ARIZONA DEPARTMENT of WATER RESOURCES

EST. 1980

SUPPLY & DEMAND

2025

BILL WILLIAMS

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2025 SUPPLY AND DEMAND ASSESSMENT
BILL WILLIAMS BASIN

1 INTRODUCTION

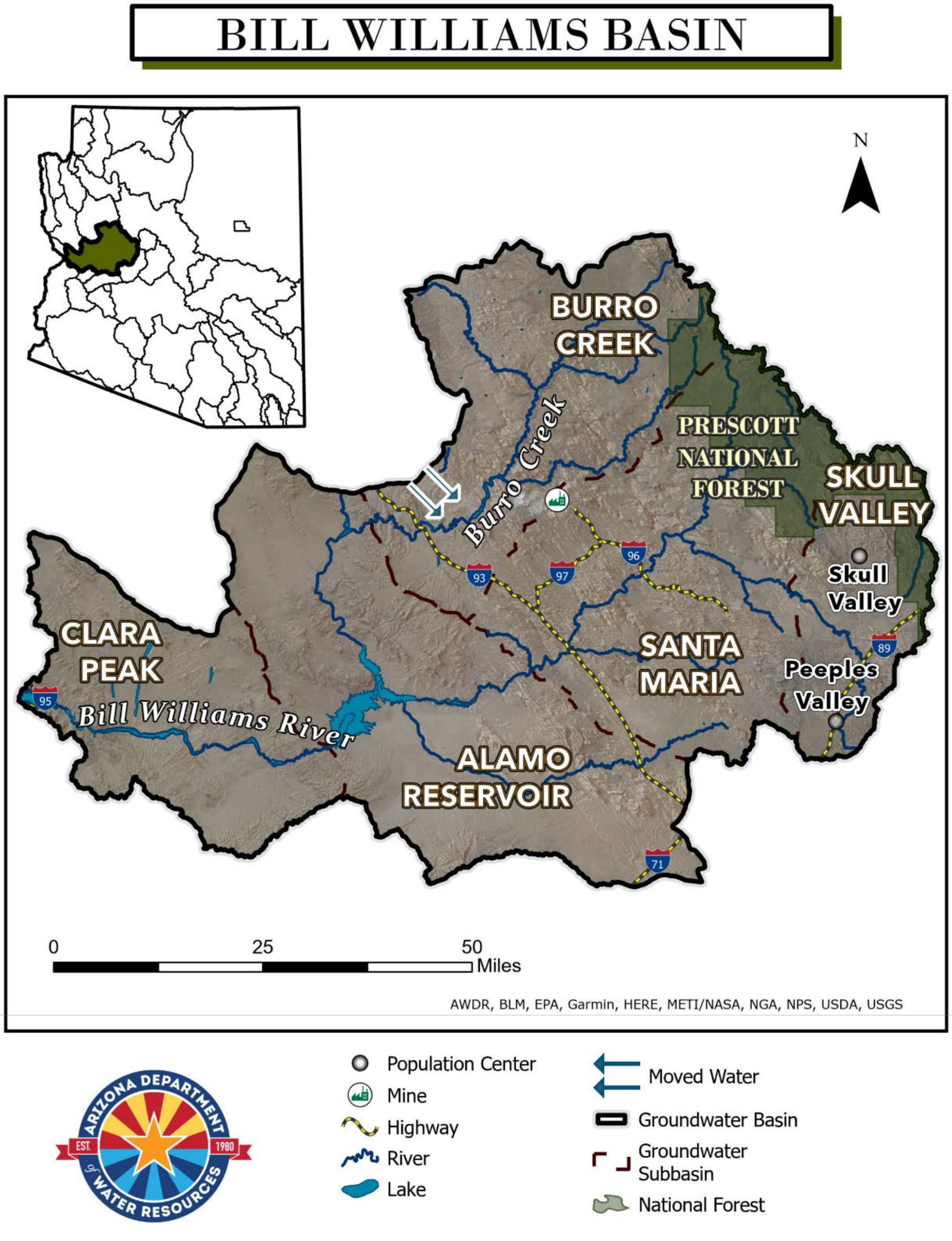

Figure 1. Map of the Bill Williams Basin.

1.1 REPORT BACKGROUND AND PURPOSE

Preparing the Supply and Demand Reports (SDRs) is a duty of the Director of the Arizona Department of Water Resources (ADWR) required by statute, as stated in Arizona Revised Statutes (A.R.S.) § 45-105(B)(14).1 Beginning in 2023, the Director must ensure that a water supply and demand assessment for at least six of Arizona's fifty-one groundwater basins are prepared and issued by December 1st of each year.

Although similar assessments have been completed periodically, 2023 was the first time ADWR allocated dedicated funding and staff to conduct assessments of all of Arizona's groundwater basins on a recurring cycle. By the end of 2027, ADWR will complete assessments for all 51 groundwater basins throughout the state, and each basin will be reassessed at least every five years. The SDRs may be used to inform the Water Infrastructure Finance Authority on funding decisions in the future (see A.R.S. § 49-1304(A)(14)[2]). The SDRs may also be used as a planning tool for water resource management by ADWR, policymakers, community members, and other interested stakeholders.

The basins and subbasins assessed in 2025 include Aravaipa Canyon, Bill Williams (Alamo Reservoir, Burro Creek, Clara Peak, Santa Maria, and Skull Valley Subbasins), Bonita Creek, Coconino Plateau, Dripping Springs Wash, Duncan Valley, Hualapai Valley, Little Colorado River Plateau, Morenci, Sacramento Valley, Safford (San Carlos Valley, Gila Valley, and San Simon Valley Subbasins), Salt River (Black River, White River, Salt River Canyon, and Salt River Lakes Subbasins), and San Simon Wash.

[1] Arizona Revised Statutes § 45-105(B)(14). https://www.azleg.gov/ars/45/00105.htm

[2] Arizona Revised Statutes § 49-1304(A)(14). https://www.azleg.gov/ars/49/01304.htm

1.2 PROCEDURE AND SCOPE

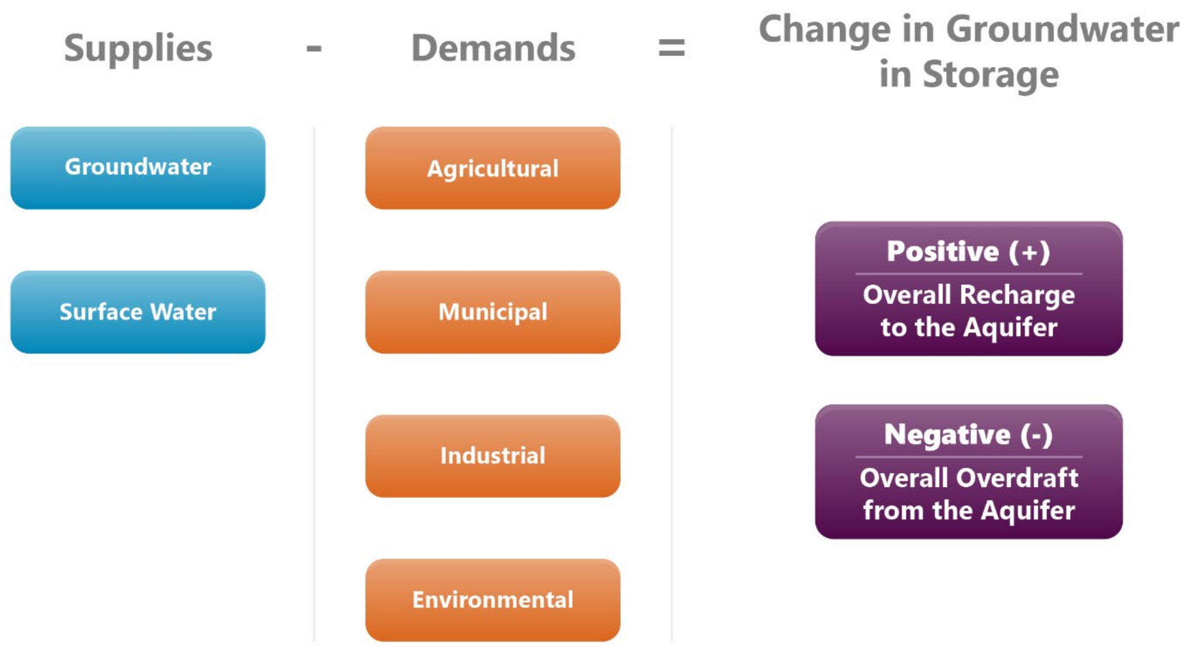

Figure 2. Depiction of the Bill Williams basin water budget, including all available supplies and demands and how they contribute to changes in groundwater in storage.

The SDRs are structured as water budgets, focusing on total inflows and outflows at the basin scale. The SDRs estimate the volumes of water demands from all uses (categorized into sectors of Agricultural, Industrial, Municipal, and Other) and the volumes of water supplies (Surface Water, Groundwater, Effluent, Incidental Recharge, Transportation Water, and Moved Water) available to meet those demands. The reports also include projected demands and supplies under various influences of future scenarios.

The SDRs are not groundwater flow models with finer geographic results. The development of regional groundwater flow models for each basin is an extensive technical process and is not feasible within the time constraints of this project. Outside of Arizona's regulated Active Management Areas (AMAs) and Irrigation Non-Expansion Areas (INAs), data is much more limited. In instances where data does exist, the data may be outdated or lack reliability. ADWR has endeavored to acquire local and specific data to generate the SDRs. However, when such information was not obtainable, staff utilized scientific literature estimates, averages, or assumptions to formulate water usage estimates.

The SDRs attempt to answer the following questions:

1. What is the estimated annual volume of water demand?
2. What is the estimated annual volume of available water supply?
3. Is there sufficient available water supply to balance water demand annually?

The water budget was calculated by subtracting the estimated annual demand from the estimated annual available supply. If demand exceeds supply in a year, the difference is subtracted from the estimated aquifer storage. If supply exceeds demand, the difference is added to estimated aquifer storage. In this manner, the process is like balancing a checkbook, totaling the credits and debits made to the account through the year to understand how much estimated groundwater is available in storage.

The SDRs are designed to be understandable to the general public. The Methods Appendix includes specific technical information and additional details regarding data and methods: [Methods Appendix]. Additional SDRs and an interactive dashboard are available for further information: [Dashboards].

1.3 METHODOLOGY AND LIMITATIONS

This study reviewed and compiled data for two primary purposes:

1. Estimate supply and demand volumes in the basin.
2. Project changes in supply and demand from possible future scenarios.

ADWR developed and compiled baseline data for the period from 1990 to 2024. Staff then developed scenarios based on the most likely impacts on water demands and supplies over 51 years (from 2025 to 2075), and then projections were generated from the baseline data. The results from these scenarios and the combined baseline data were used to estimate whether supply could meet demand each year from 1990 to 2075. ADWR independently developed both the supply and demand estimates.

Due to the limited reported water data available outside Arizona's AMAs and INAs, the supplies and demands outlined in the SDRs are estimates only. When available, ADWR used high-quality data from credible sources. Due to the need to focus staff bandwidth on developing initial methods for analysis of all 51 groundwater basins by the December 1, 2027, statutory deadline, outreach was limited to major water users in the basin. When data could not be obtained, research into existing literature and the use of representative data were necessary to develop estimates.

Please see the Methods Appendix for an in-depth discussion of the methodologies and assumptions ADWR applied to create each estimate: [Methods Appendix].

2 RESULTS

2.1 BASIN SUMMARY

The Bill Williams Basin encompasses 3,350 square miles in the western area of the state and is characterized by hilly terrain in most of the basin and by several major river drainages. The basin consists of the Buckskin Mountains to the southwest, the Poachie Mountain Range in the center, and the Black Mountains to the south. The basin is comprised of U.S. Bureau of Land Management (BLM) land (46.1%), State Trust land (30.5%), National Forest land (7.6%), and U.S. Military land (0.7%). The basin has an estimated population of 4,805 people, and 14.8% of the basin is privately owned. The aquifer system of the Bill Williams Basin consists of major aquifers including recent stream alluvium, basin fill, and volcanic rock. Previous storage estimates range from 10,000,000 to 23,000,000 acre-feet (AF) to a depth of 1,200 feet.[3] The basin includes Alamo Lake east of the Town of Swansea, a portion of the Colorado River, and the Bill Williams River which flows east to west along the La Paz and Mohave County boundaries.

2.2 SUPPLIES

2.2.1 Surface Water

ADWR examined all water sources defined as surface water in each basin. Surface water includes all water flowing in streams, canyons, ravines, or other natural channels, or in definite underground channels, whether perennial or intermittent, floodwater, wastewater, or surplus water, and of lakes, ponds, and springs discharging to the surface (A.R.S. § 45-141).[4] After examining these sources and deducting any existing surface water diversions (stockponds, reservoirs, and agricultural diversions) from the resulting volumes, ADWR generated a final estimate of the remaining water available for diversion or use. When possible, streamgage data were used to estimate surface water volumes. Where active streamgages were absent, which often applies to areas with intermittent and ephemeral streamflow, the Drainage-Area Ratio (DAR) method (see the Methods Appendix) was used to estimate surface water volume.

While Colorado River water is subject to a different legal framework, the term "surface water" necessarily encompasses Colorado River water, including Central Arizona Project ("CAP") water. Therefore, Colorado River water, including CAP water, is incorporated in the estimates of available surface water supplies. The availability of Colorado River water in Arizona will be subject to operations to be determined by the Secretary of the Interior in an ongoing federal process. While significant uncertainty surrounds the reliability of Colorado River water supplies, particularly on the mainstem of the Colorado River in the Lower Basin, this report assumes that Non-Indian Agricultural (NIA) Priority CAP water will generally not be available during the projection period, but that all other Colorado River water and CAP water will be available.

2.2.2 Groundwater

This report refers to the "inflow to" and "outflow from" the aquifer each year as groundwater. This volume is distinct from the volume of groundwater considered to be available in storage. "Inflow to" represents the annual recharge or replenishment of groundwater through processes such as the percolation of precipitation or surface water into the subsurface, which is observed through processes such as streamflow infiltration, groundwater inflow, and mountain-front recharge. "Outflow from," the movement of water leaving the system, is represented by such processes as baseflow and groundwater outflow. See the Methods Appendix for more information on how

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[3] ADWR (2009). Arizona Water Atlas, Volume 4, Section 4.2, pg. 120, Table 4.2-6. https://infoshare.azwater.gov/docushare/dsweb/Get/Document-10429/Volume_4_final_web.pdf

[4] Arizona Revised Statutes § 45-141. https://www.azleg.gov/ars/45/00141.htm

streamflow, baseflow, groundwater inflow/outflow, and mountain-front recharge estimates were obtained.

The total groundwater storage volume provided in this report reflects the volume of groundwater reasonably accessible at the average depth of the wells in the basin, rather than at the 1,200 feet groundwater storage depth used in previous ADWR reports. The water level falling below the basin's average well depth suggests that wells will have begun to go dry. Using this approach to estimate groundwater storage effectively illustrates the impact of declining water levels on the current existing infrastructure of property owners, residents, and other water users in each basin. Please note that this report does not address potential subsidence or permanent loss of aquifer storage that could occur if the estimated water volume in storage were to be removed from the basin. See the Methods Appendix for more information on how groundwater storage was estimated.

2.2.3 Effluent

Effluent is defined as "water that has been collected in a sanitary sewer for subsequent treatment in a facility that is regulated pursuant to Title 49, Chapter 2."[5] ADWR used effluent data provided by the Arizona Department of Environmental Quality (ADEQ) to estimate the amounts of effluent available for reuse. These effluent estimates are based on effluent volumes produced from wastewater treatment plants designated for reuse. These volumes do not include wastewater discharged from the treatment plants. Effluent volumes also do not include septic tanks or other wastewater collection systems. Recharge from septic tanks is included in the Incidental Recharge estimation.

2.2.4 Incidental Recharge

Incidental recharge is defined as water from human use that replenishes groundwater supplies. Incidental recharge is associated with agricultural, industrial, and municipal water demands. ADWR used data derived from demand analyses to estimate incidental recharge volumes.

2.2.5 Transportation Water

Certain basins have been identified in A.R.S. Title 45, Chapter 2, Article 8.1[6] as basins from which groundwater may be withdrawn for transportation to an AMA. Where such transportation has been authorized, that groundwater is referred to as "Transportation Water" in this report.

2.2.6 Moved Water

Any water that crosses basin boundaries through artificial means and that does not fall under the Transportation Water definition is referred to as "Moved Water" in this report. Moved Water

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[5] Arizona Revised Statutes § 45-101(4). https://www.azleg.gov/ars/45/00101.htm

[6] Arizona Revised Statutes Title 45, Chapter 2, Article 8.1. https://www.azleg.gov/arsDetail/?title=45

includes groundwater that is transported between basins that are not AMAs, pursuant to A.R.S. Title 45, Chapter 2, Article 8.[7]

2.3 SUPPLY RESULTS

This subsection contains ADWR's estimates of annual supplies available to the Bill Williams Basin.

2.3.1 Surface Water

In the Bill Williams Basin, ADWR identified the following surface water conveyances (USGS streamgages in parentheses):

- Adobe Creek
- Ally Wash
- Ash Creek
- Bear Creek
- Big Sandy River (09424450)
- Bill Williams River (09426620, 09426000))
- Black Canyon
- Bland Creek
- Boulder Creek
- Bridle Creek
- Bullard Wash
- Burnt Wash
- Burro Creek (09424447)
- Chapin Wash
- Cold Spring Canyon
- Conger Creek
- Contreras Wash
- Copper Basin Wash
- Cottonwood Canyon
- Date Creek
- Finch Wash
- Francis Creek
- Graveyard Wash
- Groom Spring Wash
- Iron Spring Wash
- Kaiser Spring Canyon
- Kirkland Creek
- Little Shipp Wash
- Little Sycamore Wash (09424580, 09424600)
- Logan Wash
- Middle Mohave Wash
- Miller Creek
- Miller Wash
- Mineral Wash
- Mississippi Wash
- Model Creek
- Mohave Wash
- North Fork Date Creek
- Peoples Canyon
- Pine Creek

[7] Arizona Revised Statutes Title 45, Chapter 2, Article 8. https://www.azleg.gov/arsDetail/?title=45

- Placeritas Creek
- Poplar Wash
- Quail Spring Wash
- Ritter Creek
- Rupley Wash
- Salt Creek
- Santa Maria River (09424900)
- Scratch Canyon
- Sheppard Wash
- Skull Valley Wash
- Smith Canyon
- South Fork Date Creek
- South Fork Santa Maria River
- Sycamore Creek
- Tonto Wash
- Waterman Creek
- West Mohave Wash
- Wilder Creek
- Wood Creek
- Woosley Wash

Flows on the Big Sandy River, Bill Williams River, Burro Creek, Little Sycamore Wash, and the Santa Maria River are measured with seven streamgages (09424450, 09426620, 09426000, 09424447, 09424580, 09424600, 09424900). For streams without streamgage data, the DAR method was applied to estimate streamflow volumes. The streamflow volume estimates provided in the table above are composites of the streamgage and DAR estimation methods.

Table 1. Estimated Surface Water Volumes in the Bill Williams Basin for 1990-2024. (SDR 2025)

Subbasin	Streamflow Minimum	Streamflow Maximum	Average Streamflow (Streamgage Method)	Average Streamflow (DAR Method)	Total Average Streamflow	Median Streamflow
Alamo Reservoir	12,923(1994)	603,909(1993)	99,807	9,403	109,210	48,843
Burro Creek	3,505(2018)	624,122(2005)	156,066	1,291	157,357	126,544
Clara Peak	215(1990)	632,550(1993)	48,587	535	49,122	6,354
Santa Maria	1,019(2002)	30,247(2019)	5,117	245	5,362	3,807
Skull Valley	1,584(2002)	160,445(1993)	26,056	2,627	28,683	10,926

All values are shown in AF. Parentheses indicate the year streamflow volume was recorded.

Surface water is estimated to contribute 196,474 AF to the supplies in the basin in a typical year. However, there are years with extremely high or low surface water inflows. Due to the extremely high flow years associated with floods, the average surface water supply in each subbasin is much higher than their respective medians per year.

Table 2. Estimated Surface Water Volumes Diverted for Use in the Bill Williams Basin for 1990-2024. (SDR 2025)

Year	Diverted Streamflow
1990	53,178
2007	53,196
2024	53,617
Average Annual Diverted Streamflow from 1990-2024	53,334

All values are shown in AF.

Examples of estimated surface water volumes diverted from the Bill Williams Basin for use, either for storage in reservoirs or municipal uses.

2.3.2 Groundwater

The following groundwater volumes were estimated in the Bill Williams Basin:

Table 3. Estimated Streamflow Infiltration Volumes in the Bill Williams Basin for 1990-2024. (SDR 2025)

Subbasin	Average Annual Streamflow Infiltration (Perennial)	Average Annual Streamflow Infiltration (Intermittent & Ephemeral)	Total Average Annual Streamflow Infiltration
Alamo Reservoir	8,484	9,027	17,511
Burro Creek	13,266	1,291	14,556
Clara Peak	4,130	456	4,586
Santa Maria	435	141	576
Skull Valley	2,215	152	2,367

All values are shown in AF.

- Streamflow Infiltration: Infiltration for perennial streams was estimated using the fixed percentage listed in the Methods Appendix. Infiltration for intermittent and ephemeral streams, was estimated using infiltration rates from the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) Soil Quality Indicators.[8] The predominant soil types were sandy, sandy-skeletal, loamy-skeletal, fine, coarse-loamy

[8] USDA NRCS. (2008). Soil Quality Indicators. United States Department of Agriculture Natural Resource Conservation Service. https://www.nrcs.usda.gov/sites/default/files/2022-10/Infiltration.pdf

respectively.[9] The standard storm duration utilized was 1.5 hours.[10] In the Alamo Reservoir Subbasin, total streamflow infiltration peaked in 1993 at approximately 107,700 AF and was lowest in 1994 at 2,451 AF. In the Burro Creek Subbasin, total streamflow infiltration peaked in 2005 at approximately 63,997 AF and was lowest in 2018 at 353 AF. In the Clara Peak Subbasin, total streamflow infiltration peaked in 1993 at approximately 58,850 AF and was lowest in 1990 at 20 AF. In the Santa Maria Subbasin, total streamflow infiltration peaked in 2019 at approximately 2,842 AF and was lowest in 2002 at 141 AF. In the Skull Valley Subbasin, total streamflow infiltration peaked in 1993 at approximately 13,066 AF and was lowest in 2002 at 133 AF.

Table 4. Estimated Groundwater Volumes in the Bill Williams Basin for 1990-2024. (SDR 2025)

Basin	Average Annual Baseflow	Average Annual Groundwater Inflow	Average Annual Groundwater Outflow	Average Annual Mountain-Front Recharge	Calculated Initial Groundwater Storage
Bill Williams	-35,536	1,000	-300	17,316	179,915(1990)

All values are shown in AF. Negative numbers indicate demands or water flows leaving the basin Parentheses indicate the representative year chosen to calculate initial storage.

- Baseflow: ADWR estimated baseflow using the USGS Hydrologic Toolbox in ArcGIS.[11] Streamgage data were utilized when available. Any gaps in the data were filled using precipitation data from PRISM[12] and the USGS StreamStats website.[13]
- Groundwater Inflow/Outflow: Inter-basin underflow volumes were based on USGS predevelopment maps and scientific literature estimates.[14]

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[9] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture (NRCS, USDA). (2016). Web Soil Survey (STATSGO2). http://websoilsurvey.nrcs.usda.gov/

[10] Food and Agriculture Organization of the United Nations (FAO). (2024). Annex 2 Infiltration Rate and Infiltration Test. https://www.fao.org/4/s8684e/s8684e0a.htm

[11] Barlow, P.M. et al. (2022). U.S. Geological Survey Hydrologic Toolbox — A graphical and mapping interface for analysis of hydrologic data: U.S. Geological Survey Techniques and Methods, book 4, chap. D3, 23 p. https://doi.org/10.3133/tm4D3

[12] PRISM Climate Group. (2024). 30-Year Normals [dataset] https://prism.oregonstate.edu/explorer/

[13] USGS. (n.d.-b). StreamStats [dataset]. https://www.usgs.gov/streamstats

[14] Tillman, F. et al. (2011). Water Availability and Use Pilot: Methods Development for a Regional Assessment of Groundwater Availability, Southwest Alluvial Basins, Arizona (Scientific Investigations Report 2011–5071). United States Geological Survey. https://media.kjzz.org/s3fs-public/field/docs/2011/09/21/sir2011-5071_text.pdf

- Mountain-Front Recharge: The mountain-front recharge estimates were calculated using precipitation data, model data, scientific literature estimates for groundwater inflows/outflows,[15] and a water budget accounting for the inflows/outflows that affected the mountain-front recharge volume.
- Groundwater Storage: Storage was calculated using either a model data plus water budget method, if model data were available for the basin, or a GIS-based geological data non-model method, if model data were unavailable for the basin (Section 2.5.4, Methods Appendix). Initial groundwater storage was calculated using wells located within alluvial aquifer boundaries in the basin. A representative year was selected containing the most water level measurements at those wells. The estimated storage volume was calculated to the basin's average well depth, 262 feet.

2.3.3 Effluent

None of the effluent produced in the Bill Williams Basin has been allocated for reuse, so no effluent is categorized as a water supply.

2.3.4 Incidental Recharge

Sources of incidental recharge in the Bill Williams Basin are agricultural, municipal, and industrial.

Table 6. Estimated Incidental Recharge Volumes in the Bill Williams Basin for 1990-2024. (SDR 2025)

Sector	1990	2007	2024
Agricultural	5,792	822	722
Municipal	49	114	256
Industrial	30	31	28

All values are shown in AF.

- Agricultural Incidental Recharge: Agricultural incidental recharge depends on the total irrigation withdrawals and irrigation efficiency within a basin. In 1990, the majority of irrigated land in the Bill Williams Basin was at Planet Ranch, located west of Alamo Lake in the Clara Peak Subbasin. USGS data and historical satellite imagery confirm that by 2007, the Planet Ranch land was no longer irrigated. This is the cause of the large decrease in total agricultural incidental recharge from 5,792 AF in 1990 to 822 AF in 2007. Since then, the estimated volume of agricultural incidental recharge has remained relatively

[15] Tillman, F. et al. (2011). Water Availability and Use Pilot: Methods Development for a Regional Assessment of Groundwater Availability, Southwest Alluvial Basins, Arizona (Scientific Investigations Report 2011–5071). United States Geological Survey. https://media.kjzz.org/s3fs-public/field/docs/2011/09/21/sir2011-5071_text.pdf

consistent. A slight decrease from 822 AF in 2007 to 722 AF in 2024 is projected due to an assumed increase in irrigation efficiency.

- Municipal Incidental Recharge: Municipal incidental recharge is a byproduct of lost and unaccounted for (L&U) water from water providers and seepage from septic tanks. The estimated volume of municipal incidental recharge has increased significantly over the baseline period from 49 AF in 1990 to 256 AF in 2024. Between 1990 and 2007, incidental recharge grew at an average rate of 4 AF per year. From 2007 to 2024, this rate doubled, averaging 8 AF per year.
- Industrial Incidental Recharge: Industrial incidental recharge occurs from the irrigation of turf facilities and is influenced by irrigation systems' total withdrawals and efficiency. The estimated volume of industrial incidental recharge has decreased slightly over the baseline period from 30 AF in 1990 to 28 AF in 2024.

2.3.5 Transportation Water

Certain basins have been identified in A.R.S. Title 45, Chapter 2, Article 8.1 as basins from which groundwater may be withdrawn for transportation to an AMA. Where such transportation has been authorized, that groundwater is referred to as "Transportation Water" in this report.

The Bill Williams Basin was not identified as a transportation water basin.

2.3.6 Moved Water

Any water that crosses basin boundaries through artificial means and that does not fall under the Transportation Water definition is referred to as "Moved Water" in this report. Moved Water includes groundwater that is transported between basins that are not AMAs, pursuant to A.R.S. Title 45, Chapter 2, Article 8.

The Bill Williams Basin was identified as a basin with moved water.

Table 8. Estimated Moved Water Volumes from the Big Sandy (Wikieup) Basin to the Bill Williams (Santa Maria) Basin for 1990 - 2024. (SDR 2025)

Year	Volume
1990	15,709
2007	17,023
2024	17,023

All values are shown in AF.

From 1990 to 2024, an average of 16,709 AF was moved annually from the Wikieup wellfield in the Big Sandy (Wikieup) Basin to the Bill Williams (Santa Maria) Basin for use at the Bagdad Mine operated by Freeport-McMoRan.

2.4 DEMAND RESULTS

The Demand subsection contains ADWR's estimates of annual demands in the Bill Williams Basin.

Table 9. Estimated Demand Volumes for the Bill Williams Basin by Sector for 1990-2024. (SDR 2025)

Sector	Subsector/Water Type	Year		
		1990	2007	2024
Agricultural	Agriculture	-18,500	-2,700	-2,790
Municipal	Residential Provider	-20	-205	-1,090
	Residential Non-Provider	-37	-213	-320
	Non-Residential	-291	-366	-367
	L&U	-44	-80	-204
Industrial	Dairies	0	0	0
	Feedlots	0	0	0
	Grazing	-262	-262	-262
	Mining*	0	0	0
	Power	0	0	-5
	Sand and Gravel	-23	-36	-36
	Turf	-244	-256	-251
	Other	0	0	0
Environmental	Riparian	-16,479	-16,479	-16,479

** Groundwater is imported from the Big Sandy basin into the Bill Williams Basin for mining purposes. The volume of water used at the mine is quantified in this report as moved water. Negative numbers indicate demands or water flows leaving the basin—all values in AF.*

2.4.1 Agricultural

Agricultural demand is water applied to two or more acres of land to produce plants or parts of plants for sale for human consumption or use as feed for livestock, range livestock, or poultry.

In 1990, most of the irrigated land in the Bill Williams Basin was at Planet Ranch located in the Clara Peak Subbasin. USGS data and historical satellite imagery confirm that by 2007, the Planet Ranch land was no longer irrigated. This is the cause of the large decrease in total irrigation withdrawals from 18,500 AF in 1990 to 2,700 AF in 2007. Since then, agricultural demand has remained relatively constant across the Bill Williams Basin.

There are currently an estimated 1,312 acres of cultivated land within the Bill Williams Basin: 902 acres in the Skull Valley Subbasin and 410 acres in the Santa Maria Subbasin. Over 90% of acreage in the Skull Valley Subbasin is used for grass and pastures. Crop type data was not available for the Santa Maria Subbasin.

Irrigation in the Skull Valley Subbasin consists of 72% sprinkler irrigation and 28% flood irrigation by acreage. In the Santa Maria Subbasin, irrigation systems were identified as 72% flood, 24% drip, and 4% sprinkler by acreage. Overall irrigation efficiency is estimated at approximately 82% for both subbasins.

2.4.2 Municipal

Municipal demand is defined as the non-agricultural and non-industrial uses of water supplied by a city, town, private water company, irrigation district, domestic water improvement district, water cooperative, or private domestic well.

The Bill Williams Basin has an estimated 4,805 residents, with no incorporated towns except for the unincorporated communities of Skull Valley and Peeples Valley. The region is influenced by other systems such as small community facilities and Alamo Lake State Park. Additional recreational usage contributes to the overall water demand.

- Residential Provider: Residential provider use is supplied by a municipal provider, or a Community Water System (CWS) as defined in A.R.S. § 45-341.[16] The Bill Williams Basin has approximately 3,651 residents served by a CWS. From 1990 to 2024, residential demand increased significantly, with the lowest annual rate of 11 AF occurring from 1990 to 2007. After 2007, the average annual demand rose rapidly to 52 AF, indicating a shift in service area population and water use patterns over time.
- Residential Non-Provider: Residential non-provider use is any residential water use that is not supplied by a municipal provider but rather by a non-public water system or domestic well. An estimated 1,154 residents in the basin rely on self-supplied water resources. From 1990 to 2024, residential water demand among non-provider users rose to approximately nine times its baseline value. From 1990 to 2007, the average annual demand increased approximately 10 AF. After 2007, water demand continued to rise, but at a slower annual rate of 6 AF.
- Non-Residential: Non-residential use is defined as municipal water not used for residential purposes but instead used for commercial, institutional, recreational, or transitory uses. Between 1990 and 2024, non-residential water demand grew by 26%.
- Lost and Unaccounted for Water: Lost and Unaccounted for water is defined as the total quantity of water from any source that enters a water distribution system minus the total amount of authorized deliveries from the distribution system during the calendar year. L&U does not account for water loss from a non-public water system or domestic well. During the baseline period, the volume of L&U water increased by more than three and a half times the 1990 level. Between 1990 and 2007, L&U rose at an average rate of approximately 2 AF per year. From 2007 onward, the rate increased to 7 AF per year.

2.4.3 Industrial

Industrial demand is water used by an industrial facility, such as a golf course, dairy, feedlot, power plant, mine, or paper mill.

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[16] Arizona Revised Statutes § 45-341. https://www.azleg.gov/ars/45/00341.htm

The current industrial water demands in the Bill Williams Basin come from grazing, power production, sand and gravel facilities, and the irrigation of turf facilities. The Bagdad mine, operated by Freeport-McMoRan, is also located in the Bill Williams Basin. The water used at the mine is sourced from the Big Sandy Basin; as such, this water was quantified as moved water in this report rather than as mining demand.

- Grazing: Grazing demand is defined as the water used to maintain stock ponds for the sole purpose of watering livestock. An estimated 15,603 animals graze in the Bill Williams Basin, the majority of which are cattle. Annual water consumption for the animals is estimated to be 262 AF.
- Power: Power demand is defined as the water use for the generation of power at thermal or renewable power plants. There is one solar power plant located in the basin that began operating in 2012. The average water use for power production is estimated to be 5 AF per year.
- Sand and Gravel: Sand and gravel demand accounts for the water use of any facility or establishment that produces aggregates or quarried materials. Water demand for sand and gravel facilities increased by 13 AF over the baseline period due to the addition of a new facility.
- Turf: Turf demand is defined as the irrigation or maintenance of any area of landscaping that is not part of a private residence. From 1990 to 2024, the volume of water used to irrigate turf facilities increased by three percent. The increase in water use during this time can be attributed to the addition of new irrigated acreage.

2.4.4 Environmental

Environmental demand is quantified within this report as evapotranspiration along streams, rivers, lakes, and drainage ways. There are many streams with surrounding riparian habitat in the Bill Williams Basin, including the Bill Williams River, Santa Maria River, Big Sandy River, Black Canyon Wash, and Bridle Creek. Large riparian areas can also be found upstream of Lake Havasu and Alamo Reservoir. The riparian demand values in the SDRs represent a high-end estimate of the potential water needs of riparian plants within a basin. In the absence of site-specific data, these estimates assume an average value for riparian plants' water needs, which does not consider local environmental conditions. Please see the Methods Appendix for an in-depth explanation of the methodologies.

- Annual net water requirements for the riparian plants are estimated to be 16,479 AF.

3 COMBINING SUPPLY AND DEMAND

The water budget in the Bill Williams Basin shows an overall positive trend over the baseline period, with both supply and demand showing fluctuations. Supply averaged 24,307 AF per year but ranged in values from the minimum of 1,351 in 2019 and a maximum of 252,315 AF in 1993. Demand values averaged 23,092 per year, with Agricultural demand showing the most substantial change throughout the baseline period, decreasing approximately 85%. Groundwater storage has increased over time due to supply exceeding demand in the basin.

Table 10. Summary of Total Estimated Demand and Supply Values from 1990-2024 in the Bill Williams Basin. (SDR 2025)

	1990	2007	2024
Supply	8,871	22,686	21,511
Demand	-36,185	-21,095	-21,093
Balance	-27,314	1,591	418
Resulting Water Available in Storage	179,915	231,211	221,226

Negative numbers indicate demands or water flows leaving the basin—all values in AF.

4 RESULTS OF PROJECTION SCENARIOS

Staff developed scenarios based on the most likely impacts on water demands and supplies over 51 years (from 2025 to 2075). Projections were then generated from the baseline data.

The projection scenarios developed are:

1. Status Quo: baseline volumes were carried forward through the projection period.
2. Growth: volumes were assumed to increase within specific parameters throughout the projection period.
3. Conservation: volumes were assumed to be influenced by specific conservation practices through the projection period.
4. Technology: volumes were assumed to be influenced by technological advancements through the projection period.
5. Climate: volumes were adjusted for three different climate scenarios, using a 1-degree Fahrenheit temperature increase in the mean annual temperature for the projection period, following a lower emissions pathway for Arizona; a 5-degree Fahrenheit temperature increase, following a medium emissions pathway; and a 10-degree Fahrenheit temperature increase, following a high emissions pathway.

While Colorado River water is subject to a different legal framework, the term "surface water" necessarily encompasses Colorado River water, including Central Arizona Project ("CAP") water. Therefore, Colorado River water, including CAP water, is incorporated in the estimates of available surface water supplies. The availability of Colorado River water in Arizona will be subject to operations to be determined by the Secretary of the Interior in an ongoing federal process. While significant uncertainty surrounds the reliability of Colorado River water supplies, particularly on the mainstem of the Colorado River in the Lower Basin, this report assumes that Non-Indian Agricultural (NIA) Priority CAP water will generally not be available during the projection period, but that all other Colorado River water and CAP water will be available.

4.1 SUPPLY PROJECTION RESULTS

4.1.1 Surface Water

For the Status Quo scenario, the estimated projected volume of surface water will remain constant until 2075.

Table 11. Estimated Surface Water Status Quo Projection Volumes for the Bill Williams Basin for 2025-2075. (SDR 2025)

Subbasin	Volume
Alamo Reservoir	87,160
Burro Creek	95,125
Clara Peak	36,100
Santa Maria	8,343
Skull Valley	19,630

All values are shown in AF.

Due to ongoing projection scenario improvements, no other projection scenarios were applied to surface water for this report.

4.1.2 Groundwater Storage

For the Status Quo scenario, the estimated projected balance between Supply and Demand will remain constant at 11,223 AF through 2075. However, a limitation of the Non-Model Groundwater Storage Method is that a physical upper storage limit is not recognized. This results in projected groundwater storage calculations, if in a positive balance, to unnaturally increase indefinitely. This limitation will be explored in future Method improvements.

Table 11. Estimated Groundwater Storage Status Quo Projection Volumes for the Bill Williams Basin for 2025-2075. (SDR 2025)

Scenario	2025	2050	2075
Status Quo	232,449	513,031	793,612

All values are shown in AF.

Due to ongoing projection scenario improvements, no other projection scenarios were applied to groundwater storage for this report.

4.1.3 Effluent

In the Bill Williams Basin, no effluent produced has been allocated for reuse. Therefore, no effluent is used as a water supply, and no supply projections were applied to the data.

4.1.4 Incidental Recharge

Table 14. Estimated Agricultural Incidental Recharge Projection Volumes for the Bill Williams Basin for 2025-2075. (SDR 2025)

Sector	Scenario	2025	2050	2075
Agricultural	Status Quo	759	759	759
	Climate – Low	759	764	770
	Climate – Medium	759	787	815
	Climate - High	759	814	869
	Conservation	759	759	759
	Growth	759	1,238	1,717
	Technology	759	684	609

All values are shown in AF.

- Status Quo: The Status Quo scenario estimated projected volume will remain constant through 2075.
- Climate: The Climate scenario is expected to result in rising temperatures and increased evapotranspiration, leading to increased irrigation withdrawals. Incidental recharge would be expected to increase with irrigation withdrawals. The projected increase in incidental recharge is about two percent for a 1° F rise in average temperature, eight percent for a 5° F rise, and 16% for a 10° F rise.
- Conservation: The Conservation scenario implements requirements similar to those in the initial AMAs' 5th Management Plan. In the Bill Williams Basin, average irrigation efficiency (per USGS data) already meets any such requirements. Therefore, further efficiency gains would not be expected in this scenario. This results in no projected change to total agricultural incidental recharge.
- Growth: The Growth scenario considers historical growth trends and the land available for potential agricultural growth. In this scenario, incidental recharge is assumed to change proportionally to withdrawals. Remote sensing data finds agricultural water use has increased in the Skull Valley and Santa Maria subbasins from 2016 to 2023. Projecting the observed trends to 2075 results in agricultural incidental recharge increasing from 759 AF to 1,717 AF.
- Technology: Irrigation systems are assumed to be upgraded with available technology to reduce system losses and overall water use. This also causes a reduction of agricultural incidental recharge. Technology improvements are projected to reduce water usage for sprinkler-irrigated fields in the Skull Valley subbasin, as well as for some flood-irrigated fields in the Santa Maria subbasin. The resulting projected decrease in agricultural incidental recharge across the Bill Williams Basin is approximately 20%.

Table 15. Estimated Municipal Incidental Recharge Projection Volumes for the Bill Williams Basin for 2025-2075. (SDR 2025)

Sector	Scenario	2025	2050	2075
Municipal	Status Quo	358	358	358
	Climate – Low	400	402	405
	Climate – Medium	400	412	424
	Climate - High	401	425	449
	Conservation	399	381	363
	Growth	377	456	538
	Technology	399	386	372

All values are shown in AF.

- Status Quo: The Status Quo scenario estimated projected volume will remain constant through 2075.
- Climate: Under the Climate scenario, rising temperatures and increased evaporation rates are expected to increase water demands. Projected incidental recharge volumes by 2075 are estimated to increase by approximately one percent under the low emissions scenario, six percent in the medium scenario, and 12% in the high emissions scenario.
- Conservation: Under the Conservation scenario, additional water-saving measures and requirements similar to those in the initial AMAs' 5th Management Plan are implemented. Under the scenario, water demand is expected to decrease nine percent by 2075.
- Growth: Under the Growth scenario, population projections produced by the Arizona Commerce Authority Office of Economic Opportunity (ACA OEO)[17] were used to estimate the growth in the basin. The incidental recharge is projected to increase 43% by 2075, driven by anticipated population growth and rising municipal water demand.
- Technology: The Technology scenario assumes widespread adoption of water monitoring technologies, such as advanced metering infrastructure (AMI) or home-based devices, with active leak detection and customer response. Estimated savings of 14,000 gallons per household per year reflect reductions from leaks and improved water use efficiency. This reduction is projected to result in a decrease in incidental recharge of seven percent by 2075.

[17] Arizona Commerce Authority (ACA). (2022a). Population Estimates. Arizona Commerce Authority. https://www.azcommerce.com/oeo/population/population-estimates/

Table 16. Estimated Industrial Incidental Recharge Projection Volumes for the Bill Williams Basin for 2025-2075. (SDR 2025)

Sector	Scenario	2025	2050	2075
Industrial	Status Quo	28	28	28
	Climate – Low	28	28	29
	Climate – Medium	28	29	30
	Climate - High	28	30	32
	Conservation	27	27	27
	Growth	28	28	28
	Technology	27	26	26

All values are shown in AF.

- Status Quo: The Status Quo scenario estimated projected volume will remain constant through 2075.
- Climate: Increased temperatures and evapotranspiration are expected to raise overall turf irrigation requirements in the Climate scenario. In the low emissions scenario, incidental recharge is projected to increase by 1 AF. In the medium and high emissions scenarios, incidental recharge is projected to increase by 2 AF and 4 AF, respectively.
- Conservation: Under the Conservation scenario, increased irrigation efficiency requirements are not expected to have an impact on industrial incidental recharge.
- Growth: Status Quo projection volumes were applied in the absence of a defined Growth scenario.
- Technology: The Technology scenario assumes that eligible acres of natural turf will be replaced with synthetic turf. Synthetic turf requires less water to maintain than natural grass and reduces groundwater recharge. The technology scenario is estimated to decrease industrial incidental recharge by one AF by 2075.

4.2 DEMAND PROJECTION RESULTS

4.2.1 Agricultural

Table 17. Estimated Projected Demand Volumes for the Agricultural Sector for the Bill Williams Basin for 2025-2075. (SDR 2025)

Scenarios	Year		
	2025	2050	2075
Status Quo	-2,935	-2,935	-2,935
Climate - Low	-2,935	-2,959	-2,983
Climate – Medium	-2,935	-3,055	-3,176
Climate - High	-2,935	-3,176	-3,417
Conservation	-2,935	-2,935	-2,935
Growth	-2,935	-4,810	-6,685
Technology	-2,935	-2,865	-2,795

Negative numbers indicate demands or water flows leaving the basin—all values in AF.

- Status Quo: The Status Quo scenario estimated projected volume will remain constant through 2075.
- Climate: The Climate scenario is expected to result in rising temperatures and increased evapotranspiration, leading to increased irrigation withdrawals. Irrigation needs in the Bill Williams Basin are estimated to increase by about two percent for a 1° F rise in average temperature, eight percent for a 5° F rise, and 16% for a 10° F rise.
- Conservation: The Conservation scenario implements requirements similar to those in the initial AMAs' 5th Management Plan. In the Bill Williams Basin, average irrigation efficiency (per USGS data) already meets any such requirements. Therefore, further efficiency gains would not be expected in this scenario.
- Growth: The Growth scenario considers historical growth trends and the land available for potential agricultural growth. Remote sensing data finds agricultural water use has increased in the Skull Valley and Santa Maria Subbasins from 2016 to 2023. Projecting the observed trends to 2075 results in the total irrigation withdrawal increasing from 2,935 AF to 6,685 AF.
- Technology: Irrigation systems are assumed to be upgraded with available technology to reduce overall water use. Technology improvements are projected to reduce water usage for sprinkler-irrigated fields in the Skull Valley Subbasin as well as for some flood-irrigated fields in the Santa Maria Subbasin. The total projected decrease in irrigation withdrawals across the Bill Williams Basin is approximately five percent.

4.2.2 Municipal

Table 18. Estimated Projected Demand Volumes for the Municipal Sector for Bill Williams Basin for 2025-2075. (SDR 2025)

	Residential Provider			Residential Non-Provider		
	2025	2050	2075	2025	2050	2075
Status Quo	-827	-827	-827	-308	-308	-308
Climate – Low	-1,090	-1,097	-1,104	-345	-347	-349
Climate – Medium	-1,092	-1,124	-1,157	-345	-355	-366
Climate - High	-1,093	-1,158	-1,224	-345	-366	-387
Conservation	-1,088	-1,039	-989	-344	-328	-313
Growth	-1,090	-1,242	-1,468	-325	-393	-464
Technology	-1,089	-1,052	-1,016	-344	-333	-321

Negative numbers indicate demands or water flows leaving the basin—all values in AF.

	Non-Residential			L&U		
	2025	2050	2075	2025	2050	2075
Status Quo	-363	-363	-363	-167	-167	-167
Climate – Low	-374	-374	-374	-526	-527	-528
Climate – Medium	-374	-374	-374	-526	-531	-536
Climate - High	-374	-374	-374	-527	-536	-545
Conservation	-374	-374	-374	-205	-141	-136
Growth	-380	-459	-542	-205	-238	-281
Technology	-374	-374	-374	-205	-200	-195

Negative numbers indicate demands or water flows leaving the basin—all values in AF.

- Status Quo: The Status Quo scenario estimated projected volume will remain constant through 2075.
- Climate: Under the Climate scenario, rising temperatures and increased evaporation rates are expected to increase water demands. By 2075, residential provider and residential non-provider demand is projected to increase one percent under the low emissions scenario, six percent under the medium scenario, and 12% under the high scenario. Non-residential demand is expected to remain unchanged across all scenarios. Lost and Unaccounted (L&U) for water is anticipated to show minimal increase under the low emissions scenario, a two precent increase for the medium scenario, and a three precent rise under the high scenario.
- Conservation: Under the Conservation scenario, additional water-saving measures and requirements similar to those in the initial AMAs' 5th Management Plan are implemented. By 2075, residential provider and residential non-provider demand is projected to decline

by nine percent. Non-residential demand is expected to remain constant throughout the projection period. The total volume of L&U water is projected to decrease by 34% by 2075.

- Growth: Under the Growth scenario, population projections produced by the Arizona Commerce Authority Office of Economic Opportunity (ACA OEO)[18] were used to estimate the growth in the basin. Residential provider water demand is projected to increase 35% by 2075 due to expected shifts in the service area population. Residential non-provider demand is projected to follow a similar trajectory of an overall increase of 43% by 2075. Non-residential demand is expected to rise by 43% over the projected period. The total volume of L&U water is projected to follow a similar trend with an increase of 37% by 2075.
- Technology: The Technology scenario assumes widespread adoption of water monitoring technologies, such as AMI or home-based devices, with active leak detection and customer response. Estimated savings of 14,000 gallons per household per year reflect reductions from leaks and improved water use efficiency. By 2075, residential provider and residential non-provider demand is anticipated to decline by seven percent. Non-residential demand is expected to remain constant with no changes. The total volume of L&U water is projected to reach a decrease of five percent by 2075.

[18] Arizona Commerce Authority (ACA). (2022a). Population Estimates. Arizona Commerce Authority. https://www.azcommerce.com/oeo/population/population-estimates/

4.2.3 Industrial

Table 19. Estimated Projected Demand Volumes for the Industrial Sector for Bill Williams Basin for 2025-2075. (SDR 2025)

	Grazing	Sand and Gravel
Status Quo	-262	-36

Status Quo projections were the only projection scenarios that were applied to the grazing and sand and gravel subsectors. Negative numbers indicate demands or water flows leaving the basin—all values in AF.

Due to ongoing projection scenario improvements, no other projection scenarios were applied to the grazing and sand and gravel subsectors for this report.

	Power			Turf		
	2025	2050	2075	2025	2050	2075
Status Quo	-5	-5	-5	-245	-245	-245
Climate – Low	-5	-5	-5	-251	-253	-255
Climate – Medium	-5	-5	-5	-251	-260	-269
Climate - High	-5	-5	-5	-252	-269	-287
Conservation				-251	-237	-237
Growth	-5	-6	-6			
Technology	-5	-3	-2	-244	-238	-232

Status Quo projection values were applied in the absence of a defined scenario for a subsector. This is indicated by a gray cell.
Negative numbers indicate demands or water flows leaving the basin—all values in AF.

- Status Quo: The Status Quo scenario estimated projected volume will remain constant through 2075.
- Climate
  - Power: The Climate scenario considers changes in consumer electrical demand and changes in power plant operations resulting from higher temperatures. The Climate scenario is not projected to have an impact on water use for power production.
  - Turf: Increased temperatures and evapotranspiration are expected to raise overall turf irrigation requirements in the Climate scenario. Irrigation demands are projected to increase by 4 AF in the low emissions scenario, 18 AF in the medium emissions scenario, and 35 AF in the high emissions scenario.
- Conservation
  - Turf: Under the Conservation scenario, increased irrigation efficiency requirements are expected to decrease turf water demand by 14 AF, or six percent.

- Growth
    - Power: The Growth scenario considers the impact that population growth, planned decommissions of existing power plants, and additions of permitted power plants will have on water demand for power production. This scenario is not projected to have a significant impact on the water use for power production in the Bill Williams Basin. By 2075, power water demand is estimated to increase by 1 AF.
- Technology
    - Power: The implementation of consumer-side and utility-side technologies is projected to reduce demand by 3 AF by 2075.
    - Turf: In the Technology scenario, it is assumed that eligible acres of natural turf will be converted to synthetic turf. The conversion of natural turf to synthetic turf is projected to decrease irrigation needs in the basin by 12 AF, or five percent, by 2075.

4.2.4 Environmental

Table 20. Estimated Projected Environmental Demand Volumes for Bill Williams Basin for 2025-2075. (SDR 2025)

	Environmental		
	2025	2050	2075
Status Quo	-16,479	-16,479	-16,479
Climate – Low	-16,479	-16,579	-16,659
Climate – Medium	-16,479	-16,787	-17,063
Climate - High	-16,479	-17,075	-17,568

Negative numbers indicate demands or water flows leaving the basin—all values in AF.

- Status Quo: The Status Quo scenario estimated projected volume will remain constant through 2075.
- Climate: The Climate scenarios for riparian use consider the impact of increased temperatures, increased evapotranspiration, and habitat transition. Under the set parameters of these scenarios, riparian consumption is expected to increase in the Bill Williams Basin as higher temperatures increase evapotranspiration from riparian plants. Riparian water consumption is estimated to increase by one percent in the low emissions scenario, four percent in the medium emissions scenario, and seven percent in the high emissions scenario.

5 CONCLUSION

The balance between water supplies and demand in the Bill Williams Basin has been positive during the baseline period. Estimated groundwater storage increased from 179,915 AF in 1990 to 221,226 AF in 2024. The largest contributor to supply has been streamflow infiltration, averaging

39,596 AF per year. If groundwater levels were to drop below the basin's average well depth of 262 feet, approximately 70% of existing wells would become dry. The average recorded water level of wells in Bill Williams Basin is 106 feet.

Streamflow estimates for Bill Williams Basin covered an extensive range. Three subbasins (Alamo Reservoir, Burro Creek, and Clara Peak) eclipsed 600,000 AF for their maximum streamflow estimations, while their minimum streamflow values were all under 13,000 AF, with Clara Peak's being the least at 215 AF in 1990. Mountain-front recharge was a major contributor to supply in the basin, averaging just over 17,000 AF per year.

Demand in the basin peaked in 1994 at 36,311 AF before steadily decreasing through the remainder of the baseline period. Agricultural demand averaged 18,500 AF between 1990 and 1994, before significantly decreasing to 4,200 AF in 1995. After this notable decrease in Agricultural demand, Environmental then became the largest demand sector for the basin, averaging 16,479 AF per year. All Municipal subsectors showed increased demand throughout the baseline period, with residential provider exhibiting the greatest increase from 20 AF to 1,090 AF

The Bill Williams Basin maintained an overall positive water balance during the baseline period.

5.1 ATTACHMENTS

- **Acronyms and Definitions**
- **References (Sources) – general**