ARIZONA TOWN HALL

Creating Solutions

NOVEMBER 2015

Keeping Arizona's Water Glass Full

KEEPING ARIZONA'S WATER GLASS FULL

NOVEMBER 2015

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We thank you for making the commitment to participate in the 107th Arizona Town Hall to be held at the Phoenix Hilton/Mesa on November 15-18, 2015. You will be discussing and developing consensus with fellow Arizonans on the topic of "Keeping Arizona's Water Glass Full."

An essential element to the success of these consensus-driven discussions is this background report that is provided to all participants before the Town Hall convenes. Arizona State University, Northern Arizona University and University of Arizona coordinated this informative background material, creating a unique resource for a full understanding of the topic.

For sharing their wealth of knowledge and professional talents, our thanks go to the editors and authors who contributed to the report. Our deepest gratitude also goes to the Arizona Board of Regents, who made great efforts to ensure that Arizona's public universities could provide this type of resource to Arizona.

The 107th Town Hall could not occur without the financial assistance of our generous Professional Partners, which (at the time of this printing) include Premier Partner APS; Executive Partner SRP; Collaborator Partners Arizona Lottery and Freeport-McMoRan; and Civic Leader Partners AECOM, AZ Water Association, Central Arizona Project, EPCOR and Jennings, Strouss & Salmon PLC.

When the 107th Town Hall ends, the background report will be combined with the recommendations from the Town Hall into a final report. This final report will be available to the public on the Town Hall's website and will be widely distributed and promoted throughout Arizona. The Town Hall's report of recommendations and background report will be used as a resource, a discussion guide and an action plan to ensure that we meet Arizona's current and future water needs.

Sincerely,

Linda Elliott-Nelson

Linda Elliott-Nelson
Board Chair, Arizona Town Hall

INTRODUCTION

Each of the last five decades has seen an Arizona Town Hall on water:

- 1965: Arizona's Water Supply
- 1977: Arizona Water: The Management of Scarcity
- 1985: Managing Water Quality in a Water Scarce State
- 1997: Ensuring Arizona's Water Quantity and Quality for the 21st Century
- 2004: Arizona's Water Future: Challenges and Opportunities

While the titles of the Town Halls have varied, the primary theme has remained largely the same: how can Arizona ensure sustainable water supplies to support its current and future needs?

This year's Town Hall continues that theme. In doing so, it recognizes that water issues in an arid state are never settled and that our leaders and citizens must continue to develop policies, practices and projects to make certain that water needed for our state's economic prosperity and its environment is reliable and secure.

Arizona has a long history of water management. In past centuries, Native people practiced sustainable forms of agriculture and built canals to deliver water to support their civilizations. In the 20th century, new settlers erected dams to capture and store surface water for farming and municipal uses. State leaders also took steps to protect Arizona's rights to Colorado River water, construct the Central Arizona Project, and enact laws to manage groundwater supplies. Because of these proactive efforts, Arizona's most populated areas do not currently face a water crisis. Some rural areas, however, are seeing more immediate problems, such as groundwater depletion and competition for limited water supplies. Statewide, Arizona will need to identify and develop additional water supplies to meet projected water demands over the next 25 to 100 years. Meanwhile, persistent drought and climate changes are affecting the resiliency of our water supplies.

This Background Report describes the state of Arizona's water supplies and the legal and policy issues that affect the use of those supplies. It addresses the competing demands for water in Arizona and political realities we face. Finally, it highlights several issues deserving of discussion in finding lasting solutions to Arizona's long-range demand imbalances. Citations to more in-depth information are included for readers to explore issues further. [1]

[1] To view a table of the recommendations of past Arizona Town Halls on water see *Town Hall Recommendations,* Water Resources Res. Center, https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/pdfs/AZ-Town-Hall- Recommendations_0.pdf (last visited Aug. 28, 2015). To view the 2004 Town Hall Background Report see Bonnie G. Colby et al., Univ. of Ariz., Arizona's Water Future: Challenges and Opportunities (2004), *available at* http://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/pdfs/az-town-hall-2004.pdf.

The Sacred Nature of Water: An Apache Perspective
– Vincent E. Randall, Director of Apache Cultural Preservation

When Bii Ke Gohnaa (Ruler of Life) created the earth the first thing he put on it was water. The Dilzhe'e Apaches believe all of creation is a living entity because the Spirit of God is in His creation. He placed everything in its proper place including water sources. We don't say this plant, that river or that rock is over there, we say it lives over there. Just as with baptism in the Christian religion so too water is a foundation on which our traditional religion is based. Water makes us whole in body and spirit. In our way there are four kinds of water: (1) springs or seeps which emanate from the ground, this water is pure and recognized as life giving with curative powers, (2) waters which flow over the surface of the earth in the form of rivers and streams, (3) falling water in the form of rain or snow and (4) the Great Western Ocean.

In our creation story People emerged up through the waters of Montezuma's Well (Tu zichil) into the second world. When this world was destroyed by the GREAT FLOOD only one young woman was left alive. We call her Changing Woman. The first child born after the Great Flood was born for Water. Even today each Apache child born is both descended from and representative of that first child, born for Water. We still practice traditions and ceremonies which link us to our heritage and the legacy of water.

The word sacred is often misused, but for us springs are sacred because they represent the original pure water put on earth by the Creator. One elder explained to me that she visits springs and they talk to her so she doesn't get lonely. Another Apache from White Mountain commented during a trip to a sacred spring, "this spring nourishes me, the animals, the grass, everyone. At first when we put our bottles up to collect the water it was dripping slowly. After we prayed and asked for help it began to drip faster. The spring knew we needed help." Stewardship of our resources and living in harmony is my walk of life. If we respect the water it will take care of us. One of our elders, Mary Sine, who is no longer with us said in reference to the Verde River around 1937 that, "As long as the River flows, life will be good." We believe that to be so.

SECTION I. THE STATE OF ARIZONA'S WATERS

A. Arizona's Water Supplies

Arizona's water supplies consist of surface water, groundwater, and reclaimed water. Surface water is water flowing in Arizona rivers, streams and other natural channels. Groundwater is water that has seeped underground from streams, rivers, and natural channels and from the land surface, and has collected in geologic units called aquifers. Reclaimed water is wastewater that has been collected in a sanitary sewer from homes and business and treated at a wastewater treatment plant for subsequent reuse. Surface water and reclaimed water may be stored underground for later use. This water is then known as stored water.

Surface water is generally considered to be a renewable water supply because it is replenished by snow and rain. Reclaimed water is also renewable because wastewater is fairly constant and tends to grow as population increases. Most groundwater is non-renewable because it was stored underground during past geologic ages and is often utilized more quickly than it is replenished.

According to the Arizona Department of Water Resources (ADWR), Arizona currently uses about 7 million acre-feet (MAF) of water annually statewide. An acre-foot of water will cover an acre of land to the depth of one foot. ADWR describes one acre-foot as enough water to support three average families for a year, assuming three people per household. Of the 7 MAF Arizona uses annually, 40 percent is Colorado River water, 40 percent is groundwater, 17 percent is from in-state rivers, and 3 percent is reclaimed water.

How these supplies are currently used is discussed in Section III of this Report.

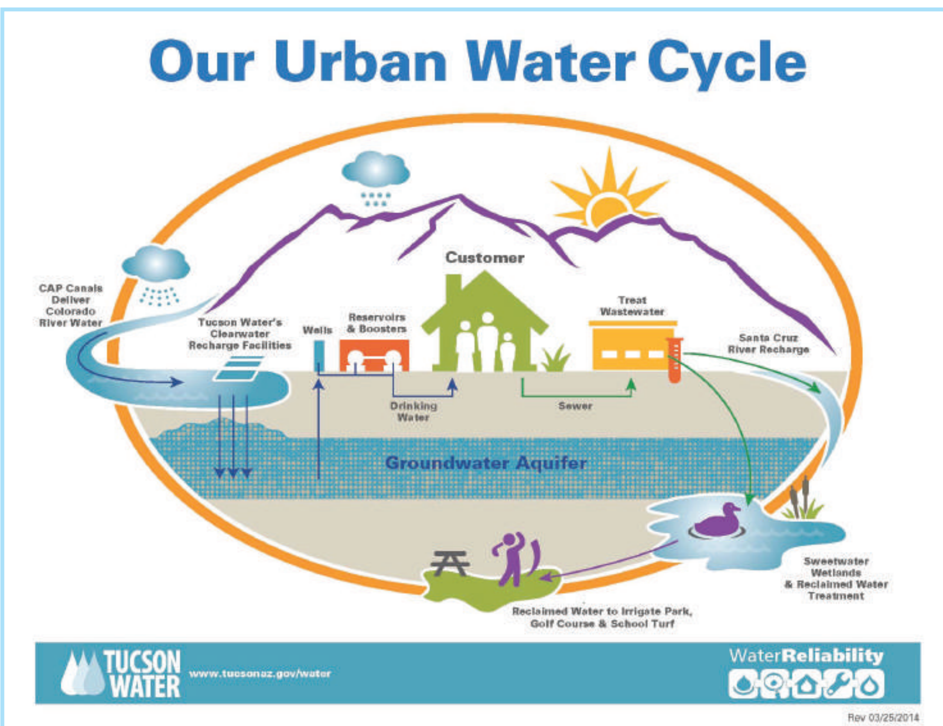
Statement from Tom Buschatzke, Director of the Arizona Department of Water Resources

Arizona is not in a water crisis. It took political capital, compromise and hard choices over many decades to create the water delivery projects, laws, regulations and intrastate and interstate agreements that effectively manage our water supplies. This forward thinking planning is one of the key reasons Arizona doesn't share California's current water problems.

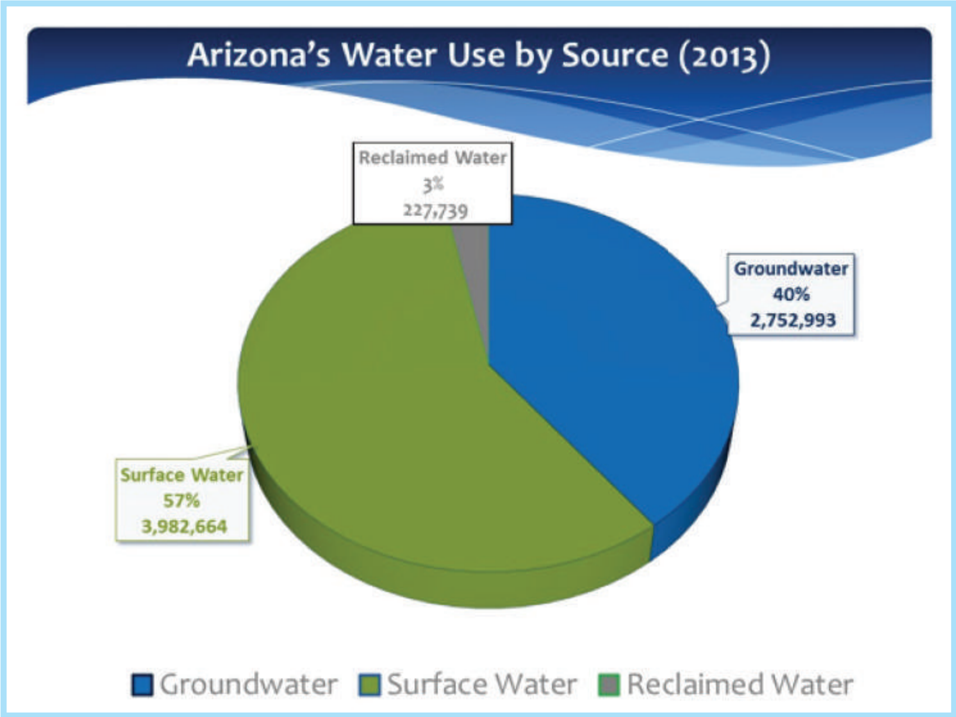
Despite Arizona's current successes, managing existing and future water supply uncertainty and vulnerability is a key strategic goal for Arizona. Maintaining and increasing the reliability of in-state surface water supplies and the Colorado River amidst projections of increasing supply variability and minimizing groundwater mining are key tasks facing the state. Maintaining Arizona's resiliency by building upon landmark management and underground water storage programs structured by the 1980 Groundwater Management Act is key.

Arizona must vigilantly protect its water rights and the autonomy to manage its water supplies. Intrastate and interstate collaboration is needed. Conservation, reuse and augmentation will be critical tools for creating reliable and sustainable surface water, groundwater and Colorado River supplies for Arizona agriculture, municipalities, industries and Indian Tribes. We must find ways to increase the reliability of the Colorado River through conservation and augmentation.

Hard choices driven by political leadership, with public support, will be necessary to insure a vibrant economy and a superior quality of life for future Arizonans.



Urban Water Cycle. Source: Developed for Tucson Water Department by Kaneen Advertising & Public Relations.



Arizona Water Use by Source. Source: Arizona Department of Water Resources (2013).

B. Projected Future Imbalances Between Water Demands and Supplies

Arizona has consistently engaged in comprehensive efforts to plan for future water needs. One such effort was conducted by the Arizona Water Resources Development Commission (WRDC), which was established by the state legislature in 2010 to assess Arizona's demand for water and the supplies available to meet those demands for the next 25, 50, and 100 years.

The WRDC 2011 Final Report (Final Report) estimated population growth in Arizona for the years 2035, 2060 and 2110 to be 10.5, 13.3 and 18.3 million people, respectively. To meet the needs of this growing population, annual water demand is expected to increase from the current amount of about 7 MAF to between 8.2 and 8.6 MAF in 2035; between 8.6 and 9.1 MAF in 2060; and between 9.9 and 10.5 MAF per year in 2110. The Final Report projected the long-term imbalance between supplies and demand to be up to 1 MAF in the next 25 to 50 years and up to 3 MAF in 100 years. At three households per acre-foot, this is enough water to serve three to nine million households.

ADWR's 2014 Strategic Vision for Water Supply Sustainability (Strategic Vision) also projects significant imbalances between future demands and water supplies. The Strategic Vision Executive Summary states on page 16:

> "Over the next 25 to 100 years, Arizona will need to identify and develop an additional 900,000 to 3.2 MAF of water supplies to meet projected water demands. While there may be viable local water supplies that have not yet been developed, water supply

acquisition and/or importation will be required for some areas of the State to realize their growth potential."[2]

Finding solutions to water supply/demand imbalances must be done in concert with our many federal, state, and tribal partners and with the Colorado River Basin States. The solutions will likely be regional in nature—an approach ADWR has taken. ADWR organized the State into 22 solution oriented "planning areas" to identify possible strategies to address these projected future imbalances. The U.S. Bureau of Reclamation has been assisting with the planning in many of the regions.

Arizona Strategic Vision Planning Areas. Source: Arizona Department of Water Resources (2014).

[2] Ariz. Dep't of Water Res., Arizona's Next Century: A Strategic Vision for Water Supply Sustainability 16 (2014).

C. Surface Water Sources

Arizona receives surface water from the Colorado River and from in-state rivers and streams. Surface water supplies are generally considered renewable, but their availability has been impacted by the continuing drought. Historically, surface water has been largely stored in above ground reservoirs that are subject to significant rates of evaporation. In the past two decades, Arizona water users have used spreading basins and injection wells to store a significant amount of surface water underground where evaporation is not an issue.

<u>Colorado River Water</u>

Seven states, many Native American communities and Mexico are entitled to receive water from the Colorado River. The Colorado River Basin is divided into an upper basin and a lower basin. The upper basin consists of the states of Wyoming, Colorado, Utah and New Mexico. The lower basin includes the states of Arizona, Nevada and California.

The following quote from the 2012 Colorado River Basin Water Supply and Demand Study shows the importance of the River:

> "The Colorado River and its tributaries provide water to nearly 40 million people for municipal use, supply water used to irrigate nearly 5.5 million acres of land, and is also the lifeblood for at least 22 federally recognized tribes (tribes), 7 National Wildlife Refuges, 4 National Recreation Areas, and 11 National Parks." [3]

Arizona is entitled to 2.8 million acre-feet (MAF) of Colorado River water annually, while California is entitled to 4.4 MAF and Nevada is entitled to 300,000 acre-feet annually. The Central Arizona Project (CAP) brings a portion of Arizona's Colorado River water to Maricopa, Pinal and Pima Counties. The CAP aqueduct system currently delivers an annual average of 1.5 MAF. The remainder of Arizona's entitlement to Colorado River water is used along the mainstem of the River in Arizona. About 1 MAF of the use along the River in Arizona is pursuant to "present perfected rights" of farmers and irrigation districts in the Yuma area recognized by the 1928 Boulder Canyon Project Act, and by four Indian tribes pursuant to the U.S. Supreme Court decree in Arizona v. California. The four tribes are the Cocopah Indian Tribe, Colorado River Indian Tribes, Fort Mohave Indian Tribe and Fort Yuma/Quechen Tribe.

CAP water is junior in priority to almost all other rights to use Colorado River water, meaning it will be reduced first when less Colorado River water is available for the lower basin. California's entitlement to Colorado River water, and most Arizona uses along the mainstem of the River, will be met before the CAP may take any water. CAP water also has a priority system. In times of shortages of CAP water, subcontractors for Municipal and Industrial (M&I) priority water and contractors for Indian priority water will have their orders for CAP water met first. Any remaining CAP water will then be made available for the non-Indian agricultural priority pool. Uses of CAP water for underground storage by the Arizona Water Banking Authority (AWBA) and replenishment by the Central Arizona Groundwater Replenishment District (CAGRD) have last priority. The responsibilities of AWBA and CAGRD are discussed in Section II of this Report.

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[3] U.S. Dep't of the Interior, Bureau of Reclamation, Colorado River Basin Water Supply and Demand Study ES-1 (2012), *available at* https://www.usbr.gov/lc/region/programs/crbstudy/finalreport/Executive%20Summary/Executive_Summary_FINAL_Dec2012.pdf.

Central Arizona Project Canal. Source: Central Arizona Project.

The Secretary of the Interior is the water master for the lower basin states and annually determines the amount of water available to the Lower Basin. The Secretary may declare a shortage if there is insufficient Colorado River water to satisfy lower basin allocations. Lower Basin water supplies are released from upstream reservoirs, notably Lake Powell, and stored for release in Lake Mead, the largest reservoir on the Colorado River system. Lake Mead can store 26 MAF.

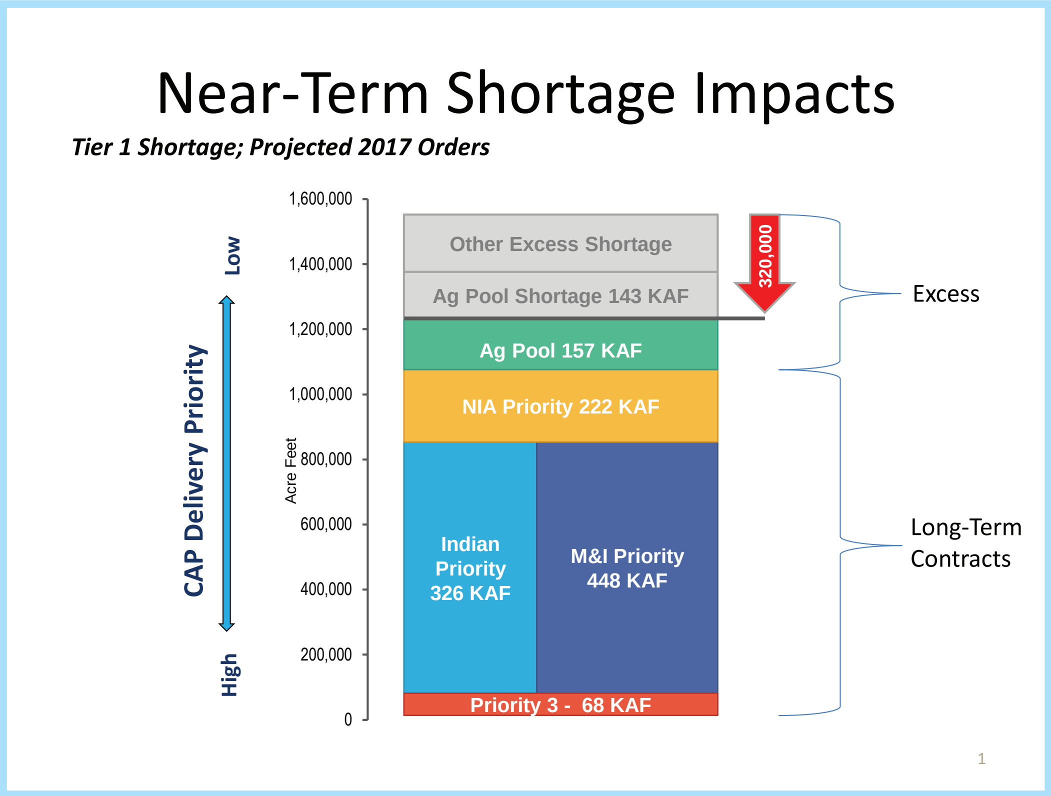
Lake Mead. Source: Central Arizona Project. Lake Powell.

Lake Powell: Source: Central Arizona Project, Steve Rottas.

The Colorado River Basin has been in a persistent drought for the past 15 years. In addition to the impact of long-term drought, Colorado River water is in jeopardy because annual allocations and operating losses on the lower Colorado River exceed average inflows to Lake Mead. In 2015 Lake Mead fell to its lowest level since 1937 when it was first filling, storing only about 10 MAF. However, based on its August 2015 24-Month Study, the Bureau of Reclamation (Reclamation), which operates the reservoirs, has confirmed that the Secretary of the Interior will not declare a shortage in 2016. Additionally, Reclamation predicts only a 18 percent probability that a shortage will be triggered in 2017. As of August 2015, the water level elevation in Lake Mead was 1078.4 feet[4] while Lake Powell was at 3611.27 feet[5].

In 2007, the Secretary of the Interior adopted the "Colorado River Interim Guidelines for Lower Basin Shortages and Coordinated Operations for Lake Powell and Lake Mead" (Interim Guidelines). These Interim Guidelines, which are in effect until 2026, have three tiers of shortage reductions triggered by water elevations in Lake Mead between 1075 and 1025 feet.

None of these reduction levels under the Interim Guidelines is expected to affect deliveries of M&I or Indian priority CAP water, but water delivery costs will increase. Cooperative conservation efforts among the Basin states are underway to keep water levels in Lake Mead above the first tier of shortage reductions, but a shortage that will reduce Arizona's entitlement to Colorado River water may be little more than a year away.



Colorado River Near-Term Shortage Impacts. Source: Central Arizona Project.

[4] Lower Colorado River Operations Schedule, U.S. Department Interior, Bureau Reclaimation, http://www.usbr.gov/lc/region/g4000/hourly/rivops.html (last visited Aug. 28, 2015).
[5] Upper Colorado Region, U.S. Department Interior, Bureau Reclaimation, http://www.usbr.gov/uc/water/rsvrs/ops/crsp_40_gc.html (last visited Aug. 28, 2015).

Cooperative Conservation Measures for the Colorado River – Central Arizona Project

Central Arizona Project (CAP) manages and delivers Colorado River water to cities, tribes, and farmers in Maricopa, Pinal, and Pima County. CAP and the Colorado River water it delivers is a critical part of Arizona's water portfolio and economic vitality. As such, CAP has undertaken a number of measures to prepare for future droughts. Not only has CAP stored water underground with the Arizona Water Banking Authority, but it has also prepared for shortages in two new innovative ways.

Pilot System Conservation Program:

CAP with interstate partners are funding a program which conserves water that stays in Lake Mead to benefit all users. This $11 million program (CAP invested $2 million) protects the river and all its users. CAP hopes to expand the program in the coming years. Currently, there are five projects underway in the Lower Basin (Arizona, California, and Nevada) conserving almost 40,000 acre-feet of water, and 10 projects in the Upper Basin (Colorado and Wyoming) conserving 4,000 acre-feet of water. Additional projects are anticipated in 2016.

Reservoir Protection Memorandum of Understanding:

CAP along with the Arizona Department of Water Resources, United States, California and Nevada are taking voluntary actions to store water in Lake Mead. This is the first time Arizona, California and Nevada are taking collaborative actions to protect Lake Mead. CAP is storing 345,000 acre-feet over 2014–17, California is storing 300,000 acre-feet, and the U.S. and Nevada are contributing a combined 95,000 acre-feet. This approach, totaling 740,000 acre-feet, could delay the onset of Colorado River shortages. Notably, CAP is the most active player in attempting to achieve conservation and storage goals outlined in the Memorandum of Understanding. CAP has the largest goal (345,000 acre-feet) and has made the most progress toward reaching the goal. By the end of 2015, CAP anticipates having stored 200,000 acre-feet of water in Lake Mead for the Memorandum, or almost 60% of the goal.

Looking South at Nevada Spillway, dam, and forebay.

In 1983, the Lake Mead water level was at 1225.79 ft with 14,075 cfs of water flowing over each spillway.

In 2015, the Lake Mead water level was at 1078 ft.

Source: U.S. Bureau of Reclamation, W. E. Sharp (1983) & Alexander Stephens (2015).

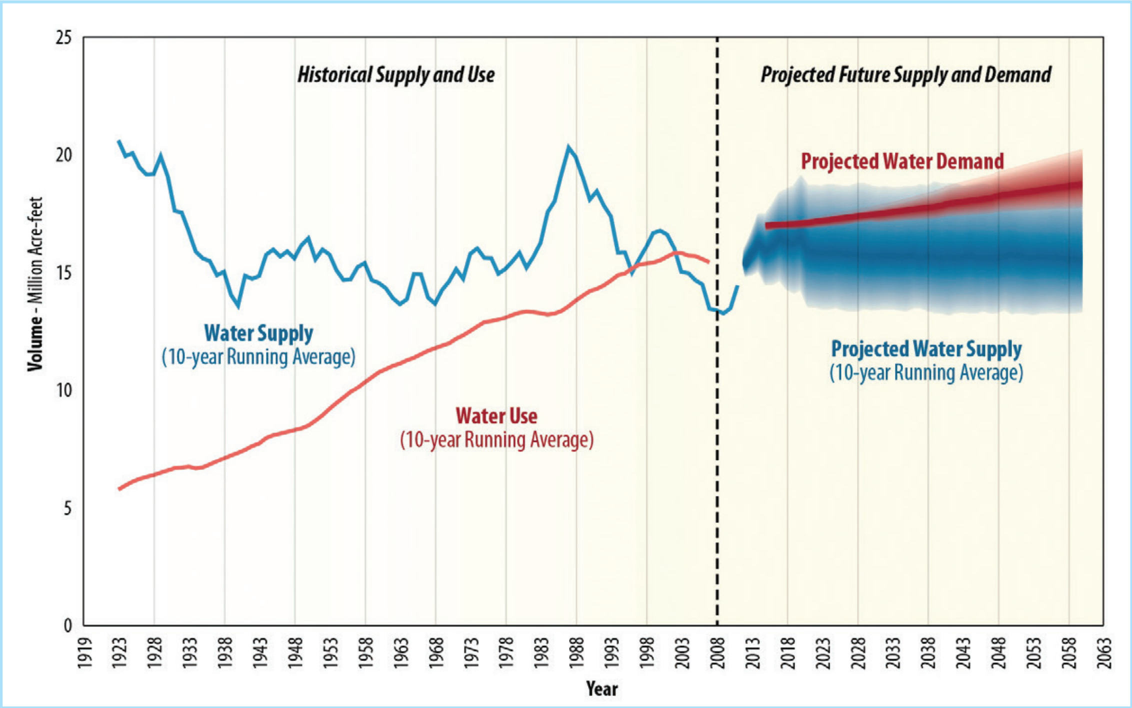
1983

2015

It has long been known that Colorado River water supplies are over-appropriated and that demands for water in the Colorado River Basin states will continue to grow. To begin to address this issue, the U.S. Bureau of Reclamation, with input from a broad range of stakeholders throughout the Colorado River Basin, published the Colorado River Basin Water Supply and Demand Study in 2012 (Basin Study). The Basin Study Area included both the area within the hydrologic basin of the Colorado River and adjacent areas that receive Colorado River water, such as southern California and Denver.

The Colorado River Basin Study Area. Source: U.S. Bureau of Reclamation (2012).

The graph below contained in the Basin Study depicts the historical water supply and use and the projected future water supply and demand in the Colorado River Basin Study Area. The amount of water available in the future is highly uncertain and dependent on a number of factors. The Basin Study projects the median long-term imbalance between supply and demand in the Basin Study Area to be 3.2 MAF by 2060. The Basin Study confirms, "The Colorado River Basin faces a range of potential future imbalances between supply and demand. Addressing such imbalances will require diligent planning and cannot be resolved through any single approach or option."



Historic Supply and Use and Projected Future Colorado River Basin Water Supply and Demand. Source: U.S. Bureau of Reclamation (2012).

The Basin Study also recognized the needs of Indian tribes to use Colorado River water. As an outcome of the Basin Study, Reclamation and the Ten Tribes Partnership (an organization of the major on-river Basin tribes) are working collaboratively to address issues facing tribal communities in the Basin and their water resources.

<u>In-State Rivers</u>

According to ADWR, 17% of Arizona's current water supply comes from in-state rivers (Salt-Verde, Gila, and others). Although some of these rivers are tributary to the Colorado River (meaning they flow into the Colorado River), Arizona rather than federal law governs use of water from these in-state rivers. Salt River Project (SRP) manages six reservoirs on the 13,000 square-mile Salt and Verde River watersheds and also the C.C. Cragin Reservoir in the Little Colorado River watershed. SRP reservoirs are capable of storing about 2.3 MAF of water and most water stored is for its member lands in the metropolitan Phoenix area. Water in storage in these reservoirs and other smaller facilities across the state have also been impacted by the recent drought.

Bill Williams River in Arizona. Source: U.S. Bureau of Reclamation, Andrew Pernick.

D. Groundwater Supplies

Arizona has a long history of augmenting renewable supplies of surface water with non-renewable supplies of groundwater. Some parts of the state are totally dependent on groundwater. When surface water flows are more plentiful, some water naturally replenishes the groundwater aquifers, but aquifers typically respond more slowly to changes in storage than rivers or lakes. It can take years to replenish groundwater supplies. Renewable groundwater includes this natural recharge from precipitation and surface flows and incidental recharge, which occurs when water percolates to the aquifer after use.

Groundwater level declines are evidence that much of the approximately 2.8 MAF of groundwater used annually in Arizona is non-renewable. This groundwater accumulated underground for hundreds to thousands of years and is replenished very slowly. Like a savings account, continued withdrawal will eventually lead to depletion. Groundwater storage in Arizona's alluvial basins was depleted by more than 74.5 million acre-feet between 1940 and 2007. The United States Geological Survey (USGS) and ADWR recently developed interactive maps that display water levels and groundwater storage in major groundwater basins in Arizona.[6] These recent maps show a general decline of groundwater levels and groundwater in storage since 1997 in Arizona. Long-term depletions of groundwater in storage mean less groundwater will be available to meet future demands.

E. Surface Water-Groundwater Interface

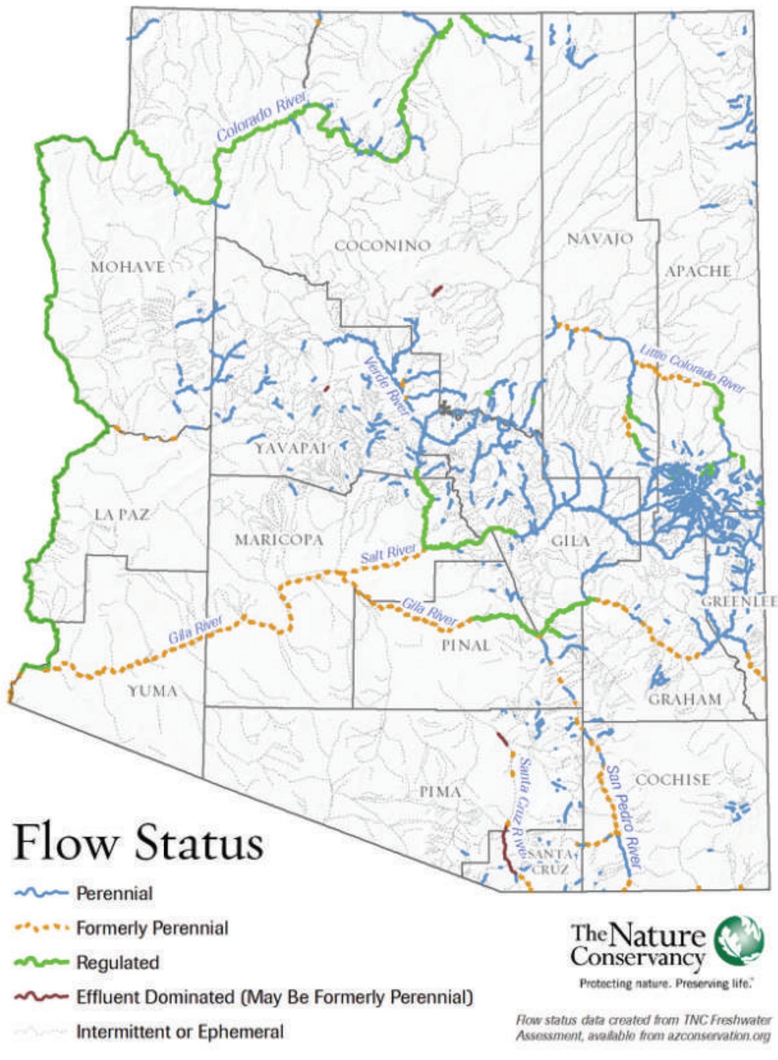
Permanent continuous flow in Arizona's perennial rivers is predominantly due to contributions from groundwater that flows to the rivers.

The Arizona Chapter of the Nature Conservancy (TNC) has demonstrated the dependence of Arizona's perennial rivers on groundwater flow.

[6] *Arizona Groundwater Conditions Interactive Map*, U.S. Geoliogical Surv., http://az.water.usgs.gov/projects/azgwconditions/index.html (last visited Aug. 21, 2015).

While modeling population growth through 2050, the TNC authors found that seven of the eighteen perennial rivers could be dewatered due to pumping of wells for municipal use.[7] Recent advances in groundwater modeling have helped water managers better understand the timing and amounts of stream flow depletion caused by pumping in adjacent alluvial aquifers. Arizona law, however, treats groundwater and surface water as separate supplies and the connection between groundwater pumping and surface water flows is the subject of continuing litigation.

The Arizona Environmental Water Needs Assessment Report of the University of Arizona Water Resources Research Center has documented how water managers have developed best management practices for some rivers to manage the rivers for the benefit of multiple purposes, including maintaining stream flows.[8]



Arizona Rivers Flow Status. Source: The Nature Conservancy Center for Science & Public Policy (2010).

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[7] Marshall et al., Sustainable Water Management in the Southwestern United States: Reality or Rhetoric?, 5 Plos One 1, 5 (2010).
[8] *See* Joanna Nadeau & Sharon B. Megdal, Univ. of Ariz. Water Res. Research Ctr., Arizona Environmental Water Needs Assessment Report (2012), *available at* https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/Assessment_2012_indesign_11-1-12_BC_1.pdf.

F. Drought/Climate Variability

Arizona is in the heart of the southwestern United States, the hottest and driest region of the country. The recently published National Climate Assessment provides a valuable summary of past and projected future climate in the region.[9] These changes are superimposed on top of the regular short-term changes to climate we are used to observing from the El Nino/La Nina cycles. The period of climate since 1950 has been hotter than any comparably long period of at least the last 600 years, with the first decade of the 21st century the warmest in the past 110-year record for the region. These increasing temperatures create an uncertain future for the distribution and timing of our already unpredictable precipitation, especially during the summer monsoons. It is predicted that snowpack in higher elevations and the associated runoff into streams will be reduced.[10]

Air temperature warming and more variable precipitation have important consequences for the quality and quantity of renewable supplies of surface water from our in-state rivers and the Colorado River. The timing and magnitude of recharge to our aquifers will also vary with these climate changes, affecting not only water supplies for human uses, but also groundwater-supported stream flow to our perennial rivers. A hotter and drier climate may result in less water available for the cooling of thermal power plants and less stream flow to produce hydroelectricity. There is the potential that agriculture may need to adapt to changes in the timing and availability of snow and rain. Increased frequency and intensity of forest wildfires due to the hotter and drier climate will threaten high quality runoff to our streams.

Drought is a natural and recurring feature of the climate of Arizona. To better prepare for drought, Arizona adopted a Drought Preparedness Plan in 2004 that is administered by ADWR.[11] Although drought affects everyone in Arizona, impacts are typically greatest in rural areas where alternative water supplies are limited or prohibitively expensive. In the future, droughts are projected to be substantially hotter, more frequent, more intense, and potentially last longer than has been observed in the historical record.

Most of Arizona has been in some degree of drought since 1996 or 1999, depending on the drought index utilized. There is evidence that this current drought is due to natural climate trends of 15 to 30 years, which are longer in duration than the 3 to 7 year El Nino/La Nina cycle. Climate scientists estimate a return within 5 to 15 years to the wetter phase of this longer climate cycle that we last experienced between the 1960's and 1990's, potentially helping alleviate the current drought. However, most water and climate experts believe permanent changes in climate are taking place. The potential impacts of future climate variability lead to greater uncertainty where water supplies are concerned.

[9] U.S. Global Change Research Program, 2014: Climate Change Impacts In The United States: The Third National Climate Assessment (Jerry M. Melillo et al. eds., 2014), *available at* http://nca2014.globalchange.gov/downloads.
[10] *Id.* at 465.
[11] Governor's Drought Task Force, Arizona Drought Preparedness Plan (2004), *available* at http://www.azwater.gov/AzDWR/StatewidePlanning/Drought/documents/operational_drought_plan.pdf.

Salt River Project Drought Planning Efforts
– Salt River Project

The extreme variability in Arizona's climate, including periods of severe drought, poses significant challenges for water planners. The Salt River Project (SRP) uses the best available science to determine how to be prepared for the inevitable times of water scarcity.

Recently, SRP turned to dendrochronology, or tree ring studies, to find out what trees can tell us about the historic flows of the Salt and Verde Rivers. The analysis revealed that mega-droughts (droughts lasting 10 years or more) occur once or twice every century and that concurrent droughts in the Colorado and Salt/Verde Systems are the norm, so it is unlikely that excess supplies on the Colorado will be available to make up for low flows in the SRP system.

In response to this information, SRP has changed its water supply management practices to be better prepared for extreme droughts. Among other measures, SRP is working with the State and Valley cities to bank Colorado River water in the ground and adjusting reservoir operations to promote greater dependability. Utilizing the extended tree ring record and modeling a severe mega-drought has allowed SRP to inform its water planning beyond what the historical record allows, resulting in a substantial increase in water supply resiliency.

G. Water Quality

Water quality affects how much water is available to meet Arizona's continually expanding demands. Water providers in Arizona are required to treat water to meet federal drinking water standards, but water users served by systems that are not regulated by the Arizona Department of Environmental Quality (ADEQ) do not have to meet these standards. While most of the population is served by regulated water systems, lack of access to water that meets drinking water standards is an issue in some remote parts of the state. The cost of treating certain contaminants, such as arsenic, is also considerable.

Other issues include preventing pollution of streams and rivers, treating reclaimed water, and dealing with increases in disinfection byproducts in drinking water. These and other issues will be discussed in Section III of this Report.

H. Watershed Services

A watershed is an area of land that is drained by a river system. Watershed services are the multiple direct and indirect benefits that people and communities receive from ecological processes and functions within a watershed. These benefits include provision of fresh water, water purification, groundwater and surface flow regulation, flood and erosion control, recharge of groundwater, nutrient cycling, maintenance of aquatic habitats and productivity, wildlife preservation, and biodiversity. [12]

[12] Kate A. Brauman et al., *The Nature and Value of Ecosystem Services: An Overview Highlighting Hydrologic Services*, 32 Ann. Rev. Evn'T Resources 67, 73, fig.3 (2007).

In Arizona, approximately 90% of surface water stream flow is generated within forested lands[13] and the majority of these lands are managed by federal, state or tribal agencies. In the Salt and Verde River watersheds, ponderosa pine forests occupy only 20% of the watershed area, but provide 50% of the water yield.[14] Fifty-nine percent of the watersheds that provide SRP and its members with high quality surface water are located on national forest lands. Additionally, Colorado River water originates in forested watersheds located primarily on national forest lands.

The Organic Administration Act of 1897 that created the National Forest Service specifically highlighted "securing favorable conditions of water flows" as one of the multiple objectives of the new agency. Gifford Pinchot, the first director of the Forest Service recognized the importance of the services provided by forested watersheds and concluded that, "A forest, large or small, may render its service in many ways. It may reach its highest usefulness by standing as a safeguard against floods, winds, snow slides, moving sands, or especially against the dearth of water in the streams."[15]

Unhealthy forests caused by historic fire suppression, logging practices and overgrazing are putting our forests at risk from catastrophic fires. Recent fires, including the Wallow Fire and the Rodeo-Chedeski fire, have demonstrated the unhealthy nature and vulnerability of these watersheds. Furthermore, wildfire occurrence and extent are increasing[16] and are projected to worsen under drought and climate change.

Catastrophic fires degrade the functioning and ability of watersheds to provide these valuable services. Burned watersheds are prone to increased flooding, changes in flow regime, and erosion that can shorten the lifespan of reservoirs and impair water quality, thus increasing costs of water treatment and infrastructure maintenance. [17] Following the 538,049 acre Wallow Fire, peak flows were 3-18 times greater than pre-fire peak flows conditions[18] and erosion across the entire watershed increased was approximately 93 times greater than pre fire sediment yields[19] and these changes increased the costs of water treatment for downstream municipal water providers. Following the Buffalo Creek and Hayman fires, Denver Water has spent more than $26 million on water quality treatment, sediment and debris removal, reclamation techniques, and infrastructure projects.[20] Often, post-fire impacts (including those impacts resulting from flash floods) are more detrimental to drinking water and wastewater systems than the fire itself. Additional negative impacts include diminished water quality from increased nutrients and other pollutants, decreases in water supply, increased water temperature, and other water infrastructure damage.

[13] Wes Swaffar & Erik Nielsen, Watershed Research and Education Program Directed Research Grant Final Technical Report 3 (2012) (citation omitted).

[14] Malchus B. Baker Jr., Hydrology, in Ecological Restoration of Southwestern Ponderosa Pine Forests 161, 162 (Peter Friederici ed., 2003) (citation omitted).

[15] Gifford Pinchot, U.S. Dep't of Agric., Bureau of Forestry, A Primer of Forestry, Part II: Practical Forestry 8 (1905).

[16] Mike D. Flannagin et al., *Implications of Changing Climate for Global Wildland Fire*, 18 Int'l J. Wildland Fire 483 (2009); A. L. Westerling et al., *Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity*, 313 Sci. 940 (2006).

[17] U.S. Dep't of the Interior, U.S. Geological Survey, Wildfire Effects On Source-Water Quality —Lessons From Fourmile Canyon Fire, Colorado, and Implications for Drinking-Water Treatment 1 (2012), *available at* http://pubs.usgs.gov/fs/2012/3095/FS12-3095.pdf.

[18] Joseph W. Wagenbrenner, *Changes in Runoff Following Wildfire in Eastern Arizona, in* Collected Abstract for ASGU Chapman Conference, Synthesizing Empirical Results to Improve Predictions of Post-Wildfire Runoff and Erosion Responses 163 (John A. Moody & Deborah A. Martin eds., 2013).

[19] *See* Joseph W. Wagenbrenner & Peter R. Robichaud, *Post-fire Bedload Sediment Delivery Across Spatial Scales in the Interior Western United States*, 39 Earth Surface Processes & Landforms 865 (2014).

[20] From Forests to Faucets: U.S. Forest Service and Denver Water Watershed Management Partnership, Denverwater.Org, http://www.denverwater.org/SupplyPlanning/WaterSupply/PartnershipUSFS/ (last visited Aug. 28, 2015).

The arid southwest is particularly prone to experiencing water shortages and is in a position to experience worsening drought conditions over the next century. Protecting scarce water resources through forest treat ments that mitigate the risk of severe forest fires is necessary to sustain these existing water resources, but forest restoration will not likely yield new long-term water supplies.[21]

I. Infrastructure

"Infrastructure" includes dams, canals, water treatment plants, pipelines and underground storage basins. Infrastructure allows for better management and use of Arizona's surface water, groundwater, reclaimed water, and "stored" water. It allows water to be captured, stored, transported, treated and delivered to where it is needed.

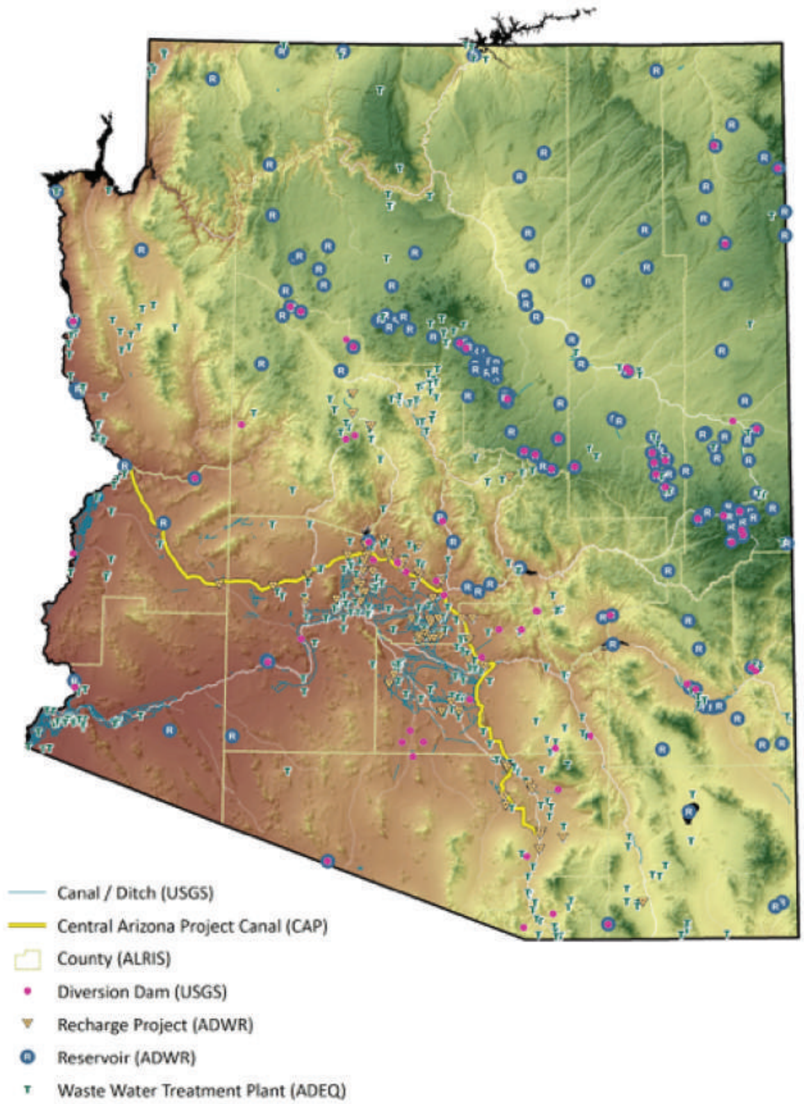
Arizona's native communities knew the value of infrastructure. As noted by the WRDC, "Nearly two millennia ago, tribal people developed a variety of techniques to create productive communities in this desert environment."[22] Beginning in the 9th century in the Salt River Valley, the Hohokam and their descendants built an elaborate system of canals to divert and deliver water from the Salt and Verde Rivers to irrigate their farms. Centuries later, the Salt River Agricultural Improvement District expanded on this system and pledged its lands as collateral for the building of Roosevelt Dam on the Salt River. Passage of the Reclamation Act of 1902 and the contribution of federal funds made construction of the dam possible.

The Central Arizona Project (CAP) was also built with federal funds to be reimbursed by water users who benefit from the CAP. Without the investment of the federal government, these and other water projects could not have been built. However, new federal funding for water projects has all but been eliminated.

Horseshoe Dam, an earth-fill structure 194 feet high on the Salt River in Arizona. Source: U.S. Bureau of Reclamation, Andrew Pernick.

[21] Marcos D. Robles et al., *Effects of Climate Variability and Accelerated Forest Thinning on Watershed-Scale Runoff in Southwestern USA Ponderosa Pine Forests*, 9 Plos ONE 1 (2014).
[22] Water Res. Dev. Comm'n, Final Report Volume I, at 1 (2011).

Typically, rural areas lack a diverse portfolio of water resources or the ability to finance the development of large-scale water projects. ADWR's Strategic Vision identified as a high priority the need to develop options for funding water supply acquisition and infrastructure construction for rural areas.



Arizona Water Infrastructure. Source: Salt River Project.

C.C. Cragin Reservoir Diversion to Payson
– Buzz Walker, Water Superintendent for Payson

Payson is one rural town that is using federal and state loans to develop a large water project. In 2000, Payson was totally dependent on local groundwater supply for its customers and was using 90% of its renewable in-town groundwater each year. A decade's long effort to produce additional groundwater from the surrounding Tonto National Forest proved unsuccessful due to US Forest Service restrictions on using public lands for public water supply. With no relief in sight Payson enacted strict growth control and water conservation measures.

In 2005, the Salt River Project acquired C.C. Cragin Reservoir from Phelps Dodge Corporation as part of the Arizona Water Settlements Act of 2004. SRP in turn was then able to offer communities in northern Gila County the opportunity to partner with SRP to develop/augment their water supplies. Payson's partnership with SRP became official in 2008 and Payson received a 3,000 acre/feet/year water right in 2010.

Payson immediately began developing engineering plans for a $50 million project to bring this water to Payson and began environmental studies necessary to obtain a special use permit from the US Forest Service to construct project elements within the Tonto Forest. The permit was issued in 2012 and Payson adopted a multiyear water rate increase plan necessary to retire project debt. To date, Payson has spent $16 million on the project and the project is scheduled for completion in the summer of 2018.

SECTION II. LEGAL/POLICY CONTEXT

This Section summarizes the basic state and federal laws that govern the use of water in Arizona. Some of the issues relating to those laws are discussed in greater detail in Section III of this Report.

A. Water Rights Under State Law

People often ask, "Who owns the water?" In Arizona, the answer is nuanced and depends on the type of water involved. In general, surface water and groundwater are public resources that are not "owned" by any person. Reclaimed water and stored water are not public resources. Different laws govern each type of water.

Surface Water

In 1919, Arizona enacted a set of laws, or code, to govern the use of surface water.[23] Established in 1980, ADWR is the state agency responsible for administering and enforcing the surface water code. The code provides that surface water belongs to the public and is subject to reasonable and beneficial use. [24] After 1919, to legally use surface water, a person must apply for a permit from the state (now ADWR) to "appropriate" the water.[25] Once the water has been diverted and put to beneficial use, the person may apply for a certificate of water right. Beneficial uses include domestic, municipal, irrigation, stock watering, water power, recreation, and wildlife, including fish.[26]

Arizona is a "prior appropriation" state, meaning the person who first appropriates surface water and puts it to beneficial use has the better right; hence the term "first in time first in right." While a surface water right may be transferred for a new use at a new location, the Director of ADWR must approve a transfer.[27] The transfer may not adversely affect other surface water rights. Additionally, if the surface water right is from a watershed that supplies water for the irrigation of lands within an irrigation district,[28] the irrigation district must consent to the transfer of the right.

Certain surface water rights in Arizona have been determined by court decrees. For example, the 1910 "Kent Decree" determined the priority dates from 1869 through 1909 for about 151,000 acres of irrigated farmland in the Salt River Valley.[29] As discussed in greater detail in Section 3 of this Report, surface water uses outside of the scope of the Kent Decree and other similar decrees have never been officially confirmed in terms of their extent and priority against other surface water claims.

Groundwater

The 1980 Arizona Groundwater Management Act[30] governs all uses of groundwater in Arizona. Like the surface water code, the Groundwater Management Act is administered and enforced by the Arizona Department of Water Resources.

[23] Ariz. Rev. Stat. §§ 45-141-206.
[24] § 45-141.
[25] § 45-152.
[26] § 45-145.
[27] § 45-172.
[28] "Irrigation district" as used here includes an agricultural improvement district or water users' association.
[29] Hurley v. Abbott, Arizona Territorial Court, No. 4564 (Mar. 1, 1910).
[30] Ariz. Rev. Stat. §§ 45-401–45-704.

The constitutionality of the Groundwater Management Act was challenged in state and federal courts almost immediately after its passage. The Town of Chino Valley complained about the expanded ability to transport groundwater. Certain farmers who believed, based on past Arizona Supreme Court decisions, that they owned the groundwater beneath their land, argued that the Act took this property right without due process. Since the Act contains a unique "non-severability" provision--meaning that if any part of the Act is declared unconstitutional, the entire Act would fail--the lawsuits threatened the survival of the entire Act. The Act survived these challenges intact. The Arizona Supreme Court found that "there is no right of ownership of groundwater in Arizona prior to its capture and withdrawal from the common supply."[31] The court further held that the legislature may enact laws regulating groundwater use under its police powers. The federal court likewise upheld the constitutionality of the Act.[32]

Although the 1980 Groundwater Management Act governs the entire state, its primary focus is on five Active Management Areas or AMAs. An AMA is a geographical area requiring active management of groundwater.[33] The AMAs are the Phoenix, Pinal, Prescott, Santa Cruz and Tucson AMAs. ADWR may designate a subsequent AMA.[34] Within AMAs, the Act:

- Recognized uses of groundwater in effect at the time the Act was passed. These uses are known as Grandfathered Groundwater Rights.[35]

- Prohibits the irrigation of new agricultural lands.[36]

- Allows new non-agricultural uses of groundwater only pursuant to a permit issued by the Department of Water Resources[37] or from a small domestic well.[38]

- Sets a management goal for each AMA.[39] The management goal for the Phoenix, Tucson and Prescott AMAs is "safe-yield" by 2025. Safe-yield means an attempt to achieve and then maintain a long-term balance between the annual amount of groundwater withdrawn in the AMA and the annual amount of natural and artificial recharge in the AMA.[40] The management goal for the Santa Cruz AMA is to maintain a safe-yield condition and to prevent local water tables from experiencing long-term declines. The management goal for the Pinal AMA is to allow development of non-irrigation (non-agricultural) uses and to preserve existing agricultural economies in the AMA for as long as feasible, consistent with preserving future water supplies for municipal and industrial uses.

- Requires the Department to adopt a series of management plans for each AMA. The plans must include continuing mandatory conservation programs for all persons withdrawing groundwater.[41]

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[31] Town of Chino Valley v. City of Prescott, 638 P.2d 1324, 1328 (Ariz. 1981).
[32] Cherry v. Steiner, 716 F.2d 687 (9th Cir. 1983).
[33] Ariz. Rev. Stat. § 45-402(2).
[34] § 45-412(A).
[35] § 45-461–483.
[36] § 45-452.
[37] § 45-512.
[38] § 45-454. These wells are called exempt wells. An exempt well has a limited pump capacity and may be used to withdraw groundwater only for non-agricultural domestic uses.
[39] § 45-562.
[40] § 45-561(12).
[41] § 45-563. In the Santa Cruz AMA, the plans must include a continuing mandatory conservation program for all persons withdrawing water, other than stored water, from a well. *Id.*

- Prohibits new wells that will unreasonably increase damage to other water users from the concentration of wells.[42]

- Requires most well owners to measure withdrawals,[43] file annual reports with the Department[44] and pay a withdrawal fee on each acre-foot withdrawn.[45]

- Provides that groundwater may be transported within an AMA,[46] but allows transportation of groundwater into an AMA only from four designated groundwater basins.[47]

- Prohibits the sale of subdivided land that does not have a 100-year assured water supply.[48]

The assured water supply requirement is undoubtedly the most innovative provision of the Act and has proven to be an effective tool to prevent groundwater mining for municipal purposes. An assured water supply means that sufficient water of adequate quality will be continuously, legally and physically available to meet the needs of the proposed use for at least 100 years, and that the financial capability has been demonstrated to construct the facilities necessary to make the water available for the proposed use. If groundwater is the proposed source of supply, its use must be consistent with the management plan and the achievement of the management goal for the AMA. ADWR has adopted rules to implement the assured water supply requirement. Because the goal of the Act is to curb groundwater withdrawals, the rules significantly limit the ability to use groundwater as an assured water supply.

The Act allows ADWR to designate cities, towns and private water companies as having an assured water supply. These designations, which must be periodically renewed, allow these water providers to serve new development within their service areas. The developer of a subdivision that will be served by a "designated" provider does not need to independently demonstrate an assured water supply. In an AMA, the developer of a subdivision that will not be served by a designated provider must obtain a certificate of assured water supply from ADWR in order to sell lots in the subdivision.

It is important to note that the assured water supply requirement applies only to subdivisions, defined in state real estate law as the division of land into six or more lots. Land splits of fewer than six lots and drilling of multiple small domestic wells circumvent the need to show an assured water supply.

Outside of AMAs, there are two levels of groundwater regulation. The first is an Irrigation Non-Expansion Area or INA. An INA is a geographical area that has insufficient groundwater to provide a reasonably safe supply for the irrigation of the cultivated lands at the current rate of withdrawal.[49] Within an INA, only acres of land that were irrigated in the five years prior to the designation of the INA may be irrigated.[50] There are no limitations on the amount of groundwater that may be pumped for irrigation of those acres or for other uses.

[42] § 45-598(A). This provision does not apply to small domestic wells known as "exempt wells."
[43] § 45-604.
[44] § 45-632.
[45] § 45-611.
[46] §§ 45-541–543.
[47] §§ 45-551–559.
[48] § 45-576.
[49] § 45-402(22).
[50] § 45-437(B).

There are three INAs: Joseph City, Douglas and Harquahala. ADWR may designate a subsequent INA[51] and groundwater users within a basin or sub-basin may initiate procedures to designate an INA.[52] ADWR has recently determined, after public hearings on a petition by groundwater users, that the San Simon Valley Sub-basin in southeastern Arizona should not be designated as an INA.[53]

In areas of the state that are not included within an AMA or INA, a person may pump any amount of groundwater for any reasonable use, and there are only a few restrictions on well drilling. Owners of pre-1980 wells were required to register these wells with the Department of Water Resources.[54] A person may drill a new well after filing a notice of intention to drill with the Department.[55] A new well may be drilled only in conformance with adopted construction standards by a well driller licensed by the Department.[56] With limited exceptions, groundwater may not be transported for a use outside of the groundwater basin in which it is pumped.[57] This limitation is discussed in more detail in Section III of this Report.

In all areas of the state outside of an AMA, a person who wishes to offer subdivided land for sale must demonstrate to ADWR whether there is a 100-year "adequate" water supply for the subdivision. Except as noted below, a determination by ADWR that an adequate water supply is not available does not prevent the sale of lots in the subdivision, but lack of an adequate water supply must be disclosed to the original lot purchasers. State law allows a county or municipality to adopt a regulation or ordinance that the final plat for a subdivision within the county or municipality will not be approved unless ADWR has determined there is an adequate water supply for the subdivision or the subdivision will be served by a municipal water provider that ADWR has designated as having an adequate water supply.[58] To date, only Cochise and Yuma Counties and the Towns of Clarkdale and Patagonia have passed these mandatory requirements.

Reclaimed Water

"Reclaimed water" is the term used to express that effluent or wastewater has been treated sufficiently to allow it to be reused for a variety of purposes.

Until 1989, the legal status of this valuable resource was unclear. That year, the Arizona Supreme Court ruled that effluent is not groundwater or surface water, and that an entity that treats wastewater may contract for its disposition and use.[59]

ADEQ regulates the treatment and reuse of wastewater in Arizona. ADEQ classifies reclaimed water based on the amount of treatment the wastewater receives. Class A and Class A+ are the highest water quality designations, signifying reclaimed water that is treated so that it is routinely free of pathogens (viruses, bacteria or other microorganisms that can cause disease). ADEQ allows use of Class A and Class A+ reclaimed water for a wide range of end uses, including uses where the public has unrestricted access. However, under

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[51] § 45-432(A).
[52] § 45-433.
[53] Ariz. Dep't of Water Res., In the Matter of the of the Petition to Designate the San Simon Valley Sub-Basin of the Safford Groundwater Basin as a Subsequent Irrigation Non-Expansion Area, Findings, Decision and Order (2015).
[54] § 45-593(A).
[55] § 45-596.
[56] § 45-594–595.
[57] § 45-544(A)(2).
[58] §§ 9-463.01(O), 11-823.
[59] Ariz. Pub. Serv. Co. v. Long, 773 P.2d 988 (Ariz. 1989).

ADEQ rules, direct use of reclaimed water for human consumption, regardless of class, is prohibited. Direct potable use of reclaimed water is discussed further in Section III of this Report.

Stored Water

In 1986, Arizona enacted laws allowing storage of water underground for later recovery and reuse. These laws were modified in 1994 and are known as the Underground Water Storage statutes.[60] ADWR administers these laws, which require permits to construct an underground storage project, to store water at a storage project, and to use a new or existing well to "recover" (pump) the stored water.

Central Arizona Project Recharge Basin in Tucson. Source: Rodolfo Peón.

Superstition Mountains Recharge Site. Source: Central Arizona Project.

In general, only CAP water and reclaimed water may be stored underground for recovery in a subsequent year. ADWR maintains a long-term storage account for each person who earns long-term storage credits and debits the account when long-term storage credits are recovered. Long-term storage credits may be transferred to another person. A person who holds long-term storage credits may recover them any place within the same AMA in which the water was stored. Once recovered, stored water may be used in the same way the water could have been used before it was stored.

[60] ARIZ. REV. STAT. §§ 45-801.01–898.01.

B. Federal and Indian Water Rights

Colorado River Water

The Colorado River is governed by a complex system of compacts, court decrees and federal legislation, collectively known as the Law of the River.[61] All rights to use Colorado River water are governed by the Law of the River.

Main Stem of the Colorado River. Source: Central Arizona Project.

The Secretary of the Interior must approve the transfer of any contract to use Colorado River water in the lower basin. In Arizona, the Department of Water Resources has the statutory responsibility to advise the Secretary prior to the approval of any transfer by a non-federal Arizona contractor of a mainstem Colorado River entitlement,[62] and has adopted a substantive policy statement setting forth its process for doing so.[63]

State law established the Central Arizona Water Conservation District (CAWCD) to operate the CAP system and deliver water to CAP contractors and subcontractors.[64] CAWCD is governed by a 15-member board of directors elected by the voters in the three-county CAP service area (Maricopa, Pinal and Pima Counties).

Reserved Water Rights

When the United States government reserves public lands for any use—including Indian reservations, military bases, or national parks—it implicitly reserves water rights.[65] These rights are often referred to as "Winters rights" after the seminal Supreme Court case establishing federal reserved water rights.[66] The

[61] For a summary of the Law of the River see *Law of the River,* Cent. Ariz. Project, http://www.cap-az.com/about-us/law-of-the-river (last visited Aug. 28, 2015).
[62] Ariz. Rev. Stat. § 45-107(D).
[63] Ariz. Dep't of Water Res., Substantive Policy Statement, Policy and Procedure for Transferring an Entitlement of Colorado River Water (2014), *available at* http://www.azwater.gov/AzDWR/Legal/LawsRulesPolicies/documents/SubstantivePolicyStatement.pdf.
[64] Ariz. Rev. Stat. § 48-3701–3783.
[65] *See generally* Winters v. United States, 207 U.S. 564 (1908). Note that the Court held in *Winters* that the Fort Belknap tribe had implicit federal reserved rights. In Arizona v. California, the Court held that *Winters* rights were held by all federally reserved public lands. Arizona v. California, 373 U.S. 546, 601 (1963).
[66] *Winters*, 207 U.S. 564.

amount of water reserved is that sufficient to meet the primary purpose for which the reservation was established.[67] In a prior appropriation state like Arizona, the priority date for reserved rights is either time immemorial for aboriginal lands reserved[68] or the date the reservation is established.[69] Federal reserved rights are not subject to state requirements for obtaining water rights, or to state forfeiture and beneficial use restrictions.

Federal reserved rights held by tribes are unique in that the "primary purpose" of the reservation is to establish a permanent homeland for the tribe.[70] Typically, courts have quantified the amount of water necessary to achieve this purpose by calculating the reservation's "practicably irrigable acreage" or PIA.[71] Calculating PIA depends on total acreage, the arability of the land, the engineering feasibility of irrigating the land, and the economic feasibility of irrigation projects.[72]

Tribal reservations differ from other federal reservations in their formation. Many "reservations" for Native People are those lands reserved by the Tribe when all other aboriginal territory was taken by or ceded to the United States. The reserved right to water is for present as well as future uses of the land. It is the speculative nature of determining future uses that led the Courts to establish PIA and Tribal Homeland as measures to quantify the water rights and fit those rights into a decree or settlement.

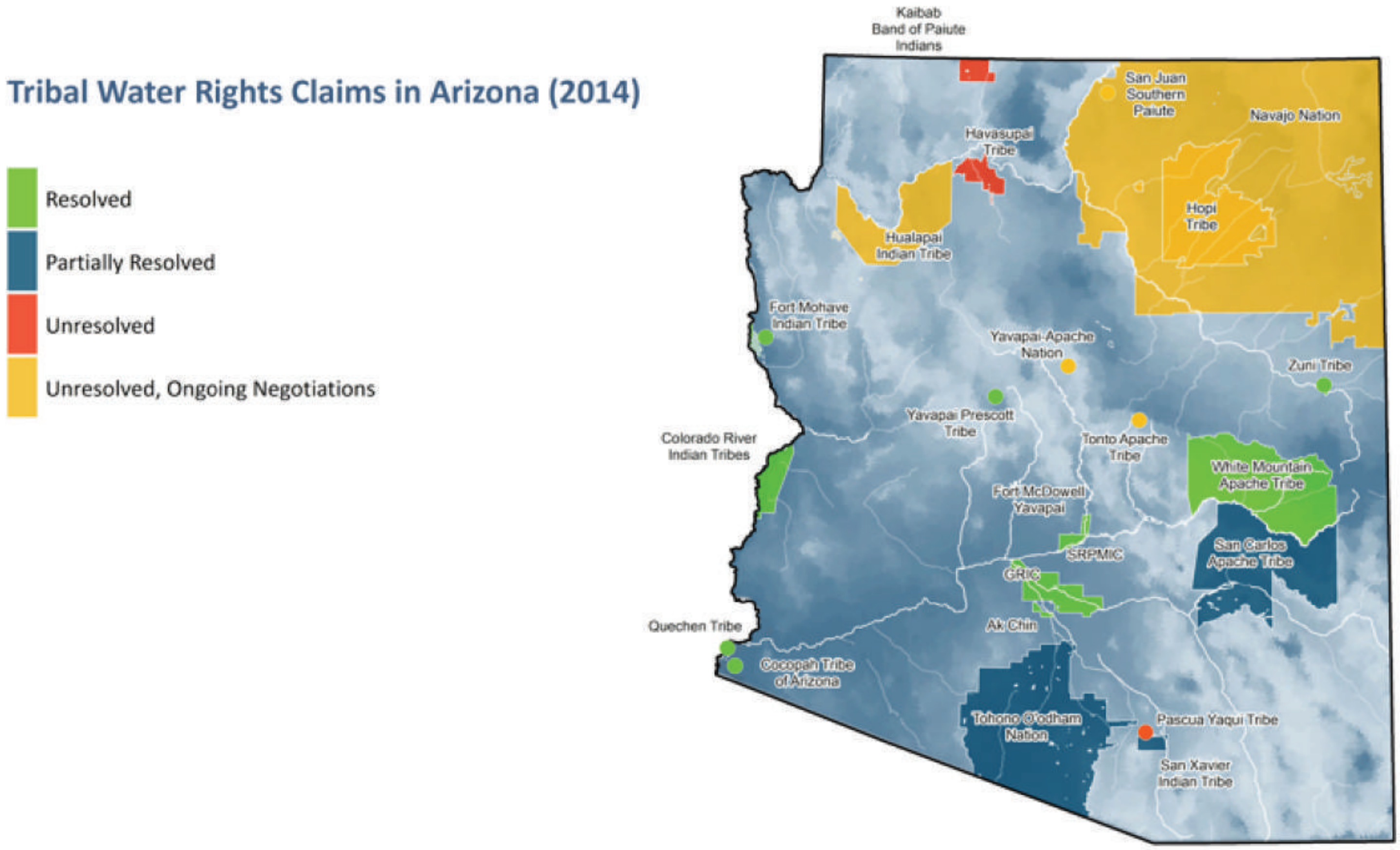
The Arizona Supreme Court declined to use PIA as the exclusive quantification method.[73] The Court rejected the notion that agriculture was the sole factor in determining a water right for a permanent homeland and recognized the potentially inequitable results of PIA when applied to tribes with reservations in rocky mountainous regions unsuitable for farming.[74] In addition to irrigation, the Arizona Supreme Court considers, among other things, tribal culture, present and future population, current uses and proposed master land or water use plans in quantifying tribal Winters rights.[75]

In 1952, Congress passed the McCarran Amendment waiving the sovereign immunity of the United States in cases determining "rights to the use of water of a river system or other source."[76] The Supreme Court held that the McCarran Amendment gave courts jurisdiction to adjudicate tribes' Winters rights as held in trust by the United States.[77] The McCarran Amendment does not waive the sovereign immunity of Tribal governments leaving Tribes to have their rights adjudicated on their behalf by the United States as was the case in Arizona v. California[78] or intervene in general stream adjudications.

[67] Cappaert v. United States, 426 U.S. 128, 141 (1976); *see also* United States v. New Mexico, 438 U.S. 696, 718 (1978).
[68] United States v. Adair, 723 F.2d 1394, 1414 (9th Cir. 1983).
[69] *Cappaert*, 426 U.S. at 138.
[70] Colville Confederated Tribes v. Walton, 647 F.2d 42, 49 (9th Cir. 1981); *see also Winters*, 207 U.S. at 576–77.
[71] *Arizona*, 373 U.S. at 600–01.
[72] *In re* Gen. Adjudication of All Rights to Use Water in Big Horn River Sys., 753 P.2d 76, 101 (Wyo. 1988), *aff'd sub nom*. Wyoming v. United States, 492 U.S. 406 (1989).
[73] *In re* the Gen. Adjudication of All Rights to Use Water in the Gila River Sys. & Source, 35 P.3d 68, 78–79 (Ariz. 2001).
[74] *Id.* at 78.
[75] *Id*. at 79–81.
[76] 43 U.S.C. § 666 (1952).
[77] Colo. River Water Conservation Dist. v. United States, 424 U.S. 800, 810 (1976).
[78] Arizona v. California, 373 U.S. 546 (1963).

Many Arizona Tribes have settled water claims with federal, state and private water rights holders through agreements ratified by Congress.[79] Tribes enter into such settlement agreements for many reasons, including to avoid the uncertainties surrounding judicial quantification of water rights and to secure financing for water infrastructure development. While each settlement is unique, common elements include the provision of federal project water through the CAP, infrastructure financing, authorization of leases of the Tribe's Winters rights, and agreements concerning groundwater pumping on and near Tribal land.

To date, several Tribes have settled water rights, but many claims have yet to be settled.



Tribal Water Rights Claims in Arizona. Source: Salt River Project (2014).

[79] *See, e.g.*, White Mountain Apache Tribe Water Rights Quantification Act, Pub. L. No. 111-291, tit. III, 124 Stat. 3064, 3073 (2010); Arizona Water Rights Settlement Act, Pub. L. No. 108-451, 118 Stat. 3478 (2004); Zuni Indian Tribe Water Rights Settlement Act, Pub. L. No. 108-34, 117 Stat. 782 (2003); Yavapai-Prescott Indian Tribe Water Rights Settlement Act, Pub. L. No. 103-434, tit. I, 108 Stat. 4526 (1994); San Carlos Apache Tribe Water Rights Settlement Act, Pub. L. No. 102-575, tit. XXXVII, 106 Stat. 4600 (1992); Fort McDowell Indian Community Water Rights Settlement Act, Pub. L. No. 101-628, 104 Stat. 4469 (1990); Salt River Pima-Maricopa Indian Community Water Rights Settlement Act, Pub. L. No. 100-512, 102 Stat. 2549 (1988); Southern Arizona Water Rights Settlement Act, Pub. L. No. 97-293, tit. III, 96 Stat. 1261 (1982) (involving water rights settlements with the Tohono O'odham Nation).

C. General Stream Adjudications

A general stream adjudication is a state court proceeding to resolve disputes over water priorities and competing uses across an entire river basin. General steam adjudications are authorized by state law, and overseen by the superior court in the county where the largest number of potential claimants resides.[80] Arizona currently has two ongoing general stream adjudications.

The Gila River Adjudication began in 1974 to resolve disputes on the Gila River, the largest in-state river in Arizona.[81] The Gila River Adjudication is now over 40 years old, and includes more than 25,000 parties and more than 90,000 claims. The Gila River basin encompasses over 60,000 square miles and includes the vast majority of Arizona's population, including the Phoenix Metropolitan Area and Tucson. Water rights to the Verde River, Salt River, Santa Cruz River, and San Pedro River are all included within the Gila River Adjudication. However, water rights to the Gila River as it passes through New Mexico are excluded, posing issues for some rural Arizona areas. The Little Colorado General Stream Adjudication began in 1978, and now has more than 5,000 parties and 15,000 claims.[82] The need to resolve these adjudications is discussed further in Section III of this Report.

D. Mexico's Water Rights

The 1944 Rivers Treaty governs how the United States and Mexico share transboundary rivers like the Colorado River and Rio Grande/Rio Bravo.[83] Diplomatic relations under the Treaty are conducted under the auspices of the International Boundary and Water Commission (IBWC). The IBWC is a binational organization with U.S. and Mexican sections, each led by an appointed commissioner. Its decisions implementing the Treaty are referred to as "Minutes," and have the status of executive agreements under U.S. law. Under the Treaty, the U.S. is obligated to deliver 1.5 million acre-feet of Colorado River water to Mexico. Minute 242 to the Treaty requires that water delivered to Mexico may not exceed a specified standard for salinity based on the annual average salinity of Colorado River water at Imperial Dam.[84]

E. Central Arizona Groundwater Replenishment District (CAGRD)

When ADWR proposed rules to limit the use of groundwater to demonstrate an assured water supply, some land developers objected that they would not be able to subdivide and sell property that did not have access to CAP water and water from in-state streams. As a political compromise to allow the new rules to be implemented, in 1993 the Arizona legislature created an exception to the use of groundwater to show an assured water supply.[85] The exception allows groundwater use by a new subdivision if ADWR determines that a 100-year supply of groundwater is physically available for the subdivision and the subdivision is enrolled in the Central Arizona Groundwater Replenishment District (CAGRD). CAGRD is a responsibility of the Central Arizona Water Conservation District, which operates the CAP. CAWCD must purchase water supplies to replenish groundwater pumped by CAGRD members.[86]

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[80] Ariz. Rev. Stat. § 45-252.

[81] *See generally In re* Rights to the Use of the Gila River, 830 P.2d 442 (Ariz. 1992).

[82] *See generally In re* Adjudication of All Rights to Use Water in the Little Colo. River Sys. & Source, No. CV-6417 (Ariz. Super. Ct.).

[83] Treaty Between the United States of America and Mexico Respecting the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, U.S.-Mex., Feb. 3, 1944, 59 Stat. 1219.

[84] Resolution on the Permanent and Definitive Solution to the International Problem of the Salinity of the Colorado River, Minute No. 242, U.S.-Mex., Aug. 30, 1973, 24 U.S.T. 1971.

[85] Ariz. Rev. Stat. §§ 45-576.01.

[86] Ariz. Rev. Stat. §§ 48-3771–3783.

As of December 31, 2013, CAWCD has the obligation to replenish the groundwater pumped for more than 1,090 subdivisions, representing about 263,700 houses. This obligation will continue to grow as long as ADWR determines there is more groundwater physically available to serve new subdivisions. CAWCD lacks authority to deny the enrollment of new subdivisions in CAGRD. Drought and shortages of Colorado River water will increase competition for water supplies that may be purchased for replenishment. Under the current CAGRD fee structure, subdivision developers are not required to pay the full cost of the water needed for replenishment. Buyers of homes on lots enrolled in CAGRD will pay for a growing amount of that cost through assessments on their property tax bills.

F. Arizona Water Banking Authority (AWBA)

Established by the Arizona legislature in 1996,[87] the powers of the Arizona Water Banking Authority (AWBA) are executed by a five-member Arizona Water Banking Authority Commission. The Commission consists of the Director of ADWR, a representative of the CAWCD, and three governor-appointed members. The ADWR Director selects a manager for AWBA and hires staff to provide technical, administrative and legal support.

AWBA is responsible for storing excess CAP[88] water underground for use in times of shortages of Colorado River water. The water is stored for certain municipal and industrial users of Colorado River water outside of the CAWCD service area and for M&I subcontractors of CAP water. AWBA may also enter into interstate water banking agreements with agencies in California and Nevada. In addition, it is responsible for storing water underground to meet certain state commitments to firm Indian settlement water. According to ADWR, AWBA has stored 3.4 MAF of water underground for uses in Arizona and another 600,000 AF for Nevada.

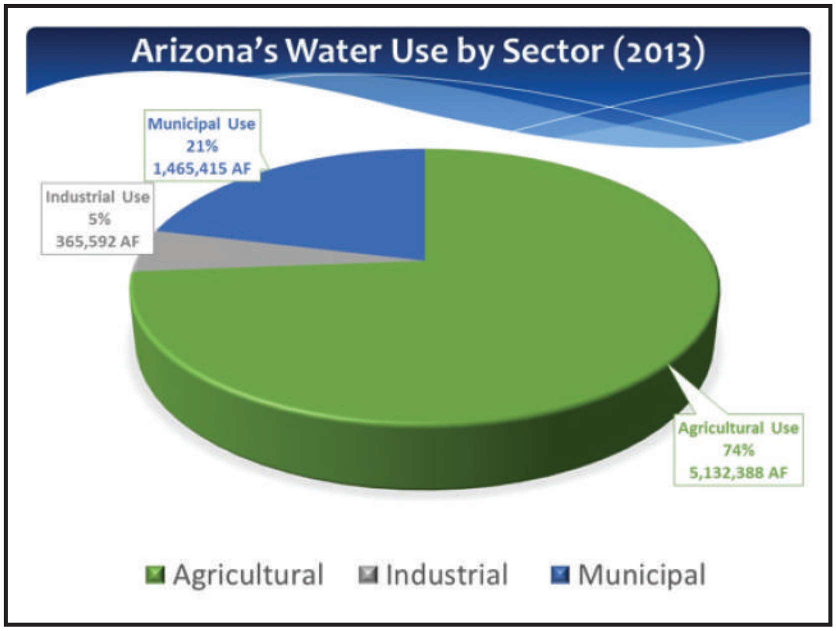
[87] §§ 45-2401–2491.
[88] "Excess CAP water" is CAP water that is not scheduled for delivery in any year by those holding long-term contracts and subcontracts to CAP water.

SECTION III. COMPETING DEMANDS/POLITICAL REALITIES

A. Water-Economy Linkages

Water Use by Sector

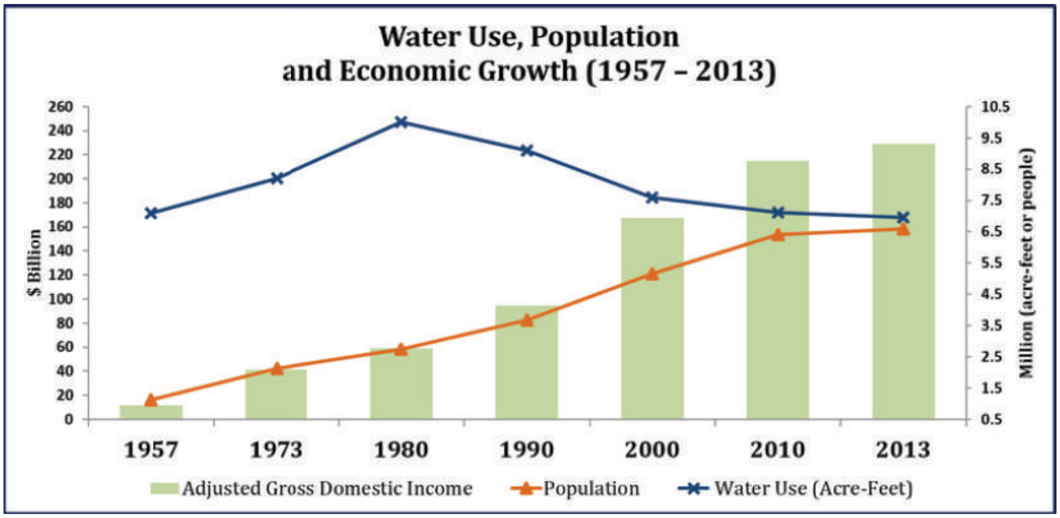
Arizona uses approximately 7.0 MAF of water annually according to ADWR. ADWR measures demand for three sectors: industrial, agricultural, and municipal. As of 2013, municipal demand represented about 21 percent of total water demand, while agricultural demand and industrial demand were about 74 percent and 5 percent respectively.



Arizona Water Use by Sector. Source: Arizona Department of Water Resources (2013).

The municipal sector includes residences, businesses and public uses such as schools and parks. Industrial uses do not receive water from a municipal provider and include mining, electrical generation, many manufacturing facilities, dairies and some golf courses. The largest percentage of water for agricultural demand goes to irrigating crops.

Water demand in Arizona is essentially the same as it was in 1957 when the population was roughly one-fifth of what it is today. Meanwhile, gross domestic income (a measure of the size of an economy) has increased from around $10 billion to close to $200 billion and Arizona's population has grown to nearly 6.6 million people. Much of the stability in water demand can be attributed to shifts away from agriculture toward the municipal sector. Water use in agriculture is expected to shrink as the municipal sector grows. Greater water use efficiency in all sectors has also contributed to stable water demand. As discussed in Section I of this Report, however, water demand is expected to increase substantially over the next 25 to 100 years and Arizonans will need to find new ways to meet increasing demands.



Arizona Water Use, Population and Economic Growth. Source: Arizona Department of Water Resources (2013).

<u>Growing Municipal Demand</u>

Providing water for people will become the most urgent need for Arizona by the middle of the 21st Century. Estimated at 1.6 MAF in 2006, municipal demand is expected to increase to roughly 2.7 MAF by 2035 and 3.4 MAF by 2060. These projections, however, were made before the economic downturn when population growth was substantially greater than it has been in the past few years. These projections also assume that per capita demand will remain essentially flat, when for most municipalities per capita demand has been declining in recent years.

Municipal demand is much broader than household uses. Business and commercial enterprises also drive demand. Many companies, from small businesses to corporations, rely on substantial amounts of water. The economic impact of a safe, reliable water supply is difficult to calculate, but studies have demonstrated that significant economic benefits are linked to reliable water supplies.[89]

Importantly, investors are acutely aware that water security is essential to managing financial risks. Perceived threats to water security make up an important part of decisions to locate enterprises or invest in development within Arizona. The notion that water scarcity is increasing in Arizona could negatively affect the willingness of financial interests to invest in the state. An important part of Arizona's success in attracting investment has been a reputation for responsible water management. The ability to demonstrate water sustainability through increased utilization of renewable water supplies may influence future investment decisions.

[89] *See, e.g.*, Tim James et al., L. William Seidman Research Inst., W. P. Carey Sch. of Bus., Ariz. State Univ., The Economic Importance of the Colorado River to the Basin Region (2014), *available at* http://protectflows.com/wp-content/uploads/2015/01/PTF-Final-121814.pdf.

Linking Land and Water Uses

The Groundwater Management Act's assured water supply requirement linked land use planning to water supplies. Cities and towns that are designated as having an assured water supply have learned to think about water in advance of growth. But more remains to be done.

One example of innovative thinking is a new ordinance passed by the City of Chandler.

"Chandler's new ordinance helps the city make decisions about land use and water use simultaneously. The ordinance allots water to new businesses based on the square-footage and the type of their building or buildings. If a business needs more water than the base allocation, the business must demonstrate it benefits the city commensurate to the extra water it requires to operate. Those benefits could include such things as creating jobs, developing the downtown corridor, revitalizing neighborhoods, or providing a new amenity, such as a park. New businesses (or expanding businesses that require new water meters) that cannot demonstrate benefits that balance an outsized demand for water will pay more for water." [90]

Industrial and Manufacturing Demands

Industrial and manufacturing uses of water in Arizona are many and varied. While such uses currently account for about five percent of total water use, ADWR does not collect data on the amount of water used by various types of businesses within this sector.

The Role of Agriculture

As discussed above, the shift of water from agriculture to municipal and industrial uses has historically resulted in a stable water demand in Arizona. It is unclear, however, how much of this shift will continue and the extent to which it is desirable. Many have begun to question the notion of large-scale transfers from the agricultural sector to the municipal and industrial sectors. As noted by Anne Castle, former Assistant Secretary for Water and Science, U.S. Department of the Interior:

> "Although about 80 percent of Colorado River water goes to agriculture, we would be unwise to assume that we can address shortages solely by removing irrigation water from farms. Retiring too much farmland will harm our economy in the Southwest, our food security and our quality of life. Further improving efficiency, judicious switching to less-thirsty crops, and using science to grow more with less water will be essential, but we must be careful not to destabilize rural economies that are the foundation of the basin."[91]

[90] Kathleen Ferris, *Smart Growth: Chandler Links Development Benefits to Water Use*, AMWUA Blog (June 8, 2015), https://amwua.wordpress.com/2015/06/08/smart-growth-chandler-links-development-benefits-to-water-use/.

[91] Anne Castle, *Busting Myths about Water Shortage*, San Diego Union-Trib. (Sept. 26, 2013, 4:00 PM), http://www.sandiegouniontribune.com/news/2013/sep/26/busting-myths-about-water-shortage/.

Rural areas increasingly fear that their local economies will be harmed if large amounts of water are moved away to urban centers. A recent case study conducted in part by Dr. George Frisvold of the University of Arizona College of Agriculture and Life Sciences for the Yuma County Agriculture Water Coalition reports:

> "Valued at 2014 dollars, agriculture and related industries contributed $2.8 billion in output to the Yuma economy. This included $2.26 billion in direct sales effects from agricultural and related industries and an additional $540 million in sales by other Yuma industries."[92]

It has also been pointed out that leaving water in agricultural use is important to provide a cushion for municipal demand. In times of shortages, temporarily fallowing agricultural land is a tool to provide water to meet municipal and industrial needs that will not be available if agricultural land is permanently retired.

The Role of Groundwater Transportation

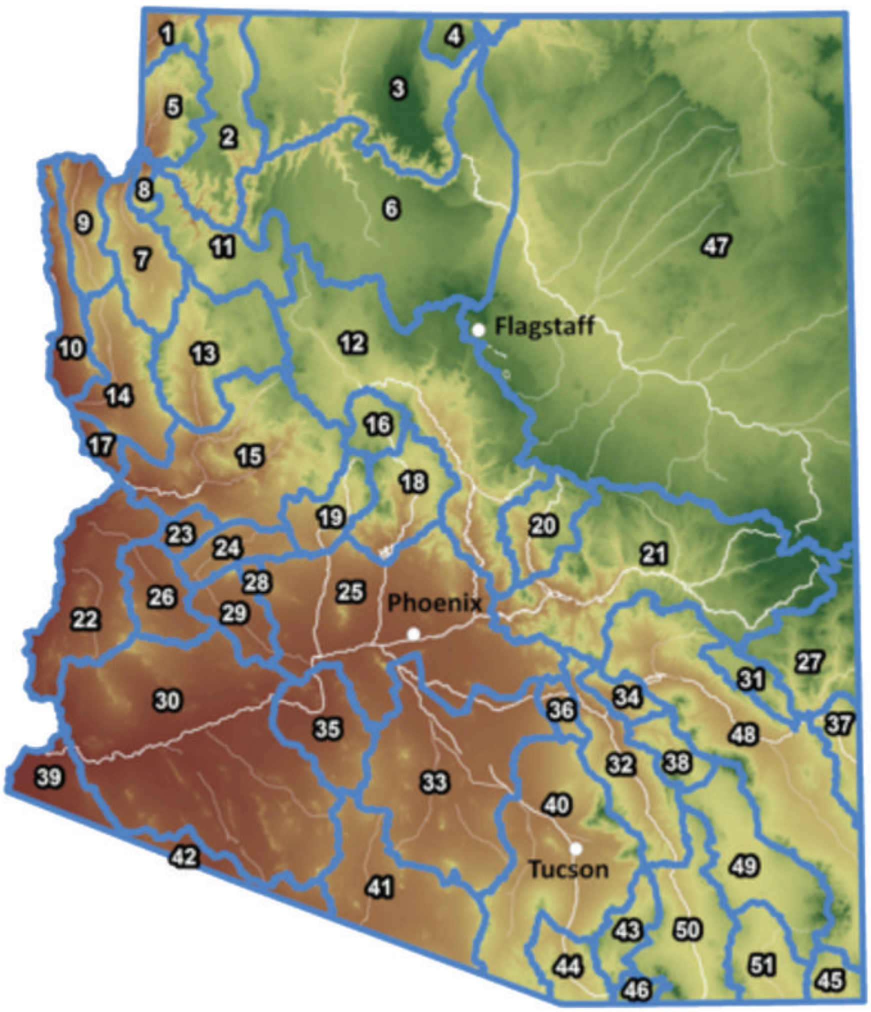
The transportation of groundwater from the location where it is pumped to the location of use has been a controversial issue in Arizona for many decades. In fact, a 1976 opinion of the Arizona Supreme Court prohibiting transportation by several copper mines and the City of Tucson was the tipping point for the development of the Groundwater Management Act.[93]

As originally passed, the Act allowed groundwater to be pumped in one groundwater basin outside of an AMA and transported to another basin or to an AMA, subject to payment of damages. In the 1980s, the cities of Phoenix and Mesa purchased agricultural land outside of the Phoenix AMA with the intent of transporting groundwater from those lands for municipal purposes. The purchase of these "water farms" created intense concern in rural areas that groundwater supplies for rural uses were endangered. As a result, the legislature amended the Act to severely limit the transportation of groundwater to an AMA, allowing this practice only from a few groundwater basins and only for specific purposes.[94] The legislature also prohibited the transportation of groundwater from one basin to another outside of an AMA.[95]

[92] Yuma Cnty. Agric. Water Coal., A Case Study in Efficiency—Agriculture and Water Use in the Yuma, Arizona Area 55 (2015).
[93] Farmers Inv. Co. v. Bettwy, 558 P.2d 14 (Ariz. 1976).
[94] Ariz. Rev. Stat. §§ 45-551–559.
[95] § 45-544.

Groundwater Basins in Arizona

1-Virgin River Basin
2-Shivwits Plateau Basin
3-Kanab Plateau Basin
4-Paria Basin
5-Grand Wash Basin
6-Coconino Plateau
7-Hualapai Basin
8-Meadview Basin
9-Detrital Valley Basin
10-Lake Mohave Basin
11-Peach Springs Basin
12-Verde River Basin
13-Big Sandy Basin
14-Sacramento Valley Basin
15-Bill Williams Basin
16-Prescott AMA
17-Lake Havasu Basin
18-Agua Fria Basin
19-Upper Hassayampa Basin
20-Tonto Creek Basin
21-Salt River Basin
22-Parker Basin
23-Butler Basin
24-Mcmullen Valley Basin
25-Phoenix AMA
26-Ranegras Plain Basin
27-Morenci Basin
28-Tiger Wash Basin
29-Harquahala Basin
30-Lower Gila Basin
31-Bonita Creek Basin
32-Lower San Pedro Basin
33-Pinal AMA
34-Dripping Springs Wash Basin
35-Gila Bend Basin
36-Donnelly Wash Basin
37-Duncan Valley Basin
38-Aravaipa Canyon Basin
39-Yuma Basin
40-Tucson AMA
41-San Simon Wash Basin
42-Western Mexican Drainage Basin
43-Cienega Creek Basin
44-Santa Cruz AMA
45-San Bernadino Valley Basin
46-San Rafael Basin
47-Little Colorado River Plateau
48-Safford Basin
49-Willcox Basin
50-Upper San Pedro Basin
51-Douglas Basin



Arizona Groundwater Basins. Source: Salt River Project.

B. Access to/Utilization of Renewable Supplies

Surface Water and Groundwater Supplies

Renewable water supplies are the foundation of water sustainability. As used in this Report, sustainability means that this natural resource—water—is available in sufficient quantities and quality to meet the needs of humans and ecosystems for the present and the future. As discussed in Section I of this Report, surface water supplies make up the largest percentage of the state's renewable supplies. However, long-term drought is threatening the availability of surface water supplies and many parts of the state do not have access to these supplies. Transfers of surface water supplies to meet new uses are legally and politically complicated. The great percentage of groundwater in Arizona is non-renewable and continued depletion of this supply means that it will not be available over the long term.

Recycled/Reclaimed Water as a Renewable Supply

Reclaimed water is playing an expanding role in meeting water demands. Reclaimed water is produced consistently throughout the year, although greater interest by homeowners in reusing grey water (water from washing machines, showers and bathtubs) for landscaping purposes may reduce the amount of reclaimed water that is available because less wastewater would flow to sewer systems.

Often, major users of reclaimed water, riparian ecosystems and irrigators downstream of wastewater treatment plant discharges, are uncounted in official calculations of water reuse. Thus, although the Arizona Department of Environmental Quality (ADEQ) reported in 2011 that 65 percent of all wastewater treatment plants in the state already distribute water for reuse at least some of the year, ADWR counts reclaimed water as only a small percentage of developed water supplies in the state. This may be because municipal and industrial uses of the source water (surface water and groundwater) account for only 25 percent of the state's overall water demand. However, a study done for the Central Arizona Project by the consulting firm HDR shows that 95 percent of the reclaimed water generated in the Phoenix, Pinal and Tucson AMAs is used for beneficial purposes.[96] These purposes include agriculture, underground storage for later reuse, power generation, industrial uses, turf irrigation and riparian habitats.

The Water Resources Development Commission Final Report conservatively estimated that 740,572 acre-feet of treated wastewater would be generated in 2035, and the quantity will continue to grow with population to just under 1.3 MAF in 2110. ADWR's Strategic Vision reported that greater use of this water source could reduce Arizona's projected water imbalance by 50 percent through 2110. This would require significant investment to plan and develop treatment and distribution infrastructure. Additionally, as wastewater treatment plants are upgraded to produce better quality reclaimed water for municipal, industrial and agricultural purposes, less flow is being discharged to riparian areas. Wastewater treatment plant discharges are the lifeblood of many riparian areas and alternative uses of this resource further threatens their survival. It should also be pointed out that since a large percentage of our treated wastewater is already being beneficially used, we may see a transition to higher-valued uses, but not necessarily a significant increase in our overall water supply.

[96] U.S. Dept of the Interior, Bureau of Reclaimation, Colorado River Basin Stakeholders Moving Forward to Address Challenges Identified in the Colorado River Basin Water Supply and Demand Study: Phase 1 Report 3-20 (2015).

As discussed in Section II, ADEQ rules prohibit direct use of reclaimed water for human consumption. ADWRs Strategic Vision notes that as demands increase and water supplies become more stretched, it will be necessary to explore and invest in direct potable reuse for drinking water supplies.[97] While many communities are interested in the future possibility of direct potable reuse, it is likely that smaller rural communities with limited water supply resilience may first face the need for implementing direct potable reuse. For this to happen, ADEQ would have to rescind the potable reuse prohibition and replace it with water quality and treatment technology criteria to ensure the public health remains protected. Rescinding the rule prohibition would also require an exemption to the moratorium on all new state agency rules currently in place.

A significant issue for the direct potable reuse of reclaimed water is the presence of contaminants of emerging concern (CECs) in trace amounts in treated wastewater discharged from sewage treatment plants. CECs are unregulated constituents, often originating from pharmaceutical and personal care products, that wind up in the sewer and are not completely removed by conventional wastewater treatment processes. CECs will have to be addressed in the development of criteria for direct potable reuse. The Advisory Panel on Emerging Contaminants (APEC), convened by ADEQ, is finalizing a report that will be helpful in understanding this issue. Additionally, an ad hoc group of stakeholder experts, the Steering Committee on Arizona Potable Reuse (SCAPR), is examining the problem.

<u>Examples of Water Recycling</u>

There are numerous examples of water recycling already occurring in Arizona. At the utility level, the Palo Palo Verde Nuclear Generating Station is one of the primary examples of in-state, water-efficient projects because it uses treated wastewater for 100% of its cooling needs. In fact, it is the only nuclear power plant in the world to use treated wastewater for its cooling water supply. The facility annually uses about 70,000 acre-feet of treated wastewater purchased from several Phoenix-area cities. The reclaimed water is recycled through the cooling towers 22 to 25 times before being sent to evaporation ponds.

Intel in Chandler recycles up to 60 percent of its water with a program that recovers, treats, and returns a portion of its rinse waters to the aquifer, and uses reclaimed water for mechanical systems (i.e., scrubbers, cooling towers), landscape watering, and farm irrigation.

In 2012, PepsiCo Frito-Lay was awarded a U.S. Water Prize for its Casa Grande snack food manufacturing facility. An innovative process water reuse system allows the facility to run almost entirely on recycled water and produces nearly zero waste. The 650,000-gallon-per-day process water recovery treatment system recycles up to 75 percent of the facility's process water. The facility has reduced its annual water use by 100 million gallons.

Municipalities in Arizona are also reclaiming wastewater for a variety of purposes such as irrigation of turf in parks and cemeteries, and for restoring riparian habitats. Many cities, towns and private water companies also store reclaimed water underground for use in times of shortages of surface water supplies.

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[97] Ariz. Dep't of Water Res., *supra* note 2, at 18.

Tres Rios Project. Source: City of Phoenix Water Services Department.

The Tres Rios Wetlands
– City of Phoenix, Water Services Department

The Tres Rios Wetlands project restores eight miles of unique riparian (streamside) habitat near the confluence of the Salt, Gila and Agua Fria Rivers in west Phoenix. The water for the project comes from the adjacent 91st Avenue Wastewater Treatment Plant, which is jointly owned and operated by Phoenix, Tempe, Mesa, Scottsdale and Glendale. Once the water is treated to meet clean water regulations, the water is put into the wetlands, which further clean the highly treated reclaimed water.

The constructed wetlands provide an exceptionally efficient cycle in the process of cleaning wastewater. In wetlands, natural, physical, chemical and biological mechanisms work together to remove and transform pollutants into harmless by-products. Nutrients and toxic compounds are physically removed or transformed by bacteria residing on the bottom of the ponds and on plant surfaces. Aquatic plants produce oxygen, which helps kill bacteria and pathogens.

The project provides habitat for threatened and endangered fish and wildlife species, reduces the potential for flood damage, and provides public recreation opportunities. Construction of Tres Rios eliminated the need to spend $300 million on traditional concrete and steel treatment facilities. An average of 75 million gallons a day of reclaimed water is currently being treated by the wetlands.

Water Conservation to Stretch Renewable Supplies

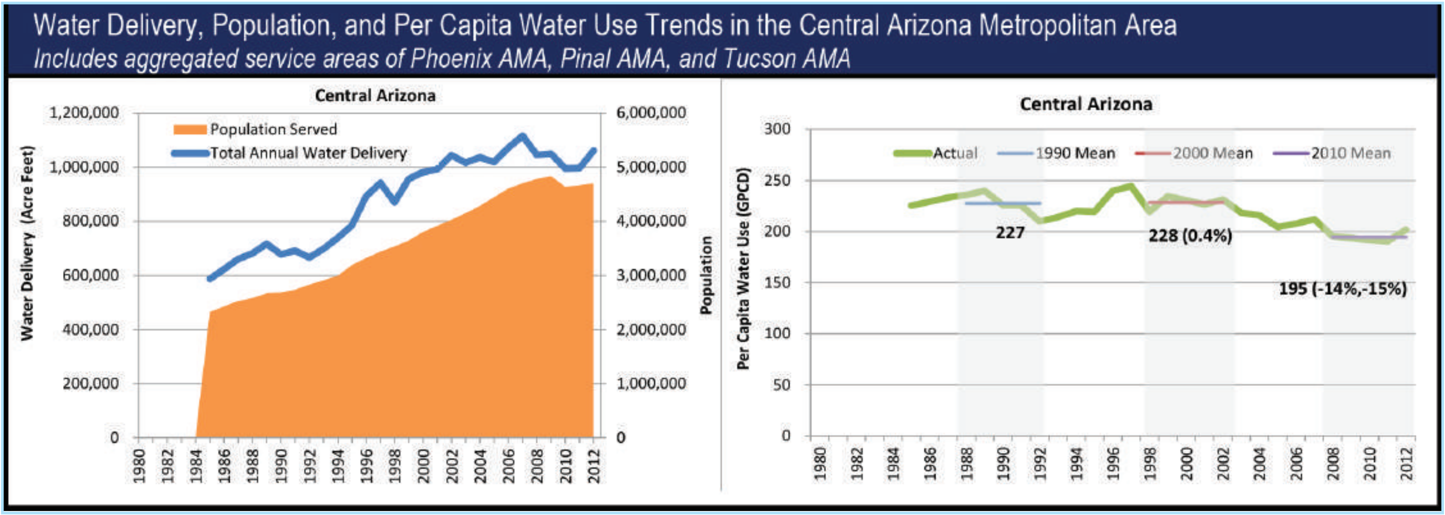
The passage of the 1980 Groundwater Management Act and its requirement that the Department of Water Resources adopt mandatory conservation requirements for all water users in the AMAs made Arizona an early leader in water conservation in the United States. Other parts of the state have also achieved significant water savings through conservation.

These efforts have stretched water supplies and delayed the need to acquire additional, more expensive supplies.

Following the release of the 2012 Colorado River Basin Water Supply and Demand Study, Reclamation and the seven Colorado River Basin states initiated a Moving Forward process to look more closely at potential actions to prevent significant shortfalls of Colorado River water to meet future demands. In May 2015, Reclamation released a comprehensive Phase 1 Report documenting the Moving Forward efforts. As Chapter 3 of the Report notes, average per capita water use rates in central Arizona have decreased by approximately 14 percent since 1990 and by 15 percent since 2000. Several large municipal providers in central Arizona have seen even greater declines in per capita use rates. For example, between 1991 and 2013, the City of Phoenix's per capita use rate decreased by 29 percent.

Conservation will always be important in Arizona, but it will not solve the imbalances between water demand and supplies that are projected for the next 25 to 100 years.

Arizona agricultural water users have also worked to increase efficiency and reduce water use.



Water Delivery, Population, and Per Capita Water Use Trends in the Central Arizona Metropolitan Area. Source: U.S. Bureau of Reclamation (2015).

Lettuce Field in Yuma, Arizona. Source: Jeff Vanuga, USDA Natural Resources Conservation Service (2011).

Handline Sprinkler Irrigation on Crops in Yuma, Arizona. Source: Jeff Vanuga, USDA Natural Resources Conservation Service (2011).

Agricultural Conservation: Yuma Case Study – Yuma County Agriculture Water Coalition.

Agriculture has been a very important part of Yuma's economy for over a hundred years. The Yuma area is unique because a combination of factors, including geographic location, fertile soils, agricultural efficiency, technological innovation, high priority use water, an available workforce and environmental stewardship have transformed the area into one of the most productive agricultural centers in the United States.

Agriculture has flourished due to the long frost-free growing season, fertile soils and the availability of quality and dependable irrigation water. Yuma has evolved into a highly productive and water efficient agricultural center. Production has shifted from long, full season summer and perennial crops to winter, multi-crop high value vegetable crops. Use of irrigation water during the hot summer months has declined greatly over the past 30 years reflecting the decline in perennial and full season crop production. Also, irrigation water diverted to farms has decreased 15 percent since 1990.

Improvements in on-farm irrigation infrastructure, including construction of concrete-lined irrigation ditches and high flow turnouts, shortened irrigation runs and use of sprinkler systems for crop establishment have improved irrigation efficiencies resulting in reduced water use. In addition, farm fields are laser-leveled each year to improve water flow across fields. Most Yuma growers use highly efficient level furrow or level basin surface irrigation systems with average application efficiencies in the 80-85 percent range. Yuma has been quick to adopt new production and irrigation technologies that have dramatically reduced overall water use and plans to continue to be at the forefront of implementing new technologies aimed at water efficiency.

Laser Leveling Field in Yuma, Arizona. Source: Jeff Vanuga, USDA Natural Resources Conservation Service (2011).

C. Diversity of Problems in Different Locations

One Size Does Not Fit All

Arizona is characterized by widely diverse geographic zones, ranging from forested mountains to arid deserts. These areas have dissimilar climates and precipitation regimes, resulting in great variability in, and accessibility to, surface water supplies. Arizona is geologically complex, which affects the availability and quality of groundwater supplies. Land ownership patterns also create complexity. Private owners hold less than 18 percent of the land within the State, while the federal government owns about 41 percent and Indian trust land (which is held in trust for the Tribes by the U.S. government) makes up about 28 percent.

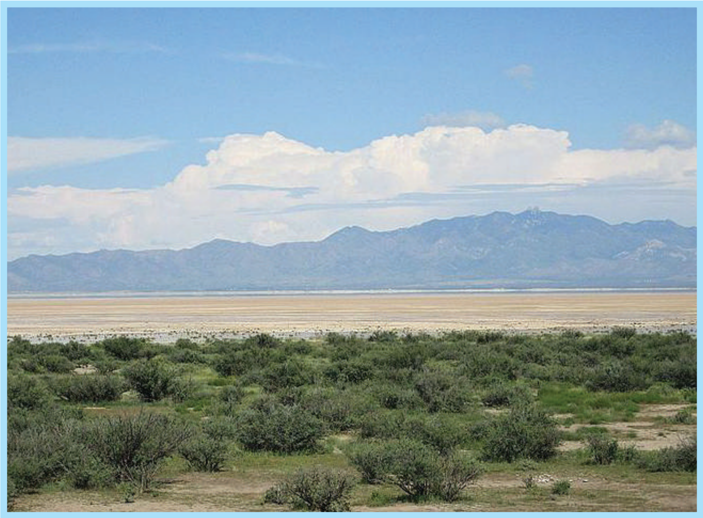
State Trust Land, administered by the Arizona State Land Department, makes up the remaining 13 percent. Ownership is often fragmented, with federal, Indian trust land, state, and private land holdings forming a checkerboard pattern that complicates the development and execution of comprehensive and cohesive land and water management strategies.

Planners recognize the uniqueness of the various regions throughout the State and the varying challenges facing those regions. No single strategy can address projected water supply imbalances across the State. Instead, regional diversity dictates a portfolio of strategies dependent on the needs of each area of the State. A thorough regional overview and evaluation of the water supply needs from which to develop this portfolio is lacking.

The Water Resources Development Commission (WRDC) studied this issue in great detail and concluded:

"[D]ue to the variability in Arizona's geology, climate, precipitation patterns, water use patterns, population growth and land ownership, evaluation of the issues and development of comprehensive solutions is extremely difficult. Arizona must develop a broad portfolio of solutions to meet the myriad of challenges that are inherent in this diverse state.

Finally, decisions must be made regarding what solutions will be most effective in discrete regions, how those solutions will be funded, and whether implementation of the solutions require legislative changes."[98]



Willcox Playa from Cochise, AZ. Source: Wikimedia Commons/The Old Pueblo

Costs of Moving Water to People

In some areas, the need for supply augmentation has generated plans for new infrastructure to bring water to areas where it is needed. Frequently controversial, these plans are expensive and implementation could overwhelm current local financial capabilities. Rural areas often lack the population and tax base to afford larger infrastructure projects. The WRDC recommended that the legislature pass laws to allow for the establishment of regional water augmentation authorities to enable diverse water providers to combine their resources to acquire water supplies and build infrastructure to make those supplies available.[99] Legislation was introduced in 2013, but defeated.

In 2008, the Arizona Investment Council estimated that the total infrastructure bill, including capital outlays, operations and maintenance, and debt service costs, to meet the water and wastewater needs of current and future Arizonans over 25 years would be just over $109 billion. This estimate included supply augmentations plans for Coconino, Cochise, Yavapai, and Gila Counties—plans still at early stages.

[98] Water Res. Dev. Comm'n, Final Report Volume I, at iv–v (2011).
[99] Water Res. Dev. Comm'n, Final Report 1–4 (2012).

Arizona Investment Council (AIC) 2008 Estimated Total Water and Wastewater Costs, 2008-2032	Water	Per Capita Costs
	(Nominal Millions)	
Drinking Water Infrastructure	$29,121	$4,752
Coconino County Supply Augmentation	$652	$1,547
Cochise County Supply Augmentation	$217	$817
Yavapai County Supply Augmentation	$197	$543
Gila County Supply Augmentation	$31	
Dam Renovation and Replacement	$336	
SRP Well Rehabitation and Replacement	$161	
Total Capital Costs	$30,716	
Total Ongoing Costs	$42,088	
Total: (All Costs)	$72,804	

Projected infrastructure needs vary across the state. The four counties were singled out for their near-term supply augmentation needs. Financing for such augmentation projects is problematic. These counties' population and economic bases will not support the development of augmentation projects without significant costs to tax and rate payers. In other counties, projected infrastructure costs are not as high, but the average across the state, excluding these four counties, is still significant, about $465 per person per year.

Of critical importance is the pressing need for construction of regional and community water systems on Indian reservations in Arizona. The Navajo Nation's Water Resource Development Strategy estimated that "approximately 30% of the households on the reservation are without direct access to public water systems and haul water long distances to provide water for their families."[100] Families spend the equivalent of $43,000 per acre-foot for water, making the water "among the most expensive in the United States for a sector of the population that is among the poorest."[101]

A list of regional water system improvement projects is included in the Navajo Nation's Water Resources Development Strategy. The projects for just the Arizona portion of the reservation were estimated to cost $836 million.[102] The federal government has a special trust responsibility to bear a substantial portion of the cost of building community water systems on Indian reservations.

[100] Navajo Nation Dep't of Water Res., Draft Water Resource Development Strategy for the Navajo Nation ix (2011).
[101] *Id.*
[102] *Id* at xii.

Public-Private Partnerships

Public-private partnerships are intended to distribute the risks and benefits of infrastructure projects between the partners. While such partnerships are not common in Arizona, many forms of these arrangements can be found nationally and worldwide. Contractual agreements frequently address the financing, construction and operation of projects. Public entities may be motivated by limitations on the public funds available for infrastructure to look for private sector partners, while the opportunity for mutual gains associated with such projects may be attractive to private entities.

Arizona's first public-private reclaimed water recharge facility will be built through a partnership between the Central Arizona Groundwater Replenishment District (CAGRD) and Liberty Utilities. Liberty Utilities provides water service to communities around Arizona, such as Litchfield Park, Hereford and Sierra Vista. The CAGRD is responsible for replenishing excess groundwater withdrawn by its members in the Phoenix, Pinal County and Tucson areas. Liberty's $2 million investment will ultimately be repaid by rate payers, while the $6 million provided by CAGRD will eventually be repaid by its members. The new recharge facility will be located in the City of Goodyear where Liberty Utilities has 12 wells pumping from the same aquifer that that this project will recharge. At the recharge facility, the water will be delivered to large, shallow basins where it will percolate into the ground and help restore water levels that have declined due to past pumping. At the same time, recharged water will count against CAGRD's replenishment obligations. The water supply will come from Liberty Utilities' Palm Valley Water Reclamation Plant, which produces approximately 3.5 million gallons per day of A+ reclaimed water—the highest quality of reclaimed water on the scale defined by the Arizona Department of Environmental Quality. The recharge facility will receive the water that is surplus after delivery of the reclaimed water now sold for park and golf course irrigation.

Public-Private Partnerships for Water Supply & Financing
– Joe Gysel, President of EPCOR Water (USA), Inc.

Public Private Partnerships (P3s) can realize significant benefits to the public by applying private sector capital and expertise to deliver efficient, reliable and essential services. As communities face growing demands associated with expanding and replacing infrastructure and environmental regulatory compliance, P3s are an increasingly important solution.

Incentivized to deliver on time and within budget, P3s infuse public projects with private investment capital, operational expertise and innovations. Moreover, P3s enable public sector partners to transfer project risks to private sector entities, fostering long-term value, budget certainty, operational performance and cost-effective services that protect and benefit the public.

Both sides of a potential P3 partnership must carefully evaluate project risks. Public sector entities must consider the value of the partnership, the quality of the services and any political or social considerations. Private sector entities will be cautious about major risks beyond their control and will build such risks into their costs. Private entities must also consider the value of the investment against financing risks, the regulatory landscape and the level of operational control.

However, in a thoughtfully structured P3 relationship, the benefits to the public extend far deeper than the partnership, creating economic engines in associated businesses and industries that ultimately contribute to an increasingly diversified and competitive economy.

D. Water Pricing/Cost

Although taxes are one vehicle for repayment of infrastructure financing, the return on investments in water infrastructure largely comes from the water rate payer. When residential water consumers pay for water, they are paying an amount estimated to keep the water utility in business. Although some water utilities have other sources of revenue, most, whether publicly or privately owned, cover their costs with the revenue generated through their customers. Therefore, anything involved in the costs of operation, such as construction, maintenance, administration, and financing, is reflected in consumers' water bills.

Infrastructure costs include the cost of acquiring, financing, replacing and improving the infrastructure that delivers water to consumers. Counted among these costs are repair and replacement of pipes, pumps and other things that wear out over time. Also included are financial costs associated with raising the money needed to pay for infrastructure, that is, the interest on bonds or loans. Maintenance and operations costs cover everyday operation, including administration, supplies, training, water quality testing and other expenses. Energy is also a substantial operating cost for pumping water. Some utilities purchase water from water suppliers such as the Central Arizona Project (CAP) and the Salt River Project (SRP), which deliver untreated water to cities, towns, agricultural users and Indian communities. Untreated, wholesale water is treated by the utilities to drinking water standards before being distributed in potable water systems. When these utilities set prices, they must include their costs for acquiring wholesale water, and the cost of water treatment. Water treatment ensures that utility customers receive water that meets drinking water standards. Treatment costs can be a substantial component of price depending on the quality of the water source. Like any business, utilities must often invest in other activities, such as regulatory compliance, lawsuits, research and data analysis for improving operations and planning for future needs. The cost of doing business must also figure in water prices. In addition, current sources of water may prove insufficient for future needs, and new sources will be sought. Acquiring these new supplies may be costly and become even more so as competition for resources grows. Investing in watershed management will also increase costs. Price to customers will reflect all these cost factors.

<u>Revenue Generation of Public and Private Water Providers</u>

Cities, towns, Indian communities, water districts, and private water companies provide local water deliveries. Approximately 85 percent of residential water customers in Arizona are served by publicly owned utilities, which are typically, although not always, run by local governments and tribal water utilities. Publicly owned utilities are not operated for profit and generally charge for the cost of service. Revenues may be used to support other services, but where this is not the case, the cost-of-service rates are designed to generate revenue that matches costs. This is rarely exact, for unexpected costs can arise, costs can be less than expected, or revenues can rise or fall relative to expectations. Reaching revenue sufficiency is essentially reaching a balanced budget, when a utility has managed to cover all of its revenue requirements, including the funding of reasonable reserves. When revenue deficiency occurs, a utility may have sufficient reserves to make up the difference. Otherwise, it may have to resort to other city funds. Such revenue shortfalls are taken into consideration when rates are next reviewed. At this point, political and economic conditions are likely to affect the potential for rate increases, as city councils weigh costs and benefits.

Privately owned water companies (usually investor-owned utilities) are overseen by the Arizona Corporation Commission (ACC). The ACC has five publicly elected commissioners who make the final decisions regarding rates, safety and effective operation of a variety of public services, including water. Before commencing operations, a private water company must obtain a Certificate of Convenience and Necessity (CC&N) from the ACC. Additionally, a privately owned utility attempting to set or change its rates must file a rate case with substantial supporting documentation and justification. The Utilities Division within the ACC conducts its own research into the utility's costs and what rates it should be permitted to charge, and then provides recommendations to the Commissioners, who decide the matter, often after hearing testimony from the company, ACC staff and other interested parties. Investor-owned water utilities propose rates to cover their investments and general operation costs, and provide a rate of return on their investment. However, they may not recover costs for which there is no direct benefit to the rate-payer.

According to the ACC, there are more than 400 individual water systems in Arizona operated by nearly 350 companies. Although there is a move toward consolidation, most private water companies operating in Arizona are small, rural companies that serve relatively isolated communities, but private water companies also serve water within cities and metropolitan areas, such as the Anthem, City of Casa Grande, City of Sierra Vista, Town of Paradise Valley, and the Sun City communities. A few large water companies, such as Arizona Water Company and EPCOR Water, operate water utilities in multiple locations. Each location will have an individual rate schedule based on local conditions.

E. Value of Aquatic and Riparian Assets

Environmental economics focuses on estimating the economic value of water outside of traditional markets. These economists categorize values as both use and non-use. Use values of water include not only agricultural production, individual household use, and industrial uses, but also recreational enjoyment of reservoirs, streams, lakes, springs, and ecosystems support by water such as those vegetated areas bordering water bodies. Some idea of the contributions of water in recreational use can be estimated from recreational surveys. Fishing generates an estimated $831.5 million on equipment and trip-related expenditures annually.[103] The impact of the nearly $1 billion in spending by anglers and hunters in Arizona during 2001 was shown to have created a statewide economic impact of $1.34 billion.[104] Watchable wildlife has a similar impact; people who watch wildlife in Arizona generate a total economic impact of $1.4 billion each year.[105] These dollars depend on water in streams, lakes, and wetlands.

The value of water beyond use is called non-use value. "Non-use" is an economic term and includes values that some might consider to be uses. Non-use values of water are numerous, including the values of habitat provision, ecosystem services, and wildfire prevention. While these non-use values of water are clearly more difficult to quantify than uses such as recreation, estimating non-use values allows decision makers to account for impacts on well being not measured through economic transactions.

Non-market valuation is an economic technique used to estimate non-use values. There are two methods of non-market valuation—stated preference and revealed preference. Both stated and revealed preference methods can be used to estimate values for water. Revealed preference methods involve using market data to estimate non-market values, such as increased property values associated with proximity to riparian

[103] Jonathan Silberman, The Economic Importance of Fishing and Hunting 14 (2003), *available at* http://www.gf.state.az.us/pdfs/w_c/FISHING_HUNTING%20Report.pdf.
[104] *Id.* at 4.
[105] Tucson Audubon Soc'y, Economic Contributions of Wildlife Viewing to the Arizona Economy: A County-Level Analysis 6 (2013), *available at* http://www.tucsonaudubon.org/images/stories/News/TAS-AZ-WildlifeWatching-Analysis-2011-130718.pdf.

Riparian Forest in Arizona. Source: U.S. Bureau of Reclamation, Alexander Stephens.

Vasey's Paradise. Source: Abraham E. Springer (2006).

environments. Stated preference methods involve surveying relevant stakeholders regarding the values they place on uses, such as support of species diversity, that are not typically categorized by economists as use. Preference surveys have established that people would be willing to pay more to maintain or restore water-related natural amenities than allow them to become environments that reflect drier conditions.

In a 2013 study, researchers found that small farm irrigators in the Verde Valley in Arizona were willing to pay approximately $184 annually in addition to their current water costs to invest in forested watershed restoration.[106] While forested watershed restoration does not guarantee increases in water quantity or quality, irrigators were willing to pay to invest in the potential non-use benefits of the restoration. In another study, researchers found that residents of Flagstaff, AZ were willing to pay an extra $5 per month on their water bill to support monitoring and maintenance of forest restoration of local watersheds.[107] Converting this willingness to pay into environmental water allocations is a challenge. Currently, there are no additional user fees anywhere in the state of Arizona that provide support for non-use values of water.

Environmental organizations such as The Nature Conservancy are using transaction-based mechanisms, such as conservation easements, to protect stream flows that support natural ecosystems. Sierra Vista and other communities are engaging in dialogues that place the needs of the environment on the water planning agenda. Programs such as Conserve to Enhance, which connects municipal water conservation with environmental restoration efforts, are demonstrating that people value water in the environment enough to support with direct monetary contributions wetland and riparian restoration, in-stream flow improvements, and green infrastructure.

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[106] Julie M. Mueller et al., *Estimating the Value of Watershed Services Following Forest Restoration*, 49 Water Resources Res. 1773, 1773 (2013).
[107] Julie M. Mueller, *Estimating Willingness to Pay for Watershed Restoration in Flagstaff, Arizona Using Dichotomous-Choice Contingent Valuation*, 87 Forestry 327, 327 (2014).

Riparian Forest in Arizona. Source: U.S. Bureau of Reclamation, Alexander Stephens.

Thunder River Springs. Source: Abraham E. Springer (2014).

The value of the environment at a national level is reflected in laws that protect environmental resources from degradation. Consideration of these laws is required for certain water resource projects. The National Environmental Policy Act of 1969 (NEPA) requires that the federal government assess potential environmental impacts before taking any major federal action. As a result of a NEPA study, projects with federal involvement may have to be modified to mitigate or compensate for potential adverse effects on the environment.

The City of Tucson and Pima County's Cooperative Water Planning
– Arlan M. Colton, Planning Director of Pima County Development Services Department.

In 2008, the City of Tucson and Pima County undertook a joint multiyear effort to identify sustainable and more cooperative water planning, working with a joint city/county citizen's advisory committee. The City of Tucson operates eastern Pima County's largest water utility, while Pima County operates the primary wastewater utility. Ultimately the Phase 2 report, which included four elements, 19 goals and 56 specific recommendations, was adopted by the elected officials of each jurisdiction. The four elements, which are clearly interconnected, addressed Water Supply, Demand Management, Comprehensive Integrated Water and Land Use Planning and Respect for the Environment.

The five year strategic action plan is currently in its fifth year, with progress reports released in each of the preceding four years.

Subsequently, in 2013 the City of Tucson adopted their general plan, "Plan Tucson" and the county in 2015 adopted its comprehensive plan, "Pima Prospers." The Water Resources Elements of both plans directly reflect the earlier study as part of its focus appropriate to the services each provides and the urban nature of the city and suburban and rural nature of the county.

In the 2012 Imagine Greater Tucson regional vision, Environmental Integrity and Prosperity were identified as two of nine shared regional values. Themes running through both Pima Prospers and Plan Tucson reflect the fundamental call to ensure sufficient water is available to support fragile ecosystems and habitats. Tourism is a key industry in Pima County and much of it is based on the Sonoran Desert and sky island landscapes. Further, the natural landscape plays an important role in attracting people and industry. Both documents recognize that there is synergy between water for these landscapes and water for economic development and jobs.

The Endangered Species Act of 1973 (ESA) is intended to protect species from extinction. The Act prohibits the taking of endangered or threatened species and changes to its critical habitat that are likely to harm the species. When a project involves species or habitat covered by ESA, mitigation measures may be prescribed that mitigate or compensate for negative impacts. In some instances, these laws bring consideration of environmental resources into water resource planning where it might otherwise have been lacking.

F. Water-Energy-Food Nexus

Water and energy are linked through mutual dependence: it takes large amounts of water to generate most forms of energy, and it takes large amounts of energy to produce, treat, and distribute water. In Arizona, the CAP is the largest single user of energy. Both water and energy are major inputs in food production. Because of these linkages, activities that affect any one of the three will have an impact on the others. Efforts to provide water, energy, or food security (the collective ability of a nation to feed itself) are most effective using a nexus approach. For example, it may be difficult to develop water resources for other uses from increased water use efficiencies in the production of food crops in the Yuma area without sacrificing productivity. Similarly, implementing suggestions such as dry cooling to reduce water use in energy generation could raise operating costs and affect supply and price decisions.

Increased production of biofuels has already had an impact of food prices. Desalination of water to increase supply would require large inputs of power. When water scarcity reduces water levels behind multipurpose dams, thus reducing hydroelectric production, both energy and food production can suffer, along with other uses. The linkages among the three sectors are complex and dynamic, requiring an integrated understanding if a solution to a problem in one sector is to avoid creating new problems in the others. Thinking about water, energy, and food in an integrated way can suggest solutions, such as energy generation from wastewater—technologies that already exist—that address multiple objectives.

G. Tribal Water Management

Tribes and communities are sovereign with respect to the use and management of their water resources. State law does not govern. Water management varies with each tribe and community. Settlements of tribal water claims can have a substantial impact on water accessibility and realistic management options.

The restoration of a significant amount of the water to which Tribes once had access has been a boon to Tribes and tribal people. It has enabled them to be a vital part of a growing Arizona economy. For example, the US Department of Agriculture reported that in 2012 there were over 118,000 acres of irrigated farmland in La Paz County.[108] Most of that land is on the Colorado River Indian reservation. The tribal farm and other tribal enterprises make the Colorado River Indian Tribe (CRIT) the largest employer in this rural county. Non-Indian farmers who lease land from the tribe benefit as well.

[108] U.S. Dep't of Agric., 2012 Census of Agriculture, Arizona State and County Data Volume I, at 248 tbl.10 (2012).

Agriculture is the dominant use of surface water for tribes along the mainstem of the Colorado River and within the CAP service area. Nearly all of the tribes have major farming operations conducted by tribally-owned farming enterprises. In addition many non-Indians farm land leased from tribes or from tribal members. Tribes generally have cooperative relations with surrounding irrigation districts. For instance, Ak-Chin farms gets the water to which they have rights through a canal belonging to the Maricopa-Stanfield Irrigation and Drainage District.

In other portions of Arizona, in the mountainous north and on the Colorado Plateau, water for domestic use is the critical need. The recent White Mountain Apache water settlement agreement focused on replacing a failing groundwater system with the construction of infrastructure to capture and deliver surface water for municipal use from the headwaters of the Salt River system.[109]

History of Gila River Indian Community Water
– David DeJong, Director of the Pima-Maricopa Irrigation Project

The Gila River Indian Community, home to the Pima and Maricopa people, is dominated by the Gila River, which for centuries provided the economic, spiritual and social wellbeing of the people. The river once provided water that fueled an extraordinary agricultural economy.

In the mid-19th century, with the federal government encouraging non-Indian settlement via the Homestead and Desert Land acts, upstream settlers dispossessed tribal growers of their water, initiating poverty and deprivation. Beginning in 1905, Congress funded a series of irrigation projects designed to protect for the tribe what limited water remained in the river. Inadequate conveyance and insufficient water, however, doomed these efforts.

After the complete loss of the Pima grain crop from water failure in 1925, the U.S. Justice Department filed suit on behalf of the tribe against neighboring users. In 1935 the federal district court in Tucson rendered its decision calling for a roughly equal division of water between the tribe and its non-Indian neighbors. The tribe, however, never received the water to which it was entitled.

The next forty years of continued litigation by federal attorneys produced little progress until Congress authorized the Central Arizona Project in 1968, in part to address the water claims of the tribe. In 1990, the tribe established a water negotiation team to discuss a comprehensive negotiated water settlement with 34 state and federal parties. In 2003, the tribe agreed to a comprehensive water settlement. The Gila River Indian Community Water Settlement Act (Title II of the Arizona Water Settlements Act) was signed into law by President George W. Bush on December 10, 2004, and the tribe established the goal of once again becoming the breadbasket of Arizona. In 1995, the tribe established the Pima-Maricopa Irrigation Project, which at full build out will irrigate nearly 90,000 acres of land, making it the largest agricultural development project in the country.

Throughout the state, groundwater is a major source of the water used in the homes of reservation residents. On the Tohono O'odham reservation, the Tohono O'odham Tribal Utility Authority has developed small groundwater systems to serve very remote villages. Most Tribes, including the Navajo Nation, have tribal utility authorities that are responsible for developing and operating municipal water systems. Riparian restoration, such as the Yuma East Wetlands project involving the Quechan Tribe, is also a tribal priority.

[109] U.S. Dep't of the Interior, Bureau of Reclamation, White Mountain Apache Tribe Rural Water System: Project Overview (2013), *available at* http://www.usbr.gov/lc/phoenix/reports/wmatrwseis/wmatfactsheet.pdf.

Water in a number of reservation areas also serves industrial customers. Tribes have a history of leasing water to mining operations on and adjacent to their land. Tribal hospitality enterprises, such as the Skywalk complex of the Hualapai Tribe, depend on water.

Many Arizona Tribes, particularly the larger ones, have sophisticated tribal water management capabilities. They have adopted water codes, monitor water quantity and quality, and conduct other water management functions that are the hallmark of Arizona municipal water systems as well.

A particularly important aspect of tribal water management is the leasing of tribal water supplies to Arizona municipalities. Leasing began with an agreement worked out by the Ak-Chin Indian Community soon after the tribe's water rights were settled in 1978. The Tribe agreed to a lease with Del Webb that enabled the community of Anthem north of Phoenix to be developed. Tribes have since entered into numerous leases. These leases provide an important source of water in the portfolios of many Valley cities, including Phoenix.[110]

Tribal water and its management are important to the overall water picture in the state. Cooperation among Tribes and other water users will continue as Arizona addresses its future water needs.

H. General Stream Adjudication Issues

The reasons for the protracted nature of these adjudications are difficult to summarize, but obvious given the sheer number and diversity of parties—cities and towns, utilities and mines tribes and military bases, national parks and eco-tourism, farmers and individual private well owners. The cost of failing to resolve these disputes is also difficult to estimate. Arizona alone has spent hundreds of millions of dollars over the years in court costs and the advisory role performed by ADWR.[111] The state's costs are a fraction of the legal and technical costs borne by parties to these adjudications, to say nothing of the immense costs of the ngoing uncertainty surrounding water rights in Arizona that will persist until these adjudications are resolved.

One of the reasons the general stream adjudications have defied efforts to reach a conclusion is Arizona's bifurcated water rights system. Arizona law treats groundwater and surface water as legally distinct resources, even though these supplies are often hydrologically linked.

For example, water percolates in the loose sand and gravel of a dry river bed. This percolating water is referred to as "subflow."[112] Someone could build a well two hundred yards away from the river bank, and assume they are pumping groundwater and thus exempt from the adjudication. However, that pumping could potentially appropriate subflow, which is legally considered surface water. Does this well belong in the general stream adjudication? If so, should the water pumped be treated as groundwater or surface water? If groundwater and surface water, how should it be divided? If it is surface water, what priority, if any, does the well owner have in the prior appropriation system?

[110] *See Water Deliveries*, Cent. Ariz. Project, http://www.cap-az.com/index.php/departments/water-operations/deliveries (last visited Aug. 29, 2015) (annual reports of water deliveries through the Central Arizona Project).
[111] John E. Thorson et al., *Dividing Western Waters: A Century of Adjudicating Rivers and Streams, Part II*, 9 U. Denv. Water L. Rev. 299, 303 (2006) (Mr. Thorson was formerly the Special Master for the Gila River and Little Colorado adjudications).
[112] *See In re* Gen. Adjudication of All Rights to Use Water in the Gila River Sys. & Source, 857 P.2d 1236 (Ariz. 1993) (discussing subflow).

As long as these questions, and many others, remain, the general stream adjudications present an obstacle to long-term water management by the state and many municipal governments, as well as many of Arizona's industries. This uncertainty adversely impacts the ability to transfer surface water rights in Arizona, which impacts economic development.

I. Forest Restoration Initiatives

Despite the well-recognized effectiveness and necessity of restoring forest processes and reducing harm to forest communities, agency land managers have been unable to finance these needed treatments due to budgetary constraints. Lack of federal, and to a lesser extent, state government investments in these relatively low-cost preventative restoration treatments has resulted in a costly negative feedback loop: as wildfire suppression costs set a new record each year, the practice of fire borrowing (a process of borrowing from non-fire functions of the USFS in order to fund fire suppression) undercuts preventive projects and leaves these watersheds even more vulnerable.[113]

Restoring these forested watersheds to healthy conditions represents a significant challenge for forest managers and the state. The Four Forest Restoration Initiative (4FRI) represents an ambitious approach to restore 2.4 million acres of Ponderosa Pine Forest across 4 national forests in Arizona; however it is yet to be seen if this model of unsubsidized restoration is financially viable for forest industries to profitably restore the forests. Given declining federal budgets for forest restoration, new innovative programs to finance forest restoration based on protecting and securing watershed values may be warranted. Currently most water investments from downstream beneficiaries are limited to investments in water delivery, treatment and distribution infrastructure, with little to no investment in securing the health of these forested watersheds to avoid future water costs associated with catastrophic wildfire. A recent EPA study concluded that $1 of source water protection yielded on average $27 in avoided water treatment costs.[114] New private-public partnership investment programs, such as SRPs partnership with the National Forest Foundation to fund and restore National Forest lands within the 64,000 acres of the CC Cragin reservoir basin, the City of Flagstaff's $10 million investment on US Forest Service lands as part of the Flagstaff Watershed Protection Project, or the 1% for the Verde River Campaign, represent alternative models of financing these needed restoration investments in watershed health.

Growing community awareness of forest health issues and the magnitude of the impacts from the 2010 Schultz Fire contributed to the eventual creation of a Payment for Watershed Service (PWS) program in Flagstaff. In 2010 and 2011, research and community action led to a workshop for city managers and city commissions to explore the possibility of Flagstaff investing in the restoration of national forests in the city's watersheds. As a result, the City Manager and other department officials made the decision to propose a bond-financed PWS project to the Flagstaff City Council to protect city watershed resources. On November 6, 2012, a $10 million bond (Item 405) was on the ballot as the "Forest Health and Water Supply Protection Project," with the intent of restoring approximately 10,544 acres within two priority city watersheds in the Coconino National Forest. Bond 405 passed with an overwhelming 73.6% majority, becoming the first forest treatment PWS project in the United States to be voted on by the public and financed by a municipal bond.

[113] *See* Ross Gorte, Headwaters Econ., The Rising Cost of Wildfire Protection (2013), *available at* http://headwaterseconomics.org/wphw/wp-content/uploads/fire-costs-background-report.pdf.
[114] World Res. Inst., Natural Infrastructure 15 (Todd Gartner et al. eds., 2013), *available at* http://www.wri.org/sites/default/files/wri13_report_4c_naturalinfrastructure_v2.pdf (citation omitted).

J. Meeting Obligations to Mexico

As discussed previously in Section II, the United States has the obligation to deliver 1.5 MAF of Colorado River to Mexico annual. Consequently, water scarcity in the Colorado River Basin (aggravated by ongoing drought conditions) affects Mexico as well as the Colorado River Basin states.

The year 2012 saw the first bi-national agreement to directly provide water releases to support habitat restoration and environmental water needs. The agreement allowed Mexico to store and release a portion of Mexico's Colorado River water for environmental benefits in Mexico. Minute 319, an agreement of the International Boundary and Water Commission implementing the 1944 Rivers Treaty between Mexico and the U.S., contained provisions for a one-time pulse (short burst) flow of Colorado River water to create and support habitat restoration, and a base (sustained) flow to support habitat created or enhanced by the pulse flow. A consortium of non-governmental organizations, including the Sonoran Institute, Pronatura Noroeste, and the Nature Conservancy, are raising funds to lease water rights in Mexico to support the baseflow.

Minute 319 is a successful example of bi-national management of the Colorado River. It allows Mexico to store its water behind U.S. dams, and provides that Mexico will share shortages. The volume of water for Mexico will be reduced on the same proportion as the reduction faced by lower basin states under the Interim Guidelines. The collaborative management introduced by Minute 319 may be a model for resolving outstanding water issues between the United States and Mexico.

K. Emerging Water Quality Issues

Non-Point Sources of Pollution to Surface Waters

Arizona has been very successful in curbing point source discharges of pollution to surface waters through use of permits issued under the federal Clean Water Act. The next challenge is addressing nonpoint sources of pollution. Nonpoint source discharges are now the main cause of violations of surface water quality standards. Nonpoint discharges may be associated with runoff from agriculture, grazing, recreational, forestry, construction, urban stormwater, and other sources. Because of the dispersed nature of most discharges, controls often rely on implementation of a set of best management practices involving multiple public and private stakeholders and partners. Some projects are now being designed with multiple source-benefit components, which integrate pollution control measures with water conservation and water supply measures.

Disinfection Byproducts (DBPs) in Drinking Water

Chlorine disinfection of drinking water creates carcinogenic disinfection byproducts (DBPs) in finished water distributed to customers. The federal government has established Maximum Contaminant Levels (MCLs) for many DBPs. Two issues loom. First, MCLs for some existing DBPs are being lowered based on new health information and standards for new DBP compounds are being added. Second, DBP levels in finished water correlate with the level of organic carbon in the source water that is being treated. When source waters with higher organic carbon levels are chlorinated, higher levels of DBPs are produced.

Due to drought/climate change, organic carbon levels in surface water sources are increasing, and, and hence, higher levels of DBPs in finished drinking water are being produced. Forest health is an issue, because forest fires are a worrisome contributor of organic carbon to water supply reservoirs. Many drinking water utilities consider meeting DBP standards and the potential for violating standards due to increased organic carbon loads in their source waters as the main driver for future costly infrastructure upgrades.

Challenges in Meeting New Drinking Water Standards

New federal Maximum Contaminant Level (MCL) drinking water standards are likely to be promulgated in the near future. Standards for contaminants such as Chromium+6 (Cr+6) and perchlorate are under consideration. Quite a few public drinking water systems in Arizona may be affected depending on the adopted level. This is particularly true for Cr+6, which is present naturally in many groundwater sources in Arizona. If adopted levels are exceeded in source waters, drinking water utilities would have to treat, blend, or tap other sources to comply with the standards. Similar to when the MCL for arsenic was lowered in 2006, this could be a very expensive undertaking for drinking water utilities.

Management/Disposal of Desalination Brines

As Arizona looks to exploiting its brackish water resources and treating currently degraded sources, such as reclaimed water, for higher end uses, brines from the reverse osmosis (RO) process increasingly will be generated. Brine management/disposal is the biggest hurdle to the use of these water sources. According to experts, deep-well injection of desalination brines may be the only economical management/disposal approach. To date, ADEQ has not issued permits for deep well injection of desalination brines under its Aquifer Protection Permit (APP) program. To move forward with permitting of deep well injection, ADEQ, in collaboration with stakeholders, would need to develop criteria on siting, drilling, testing, operation and maintenance, and monitoring and reporting that would ensure compliance with APP program requirements.

SECTION IV. STEPS FORWARD

In its Strategic Vision, ADWR states:

> "There is no single strategy that can address projected water supply imbalances across the State. Instead a portfolio of strategies needs to implemented dependent on the needs of each area of the state. It is very important to recognize the uniqueness of the various regions throughout the State and the varying challenges facing those regions."[115]

ADWR identified several potential new water supplies, including additional conservation, use of brackish groundwater supplies, importation of water from outside Arizona, transportation of water within Arizona, increased use of reclaimed water, and capture and use of stormwater.

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[115] Ariz. Dep't of Water Res., *supra* note 2, at 64.

Most, if not all, of these potential water supplies face economic, political or engineering challenges. For example:

- Financing necessary to build wastewater treatment plants, desalination plants and pipelines to transport water is limited. The WRDC examined potential funding sources in great detail and was unable to recommend any sustainable financing mechanism. Given budget shortfalls, it is unlikely that the legislature will make general fund appropriations available for these purposes.

- Moving water supplies from one part of the state to another faces political challenges in addition to economic, engineering and environmental obstacles. Rural communities fear that transferring water away from agricultural uses to urban and industrial uses in other parts of the state will weaken their economies and way of life. Mechanisms have not yet been put in place that provide the comfort these rural communities desire.

- Conservation, while less expensive than other alternatives, will not provide the magnitude of water supplies projected to be needed to meet demand.

It will take leadership, a knowledgeable electorate, planning, cooperation and investments to secure sustainable water supplies for Arizona's future. It will also take a shared vision for the future. We should be unafraid to ask the tough questions. For example, is it important to preserve some agriculture? Should groundwater management be implemented statewide? Should we limit the proliferation of new wells that are impacting existing wells, our surface water supplies and our riparian habitats? Should all new subdivisions in the state be required to have a 100-year water supply? Should we build where water and the infrastructure to deliver it are located? How do we ensure that basic human needs for safe drinking water are met in all Arizona communities? What is the role of technology? Will Arizonans become comfortable with reclaimed water as a potable supply? What about our urban lifestyles? Do we want our environment to be stark, hot and unfriendly, or are we concerned about heat islands, places to recreate and trees that protect us from the sun? What are we willing to invest?

The conversation will not be easy, but it will be necessary if we are to find a balanced approach to our future water security.

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