater or surface water in areas with sufficient supplies to satisfy both municipal and industrial demands, or reclaimed water provided by municipal water providers. As a result, industrial users will generally not compete with the municipal sector for renewable water supplies.

4. There will be an increasing interest and an environmental requirement to preserve and enhance stream flows in Arizona's streams for protection of habitat for fish and wildlife. This will further limit access to interconnected groundwater.

Given these assumptions, Table 6 shows a more reasoned projection of the amount of renewable water supplies by water source on a statewide basis, along with the projected municipal water demands. This estimate is derived from an analysis of the availability of the following water sources:

1. In-state surface water supplies available for use in the municipal sector are estimated to be 725,000 acre-feet in 2020 and increase to 1,100,000 acre-feet as surface water rights are converted or transferred to serve municipal uses in response to urbanization in Apache, Maricopa, Pinal, Navajo, Graham, and Yavapai counties. The remaining in-state surface water supplies would not be converted or transferred to the municipal sector. These supplies include: (1) non-Indian water supplies in the Gila, Salt, San Pedro, Bill Williams, Hassayampa and Little Colorado River watersheds that will remain in the agricultural, industrial, and fish and wildlife sectors, and (2) Indian water supplies in the Gila, Salt, and Verde watersheds that will continue to be used on Indian Reservations for agricultural and industrial purposes.

2. Colorado River supplies are estimated to be 1,059,664 acre-feet in 2020 and increase to 1,149,664 acre-feet in 2100. They include the following components:

Colorado River Allocation Components	Quantity (acre-feet)				
	2020	**2040**	**2060**	**2080**	**2100**
Non-Indian CAP	720,664	720,664	720,664	720,664	720,664
Current CAP Leases	154,000	154,000	154,000	154,000	154,000
Future CAP Leases	25,000	25,000	25,000	25,000	25,000
Mainstem M&I Entitlements	140,000	140,000	140,000	140,000	140,000
Non-Indian Agriculture Conversion	20,000	50,000	80,000	100,000	120,000
Total	**1,059,664**	**1,089,664**	**1,109,664**	**1,129,664**	**1,149,664**

Table 5. Colorado River supplies projected to be available for municipal purposes from 2020 to 2100.

3. Groundwater supplies are estimated to be 323,781 acre-feet in 2020 and increase to 511,584 acre-feet in 2100. These amounts are slightly higher than the amounts shown in Table 3 and now include additional pumping to serve relatively small amounts of municipal demands in several counties outside of AMAs (Apache, Graham, Greenlee, La Paz, and Navajo counties).

4. The reclaimed water supplies are the same as in Table 3.

Water Source	Quantity (acre-feet)				
	2020	2040	2060	2080	2100
In-State Surface Water	725,000	825,000	950,000	1,050,000	1,100,000
Colorado River Water	1,059,664	1,089,664	1,109,664	1,129,664	1,149,664
Groundwater[36]	323,781	413,299	461,851	486,718	511,584
Reclaimed Water[37]	152,196	203,253	482,317	555,822	629,327
Total Renewable Water Supplies	**2,260,641**	**2,531,216**	**3,003,832**	**3,222,204**	**3,390,575**
Projected Municipal Water Demands	**2,029,283**	**2,710,042**	**3,215,444**	**3,705,478**	**4,195,512**
Surplus (Deficit)	**231,358**	**(178,826)**	**(211,612)**	**(483,274)**	**(804,937)**

Table 6. Revised estimate of the amount of renewable water supplies by source in Arizona. These estimates consider projected uses and limits on the transfer of some water sources.

Unlike the previous statewide projections, these projections suggest that Arizona's municipal water demand will exceed the amount of renewable water supplies available for municipal uses some time between 2020 and 2040. However, even this analysis underestimates the potential municipal water shortfall because it still compares projected statewide water availability with projected statewide municipal demands. In order to determine which areas of the state are projected to have sufficient water supplies to serve their future municipal demand and which do not, an analysis of supplies and demands by smaller regions of the state is necessary. For purposes of this analysis, we analyze water supplies and demands by county.

There are some counties in Arizona where a detailed analysis of the currently available water supplies is not necessary because either (1) the available surface water supplies are clearly sufficient to serve the projected demand or (2) the projected demand is significantly less than the combined amount of available renewable water and groundwater supplies. These counties include Apache, Graham, Greenlee, La Paz, Navajo, and Yuma. As discussed earlier, the surface water supplies available in Graham and Greenlee counties are clearly sufficient to serve the projected municipal demands well into the future. A similar situation

36. Includes incidental recharge from municipal use (4% of municipal water demand), and AMA renewable groundwater. *See supra* note 27.

37. Assumes 30% of projected municipal demand will be available as effluent. Prior to 2050, we assume 25% of the effluent will be reclaimed and re-used for drinking water purposes and after 2050, we assume 50% will be reclaimed and reused for drinking water purposes.

occurs in Yuma County, where the quantity of Colorado River water (existing municipal supplies and conversions and/or transfers of agricultural supplies) is more than sufficient to serve the projected municipal demands well into the future.

In Apache, La Paz, and Navajo counties the combined amount of surface water and groundwater is sufficient to serve the projected municipal demands in the future.[38] In La Paz County the annual municipal water demand in 2100 is projected to be approximately 9,400 acre-feet. The municipal providers in La Paz County have access to mainstem Colorado River water supplies as well as groundwater in sufficient quantities to serve this level of municipal demand, and greater, in the future. As for Apache and Navajo counties, the vast majority of the municipal providers in both counties withdraw groundwater from the C-aquifer, a very large aquifer that covers most of the northwest part of the state and has a very extensive area from which it is recharged. Additionally, in both counties, there are sufficient surface water supplies that could be converted or transferred for use in the municipal sector. We believe these supplies will eventually be used to supplement the groundwater sources and consequently sufficient water should be available in these counties to serve the projected municipal demands through 2100.

The remaining counties, Cochise, Coconino, Gila, Maricopa, Mohave, Pima, Pinal, Santa Cruz, and Yavapai, however, warrant a more detailed analysis of supplies and demands given their significant projected population growth and/or their projected limited water supplies. In fact, in three of these counties (Cochise, Mohave and Yavapai) there is significant concern today about whether sufficient water exists to serve the soaring population growth.

The Appendix shows the projected municipal water supplies and demands in these nine counties from 2020 to 2100 in table and graph form. A summary of these results are shown in Table 7.

38. There is some uncertainty regarding the supplies available for Indian municipal demands in these counties; however, we believe a portion of the Indian CAP supplies, the Cibola Valley Irrigation and Drainage District water acquired by the Hopi Tribe, and groundwater from the C-, N-, and alluvial aquifers will be sufficient to meet the Tribes' long-term municipal demands.

County	Quantity of Surplus or (Deficit) in acre-feet				
	2020	2040	2060	2080	2100
Cochise	(14,443)	(14,901)	(15,785)	(19,685)	(23,585)
Coconino	(18,694)	(22,788)	(23,319)	(26,097)	(28,876)
Gila	(5,576)	(7,033)	(7,262)	(8,451)	(9,641)
Maricopa	128,889	(166,693)	(213,556)	(390,716)	(617,875)
Mohave	8,570	4,753	3,353	(9,888)	(23,129)
Pima	81,179	72,450	43,361	14,675	(14,011)
Pinal	22,385	(61,280)	(94,145)	(160,861)	(252,579)
Santa Cruz	4,303	6,377	10,587	8,664	6,742
Yavapai	(9,972)	(19,824)	(17,945)	(24,282)	(33,118)
Total	**196,641**	**(208,939)**	**(314,711)**	**(616,641)**	**(996,072)**

Table 7. Projected surplus or deficit in renewable water supplies available to serve projected municipal water demands.

The projections show that a significant supply deficit exists in Cochise, Coconino, Gila, and Yavapai counties beginning in 2020 and continuing in to the future. These significant deficits exist for several reasons.

First, except for Yavapai County,[39] the amount of groundwater available in each of these counties has been limited to the estimated amount of incidental recharge occurring from the overall use of water in the municipal sector for that county. These amounts are less than what is currently being withdrawn in these counties for municipal use. However, in the major growth areas of each of these counties, there is presently a concern about the long-term sustainability of the region's groundwater supply. In parts of Coconino and Gila counties (Flagstaff, Williams, Payson, Pine, and Strawberry), the concern is primarily a matter of the physical sustainability of the area's groundwater supply, while in Cochise and Yavapai counties the concern relates to the legal availability of groundwater because much of the groundwater along the San Pedro River in Cochise County and the Verde River and its tributaries in Yavapai County is interconnected with surface water.

The relatively small amount of in-state surface water rights in these counties is another factor that affects the amount of the deficit. In each of these counties the projected amount of in-state surface water is less than 50% of the

39. In Yavapai County we have assumed additional groundwater pumping from the Big Chino Valley for importation into the Prescott AMA, and additional groundwater pumping in the Prescott AMA and Verde Valley equivalent to their current levels of groundwater pumping.

long-term municipal demand, and in most counties it is less than 30% (see Appendix). Additionally, only one of the municipal providers operating in these counties has an allocation of Colorado River water.[40] As a result, the long-term municipal demand in these counties is projected to greatly exceed the available renewable supply.

In Maricopa and Pinal counties the projections show that a sufficient water supply exists to serve the estimated municipal demand through 2020. However, in future years, the supply is anticipated to fall below the projected municipal demand. By 2100, the county municipal water supply deficits are substantial: Maricopa County (24% of total annual demand; approximately 620,000 acre-feet/year) and Pinal County (46% of total annual demand; approximately 252,000 acre-feet per year). The projections for Pima County show that sufficient supplies exist through 2080, but by 2100 the municipal demand exceeds the supply by about 3% (14,000 acre-feet/year). In Mohave County, the projections show that the renewable water supplies are nearly equivalent to the estimated municipal demand prior to 2060.[41] However, after 2060 the municipal demand is projected to be greater than the supply and by 2100 the supply shortfall is projected to be approximately 23,000 acre-feet per year or about 17% of the County's municipal water demand. Lastly, the projections for Santa Cruz County show that sufficient renewable water supplies exist in the county to serve the future municipal demands. Most of the available supply is surface water from the Santa Cruz River.

Again, the water demand projections used in this analysis are based on population projections and current estimated municipal water provider GPCD rates. In terms of water supplies, the projections consider (1) the changes in the allocations of CAP water embodied in the Arizona Water Settlements Act of 2004, (2) the limitations on groundwater use in AMAs and apply these principles to counties outside of AMAs where water supply and demand concerns are currently an issue because of population growth (Coconino, Cochise, Gila, Mohave, and Yavapai counties), (3) reasonable assumptions concerning the change in use and location of use of surface water rights currently used for agricultural purposes, and (4) that a full supply of in-state surface water and Colorado River water will be available for use every year.

On this last point, however, we know that Arizona's watersheds and those in the Colorado River Basin are subject to severe and extensive droughts. This is of particular concern for the CAP supply (including a portion of the mainstem Colorado River entitlement) because it is currently regarded as the most junior water entitlement on the Colorado River. While it is difficult to predict the severity of future droughts, Arizona has attempted to plan for shortages in the CAP supply by storing surplus CAP water in underground storage projects for future

40. Brooke Utilities, which operates two small water companies in Pine and Strawberry, has an allocation of 106 acre-feet of CAP water.

41. Of interest, the vast majority of the non-Indian renewable water supplies in Mohave County are mainstem Colorado River entitlements under contract to municipal providers along the Colorado River. Municipal providers who serve the planned high growth areas near Kingman currently do not have Colorado River entitlements.

withdrawal. However, even with the water storage program, given the recent research on drought cycles in the Colorado River Basin and the potential for increased water development in the upper Colorado River Basin, there remains some uncertainty about the quantity of CAP water that will be available to Arizona in the long-term. This concern exists for Arizona's in-state surface water sources as well. While Arizona has specifically planned for supplementing its CAP supplies during shortage years, there is no specific plan in place to augment Arizona's in-state surface water supplies during extended drought periods. Consequently, the actual water supply deficits could be even more severe than projected in this analysis.

In summary, given the assumptions described above, the projections show that in Arizona's most populous counties there may not be sufficient renewable water supplies to supply the projected municipal water demand beginning as early as 2020. In some counties, the supply deficits are substantial relative to the size of the projected county municipal demand (Coconino, Cochise, Gila, Mohave, and Yavapai counties), while in others the deficits are substantial in terms of overall magnitude (Maricopa and Pinal counties). The total volume of deficit is projected to be 1,000,000 acre-feet per year by 2100.

Again, these projections assume that a full supply of surface water is available every year. If the long-term availability of CAP water and the Arizona in-state surface water supplies are negatively impacted by drought and the effects of climate change, and the state's projected population continues as it has historically, the deficit between the water supply and the water demand could be even higher. While additional conservation and increased groundwater pumping might be acceptable solutions to offset these deficits in the short-term, they are not sustainable in the long-term. In order for Arizona to sustain its projected population in the future, the state will need to significantly augment its water supplies.

VI. WATER AUGMENTATION OPTIONS FOR ARIZONA

There are essentially two approaches that Arizona could pursue to augment the water supplies used in the eight counties projected to have insufficient renewable water supplies to serve the municipal water demand ("Eight County Area"). One approach would be to identify other supplies in Arizona that could be used for municipal purposes but have not been considered for this use in this analysis ("in-state options"). The other approach would be for Arizona to acquire a water supply from outside the state ("out-of-state options"). In this case the supply could be transferred and delivered directly to the state or it could be delivered to another water user in exchange for a commensurate amount of water delivered to Arizona.

A. In-State Options

There are two in-state options that could reasonably be considered to augment the water supplies used in the Eight County Area. One option would be to increase the percentage of effluent that could be reclaimed and used by municipal providers for drinking water purposes. Currently, less than 10% of the effluent produced in Arizona is reclaimed and used for drinking water purposes. The analysis in this Article assumes that up until 2040, 25% of the effluent produced would be reclaimed and used by municipal providers for drinking water, and after 2040, 50% of the effluent would be reclaimed and used for drinking water. If these rates were increased by an additional 25%, the overall deficit for these counties would be reduced by 75,000 acre-feet in 2040 and by 200,000 to 300,000 acre-feet between 2060 and 2100. If these rates were increased by an additional 50% (assumes 100% of the reclaimed water would be used for drinking water after 2040) the overall deficit would be reduced by 175,000 acre-feet in 2040 and by 450,000 to 550,000 acre-feet between 2060 and 2100. The vast majority of the deficit reductions would occur in Maricopa, Pima, and Pinal counties.

While increased use of reclaimed water for drinking water purposes would reduce the supply deficit, it would not eliminate it entirely. More importantly, however, it is highly unlikely that 100% of the effluent produced in the Eight County Area could actually be reclaimed and used for drinking water purposes. Currently the vast majority of reclaimed water is distributed for agricultural and industrial uses, and as a supply for turf and plants in residential, commercial, and municipal landscaping. In the future, there are likely to be more opportunities to use reclaimed water as a drinking water source through underground recharge and recovery programs.

Even so, it is improbable that reclaimed water currently used for existing industrial and landscaping uses will cease or that all of the reclaimed water produced in the future will be used entirely for drinking water. Reclaimed water will continue to be used for agricultural, industrial, and fish and wildlife uses in certain areas of Arizona. Residents of Arizona are likely to expect that turf and other landscaping amenities will continue to be included as part of common areas and open space for residential, commercial, and municipal land developments. These uses would presumably continue to be irrigated with reclaimed water rather than other sources. Furthermore, more expansive landscaping may prove necessary to counteract the heat island effect associated with higher density and more expansive urbanization that will arise with the projected significant population growth within the Arizona Sun Corridor.

Additionally, it is reasonable to expect that a portion of the reclaimed water stored underground will be used to firm in-state surface water supplies affected by drought. Consequently, greater use of reclaimed water alone will not provide a long-term solution to the water supply shortfall affecting the Eight County Area.

The other in-state option that could be considered to address the water supply shortfall would involve the acquisition of rights to Colorado River entitlements (CAP and/or mainstem entitlements) and the delivery of that water to the Eight County Area. For purposes of this paper it is estimated that an additional 25,000 acre-feet of CAP water would be leased from Indian Tribes on a long-term basis (e.g., 100 years or more), which would be enough to satisfy the state's assured water supply requirements. This would bring the total amount of CAP water leased under long-term contracts to 179,000 acre-feet or about 27% of the Indian supply. Indian tribes may actually lease more than the 25,000 acre-feet in the future; however, the leases may be shorter in duration to accommodate the tribes' needs to eventually use CAP water on their reservations for various economic development purposes. Accordingly, the future leases of Indian CAP water would not provide a sufficient amount of water to address the water supply shortfall on a long-term basis. Future Indian CAP leases would, however, provide another option to firm municipal surface water supplies used in the Eight County Area.

In terms of mainstem Colorado River entitlements, for the purposes of this paper, it is assumed that none of these supplies would be transferred on a long-term basis for use by municipal water providers in the Eight County Area. The legal authority to transfer mainstem Indian entitlements away from the reservations is unclear, although more definitive authority may be established in the future. The arrangement under which mainstem Indian entitlements would be considered for "transfer" to municipal providers in central Arizona would likely come under a forbearance agreement. A forbearance arrangement would not actually be a permanent transfer, but simply an arrangement for one entity to discontinue use of its legal entitlement to water for a period of time while another entity uses it. Under the arrangement, the municipal provider would obtain access to the water and, assuming an arrangement could be made with CAP, have the water delivered into central Arizona.

However, some of the complex legal issues associated with the "out-of-watershed" transfer of agricultural water from in-state sources may limit the extent to which mainstem Colorado River entitlements are used in central Arizona. For example, in a time of drought, when CAP entitlement holders would normally be authorized to receive a portion of any unused mainstem Indian entitlements, those holders are likely to adamantly object if the water is unavailable to them because of a forbearance arrangement that resulted in the water going to a non-CAP contract user. In anticipation of such problems, it is likely that any forbearance arrangement would contain provisions that required the user of the Indian entitlement to possibly relinquish the use of the water during times of drought. Consequently, most, if not all, mainstem Colorado River forbearance arrangements would not be reliable to sustain future municipal uses in the long-term. However, these arrangements would be useful to firm Arizona's junior priority Colorado River entitlement and its in-state surface water supplies.

In terms of non-Indian mainstem entitlements, there is likely to be significant resistance to permanently transferring these supplies away from the Colorado River region because they will eventually be used in Yuma, La Paz, and Mohave counties to supply future municipal and industrial demands. Additionally, there are unlikely to be large scale programs to transfer conserved non-Indian agricultural mainstem water to central Arizona because of the same legal impediments discussed above that impact arrangements to forbear Indian mainstem entitlements. Thus, non-Indian mainstem entitlements, whether in whole or in part (conserved water), would not be a dependable solution for the water supply deficit in the Eight County Area. Instead, as with Indian forbearance arrangements, conserved water could serve as a source to firm Arizona's in-state surface water supplies and its junior priority Colorado River entitlements.

In summary, each of the in-state options individually is insufficient in volume and in reliability to satisfy Arizona's long-term water supply needs for the Eight County Area. Collectively, with careful management, these supplies might be able to satisfy a good portion of the water supply shortfall anticipated to occur through 2040. Beyond 2040, Arizona would still require additional water sources from outside the state to satisfy its projected municipal demands.

B. Out-of-State Options

One out-of-state option Arizona could consider to augment the state's water supply would be to import water from the Columbia River Basin via the Colorado River Basin. There is a significant amount of water that could be imported from the Columbia River Basin into the Colorado River Basin and a favorable climatic pattern to help support the transfer program. Recent research concerning the location of the Polar Jet Stream and Pacific Ocean water temperatures over the last three decades has shown that when the Pacific Northwest is wet—i.e., has abundant precipitation and runoff—the Southwest is dry, at least during the El Niño/La Niña cycle.[42] This research also shows that the converse is true. As a result, a water transfer program that would take water from the Pacific Northwest during wet periods (when abundant water is in the Columbia River system) and deliver that water to the Colorado River system during dry periods (when its vast reservoirs are only partially full) would actually result in a more efficient utilization of water in both river systems. Such a program could significantly improve the reliability of Colorado River water supplies.

However, there is a myriad of difficult political, environmental, and legal issues that would have to be overcome to make this option viable. Politically, the Columbia River Basin states have historically been staunchly opposed to allowing any diversion of water out of the Columbia Basin. In fact, when the Colorado River Basin Project Act (Basin Project Act) was authorized, Senator Henry Jackson from Washington led an effort to get a moratorium provision added to the Basin Project Act's authorizing legislation that prevented the study of whether water from the outside the Colorado River Basin could be used to augment the Colorado River's supplies. While this moratorium has long expired, the views of political leaders and water, power, and environmental interests from the Columbia River Basin have probably not changed.

Furthermore, over the last decade, environmental issues associated with the preservation of salmon indigenous to the Columbia River system have placed additional constraints on the use of water in the Columbia River Basin. These constraints are focused on limiting diversions in order to provide more free flowing water in the Columbia River system. As a result, any plan to take water from the Columbia River Basin would now face significant environmental hurdles.

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42. *See* Kelly T. Redmond & Roy W. Koch, *Surface Climate and Streamflow Variability in the Western United States and Their Relationship to Large-Scale Circulation Indices*, 27 WATER RESOURCES RES. 2381 (1991); Earth System Research Laboratory, Composite ENSO, http://www.cdc.noaa.gov/ENSO/enso.comp.html (last visited Apr. 14, 2007); ENSO Composite U.S. Temperature and Precipitation, http://www.cdc.noaa.gov/ENSO/enso.comp.std.html (last visited Apr. 14, 2007).

Even assuming the political and environmental issues could be addressed, questions would remain about the extent to which Arizona could gain sufficient water from the Columbia River Basin to satisfy its long-term water needs.

Central to this uncertainty would be the structure of a compact among the Columbia River Basin states and Colorado River Basin states. Given Arizona's projected population and limited renewable water supplies compared to other Colorado River Basin states, Arizona's long-term water deficit is likely much more significant than those of any other Colorado River Basin state. Moreover, given its limited long-term Colorado River supply (its largest Colorado River allocation, CAP water, is currently regarded as the most junior supply on the Colorado River system), Arizona would need a disproportionately larger quantity of water from the Columbia River system than the other states. Arizona's demand for a proportionately larger allocation of Columbia River Basin water would also likely require it to assume a proportionately larger risk, and cost, associated with the diversion and use of water from the Columbia River system.

In summary, the complexity of developing a multi-basin state compact would require a significant negotiation effort among the states. Based on the history of negotiations among the Colorado River Basin states, it is uncertain whether a compact could be reached that would be satisfactory to Arizona. Given all of these factors, it is highly unlikely that Arizona could rely on imported water from the Columbia River Basin to satisfy its long-term water needs. However, a narrowly focused importation program that would take water from the Columbia River during wet periods in the Pacific Northwest when sufficient water was available for both salmon and importation might provide a good solution for the Colorado River Basin states to firm their supplies during drought periods.

Another option that could potentially provide Arizona with access to a significant quantity of renewable water would be an exchange arrangement with California involving Pacific Ocean water and Colorado River water. Under this proposal, Arizona would develop a freshwater supply by desalinating Pacific Ocean water for delivery to California—Metropolitan Water District ("MWD") and San Diego County Water Authority ("SDCWA")—in exchange for a portion of California's Colorado River entitlement. Arizona could potentially gain access to as much as 1,000,000 acre-feet of Colorado River water if it could provide a full replacement supply to MWD and SDCWA for their current and recently proposed Colorado River supplies, and also incorporate into the exchange additional quantities of conserved water that MWD and SDCWA are both contemplating developing in the future.

The advantages of this proposal are that it is a relatively straightforward concept, it would produce a drought-proof water supply for exchange with California, and it would not impact other states with Colorado River allocations. The potential limitations of this concept are the feasibility of desalinating 1,000,000 acre-feet of ocean water per year along the southern California coast as a supply source to exchange with Arizona, and the interest of California to do the exchange. With respect to the former, at the present time southern California water interests are contemplating developing eight desalination plants with the combined capacity to produce nearly 336,000 acre-feet of freshwater per year.[43] However, one of the more significant issues that must be addressed in the desalination planning process in California is finding acceptable sites for desalination plants. While the current proposed plants appear to be located in suitable areas, given the interests of southern Californians to preserve their ocean front properties, it may be very difficult to find acceptable locations in the future, especially if the plant is designed to produce water to trade with Arizona.

The latter issue, however, is even more problematic. California's current interest in developing desalination plants along its coastline stems from its immediate need to develop additional water supplies for its growing population, to improve the reliability of its existing water supplies, and to provide water for environmental uses.[44] Arizona's need for additional water is still many years away. Consequently, it is likely that by the time Arizona is prepared to trade desalinated water for a portion of California's Colorado River entitlement, California will have very little interest in trading because it will have already developed the sites to desalinate seawater along its coastline for its own needs. Additionally, to serve its future population, California will likely develop more plants or expand existing facilities on its own, rather than allowing Arizona to develop or expand plants to trade desalinated water with California for Colorado River water. Lastly, there are no indications that MWD will be interested in shutting down its Colorado River water delivery system to accommodate Arizona's need for additional water via an exchange for desalinated water.

A more promising and farsighted alternative to explore for developing a new source of renewable water would be an exchange of desalinated water with Mexico. Under this arrangement—an Arizona-Mexico Water Augmentation Consortium ("Consortium")—Arizona, working with the United States and Mexico, would desalinate seawater from the Gulf of California and provide the freshwater to Mexico in exchange for Mexico's allocation of Colorado River water. Currently, the majority of Mexico's Colorado River water is used for agricultural purposes. Depending on the location of the desalination plants and the infrastructure to deliver water to Mexico's agricultural areas, the Consortium could be expanded by exchanging additional desalinated water with California agricultural water users for a portion of their Colorado River entitlements.

The Consortium has multiple advantages over other options. Like the Arizona and California water exchange, it is a straightforward alternative that would produce a drought-proof water supply without impacting other Colorado River Basin states. However, unlike California, Mexico would likely have a significant interest in working with the United States and Arizona to facilitate development of desalination plants in the region. Mexico has a strong interest in improving the quality of water used in northern Mexico. At present the quality of Colorado River water provided by the United States to Mexico is a serious concern

43. *See* HEATHER COOLEY, PETER H. GLEICK & GARY WOLFF, PAC. INST., DESALINATION, WITH A GRAIN OF SALT: A CALIFORNIA PERSPECTIVE 35 (2006).

44. *See id.* at 2.

to Mexico because it adversely impacts farming in northern Mexico.[45] Under this exchange arrangement Mexico would receive better quality water than it now receives from the United States. Another advantage of the exchange is that it would provide Mexico with an opportunity to develop a new source of drinking water for northern Sonora and possibly northern Baja California. In these areas of Mexico, there is a significant need for additional drinking water supplies.[46] By working jointly with Mexico, Arizona and the United States could help Mexico solve this critical problem. Still another benefit of the Consortium would be the potential for further regional economic development for Arizona and Mexico.

The potential limitation of this desalination/water exchange arrangement is the feasibility of desalinating sufficient freshwater to exchange with Mexico to meet Arizona's long-term municipal water supply needs. One of the frequent criticisms of desalinating seawater is that it costs more to produce when compared to the costs of existing drinking water supplies. Many factors influence the cost of desalinating seawater to produce freshwater, including (1) plant capacity, (2) feed water quality, (3) pretreatment needs, (4) the type of desalination process, (5) the energy supply, and (6) financing costs.[47] In general, because of economies of scale and assuming all factors being equal, larger plants tend to be less expensive to operate than smaller plants.[48] With current reverse osmosis technologies, reported costs per acre-foot for smaller plants (<1 million gallons per day or 1,000 acre-feet per year) typically exceed $1,800 per acre-foot, while larger-size plants (>10 million gallons per day or 11,000 acre-feet per year) range from $500 to $1,200 per acre-foot.[49]

The single largest cost component associated with the desalination process is the cost of energy. By co-locating a power plant and a desalination plant the energy cost for treating seawater would decrease significantly. Additionally, as new treatment technologies are developed, the overall cost to desalinate seawater is expected to decrease even further.[50] The cost of desalinating seawater to agricultural use standards is expected to be lower still.

While desalinated seawater is more costly than existing drinking water supplies, it is important to remember that the cost of current drinking water supplies are relatively low because they are derived from water sources secured more than 50 to 100 years ago. Given the limited availability of renewable water supplies in the Southwest and the environmental constraints associated with developing those supplies further, the costs for water produced from the next

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45. *See* U.S. Dep't of the Interior, Colorado River Basin Salinity Control Program—Overview, http://www.usbr.gov/dataweb/html/crwq.html (last visited March 29, 2007).

46. Dennis Small & Paul Gallagher, *Produce Water, or Fight Over It, Is the Real Issue in the West*, EXEC. INTELL. REV., Oct. 15, 2004, at 53.

47. SHAHID CHAUDHRY, CAL. ENERGY COMM'N, UNIT COST OF DESALINATION 2, *available at* http://www.owue.water.ca.gov/recycle/desal/Docs/UnitCostofDesalination.doc (last visited Apr. 25, 2007) (report on meeting with Metropolitan Water District).

48. *Id.*

49. *Id.* at 4–5; Shahid Chaudhry, Unit Cost of Desalination 2 (July 30, 2003), *available at* http://www.owue.water.ca.gov/recycle/desal/Docs/UnitCostDesalination.pdf.

50. *See* COOLEY ET AL., *supra* note 43, at 44–45.

generation of water sources are undoubtedly going to be much greater than current water costs. In effect, Arizona and other southwestern states have already picked the "low-hanging fruit" when it comes to water supplies. In the future, we all will have to go "higher in the tree" for our drinking water supplies.

Another area of criticism regarding desalinated water technology is the environmental concern relating to the disposal of the salt brine generated from the desalination process and the possible impingement and entrainment of marine organisms in a desalination plant's intake pipes.[51] While these issues have been mentioned by opponents of desalination plants, there has not been significant research on either issue to fully understand how much they impact the environment, if at all, and further, how the impacts, if any, might be monitored and mitigated.

On the other hand, there are several potential environmental benefits to desalinating seawater from the Gulf of California. As discussed previously, under this proposal, the desalinated water would significantly improve the quality of water being used in Mexico for farming. This water is also used for various domestic uses and consequently would be a significant improvement for those uses as well. Additionally, some of the desalinated water could be used to replace the poor quality water being delivered to the Cienega de Santa Clara wetlands. This could improve the wetlands ecosystem and provide the wetlands with a more reliable, consistent quality water supply.

In summary, each of the out-of-state options could potentially produce a significant amount of water for Arizona to use to serve the state's projected population in the long-term. There are advantages and disadvantages of each alternative; however, the Arizona-Mexico Water Augmentation Consortium may be the most viable. While this alternative appears promising, there are still significant economic and environmental feasibility issues that need to be addressed. Fortunately, Arizona has some time to evaluate these issues to determine whether a consortium with Mexico could work.

VII. CONCLUSION

Because of foresight and planning by Arizona's past leaders, the quantity of renewable water supplies, including renewable groundwater, across most of Arizona is sufficient to sustain the current population.[52] Within twenty years, however, assuming Arizona's population growth continues as projected, the municipal water demand in most counties of the state will reach or exceed the limit of the available renewable water supplies. Increased levels of water conservation and reuse of reclaimed water, together with increased groundwater pumping and

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51. *Id.* at 6.

52. There are a few locations in several counties—all rural, with increasing population, limited in-state surface water sources, and no current access to Colorado River water—where the currently available renewable water supplies are insufficient to supply the current population. In these areas, municipal providers are pumping groundwater at rates that exceed recharge to make up the shortfall in renewable water sources. In order for these areas to continue to serve their projected population, they will need to obtain additional renewable water supplies in the very near future.

some agricultural-to-urban water transfers, will provide a short-term solution to offset the renewable water supply deficit. In the long-term, however, Arizona will need to identify and implement a permanent solution to augment the state's renewable water supplies to sustain its anticipated long-term population. Similar to the state's requirements for municipal providers in AMAs, the state's solution should provide its citizens with an assured water supply for one hundred years or more. Given the state's potential population growth over the next century, Arizona could need as much as 1,000,000 to 1,500,000 acre-feet of additional water.

As might be expected, the alternatives available for developing up to 1,500,000 acre-feet of water over the next one hundred years are limited. The various in-state options include greater use of reclaimed water and transfers of agricultural water rights to urban areas for municipal use. As noted earlier, these options provide a good solution for bridging the renewable water supply shortfall in the short-term, but they are insufficient to sustain the expected municipal demand in the long-term. The out-of-state options include transferring water from the Columbia River Basin into the Colorado River Basin, and trading desalinated ocean water for Colorado River water with either California or Mexico. While importation of Columbia River water could be helpful in firming Colorado River supplies during drought periods, the political, environmental, and legal issues associated with such a transfer are extremely complex, making this option impractical as a long-term solution to augment Arizona's water supplies.

The seawater desalination/water exchange options are more straightforward to implement and would produce a drought-proof water supply. Unfortunately, California's own long-term water needs and the limited desalination sites along southern California's coastline make an exchange of desalinated seawater by Arizona for California Colorado River water unworkable. On the other hand, Mexico's interest in obtaining a better water supply for its agricultural uses and its own needs for drinking water supplies make it a more suitable partner for Arizona to trade for additional Colorado River supplies. While there are questions about the feasibility of desalinating the quantity of water needed by Arizona over the next one hundred years, Arizona and Mexico have time to explore the options and to determine the most feasible method to accomplish the exchange. Additionally, the technology and costs of producing freshwater from seawater, and the methods of minimizing or mitigating environmental concerns, are likely to improve significantly in the near future, and in the long-term, as the interest in desalinating seawater continues to grow and grow.

Even though Arizona has time to prepare for its future water needs, past experience shows that large water supply projects, e.g. the CAP, take many years to plan and develop. Accomplishing an exchange with Mexico using desalinated water from the Gulf of Mexico will require a concerted, coordinated effort among Arizona, Mexico, and the United States. The Arizona–Mexico Commission, chaired by the Governors of Arizona and Sonora, Mexico, could provide the forum to initiate these discussions. Concurrently, Arizona will need to identify a method for planning the project—including financing, construction, and management. Given the projected widespread need for water across most of Arizona and the importance of such a program to the state's future, the best approach might be the creation of an Arizona Water Authority to oversee Arizona's portion of the Consortium. Such an authority would be governed by qualified water resource engineering and business leaders appointed by the Governor and would need broad-based authority to perform all of the necessary functions to deliver water to municipal water providers within Arizona.

Today's Arizonans are the beneficiaries of the vision and thoughtful planning of past leaders. Arizona is one of the fastest growing states in the country. Its climate provides a relatively easy lifestyle and its low risk of natural disasters make it a very desirable place for people to make it home—on both a temporary and permanent basis. To ensure that the quality of life enjoyed by its citizens today is preserved for future generations, Arizona's current leaders must begin to plan for the development of additional water supplies.

APPENDIX C
LEGISLATION AND STATUTES

State of Arizona
House of Representatives
Forty-eighth Legislature
First Regular Session
2007

HOUSE BILL 2692
AN ACT

AMENDING SECTIONS 41-3014.06, 49-1201, 49-1202, 49-1203, 49-1261, 49-1263, 49-1264, 49-1265 AND 49-1267, ARIZONA REVISED STATUTES; CHANGING THE DESIGNATION OF TITLE 49, CHAPTER 8, ARTICLE 2, ARIZONA REVISED STATUTES, TO "CLEAN WATER REVOLVING FUND, DRINKING WATER REVOLVING FUND AND HARDSHIP GRANT FUND FINANCIAL PROVISIONS"; AMENDING TITLE 49, CHAPTER 8, ARIZONA REVISED STATUTES. BY ADDING ARTICLE 3; RELATING TO THE WATER INFRASTRUCTURE FINANCE PROGRAM; PROVIDING FOR CONDITIONAL ENACTMENT.

Be it enacted by the Legislature of the State of Arizona:
Section 1. Section 41-3014.06, Arizona Revised Statutes, is amended to read:
41-3014.06. Water infrastructure finance authority; termination July 1, 2014
A. The water infrastructure finance authority terminates on July 1, 2014.
B. Sections 49-1201 through 49-1204, 49-1224 through 49-1226, 49-1244, 49-1245, 49-1246, and 49-1261 through 49-1268 49-1269 AND 49-1274 THROUGH 49-1282 are repealed on January 1, 2015, if the authority:
1. Has no outstanding contractual obligations with the United States or any United States agency.
2. Has no debts, obligations or guarantees that were issued for the purposes of title 49, chapter 8.
3. Has otherwise provided for paying or retiring such debts or obligations.
C. If any debt or obligation listed in subsection B of this section exists and no satisfactory provision has been made to pay or retire the debt or obligation, the authority and statutes shall continue in existence until the debt or obligation is fully satisfied.

Sec. 2. Section 49-1201, Arizona Revised Statutes, is amended to read:
49-1201. Definitions
In this article CHAPTER, unless the context otherwise requires:
1. "Authority" means the water infrastructure finance authority of Arizona.
2. "Board" means the board of directors of the authority.
3. "Bonds of a political subdivision" means bonds issued by a political subdivision as authorized by law.
4. "Clean water act" means the federal water pollution control act amendments of 1972 (P.L. 92-500; 86 Stat. 816), as amended by the water quality act of 1987 (P.L. 100-4; 101 Stat. 7).
5. "COMMITTEE" MEANS THE WATER SUPPLY DEVELOPMENT FUND COMMITTEE ESTABLISHED BY SECTION 49-1202, SUBSECTION B.
5. 6. "Drinking water facility" means a community water system or a nonprofit noncommunity water system as defined in the safe drinking water act (P.L. 93-523; 88 Stat. 1660; P.L. 95-190; 91 Stat. 1393; P.L. 104-182; 110 Stat. 1613) that is located in this state. For purposes of this article, drinking water facility does not include water systems owned by federal agencies.
6. 7. "Financial assistance loan repayment agreement" means an agreement to repay a loan provided to design, construct, acquire, rehabilitate or improve water or wastewater infrastructure, related property and appurtenances OR A LOAN PROVIDED TO FINANCE A WATER SUPPLY DEVELOPMENT PROJECT.
7. 8. "Indian tribe" means any Indian tribe, band, group or community that is recognized by the United States secretary of the interior and that exercises governmental authority within the limits of any Indian reservation

under the jurisdiction of the United States government, notwithstanding the issuance of any patent and including rights-of-way running through the reservation.
8. 9. “Nonpoint source project” means a project designed to implement a certified water quality management plan.
9. 10. “Political subdivision” means a county, city, town or special taxing district authorized by law to construct wastewater treatment facilities, drinking water facilities or nonpoint source projects.
10. 11. “Safe drinking water act” means the federal safe drinking water act (P.L. 93-523; 88 Stat. 1660; P.L. 95-190; 91 Stat. 1393; P.L. 104-182; 110 Stat. 1613), as amended in 1996.
11. 12. “Technical assistance loan repayment agreement” means EITHER OF THE FOLLOWING:
(a) An agreement to repay a loan provided to develop, plan and design water or wastewater infrastructure, related property and appurtenances. The agreement shall be for a term of not more than three years and the maximum amount that may be borrowed is limited to not more than five hundred thousand dollars.
(b) AN AGREEMENT TO REPAY A LOAN PROVIDED TO DEVELOP, PLAN OR DESIGN A WATER SUPPLY DEVELOPMENT PROJECT.
12. 13. “Wastewater treatment facility” means a treatment works, as defined in section 212 of the clean water act, that is located in this state and that is designed to hold, cleanse or purify or to prevent the discharge of untreated or inadequately treated sewage or other polluted waters for purposes of complying with the clean water act.
14. “WATER PROVIDER” MEANS ANY OF THE FOLLOWING:
(a) A MUNICIPAL WATER DELIVERY SYSTEM AS DEFINED IN SECTION 42-5301, PARAGRAPHS 1 AND 3.
(b) A MUNICIPAL WATER DELIVERY SYSTEM AS DEFINED IN SECTION 42-5301, PARAGRAPH 2, WHICH HAS ENTERED INTO A PARTNERSHIP WITH A CITY, TOWN OR COUNTY FOR A WATER SUPPLY AUGMENTATION PLAN.
(c) A COUNTY WATER AUGMENTATION AUTHORITY ESTABLISHED UNDER TITLE 45, CHAPTER 11.
(d) A COUNTY WATER AUTHORITY ESTABLISHED UNDER TITLE 45, CHAPTER 13.
(e) AN INDIAN TRIBE.
(f) A COMMUNITY FACILITIES DISTRICT AS ESTABLISHED BY TITLE 48, CHAPTER 4.
15. “WATER SUPPLY DEVELOPMENT” MEANS EITHER OF THE FOLLOWING:
(a) THE ACQUISITION OF WATER OR RIGHTS TO OR CONTRACTS FOR WATER TO AUGMENT THE WATER SUPPLY OF A WATER PROVIDER.
(b) THE DEVELOPMENT OF FACILITIES FOR ANY OF THE FOLLOWING PURPOSES:
(i) CONVEYANCE, STORAGE OR RECOVERY OF WATER.
(ii) RECLAMATION AND REUSE OF WATER.
(iii) REPLENISHMENT OF GROUNDWATER.

Sec. 3. Section 49-1202, Arizona Revised Statutes, is amended to read:
49-1202. Water infrastructure finance authority of Arizona; board; water supply development fund committee; violation; classification
A. The water infrastructure finance authority of Arizona is established. A board of directors shall govern the authority. The board of directors consists of:
1. The director of environmental quality, or the director’s representative, who serves as chairman.
2. The director of the department of commerce or the director’s representative.
3. The state treasurer or the treasurer’s representative.
4. One member WHO IS appointed by the governor to represent municipalities with populations of fifty thousand persons or more according to the most recent United States decennial census.
5. One member WHO IS appointed by the governor to represent municipalities with populations of less than

fifty thousand persons from a county with a population of less than five hundred thousand persons according to the most recent United States decennial census.
6. One member WHO IS appointed by the governor to represent counties with populations of five hundred thousand persons or more according to the most recent United States decennial census.
7. One member WHO IS appointed by the governor to represent sanitary districts in counties with populations of less than five hundred thousand persons according to the most recent United States decennial census.
8. The director of water resources or the director's representative.
9. The chairman of the Arizona corporation commission or the chairman's representative.
10. One member WHO IS appointed by the governor from a public water system that serves five hundred persons or more.
11. One member WHO IS appointed by the governor from a public water system that serves fewer than five hundred persons.
12. One member WHO IS appointed by the governor to represent Indian tribes.
B. THE WATER SUPPLY DEVELOPMENT FUND COMMITTEE OF THE AUTHORITY IS ESTABLISHED. THE COMMITTEE CONSISTS OF:
1. THE DIRECTOR OF WATER RESOURCES, OR THE DIRECTOR'S REPRESENTATIVE, WHO SERVES AS CHAIRPERSON OF THE COMMITTEE.
2. THE DIRECTOR OF ENVIRONMENTAL QUALITY, OR THE DIRECTOR'S REPRESENTATIVE, WHO SERVES AS VICE CHAIRPERSON OF THE COMMITTEE.
3. THE CHAIRMAN OF THE CORPORATION COMMISSION OR THE CHAIRMAN'S REPRESENTATIVE.
4. THE STATE TREASURER OR THE TREASURER'S REPRESENTATIVE.
5. ONE MEMBER WHO IS APPOINTED BY THE GOVERNOR TO REPRESENT MUNICIPALITIES WITH POPULATIONS OF FIFTY THOUSAND PERSONS OR MORE BUT LESS THAN ONE HUNDRED THOUSAND PERSONS.
6. ONE MEMBER WHO IS APPOINTED BY THE GOVERNOR TO REPRESENT MUNICIPALITIES WITH POPULATIONS OF LESS THAN FIFTY THOUSAND PERSONS FROM A COUNTY WITH A POPULATION OF LESS THAN FIVE HUNDRED THOUSAND PERSONS.
7. ONE MEMBER WHO IS APPOINTED BY THE GOVERNOR TO REPRESENT COUNTIES WITH POPULATIONS OF LESS THAN TWO HUNDRED THOUSAND PERSONS.
8. ONE MEMBER WHO IS APPOINTED BY THE GOVERNOR TO REPRESENT COUNTIES WITH POPULATIONS OF TWO HUNDRED THOUSAND PERSONS OR MORE BUT LESS THAN ONE MILLION PERSONS.
9. ONE MEMBER WHO IS APPOINTED BY THE GOVERNOR TO REPRESENT COUNTIES WITH POPULATIONS OF ONE MILLION PERSONS OR MORE.
10. ONE MEMBER WHO IS APPOINTED BY THE GOVERNOR TO REPRESENT CITIES WITH POPULATIONS OF MORE THAN ONE HUNDRED THOUSAND PERSONS IN COUNTIES WITH POPULATIONS OF MORE THAN ONE MILLION PERSONS.
11. ONE MEMBER WHO IS APPOINTED BY THE GOVERNOR FROM A PUBLIC SERVICE CORPORATION THAT SERVES ONE THOUSAND EIGHT HUNDRED FIFTY PERSONS OR MORE.
12. ONE MEMBER WHO IS APPOINTED BY THE GOVERNOR FROM A PUBLIC WATER SYSTEM THAT SERVES FEWER THAN ONE THOUSAND EIGHT HUNDRED FIFTY PERSONS.
13. ONE MEMBER WHO IS APPOINTED BY THE GOVERNOR TO REPRESENT INDIAN TRIBES.
B. C. Members OF THE BOARD AND THE COMMITTEE WHO ARE appointed by the governor serve at the governor's pleasure and serve staggered five year terms. Members of the board AND THE COMMITTEE are not eligible to receive compensation for their services but are eligible for reimbursement for travel and other expenses pursuant to title 38, chapter 4, article 2. Members of the board AND THE COMMITTEE are public officers for purposes of title 38, and the authority is a AND THE COMMITTEE ARE public body BODIES for

purposes of title 38, chapter 3, article 3.1.
C. D. Members of the board shall not have any direct or indirect personal financial interest in any clean water or drinking water project financed under this article. MEMBERS OF THE COMMITTEE SHALL NOT HAVE ANY DIRECT OR INDIRECT PERSONAL FINANCIAL INTEREST IN ANY WATER SUPPLY DEVELOPMENT PROJECT FINANCED UNDER THIS ARTICLE. For THE purposes of this subsection, a member of the board OR THE COMMITTEE who is a full-time employee of a participant in or applicant for a loan does not have a direct or indirect personal financial interest in a project. A violation of this subsection is a class 1 misdemeanor.
D. E. The department of environmental quality shall provide clerical support and office and meeting space to the board.
F. THE DEPARTMENT OF WATER RESOURCES SHALL PROVIDE TECHNICAL ASSISTANCE TO THE COMMITTEE AS REQUESTED BY THE COMMITTEE.

Sec. 4. Section 49-1203, Arizona Revised Statutes, is amended to read:
49-1203. Powers and duties of authority; definition
A. The authority is a corporate and politic body and shall have an official seal that shall be judicially noticed. The authority may sue and be sued, contract and acquire, hold, operate and dispose of property.
B. The authority, through its board, may:
1. Issue negotiable water quality bonds pursuant to section 49-1261 for the following purposes:
(a) To generate the state match required by the clean water act for the clean water revolving fund and to generate the match required by the safe drinking water act for the drinking water revolving fund.
(b) To provide financial assistance to political subdivisions, Indian tribes and eligible drinking water facilities for constructing, acquiring or improving wastewater treatment facilities, drinking water facilities, nonpoint source projects and other related water quality facilities and projects.
2. ISSUE WATER SUPPLY DEVELOPMENT BONDS FOR THE PURPOSE OF PROVIDING FINANCIAL ASSISTANCE TO WATER PROVIDERS FOR WATER SUPPLY DEVELOPMENT PURPOSES PURSUANT TO SECTIONS 49-1274 AND 49-1275.
2. 3. Provide financial assistance to political subdivisions and Indian tribes from monies in the clean water revolving fund to finance wastewater treatment projects.
3. 4. Provide financial assistance to drinking water facilities from monies in the drinking water revolving fund to finance these facilities.
5. PROVIDE FINANCIAL ASSISTANCE TO WATER PROVIDERS FROM MONIES IN THE WATER SUPPLY DEVELOPMENT REVOLVING FUND TO FINANCE WATER SUPPLY DEVELOPMENT.
4. 6. Guarantee debt obligations of, and provide linked deposit guarantees through third party lenders to:
(a) Political subdivisions that are issued to finance wastewater treatment projects.
(b) Drinking water facilities that are issued to finance these facilities.
(c) WATER PROVIDERS THAT ARE ISSUED TO FINANCE WATER SUPPLY DEVELOPMENT PROJECTS.
5. 7. Provide linked deposit guarantees through third party lenders to political subdivisions, and drinking water facilities AND WATER PROVIDERS.
6. 8. Apply for, accept and administer grants and other financial assistance from the United States government and from other public and private sources.
7. 9. Enter into capitalization grant agreements with the United States environmental protection agency.
8. 10. Adopt rules pursuant to title 41, chapter 6 governing the application for and awarding of wastewater treatment facility, drinking water facility and nonpoint source project financial assistance under this article CHAPTER, the administration of the clean water revolving fund and the drinking water revolving fund and the issuance of water quality bonds.
9. 11. Hire a director and staff for the authority.

10. 12. Contract for the services of outside advisors, attorneys, consultants and aides reasonably necessary or desirable to allow the authority to adequately perform its duties.
11. 13. Contract and incur obligations as reasonably necessary or desirable within the general scope of authority activities and operations to allow the authority to adequately perform its duties.
12. 14. Assess financial assistance origination fees and annual fees to cover the reasonable costs of administering the authority and the monies administered by the authority. Any fees collected pursuant to this paragraph constitute governmental revenue and may be used for any purpose consistent with the mission and objectives of the authority.
13. 15. Perform any function of a fund manager under the CERCLA Brownfields cleanup revolving loan fund program as requested by the department. The board shall perform any action authorized under this article on behalf of the Brownfields cleanup revolving loan fund program established pursuant to chapter 2, article 1.1 of this title at the request of the department. In order to perform these functions, the board shall enter into a written agreement with the department.
14. 16. Provide grants, staff assistance or technical assistance in the form of loan repayment agreements and other professional assistance to political subdivisions, any county with a population of less than five hundred thousand persons, Indian tribes and community water systems in connection with the development or financing of wastewater, drinking water, water reclamation or related water infrastructure. Assistance provided under a technical assistance loan repayment agreement shall be in a form and under terms determined by the authority and shall be repaid not more than three years after the date that the monies are advanced to the applicant. The provision of technical assistance by the authority does not create any liability for the authority or this state regarding the design, construction or operation of any infrastructure project.
17. PROVIDE GRANTS, STAFF ASSISTANCE OR TECHNICAL ASSISTANCE IN THE FORM OF LOAN REPAYMENT AGREEMENTS AND OTHER PROFESSIONAL ASSISTANCE TO WATER PROVIDERS IN CONNECTION WITH THE PLANNING OR DESIGN OF WATER SUPPLY DEVELOPMENT PROJECTS AS DETERMINED BY THE COMMITTEE PURSUANT TO SECTION 49-1274. A SINGLE GRANT SHALL NOT EXCEED ONE HUNDRED THOUSAND DOLLARS. ASSISTANCE PROVIDED UNDER A TECHNICAL ASSISTANCE LOAN REPAYMENT AGREEMENT SHALL BE IN A FORM AND UNDER TERMS DETERMINED BY THE COMMITTEE AND SHALL BE REPAID NOT MORE THAN THREE YEARS AFTER THE DATE THAT THE MONIES ARE ADVANCED TO THE APPLICANT. THE PROVISION OF TECHNICAL ASSISTANCE BY THE AUTHORITY OR THE COMMITTEE DOES NOT CREATE ANY LIABILITY FOR THE AUTHORITY, THE COMMITTEE OR THIS STATE REGARDING THE DESIGN, CONSTRUCTION OR OPERATION OF ANY WATER SUPPLY DEVELOPMENT PROJECT.
C. THE AUTHORITY, IN CONSULTATION WITH THE COMMITTEE, MAY:
1. ADOPT RULES PURSUANT TO TITLE 41, CHAPTER 6 GOVERNING THE APPLICATION FOR AND AWARDING OF WATER SUPPLY DEVELOPMENT FUND PROJECT FINANCIAL ASSISTANCE UNDER THIS CHAPTER AND THE ADMINISTRATION OF THE WATER SUPPLY DEVELOPMENT REVOLVING FUND.
2. APPOINT A TECHNICAL ADVISORY SUBCOMMITTEE OF NOT MORE THAN FIVE PERSONS WITH EXPERTISE IN WATER RESOURCE PLANNING AND DEVELOPMENT TO ADVISE THE COMMITTEE REGARDING THE TECHNICAL FEASIBILITY OF WATER SUPPLY DEVELOPMENT PROJECTS.
C. D. The board shall deposit, pursuant to sections 35-146 and 35-147, any monies received pursuant to subsection B, paragraph 6 8 of this section in the appropriate fund as prescribed by the grant or other financial assistance agreement.
D. E. Disbursements of monies by the water infrastructure finance authority pursuant to a financial assistance agreement are not subject to title 41, chapter 23.
E. F. For THE purposes of the safe drinking water act, the department of environmental quality is the state

agency with primary responsibility for administration of this state's public water system supervision program and, in consultation with other appropriate state agencies, is the lead agency in establishing assistance priorities as prescribed by section 49-1243, subsection A, paragraph 6 and section 49-1244, subsection B, paragraph 3.
F. G. For THE purposes of this section, "CERCLA" has the same meaning prescribed in section 49-201.

Sec. 5. Heading change
The article heading of title 49, chapter 8, article 2, Arizona Revised Statutes, is changed from "FINANCIAL PROVISIONS" to "CLEAN WATER REVOLVING FUND, DRINKING WATER REVOLVING FUND AND HARDSHIP GRANT FUND FINANCIAL PROVISIONS."

Sec. 6. Section 49-1261, Arizona Revised Statutes, is amended to read:
49-1261. Water quality bonds
A. The authority, through the board of directors, may issue negotiable water quality bonds in a principal amount that in its opinion is necessary to provide sufficient monies for financial assistance under this chapter ARTICLE, maintaining sufficient reserves to secure the bonds, to pay the necessary costs of issuing, selling and redeeming the bonds and to pay other expenditures of the authority incidental to and necessary and convenient to carry out the purposes of this article.
B. The board must authorize the bonds by resolution. The resolution shall prescribe:
1. The rate or rates of interest and the denominations of the bonds.
2. The date or dates of the bonds and maturity.
3. The coupon or registered form of the bonds.
4. The manner of executing the bonds.
5. The medium and place of payment.
6. The terms of redemption.
C. The bonds shall be sold at public or private sale at the price and on the terms determined by the board. All proceeds from the issuance of bonds shall be deposited in the appropriate accounts of the funds administered by the board.
D. The board shall publish a notice of its intention to issue bonds under this article for at least five consecutive days in a newspaper published in this state. The last day of publication must be at least ten days before issuing the bonds. The notice shall state the amount of the bonds to be sold and the intended date of issuance. A copy of the notice shall be hand delivered or sent, by certified mail, return receipt requested, to the director of the department of administration on or before the last day of publication.
E. To secure any bonds authorized by this section, the board by resolution may:
1. Provide that bonds issued under this section may be secured by a first lien on all or part of the monies paid into the appropriate account or subaccount of the funds administered by the authority.
2. Pledge or assign to or in trust for the benefit of the holder or holders of the bonds any part or appropriate account or subaccount of the monies in the funds as is necessary to pay the principal and interest of the bonds as they come due.
3. Set aside, regulate and dispose of reserves and sinking funds.
4. Provide that sufficient amounts of the proceeds from the sale of the bonds may be used to fully or partly fund any reserves or sinking funds set up by the bond resolution.
5. Prescribe the procedure, if any, by which the terms of any contract with bondholders may be amended or abrogated, the amount of bonds the holders of which must consent to and the manner in which consent may be given.
6. Provide for payment from the proceeds of the sale of the bonds of all legal and financial expenses incurred by the board in issuing, selling, delivering and paying the bonds.
7. Do any other matters that in any way may affect the security and protection of the bonds.
F. The members of the board or any person executing the bonds are not personally liable for the payment of the

bonds. The bonds are valid and binding obligations notwithstanding that before the delivery of the bonds any of the persons whose signatures appear on the bonds cease to be members of the board. From and after the sale and delivery of the bonds, they are incontestable by the board.
G. The board, out of any available monies, may purchase bonds, which may be canceled, at a price not exceeding either of the following:
1. If the bonds are then redeemable, the redemption price then applicable plus accrued interest to the next interest payment date.
2. If the bonds are not then redeemable, the redemption price applicable on the first date after purchase on which the bonds become subject to redemption plus accrued interest to that date.

Sec. 7. Section 49-1263, Arizona Revised Statutes, is amended to read:
49-1263. Bond obligations of the authority
Bonds issued under this chapter ARTICLE are obligations of the water infrastructure finance authority of Arizona, are payable only according to their terms and are not obligations general, special or otherwise of this state. The bonds do not constitute a legal debt of this state and are not enforceable against this state. Payment of the bonds is not enforceable out of any state monies other than the income and revenue pledged and assigned to, or in trust for the benefit of, the holder or holders of the bonds.

Sec. 8. Section 49-1264, Arizona Revised Statutes, is amended to read:
49-1264. Certification of bonds by attorney general
The board may submit any water quality bonds issued under this chapter ARTICLE to the attorney general after all proceedings for their authorization have been completed. On submission the attorney general shall examine and pass on the validity of the bonds and the regularity of the proceedings. If the proceedings comply with this article, and if the attorney general determines that, when delivered and paid for, the bonds will constitute binding and legal obligations of the board, the attorney general shall certify on the back of each bond, in substance, that it is issued according to the constitution and laws of this state.

Sec. 9. Section 49-1265, Arizona Revised Statutes, is amended to read:
49-1265. Water quality bonds as legal investments
Water quality bonds issued under this chapter ARTICLE are securities in which public officers and bodies of this state and of municipalities and political subdivisions of this state, all companies, associations and other persons carrying on an insurance business, all financial institutions, investment companies and other persons carrying on a banking business, all fiduciaries and all other persons who are authorized to invest in obligations of this state may properly and legally invest. The bonds are also securities that may be deposited with public officers or bodies of this state and municipalities and political subdivisions of this state for purposes that require the deposit of state bonds or obligations.

Sec. 10. Section 49-1267, Arizona Revised Statutes, is amended to read:
49-1267. Hardship grant fund
A. The hardship grant fund is established to be administered by the authority consisting of:
1. Monies received for that purpose from the United States government, including monies that are awarded to this state pursuant to title II of the clean water act and that are no longer obligated to the construction grants program.
2. Gifts, grants and other donations received for that purpose from public or private sources.
3. Monies appropriated by the legislature for the hardship grant program.
B. Monies in the fund are continuously appropriated and are exempt from the provisions of section 35-190 relating to lapsing of appropriations.
C. The board shall administer the fund pursuant to rule and in compliance with this section and guidance from

the United States government.
D. Monies in the fund may be used for the following purposes:
1. Providing hardship grants to political subdivisions or Indian tribes to plan, design, acquire, construct or improve wastewater collection and treatment facilities.
2. Providing training and technical assistance related to the operation and maintenance of wastewater systems.
E. The board shall use the monies and other assets in the fund only for the purposes authorized by this chapter ARTICLE.
F. The board shall establish a hardship grant program account and as many other accounts and subaccounts as required to administer the hardship grant fund.
G. All proceeds of hardship grant program monies that are received from the United States shall be deposited in the hardship grant fund and shall be used only to provide grants and technical assistance to political subdivisions or Indian tribes to plan, design, acquire, construct or improve wastewater collection and treatment facilities.

Sec. 11. Title 49, chapter 8, Arizona Revised Statutes, is amended by adding article 3, to read:

ARTICLE 3. WATER SUPPLY DEVELOPMENT
REVOLVING FUND FINANCIAL PROVISIONS

49-1271. Water supply development revolving fund; legislative intent
A. THE WATER SUPPLY DEVELOPMENT REVOLVING FUND IS ESTABLISHED TO BE MAINTAINED IN PERPETUITY CONSISTING OF:
1. MONIES RECEIVED FROM THE ISSUANCE AND SALE OF WATER SUPPLY DEVELOPMENT BONDS UNDER SECTION 49-1278.
2. MONIES APPROPRIATED BY THE LEGISLATURE TO THE WATER SUPPLY DEVELOPMENT REVOLVING FUND.
3. MONIES RECEIVED FOR WATER SUPPLY DEVELOPMENT PURPOSES FROM THE UNITED STATES GOVERNMENT.
4. MONIES RECEIVED FROM WATER PROVIDERS AS LOAN REPAYMENTS, INTEREST AND PENALTIES.
5. INTEREST AND OTHER INCOME RECEIVED FROM INVESTING MONIES IN THE FUND.
6. GIFTS, GRANTS AND DONATIONS RECEIVED FOR WATER SUPPLY DEVELOPMENT PURPOSES FROM ANY PUBLIC OR PRIVATE SOURCE.
B. MONIES IN THE FUND ARE CONTINUOUSLY APPROPRIATED AND ARE EXEMPT FROM THE PROVISIONS OF SECTION 35-190 RELATING TO LAPSING OF APPROPRIATIONS.
C. THE LEGISLATURE FINDS THAT MANY WATER PROVIDERS IN THIS STATE, PARTICULARLY IN RURAL AREAS, LACK ACCESS TO SUFFICIENT WATER SUPPLIES TO MEET THEIR LONG-TERM WATER DEMANDS AND NEED FINANCIAL ASSISTANCE TO CONSTRUCT WATER SUPPLY PROJECTS AND OBTAIN ADDITIONAL WATER SUPPLIES. IT IS THE INTENT OF THE LEGISLATURE THAT THE WATER SUPPLY DEVELOPMENT REVOLVING FUND ESTABLISHED BY THIS SECTION BE USED TO PROVIDE FINANCIAL ASSISTANCE TO THESE WATER PROVIDERS UNDER THE TERMS SET FORTH IN THIS ARTICLE.
49-1272. Water supply development revolving fund; administration
A. THE BOARD SHALL ADMINISTER THE WATER SUPPLY DEVELOPMENT REVOLVING FUND.
B. ON NOTICE FROM THE BOARD, THE STATE TREASURER SHALL INVEST AND DIVEST MONIES IN THE FUND AS PROVIDED BY SECTION 35-313, AND MONIES EARNED FROM INVESTMENT SHALL BE CREDITED TO THE FUND.
C. MONIES AND OTHER ASSETS IN THE FUND SHALL BE USED SOLELY FOR THE PURPOSES AUTHORIZED BY THIS ARTICLE.
49-1273. Water supply development revolving fund; purposes; limitation

A. MONIES IN THE WATER SUPPLY DEVELOPMENT REVOLVING FUND MAY BE USED FOR THE FOLLOWING PURPOSES:

1. MAKING WATER SUPPLY DEVELOPMENT LOANS TO WATER PROVIDERS IN THIS STATE UNDER SECTION 49-1274 FOR WATER SUPPLY DEVELOPMENT PURPOSES.

2. MAKING LOANS OR GRANTS TO WATER PROVIDERS FOR THE PLANNING OR DESIGN OF WATER SUPPLY DEVELOPMENT PROJECTS. A SINGLE GRANT SHALL NOT EXCEED ONE HUNDRED THOUSAND DOLLARS.

3. PURCHASING OR REFINANCING DEBT OBLIGATIONS OF WATER PROVIDERS AT OR BELOW MARKET RATE IF THE DEBT OBLIGATION WAS ISSUED FOR A WATER SUPPLY DEVELOPMENT PURPOSE.

4. PROVIDING FINANCIAL ASSISTANCE TO WATER PROVIDERS WITH BONDING AUTHORITY TO PURCHASE INSURANCE FOR LOCAL BOND OBLIGATIONS INCURRED BY THEM FOR WATER SUPPLY DEVELOPMENT PURPOSES.

5. PAYING THE COSTS TO ADMINISTER THE FUND.

6. PROVIDING LINKED DEPOSIT GUARANTEES THROUGH THIRD PARTY LENDERS BY DEPOSITING MONIES WITH THE LENDER ON THE CONDITION THAT THE LENDER MAKE A LOAN ON TERMS APPROVED BY THE COMMITTEE, AT A RATE OF RETURN ON THE DEPOSIT APPROVED BY THE COMMITTEE AND THE STATE TREASURER AND BY GIVING THE LENDER RECOURSE AGAINST THE DEPOSIT OF LOAN REPAYMENTS THAT ARE NOT MADE WHEN DUE.

B. IF THE MONIES PLEDGED TO SECURE WATER SUPPLY DEVELOPMENT BONDS ISSUED PURSUANT TO SECTION 49-1278 BECOME INSUFFICIENT TO PAY THE PRINCIPAL AND INTEREST ON THE WATER SUPPLY DEVELOPMENT BONDS GUARANTEED BY THE WATER SUPPLY DEVELOPMENT REVOLVING FUND, THE AUTHORITY SHALL DIRECT THE STATE TREASURER TO LIQUIDATE SECURITIES IN THE FUND AS MAY BE NECESSARY AND SHALL APPLY THOSE PROCEEDS TO MAKE CURRENT ALL PAYMENTS THEN DUE ON THE BONDS. THE STATE TREASURER SHALL IMMEDIATELY NOTIFY THE ATTORNEY GENERAL AND AUDITOR GENERAL OF THE INSUFFICIENCY. THE AUDITOR GENERAL SHALL AUDIT THE CIRCUMSTANCES SURROUNDING THE DEPLETION OF THE FUND AND REPORT THE FINDINGS TO THE ATTORNEY GENERAL. THE ATTORNEY GENERAL SHALL CONDUCT AN INVESTIGATION AND REPORT THOSE FINDINGS TO THE GOVERNOR AND THE LEGISLATURE.

C. MONIES IN THE WATER SUPPLY DEVELOPMENT REVOLVING FUND SHALL NOT BE USED TO PROVIDE FINANCIAL ASSISTANCE TO A WATER PROVIDER, OTHER THAN AN INDIAN TRIBE, UNLESS ONE OF THE FOLLOWING APPLIES:

1. THE BOARD OF SUPERVISORS OF THE COUNTY IN WHICH THE WATER PROVIDER IS LOCATED HAS ADOPTED THE PROVISION AUTHORIZED BY SECTION 11-806.01, SUBSECTION F.

2. THE WATER PROVIDER IS LOCATED IN A CITY OR TOWN AND THE LEGISLATIVE BODY OF THE CITY OR TOWN HAS ENACTED THE ORDINANCE AUTHORIZED BY SECTION 9-463.01, SUBSECTION O.

3. THE WATER PROVIDER IS LOCATED IN AN ACTIVE MANAGEMENT AREA ESTABLISHED PURSUANT TO TITLE 45, CHAPTER 2, ARTICLE 2.

49-1274. Water supply development revolving fund financial assistance; procedures

A. IN COMPLIANCE WITH ANY APPLICABLE REQUIREMENTS, A WATER PROVIDER MAY APPLY TO THE AUTHORITY FOR AND ACCEPT AND INCUR INDEBTEDNESS AS A RESULT OF A LOAN OR ANY OTHER FINANCIAL ASSISTANCE PURSUANT TO SECTION 49-1273 FROM THE WATER SUPPLY DEVELOPMENT REVOLVING FUND FOR WATER SUPPLY DEVELOPMENT PURPOSES. IN COMPLIANCE WITH ANY APPLICABLE REQUIREMENTS, A WATER PROVIDER MAY ALSO APPLY TO THE AUTHORITY FOR AND ACCEPT GRANTS, STAFF ASSISTANCE OR TECHNICAL ASSISTANCE FOR THE PLANNING OR DESIGN OF A WATER SUPPLY DEVELOPMENT PROJECT.

A WATER PROVIDER THAT APPLIES FOR AND ACCEPTS A LOAN OR OTHER FINANCIAL ASSISTANCE UNDER THIS ARTICLE IS NOT PRECLUDED FROM APPLYING FOR AND ACCEPTING A LOAN OR OTHER FINANCIAL ASSISTANCE UNDER ARTICLE 2 OF THIS CHAPTER OR UNDER ANY OTHER LAW.

B. THE AUTHORITY, IN CONSULTATION WITH THE COMMITTEE, SHALL:

1. PRESCRIBE A SIMPLIFIED FORM AND PROCEDURE TO APPLY FOR AND APPROVE ASSISTANCE.

2. ESTABLISH BY RULE CRITERIA BY WHICH ASSISTANCE WILL BE AWARDED, INCLUDING REQUIREMENTS FOR LOCAL PARTICIPATION IN PROJECT COSTS, IF DEEMED ADVISABLE. THE CRITERIA SHALL INCLUDE:

(a) A DETERMINATION OF THE ABILITY OF THE APPLICANT TO REPAY A LOAN ACCORDING TO THE TERMS AND CONDITIONS ESTABLISHED BY THIS SECTION. AT THE OPTION OF THE COMMITTEE, THE EXISTENCE OF A CURRENT INVESTMENT GRADE RATING ON EXISTING DEBT OF THE APPLICANT THAT IS SECURED BY THE SAME REVENUES TO BE PLEDGED TO SECURE REPAYMENT UNDER THE LOAN REPAYMENT AGREEMENT CONSTITUTES EVIDENCE REGARDING ABILITY TO REPAY A LOAN.

(b) A DETERMINATION OF THE APPLICANT'S LEGAL CAPABILITY TO ENTER INTO A LOAN REPAYMENT AGREEMENT.

(c) A DETERMINATION OF THE APPLICANT'S FINANCIAL ABILITY TO CONSTRUCT, OPERATE AND MAINTAIN THE PROJECT IF IT RECEIVES THE FINANCIAL ASSISTANCE.

(d) A DETERMINATION OF THE APPLICANT'S ABILITY TO MANAGE THE PROJECT.

(e) A DETERMINATION OF THE APPLICANT'S ABILITY TO MEET ANY APPLICABLE ENVIRONMENTAL REQUIREMENTS IMPOSED BY FEDERAL OR STATE AGENCIES.

(f) A DETERMINATION OF THE APPLICANT'S ABILITY TO ACQUIRE ANY NECESSARY REGULATORY PERMITS.

3. DETERMINE THE ORDER AND PRIORITY OF PROJECTS ASSISTED UNDER THIS SECTION BASED ON THE MERITS OF THE APPLICATION WITH RESPECT TO WATER SUPPLY DEVELOPMENT ISSUES, INCLUDING THE FOLLOWING:

(a) EXISTING, NEAR-TERM AND LONG-TERM WATER DEMANDS OF THE WATER PROVIDER COMPARED TO THE EXISTING WATER SUPPLIES OF THE WATER PROVIDER.

(b) EXISTING AND PLANNED CONSERVATION AND WATER MANAGEMENT PROGRAMS OF THE WATER PROVIDER.

(c) BENEFITS OF THE PROJECT.

(d) THE SUSTAINABILITY OF THE WATER SUPPLY TO BE DEVELOPED THROUGH THE PROJECT.

(e) THE WATER PROVIDER'S NEED FOR FINANCIAL ASSISTANCE.

(f) THE COST-EFFECTIVENESS OF THE PROJECT.

C. THE COMMITTEE SHALL REVIEW ON ITS MERITS EACH APPLICATION RECEIVED AND SHALL INFORM THE APPLICANT OF THE COMMITTEE'S DETERMINATION WITHIN NINETY DAYS AFTER RECEIPT OF A COMPLETE AND CORRECT APPLICATION. IF THE APPLICATION IS NOT APPROVED, THE COMMITTEE SHALL NOTIFY THE APPLICANT, STATING THE REASONS. IF THE APPLICATION IS APPROVED, THE COMMITTEE MAY CONDITION THE APPROVAL ON ASSURANCES THE COMMITTEE DEEMS NECESSARY TO ENSURE THAT THE FINANCIAL ASSISTANCE WILL BE USED ACCORDING TO LAW AND THE TERMS OF THE APPLICATION.

D. ON APPROVAL OF AN APPLICATION UNDER THIS SECTION BY THE COMMITTEE, THE AUTHORITY SHALL USE MONIES IN THE WATER SUPPLY DEVELOPMENT REVOLVING FUND TO FINANCE THE PROJECT.

49-1275. Water supply development revolving fund financial assistance; terms

A. A LOAN FROM THE WATER SUPPLY DEVELOPMENT REVOLVING FUND SHALL BE

EVIDENCED BY BONDS, IF THE WATER PROVIDER HAS BONDING AUTHORITY, OR BY A FINANCIAL ASSISTANCE AGREEMENT, DELIVERED TO AND HELD BY THE AUTHORITY.

B. A LOAN UNDER THIS SECTION SHALL:

1. BE REPAID NOT MORE THAN THIRTY YEARS AFTER THE DATE INCURRED.

2. REQUIRE THAT INTEREST PAYMENTS BEGIN NOT LATER THAN THE NEXT DATE THAT EITHER PRINCIPAL OR INTEREST MUST BE PAID BY THE AUTHORITY TO THE HOLDERS OF ANY OF THE AUTHORITY'S BONDS THAT PROVIDED FUNDING FOR THE LOAN. IF THE LOAN IS FOR CONSTRUCTION OF WATER SUPPLY DEVELOPMENT FACILITIES, THE AUTHORITY MAY PROVIDE THAT LOAN INTEREST ACCRUING DURING CONSTRUCTION AND ONE YEAR AFTER COMPLETION OF THE CONSTRUCTION BE CAPITALIZED IN THE LOAN.

3. BE CONDITIONED ON THE ESTABLISHMENT OF A DEDICATED REVENUE SOURCE FOR REPAYING THE LOAN.

C. THE AUTHORITY, IN CONSULTATION WITH THE COMMITTEE, SHALL PRESCRIBE THE RATE OF INTEREST ON LOANS MADE UNDER THIS SECTION, BUT THE RATE SHALL NOT EXCEED THE PREVAILING MARKET RATE FOR SIMILAR TYPES OF LOANS. THE AUTHORITY, UPON RECOMMENDATIONS FROM THE COMMITTEE, MAY ADOPT RULES WHICH PROVIDE FOR FLEXIBLE INTEREST RATES AND INTEREST FREE LOANS. ALL FINANCIAL ASSISTANCE AGREEMENTS OR BONDS OF A WATER PROVIDER SHALL CLEARLY SPECIFY THE AMOUNT OF PRINCIPAL AND INTEREST AND ANY REDEMPTION PREMIUM THAT IS DUE ON ANY PAYMENT DATE.

D. THE APPROVAL OF A LOAN IS CONDITIONED ON A WRITTEN COMMITMENT BY THE WATER PROVIDER TO COMPLETE ALL APPLICABLE REVIEWS AND APPROVALS AND TO SECURE ALL REQUIRED PERMITS IN A TIMELY MANNER.

E. A LOAN MADE TO A WATER PROVIDER UNDER THIS SECTION MAY BE SECURED ADDITIONALLY BY AN IRREVOCABLE PLEDGE OF ANY SHARED STATE REVENUES DUE TO THE WATER PROVIDER FOR THE DURATION OF THE LOAN AS PRESCRIBED BY A RESOLUTION OF THE COMMITTEE. IF THE COMMITTEE REQUIRES AN IRREVOCABLE PLEDGE OF THE SHARED STATE REVENUES FOR FINANCIAL ASSISTANCE LOAN REPAYMENT AGREEMENTS, THE AUTHORITY SHALL ENTER INTO AN INTERCREDITOR AGREEMENT WITH THE GREATER ARIZONA DEVELOPMENT AUTHORITY TO DEFINE THE ALLOCATION OF SHARED STATE REVENUES IN RELATION TO INDIVIDUAL BORROWERS. IF A PLEDGE IS REQUIRED AND A WATER PROVIDER FAILS TO MAKE ANY PAYMENT DUE TO THE AUTHORITY UNDER ITS LOAN REPAYMENT AGREEMENT OR BONDS, THE AUTHORITY SHALL CERTIFY TO THE STATE TREASURER AND NOTIFY THE GOVERNING BODY OF THE DEFAULTING WATER PROVIDER THAT THE WATER PROVIDER HAS FAILED TO MAKE THE REQUIRED PAYMENT AND SHALL DIRECT A WITHHOLDING OF STATE SHARED REVENUES AS PRESCRIBED IN SUBSECTION F OF THIS SECTION. THE CERTIFICATE OF DEFAULT SHALL BE IN THE FORM DETERMINED BY THE AUTHORITY, EXCEPT THAT THE CERTIFICATE SHALL SPECIFY THE AMOUNT REQUIRED TO SATISFY THE UNPAID PAYMENT OBLIGATION OF THE WATER PROVIDER.

F. ON RECEIPT OF A CERTIFICATE OF DEFAULT FROM THE AUTHORITY, THE STATE TREASURER, TO THE EXTENT NOT EXPRESSLY PROHIBITED BY LAW, SHALL WITHHOLD ANY MONIES DUE TO THE DEFAULTING WATER PROVIDER FROM THE NEXT SUCCEEDING DISTRIBUTION OF MONIES PURSUANT TO SECTION 42-5029. IN THE CASE OF A CITY OR TOWN, THE STATE TREASURER SHALL ALSO WITHHOLD FROM THE MONIES DUE TO THE DEFAULTING CITY OR TOWN FROM THE NEXT SUCCEEDING DISTRIBUTION OF MONIES PURSUANT TO SECTION 43-206 THE AMOUNT SPECIFIED IN THE CERTIFICATE OF DEFAULT AND SHALL IMMEDIATELY DEPOSIT THE MONIES IN THE WATER SUPPLY DEVELOPMENT REVOLVING FUND. THE STATE TREASURER SHALL CONTINUE TO WITHHOLD AND DEPOSIT MONIES UNTIL THE AUTHORITY

CERTIFIES TO THE STATE TREASURER THAT THE DEFAULT HAS BEEN CURED. THE STATE TREASURER SHALL NOT WITHHOLD ANY AMOUNT THAT IS NECESSARY TO MAKE ANY REQUIRED DEPOSITS THEN DUE FOR THE PAYMENT OF PRINCIPAL AND INTEREST ON BONDS OF THE WATER PROVIDER IF SO CERTIFIED BY THE DEFAULTING WATER PROVIDER TO THE STATE TREASURER AND THE AUTHORITY. THE WATER PROVIDER SHALL NOT CERTIFY DEPOSITS AS NECESSARY FOR PAYMENT FOR BONDS UNLESS THE BONDS WERE ISSUED BEFORE THE DATE OF THE LOAN REPAYMENT AGREEMENT AND THE BONDS WERE SECURED BY A PLEDGE OF DISTRIBUTION MADE PURSUANT TO SECTIONS 42-5029 AND 43-206.

49-1276. Enforcement; attorney general

THE ATTORNEY GENERAL MAY TAKE ACTIONS NECESSARY TO ENFORCE THE LOAN CONTRACT AND ACHIEVE REPAYMENT OF LOANS PROVIDED BY THE AUTHORITY PURSUANT TO SECTIONS 49-1274 AND 49-1275.

49-1277. Water supply development bonds

A. THE AUTHORITY MAY ISSUE NEGOTIABLE WATER SUPPLY DEVELOPMENT BONDS IN A PRINCIPAL AMOUNT NECESSARY TO PROVIDE SUFFICIENT MONIES FOR THOSE PROJECTS APPROVED UNDER THIS ARTICLE AND INCLUDING SUCH ITEMS AS MAINTAINING SUFFICIENT RESERVES TO SECURE THE BONDS, TO PAY THE NECESSARY COSTS OF ISSUING, SELLING AND REDEEMING THE BONDS AND TO PAY OTHER EXPENDITURES OF THE AUTHORITY INCIDENTAL TO AND NECESSARY AND CONVENIENT TO CARRY OUT THE PURPOSES OF THIS ARTICLE. THE BOARD SHALL ISSUE THE BONDS PURSUANT TO SUBSECTIONS C AND D.

B. THE BOARD SHALL AUTHORIZE THE BONDS BY RESOLUTION. THE RESOLUTION SHALL PRESCRIBE:

1. THE RATE OR RATES OF INTEREST AND THE DENOMINATIONS OF THE BONDS.
2. THE DATE OR DATES OF THE BONDS AND MATURITY.
3. THE COUPON OR REGISTERED FORM OF THE BONDS.
4. THE MANNER OF EXECUTING THE BONDS.
5. THE MEDIUM AND PLACE OF PAYMENT.
6. THE TERMS OF REDEMPTION.

C. THE BONDS SHALL BE SOLD AT PUBLIC OR PRIVATE SALE AT THE PRICE AND ON THE TERMS DETERMINED BY THE BOARD. ALL PROCEEDS FROM THE ISSUANCE OF BONDS SHALL BE DEPOSITED IN THE APPROPRIATE ACCOUNTS OF THE FUNDS ADMINISTERED BY THE AUTHORITY.

D. THE BOARD SHALL PUBLISH A NOTICE OF ITS INTENTION TO ISSUE BONDS UNDER THIS ARTICLE FOR AT LEAST FIVE CONSECUTIVE DAYS IN A NEWSPAPER PUBLISHED IN THIS STATE. THE LAST DAY OF PUBLICATION MUST BE AT LEAST TEN DAYS BEFORE ISSUING THE BONDS. THE NOTICE SHALL STATE THE AMOUNT OF THE BONDS TO BE SOLD AND THE INTENDED DATE OF ISSUANCE. A COPY OF THE NOTICE SHALL BE HAND DELIVERED OR SENT, BY CERTIFIED MAIL, RETURN RECEIPT REQUESTED, TO THE DIRECTOR OF THE DEPARTMENT OF ADMINISTRATION ON OR BEFORE THE LAST DAY OF PUBLICATION.

E. TO SECURE ANY BONDS AUTHORIZED BY THIS SECTION, THE BOARD BY RESOLUTION MAY:

1. PROVIDE THAT BONDS ISSUED UNDER THIS SECTION MAY BE SECURED BY A FIRST LIEN ON ALL OR PART OF THE MONIES PAID INTO THE APPROPRIATE ACCOUNT OR SUBACCOUNT OF THE FUNDS ADMINISTERED BY THE AUTHORITY.
2. PLEDGE OR ASSIGN TO OR IN TRUST FOR THE BENEFIT OF THE HOLDER OR HOLDERS OF THE BONDS ANY PART OR APPROPRIATE ACCOUNT OR SUBACCOUNT OF THE MONIES IN THE FUNDS AS IS NECESSARY TO PAY THE PRINCIPAL AND INTEREST OF THE BONDS AS THEY COME DUE.
3. SET ASIDE, REGULATE AND DISPOSE OF RESERVES AND SINKING FUNDS.

4. PROVIDE THAT SUFFICIENT AMOUNTS OF THE PROCEEDS FROM THE SALE OF THE BONDS MAY BE USED TO FULLY OR PARTLY FUND ANY RESERVES OR SINKING FUNDS SET UP BY THE BOND RESOLUTION.
5. PRESCRIBE THE PROCEDURE, IF ANY, BY WHICH THE TERMS OF ANY CONTRACT WITH BONDHOLDERS MAY BE AMENDED OR ABROGATED, THE AMOUNT OF BONDS THE HOLDERS OF WHICH MUST CONSENT TO AND THE MANNER IN WHICH CONSENT MAY BE GIVEN.
6. PROVIDE FOR PAYMENT FROM THE PROCEEDS OF THE SALE OF THE BONDS OF ALL LEGAL AND FINANCIAL EXPENSES INCURRED BY THE BOARD IN ISSUING, SELLING, DELIVERING AND PAYING THE BONDS.
7. DO ANY OTHER MATTERS THAT IN ANY WAY MAY AFFECT THE SECURITY AND PROTECTION OF THE BONDS.
F. ANY MEMBER OF THE BOARD, ANY MEMBER OF THE COMMITTEE OR ANY PERSON EXECUTING THE BONDS IS NOT PERSONALLY LIABLE FOR THE PAYMENT OF THE BONDS. THE BONDS ARE VALID AND BINDING OBLIGATIONS NOTWITHSTANDING THAT BEFORE THE DELIVERY OF THE BONDS ANY OF THE PERSONS WHOSE SIGNATURES APPEAR ON THE BONDS CEASE TO BE MEMBERS OF THE BOARD. FROM AND AFTER THE SALE AND DELIVERY OF THE BONDS, THEY ARE INCONTESTABLE BY THE BOARD AND THE COMMITTEE.
G. THE BOARD, OUT OF ANY AVAILABLE MONIES, MAY PURCHASE BONDS, WHICH MAY BE CANCELED, AT A PRICE NOT EXCEEDING EITHER OF THE FOLLOWING:
1. IF THE BONDS ARE THEN REDEEMABLE, THE REDEMPTION PRICE THEN APPLICABLE PLUS ACCRUED INTEREST TO THE NEXT INTEREST PAYMENT DATE.
2. IF THE BONDS ARE NOT THEN REDEEMABLE, THE REDEMPTION PRICE APPLICABLE ON THE FIRST DATE AFTER PURCHASE ON WHICH THE BONDS BECOME SUBJECT TO REDEMPTION PLUS ACCRUED INTEREST TO THAT DATE.
49-1278. Water supply development bonds; purpose
A. WATER SUPPLY DEVELOPMENT BONDS MAY BE ISSUED TO PROVIDE FINANCIAL ASSISTANCE UNDER THIS ARTICLE AND TO INCREASE THE CAPITALIZATION OF THE WATER SUPPLY DEVELOPMENT REVOLVING FUND TO ACCOMPLISH THE PURPOSES STATED IN SECTION 49-1273. THESE BONDS MAY BE SECURED BY ANY MONIES RECEIVED OR TO BE RECEIVED IN THE WATER SUPPLY DEVELOPMENT REVOLVING FUND. AMOUNTS IN THE WATER SUPPLY DEVELOPMENT REVOLVING FUND MAY BE USED TO CURE DEFAULTS ON LOANS MADE FROM THE WATER SUPPLY DEVELOPMENT REVOLVING FUND TO THE EXTENT OTHERWISE PERMITTED BY LAW.
B. ANY PLEDGE MADE UNDER THIS ARTICLE IS VALID AND BINDING FROM THE TIME WHEN THE PLEDGE IS MADE. THE MONIES PLEDGED AND RECEIVED TO BE PLACED IN THE APPROPRIATE FUND ARE IMMEDIATELY SUBJECT TO THE LIEN OF THE PLEDGE WITHOUT ANY FUTURE PHYSICAL DELIVERY OR FURTHER ACT, AND ANY SUCH LIEN OF ANY PLEDGE IS VALID OR BINDING AGAINST ALL PARTIES HAVING CLAIMS OF ANY KIND IN TORT, CONTRACT OR OTHERWISE AGAINST THE BOARD REGARDLESS OF WHETHER THE PARTIES HAVE NOTICE OF THE LIEN. THE OFFICIAL RESOLUTION OR TRUST INDENTURE OR ANY INSTRUMENT BY WHICH THIS PLEDGE IS CREATED, WHEN PLACED IN THE BOARD’S RECORDS, IS NOTICE TO ALL CONCERNED OF THE CREATION OF THE PLEDGE, AND THOSE INSTRUMENTS NEED NOT BE RECORDED IN ANY OTHER PLACE.
C. THE BONDS ISSUED UNDER THIS SECTION, THEIR TRANSFER AND THE INCOME THEY PRODUCE ARE EXEMPT FROM TAXATION BY THIS STATE OR BY ANY POLITICAL SUBDIVISION OF THIS STATE.
49-1279. Bond obligations of the authority
BONDS ISSUED UNDER THIS ARTICLE ARE OBLIGATIONS OF THE WATER INFRASTRUCTURE

FINANCE AUTHORITY OF ARIZONA, ARE PAYABLE ONLY ACCORDING TO THEIR TERMS AND ARE NOT GENERAL OBLIGATIONS, SPECIAL OBLIGATIONS OR OTHERWISE OF THIS STATE. THE BONDS DO NOT CONSTITUTE A LEGAL DEBT OF THIS STATE AND ARE NOT ENFORCEABLE AGAINST THIS STATE. PAYMENT OF THE BONDS IS NOT ENFORCEABLE OUT OF ANY STATE MONIES OTHER THAN THE INCOME AND REVENUE PLEDGED AND ASSIGNED TO, OR IN TRUST FOR THE BENEFIT OF, THE HOLDER OR HOLDERS OF THE BONDS.

49-1280. Certification of bonds by attorney general

THE BOARD MAY SUBMIT ANY WATER SUPPLY DEVELOPMENT BONDS ISSUED UNDER THIS ARTICLE TO THE ATTORNEY GENERAL AFTER ALL PROCEEDINGS FOR THEIR AUTHORIZATION HAVE BEEN COMPLETED. ON SUBMISSION, THE ATTORNEY GENERAL SHALL EXAMINE AND PASS ON THE VALIDITY OF THE BONDS AND THE REGULARITY OF THE PROCEEDINGS. IF THE PROCEEDINGS COMPLY WITH THIS ARTICLE, AND IF THE ATTORNEY GENERAL DETERMINES THAT, WHEN DELIVERED AND PAID FOR, THE BONDS WILL CONSTITUTE BINDING AND LEGAL OBLIGATIONS OF THE BOARD, THE ATTORNEY GENERAL SHALL CERTIFY ON THE BACK OF EACH BOND, IN SUBSTANCE, THAT IT IS ISSUED ACCORDING TO THE CONSTITUTION AND LAWS OF THIS STATE.

49-1281. Water supply development bonds as legal investments

WATER SUPPLY DEVELOPMENT BONDS ISSUED UNDER THIS ARTICLE ARE SECURITIES IN WHICH PUBLIC OFFICERS AND BODIES OF THIS STATE AND OF MUNICIPALITIES AND POLITICAL SUBDIVISIONS OF THIS STATE, ALL COMPANIES, ASSOCIATIONS AND OTHER PERSONS CARRYING ON AN INSURANCE BUSINESS, ALL FINANCIAL INSTITUTIONS, INVESTMENT COMPANIES AND OTHER PERSONS CARRYING ON A BANKING BUSINESS, ALL FIDUCIARIES AND ALL OTHER PERSONS WHO ARE AUTHORIZED TO INVEST IN OBLIGATIONS OF THIS STATE MAY PROPERLY AND LEGALLY INVEST. THE BONDS ARE ALSO SECURITIES THAT MAY BE DEPOSITED WITH PUBLIC OFFICERS OR BODIES OF THIS STATE AND MUNICIPALITIES AND POLITICAL SUBDIVISIONS OF THIS STATE FOR PURPOSES THAT REQUIRE THE DEPOSIT OF STATE BONDS OR OBLIGATIONS.

49-1282. Agreement of state

THIS STATE PLEDGES TO AND AGREES WITH THE HOLDERS OF THE BONDS THAT THIS STATE WILL NOT LIMIT OR ALTER THE RIGHTS VESTED IN THE WATER INFRASTRUCTURE FINANCE AUTHORITY OF ARIZONA OR ANY SUCCESSOR AGENCY TO COLLECT THE MONIES NECESSARY TO PRODUCE SUFFICIENT REVENUE TO FULFILL THE TERMS OF ANY AGREEMENTS MADE WITH THE HOLDERS OF THE BONDS, OR IN ANY WAY IMPAIR THE RIGHTS AND REMEDIES OF THE BONDHOLDERS, UNTIL ALL BONDS ISSUED UNDER THIS ARTICLE, TOGETHER WITH INTEREST, INCLUDING INTEREST ON ANY UNPAID INSTALLMENTS OF INTEREST, AND ALL COSTS AND EXPENSES IN CONNECTION WITH ANY ACTION OR PROCEEDINGS BY OR ON BEHALF OF THE BONDHOLDERS, ARE FULLY MET AND DISCHARGED. THE BOARD AS AGENT FOR THIS STATE MAY INCLUDE THIS PLEDGE AND UNDERTAKING IN ITS RESOLUTIONS AND INDENTURES SECURING ITS BONDS.

Sec. 12. Initial terms of members of the water supply development fund committee

A. Notwithstanding section 49-1202, Arizona Revised Statutes, as amended by this act, the initial terms of water supply development fund committee members appointed by the governor are:

1. One term ending January 31, 2009.
2. Two terms ending January 31, 2010.
3. Two terms ending January 31, 2011.
4. Two terms ending January 31, 2012.
5. Two terms ending January 31, 2013.

B. The governor shall make all subsequent appointments as prescribed by statute.

Sec. 13. Conditional enactment
This act does not become effective unless Senate Bill 1575, forty-eighth legislature, first regular session, relating to water adequacy provisions, becomes law.
APPROVED BY THE GOVERNOR MAY 24, 2007.
FILED IN THE OFFICE OF THE SECRETARY OF STATE MAY 24, 2007.

A.R.S. § 49-1273. Water supply development revolving fund; purposes; limitation

A. Monies in the water supply development revolving fund may be used for the following purposes:

1. Making water supply development loans to water providers in this state under section 49-1274 for water supply development purposes.
2. Making loans or grants to water providers for the planning or design of water supply development projects. A single grant shall not exceed one hundred thousand dollars.
3. Purchasing or refinancing debt obligations of water providers at or below market rate if the debt obligation was issued for a water supply development purpose.
4. Providing financial assistance to water providers with bonding authority to purchase insurance for local bond obligations incurred by them for water supply development purposes.
5. Paying the costs to administer the fund.
6. Providing linked deposit guarantees through third party lenders by depositing monies with the lender on the condition that the lender make a loan on terms approved by the committee, at a rate of return on the deposit approved by the committee and the state treasurer and by giving the lender recourse against the deposit of loan repayments that are not made when due.

B. If the monies pledged to secure water supply development bonds issued pursuant to section 49-1278 become insufficient to pay the principal and interest on the water supply development bonds guaranteed by the water supply development revolving fund, the authority shall direct the state treasurer to liquidate securities in the fund as may be necessary and shall apply those proceeds to make current all payments then due on the bonds. The state treasurer shall immediately notify the attorney general and auditor general of the insufficiency. The auditor general shall audit the circumstances surrounding the depletion of the fund and report the findings to the attorney general. The attorney general shall conduct an investigation and report those findings to the governor and the legislature.

C. Monies in the water supply development revolving fund shall not be used to provide financial assistance to a water provider, other than an Indian tribe, unless one of the following applies:

1. The board of supervisors of the county in which the water provider is located has adopted the provision authorized by section 11-823, subsection A.
2. The water provider is located in a city or town and the legislative body of the city or town has enacted the ordinance authorized by section 9-463.01, subsection O.
3. The water provider is located in an active management area established pursuant to title 45, chapter 2, article 2.

A.R.S. § 42-5301. Definition of municipal water delivery system

In this article, unless the context otherwise requires "municipal water delivery system" means an entity that distributes or sells potable water primarily through a pipeline delivery system which is owned by either:

1. A city or town incorporated or chartered under the constitution and laws of this state.
2. A private entity which is regulated as a public service corporation by the Arizona corporation commission under a certificate of public convenience and necessity.
3. A special taxing district established under title 48, chapter 6.
4. An entity which is regulated as a water supply system by the department of environmental quality.

WRDC Legislative Recommendations Working Group Report

Working Group Chair: Supervisor Pat Call, Cochise County
By: John Munderloh, Vice-Chair, Town of Prescott Valley

INTRODUCTION

In 2010, the Arizona Legislature passed H.B. 2661 that created the Water Resources Development Commission (WRDC) for the purpose of assessing the current and future water needs of Arizona. As a part of this effort the WRDC created five committees (Population, Water Supply & Demand, Environmental, Finance and Report committees) to address specific objectives associated with the assessment. In April of 2011 the WRDC formed an additional working group, the Legislative Recommendations Working Group. The Legislative Recommendations Working Group was directed to focus their efforts on the task outlined in H.B. 2661(D) that specifies that the WRDC is to include "…recommendations for suggested legislation" in its report to the Governor, the Speaker of the House of Representatives, and the President of the Senate. Prior to the formation of the Legislative Recommendations Working Group, this task was previously identified in the work plan for the Report Committee. The working group was directed to submit its final report by August 15, 2011.

OBJECTIVE

Specifically, the task outlined by the WRDC for the Legislative Recommendations Work Group was to determine if the results from the other study tasks outlined in H.B. 2661 would require legislative action, and if so, to develop legislative proposals. In the simplest terms, the WRDC committees determined that significant additional water supplies will be needed to meet projected new demands in certain areas of the state, development of new water supplies should consider and not impact environmental needs, and that substantial financial commitment will be required to accomplish these two objectives.

METHODS

The Legislative Recommendations Working Group met on 4/25/2011, 5/16/2011, 6/13/2011 and 8/8/2011. During the course of its meetings, presentations were received on two issues, the Water Resources Development Revolving Fund and a "strawman" proposal for a statewide or regional water augmentation authority.

The focus on the Water Resources Development Revolving Fund was that though it exists, it has no funds to provide for water resources development. Information was provided on potential alternative revenue sources including:

- Ad Valorem Taxes
- Water Withdrawal Fees
- Transaction Privilege Tax
- Bottle Water Tax
- Permit Fees
- General Fund Appropriations

In addition, information was provided to the working group on how much revenue could be anticipated from each potential revenue source.

The "strawman" proposal for a statewide water augmentation authority had been developed by representatives from the Northern Arizona Municipal Water Users Association in response to the Central Arizona Project's *Just Water* proposal and had been receiving input from several other water providers, including the Arizona Municipal Water Users Association, City of Phoenix, City of Tucson, Mohave County Water Authority, Upper San Pedro Watershed, Central Arizona Project and Salt River Project. The "Strawman" proposal helped frame some the water resource development and water infrastructure challenges facing areas outside of the three-county CAP service area and put forward a recommendation to form a statewide water augmentation authority. One issue highlighted by this proposal is that multiple water stakeholders need mechanisms that let them form legal partnerships to jointly acquire water rights and build water infrastructure projects.

The Legislative Recommendations Work Group examined a number of existing governance mechanisms that could help develop and finance joint water supply projects. These included special districts, intergovernmental agreements, other contractual arrangements and the joint powers legislation (A.R.S. §11-952.02). The working group concluded that all have certain drawbacks. Specific improvements have yet to be worked through by the group.

Another item of discussion for the working group was whether a statewide or regional entity made up of various water stakeholders could legally access the Water Supply Development Revolving Fund (A.R.S. § 49-1271).

ISSUES AND CONCERNS

A number of issues and concerns were noted by the working group members during discussion:

1. Should the water supply development entity be statewide or several regional entities? There are typically three main components to a water supply project: 1) Acquiring water rights through development or purchase, 2) Financing and building infrastructure, 3) Operation and maintenance of the project.
    a. Will multiple regional entities increase competition for limited water rights?
    b. Since water supply infrastructure, by nature, will have a limited service area, a regional entity makes sense for financing, infrastructure development and repayment.
        i. Does or should the State of Arizona participate in the regional entities as a stakeholder?
        ii. Can the State of Arizona lend its financial credibility to project financing without having financial obligations?
2. Can private entities, such as private water companies and mines, be part of the regional or statewide water development entity?
    a. Current legislation in A.R.S. § 11-952 would exclude private entities.
3. Is a regional or statewide water development entity eligible to access the Water Supply Development Revolving Fund?

a. Currently this fund is limited to water providers defined in A.R.S. § 49-1201(14).
b. Currently only water providers that are within Active Management Areas or have adopted Adequate Water Supply rules can access this fund. Adequate Water Supply rules only apply to community water providers, not mines or agriculture.

RECOMENDATIONS

The H.B. 2661 that establishes the WRDC has set a due date for its report to the Governor and Legislature of October 1, 2011. The Legislative Recommendations Working Group will not be able to fully consider the outlined issues and suggest legislative changes (if necessary) by that time. The WRDC does not sunset until September 30, 2012 in accordance with H.B. 2661. The Legislative Recommendations Work Group recommends the WRDC direct the Legislative Recommendations Working Group to continue consideration and develop final recommendations regarding legislation (if necessary) for funding the Water Supply Development Fund and enabling formation of a state or regional water augmentation authority. The Working Group recommends a deadline be given to provide a full report to the WRDC by August 1, 2012.