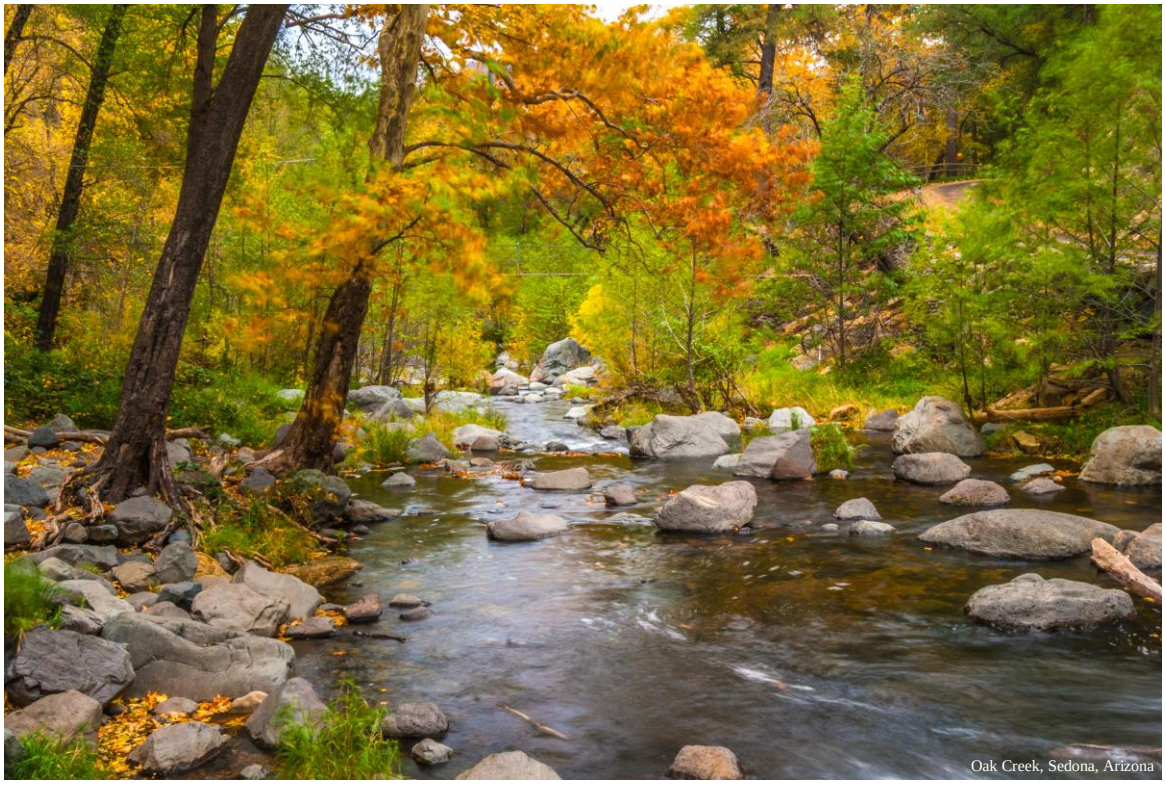
2017
Arizona Drought Preparedness Annual Report

For Water Year 2017: October 1, 2016 – September 30, 2017



Oak Creek, Sedona, Arizona

ARIZONA DEPARTMENT OF WATER RESOURCES
EST. 1980

PROTECTING
ARIZONA'S WATER SUPPLIES
for ITS NEXT CENTURY

2017 Arizona Drought Preparedness Annual Report

Acknowledgements

The *Arizona Drought Preparedness Plan* was adopted in 2004 and its continued implementation ordered in 2007 (EO 2007-10). The Arizona Department of Water Resources (ADWR) prepares the report each year based on updates from the Governor's Drought Interagency Coordinating Group, Drought Monitoring Technical Committee, Local Drought Impact Groups, and others. The Arizona 2017 Drought Preparedness Annual Report covers the drought conditions and preparedness activities for the 2016 water year, from October 1, 2016 through September 30, 2017. ADWR acknowledges and thanks all who contributed to this report.

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2017 Arizona Drought Preparedness Annual Report

1. Introduction

Arizona has been in a state of long-term drought since the mid-1990s. During that time, 16 of the last 23 years have been drier than normal statewide. Increasing temperatures, particularly in the winter, have led to fewer snow events, reducing the snowpack and spring run-off into the reservoirs and aquifers. This past winter brought near average precipitation to Arizona northern and eastern watersheds, but was relatively dry in the southeastern watersheds. The monsoon rainfall was highly localized and storm activity ended early in September, followed by unusually high temperatures and dry conditions. The Salt-Verde reservoir system water storage has improved from 47% of capacity last year to 65% of reservoir capacity. Above average streamflow was observed throughout much of the Colorado River Basin, which also improved water supply conditions for the State.

The current seasonal outlook from the National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center is for below average winter precipitation in Arizona and the southern tier of the United States. When coupled with the temperature outlook for a warmer than normal winter, the water resource situation is not expected to improve in the short term. Arizona's Drought Preparedness Plan activities continue to provide a framework to monitor drought conditions, improve understanding of drought impacts, and determine mechanisms for limiting future vulnerability.

2. Drought Status Summary

2.A. Winter Precipitation: October 2016 – April 2017

The winter of 2015-16 (**Fig. 1**) was much wetter than the previous four years in the upper Colorado River Basin as well as on the Little Colorado River and Upper Colorado River Watersheds in Arizona. The rest of Arizona was quite dry at less than 80% of average. By comparison, the winter of 2016-17 was significantly wetter across the entire Colorado River Basin (**Fig. 2**). The Salt-Verde, Agua Fria and Lower Gila Watersheds all received 110 to 120% of average precipitation and the Upper Gila, San Pedro and Santa Cruz Watersheds were all at or above 100% of average precipitation. While the winter began with dry conditions in October, November through February were extremely wet across the higher elevations of northern and eastern Arizona. Dry conditions returned in March and April, but the overall winter was much wetter than average across the western two-thirds of Arizona. This was an El Niño Southern Oscillation (ENSO) neutral year, but the wet conditions on the Upper Basin over two consecutive years have provided much needed inflow to Lakes Powell and Mead. Lake Powell's elevation increased by 17.61 feet and Mead's elevation rose by 6.82 feet this past year.

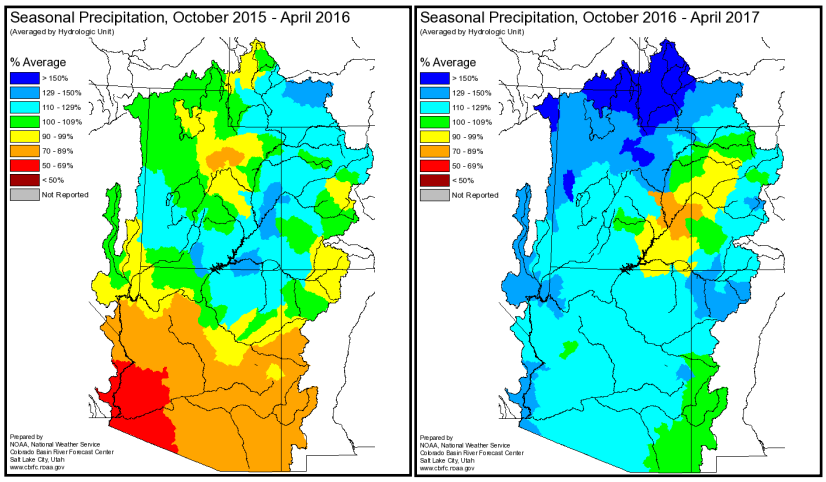


Figure 1 (left). Precipitation Oct. 2015- Apr. 2016

Figure 2 (right). Precipitation Oct. 2016 - Apr. 2017

Snow accumulation during the winter season (**Fig. 3**) was about normal across the State. Heavy storms in late January and February brought the snowpack up temporarily. However, very little snow accumulated for the remainder of the season and the statewide snowpack ended up at about the 30-year median.

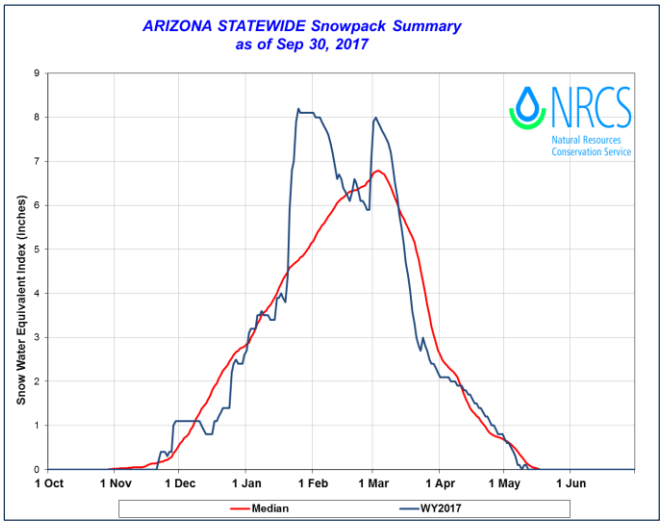


Figure 3. 2017 Snowpack Summary According to Data Collected from the USDA Natural Resources Conservation Service.

2.B. Monsoon Precipitation: June – September 2017

The 2016 monsoon rainfall (**Fig. 4**) was much less localized than the 2017 monsoon rainfall (**Fig. 5**). Southern Arizona, which depends on summer precipitation, was left quite dry in many locations, and the Colorado Plateau had a very dry monsoon season. Mohave County was one of the wettest counties this summer with well over 150% of average rainfall across much of the county. A few locations, like Tucson, had an extremely wet July, but the statewide totals through the summer were generally near to below average. The northeast quarter of the State, above the Mogollon Rim was extremely dry as was most of Yuma County. Unlike the past several years, very few eastern Pacific hurricanes moved northward up the coast to augment the monsoon with tropical moisture.

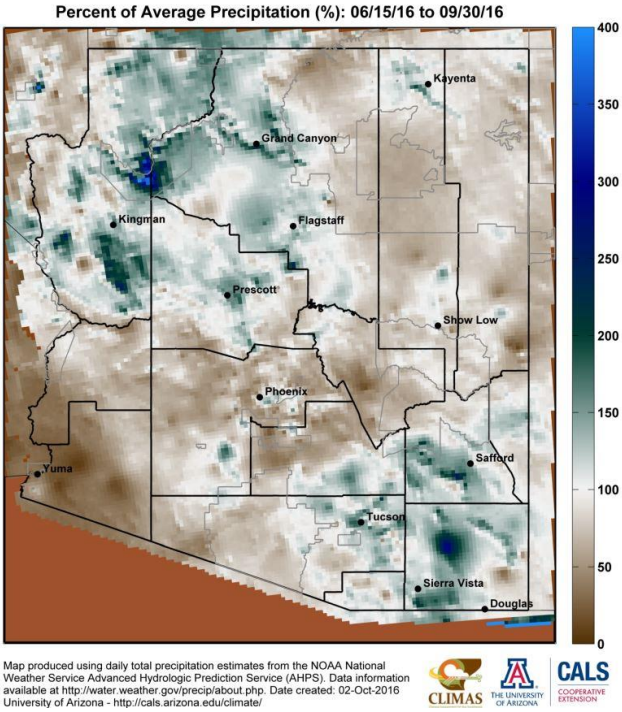


Figure 4. Monsoon 2016 percent of Normal Rainfall

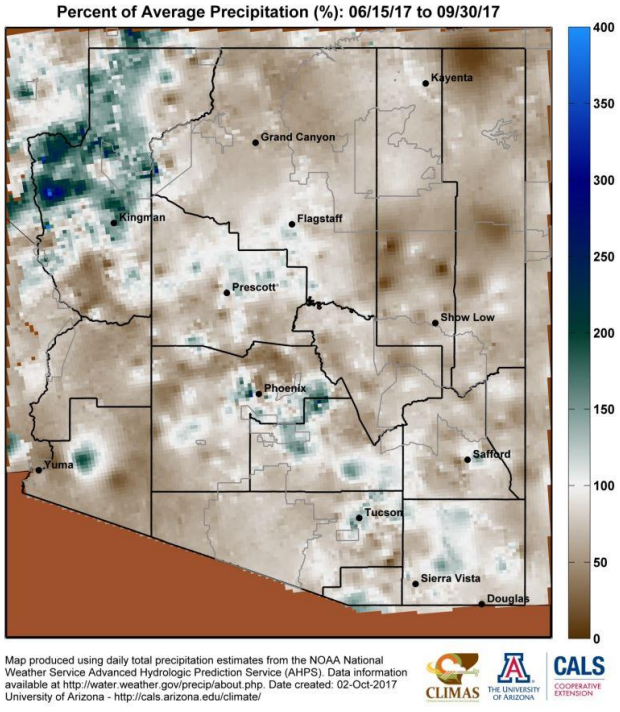


Figure 5. Monsoon 2017 percent of Normal Rainfall

2.C. Cumulative Precipitation and Streamflow Summary

Precipitation

Cumulative precipitation for water year 2017 ended up at about normal levels throughout the mountainous areas of Arizona, ranging from 91% to 114% of average in the major river watersheds. A normal winter was followed by a normal monsoon which resulted in the average conditions for the entire water year (**Table 1**).

Table 1. Water Year 2017 Mountain Precipitation (as of September 30, 2017)	
Major watersheds	**Percent of 30-year Average Precipitation**
Salt River Watershed	97%
Verde River Watershed	114%
San Francisco-Upper Gila River Watersheds	91%
Little Colorado River Watershed	108%

Streamflow

Overall drought status as indicated by streamflow data shows a decrease in drought severity throughout Arizona from 2016 to 2017 **(Fig. 6)**. Most watersheds are showing no drought to abnormally dry conditions similar to 2016 (16 in these two categories in 2016, and 17 in 2017). Watersheds that increased drought status did so by one to two drought categories; those that decreased also did so by one or two categories. Out of the 25 watersheds; six remained at the same level, 11 decreased, and eight increased in drought severity.

The reduction in drought severity based on streamflow is the result of precipitation intensity and timing during the winter along with snow melt in the spring. In addition, monsoon storms produced significant runoff, especially in the month of July.

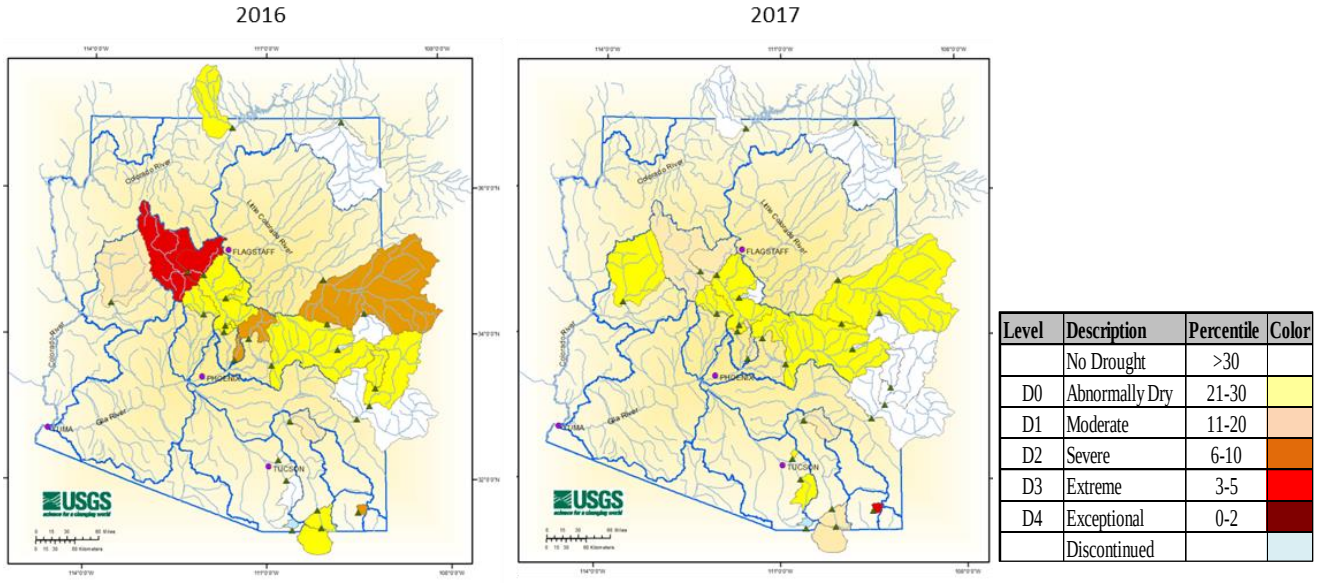


Figure 6. Overall drought condition improvement from 2016 to 2017, as determined by USGS stream gages.

2.D. Water Supply Status

Colorado River Basin and Reservoir Status[1]

Above average streamflow was observed throughout much of the Colorado River Basin during water year 2017. Unregulated[2] inflow to Lake Powell in water year 2017 was 11.91 million acre-feet (MAF), or 110% of the 30-year average[3], which is 10.83 MAF. Unregulated inflow for the 2017 runoff season (April through July) to Flaming Gorge, Blue Mesa, and Navajo Upper Basin Reservoirs was 226, 136, and 106% of average, respectively. Cumulative precipitation received within the Upper Colorado River Basin during water year 2017 was 109% of average. The Colorado River total system storage experienced a net increase of 2.75 MAF in water year 2017. Reservoir storage in Lake Powell increased by 1.85 MAF. Reservoir storage in Lake Mead increased by 0.57 MAF. At the beginning of water year 2017 (October 1, 2016), Colorado River total system storage was 51% of capacity. As of September 30, 2017, total system storage was 55% of capacity.

Snowpack conditions throughout the snow accumulation season also trended above average across most of the Colorado River Basin. The basin-wide snow-water equivalent measured 122% of average on April 1, 2017. Total seasonal accumulation peaked at approximately 126% of average on March 10, 2017. On April 1, 2017, the snow-water equivalents for the Green River, Upper Colorado River Headwaters, and San Juan River Basins were 157, 97, and 120% of average, respectively.

During the 2017 spring runoff period, inflows to Lake Powell peaked on June 13, 2017, at approximately 60,600 cubic feet per second (CFS). The April through July unregulated inflow volume for Lake Powell was 8.17 MAF which was 114% of average. Lower Basin tributary inflows above Lake Mead were near average for water year 2017. Tributary inflow from the Little Colorado River totaled 0.130 MAF, or 90% of the long-term average. Tributary inflow from the Virgin River totaled 0.159 MAF, or 88% of the long-term average. Tributary inflows in the Lower Colorado River Basin below Hoover Dam were below average during water year 2017. Total tributary inflow from the Bill Williams River was 0.022 MAF, and total tributary inflow from the Gila River was 0.006 MAF.

At the beginning of calendar year 2017, the probability of a Colorado River Lower Basin shortage declaration in 2018 was 34%. Due to the projected increased runoff from the snowpack in the Upper Basin and conservation programs designed to leave water in Lake Mead, April 2017 projections by the United States Bureau of Reclamation (Reclamation) for a shortage in 2018 decreased to less than 1%. The official operational forecast for 2018 made by Reclamation in August shows a 0% chance of shortage in 2018 and 15% chance of a shortage declaration in 2019.

Salt and Verde Reservoirs

This is the first above-median runoff season (January-May) in the last seven years that the Salt and Verde Watersheds have experienced. As a result, during runoff season Roosevelt Lake increased from 35% to 71% full and Bartlett and Horseshoe reservoirs on the Verde system went from 45% full to 100% full, and even had to spill some water. For the first time since 2010, water was also spilled over Granite Reef Dam. During the monsoon season, normal precipitation was received for the entire summer; however, its distribution was heavily weighted to July, resulting in well above normal monthly precipitation. The monsoon storms diminished rapidly in August and since then, dry conditions persisted across the entire system. As of October 1,

[1]Information in this section was taken from the United States Bureau of Reclamation's draft "Annual Operating Plan for Colorado River Reservoirs 2018." The information has been updated to the end of the 2017 water year, where appropriate and where data was available.
[2]Unregulated inflow adjusts for the effects of operations at upstream reservoirs. It is computed by adding the change in storage and the evaporation losses from upstream reservoirs to the observed inflow. Unregulated inflow is used because it provides an inflow time series that is not biased by upstream reservoir operations.
[3]All unregulated inflow, precipitation, and snowpack statistics are based on the 30-year period 1981-2010.

2017, total storage of the Salt and Verde system was at 65% capacity, compared to 47% at this time last year. Past winters with similar climate predictions have resulted in dry or wet winters, making this upcoming winter fairly unpredictable.

2.E. Drought Index Wells

Two ADWR groundwater index wells located in southeastern Arizona serve as qualitative supplements to existing drought indicators (**Fig. 8**). Both wells have been identified as meeting criteria for the United States Geological Survey (USGS) Climate Response Network observation wells. Continuous groundwater levels for each well are plotted in Figures 9-10, with colored overlays corresponding to historical short- or long-term drought categories (of the watershed if before March 2010, or at the location of groundwater level measurement if after March 2010). The solid blue lines represent historical daily median depth-to-water (DTW) below land surface during the periods of record shown. DTW measurements are recorded near-continuously (four times per day) via a pressure transducer and verified with less frequent manual measurements (four times per year).

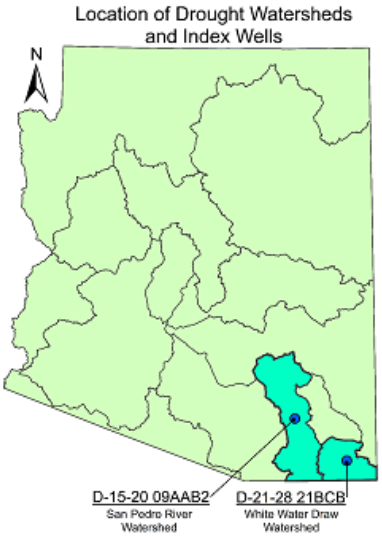


Figure 8. Arizona drought watersheds (WS).
Well # D-15-20 09AAB2 is located near the center of the San Pedro River WS.
Well # D-21-28 21BCB is located near the center of the Whitewater Draw WS.

Watershed Groundwater Index Well

Figure 9 depicts a continuous record of water level data for ADWR Index Well "D-15-20 09AAB2", located in the San Pedro River Watershed. Monitoring at this site began on June 7, 2009 with an initial depth to water of 32.21 feet. The record minimum depth to water of 26.1 feet was observed on September 20, 2014. The maximum record depth to water of 33.89 feet has been observed on two separate occasions, first on July 4, 2014, and again on July 13, 2017. This year has shown a continuation of a clear seasonal pattern in the hydrograph, with slightly better than average recharge carrying on through July 2017. Similar to previous years, declines in water levels were observed throughout the spring and fall seasons. Projection of seasonal pattern suggests that declines will likely continue until winter precipitation events bring additional recharge to the area. Long-term drought designations continue to reflect the observable trends in the hydrograph. This is particularly evident during the Spring of 2017, as water levels declined to record lows and the drought category increased in severity.

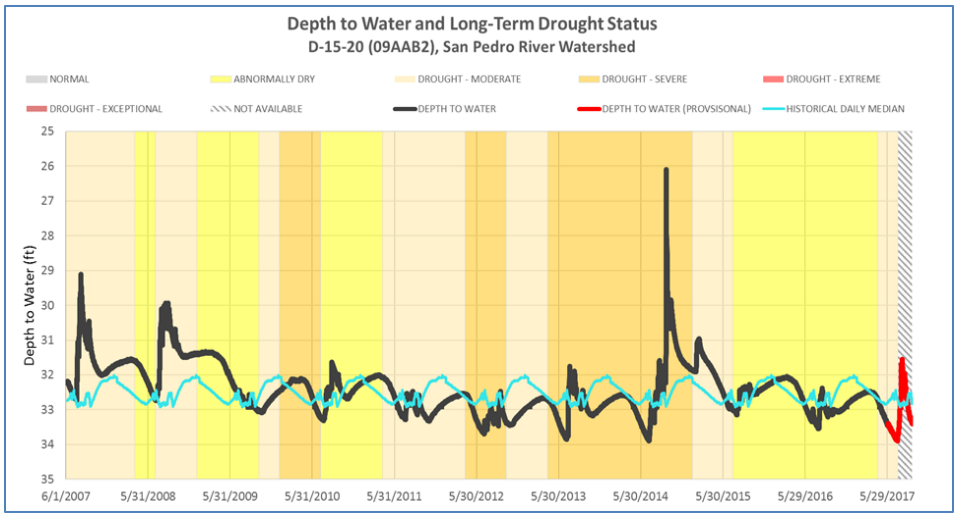


Figure 9. Continuous groundwater levels for drought index well in the San Pedro River Watershed, plotted with long-term drought status, and historical daily median depth-to-water.

Whitewater Draw Watershed Groundwater Index Well

Figure 10 depicts a continuous record of water level data for ADWR Index Well "D-21-28 21BCB", located in the Whitewater Draw Watershed. Monitoring at this site began on April 9, 2009, with an initial depth to water of 4.76 feet. The minimum record depth to water of 1.40 feet was recorded on January 31, 2015. The maximum recorded depth to water of 18.35 feet was observed on September 13, 2012. Steady declines in water level persisted from early 2015 through mid-2017, resulting in over 12 feet of total decline of the water table. As of July 2017, the hydrograph shows a positive trend, with water levels rebounding nearly 10 feet over the course of two months. The declines observed between 2015 and 2017 are not reflected well in the corresponding long-term drought designations, as the drought category decreased in severity.

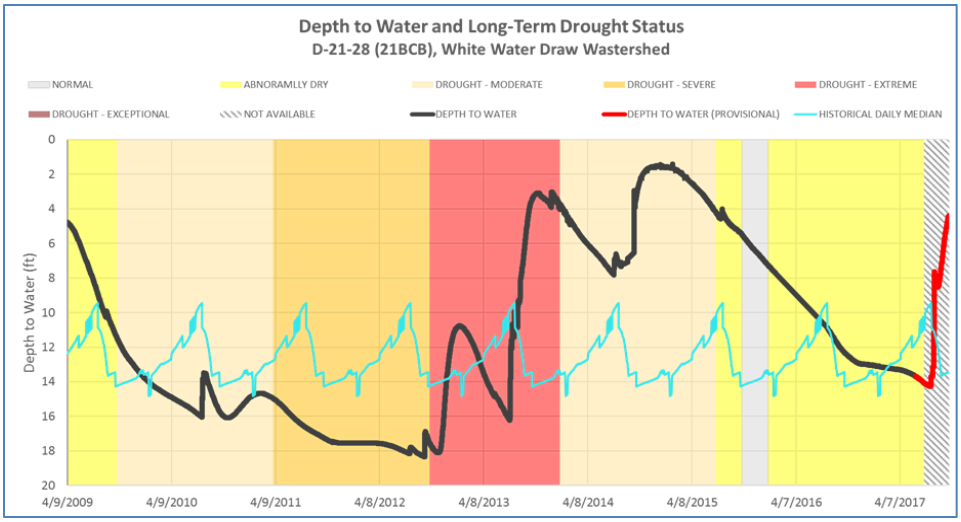


Figure 10. Continuous groundwater levels for drought index well in the Whitewater Draw Watershed, plotted with long-term drought status, and historical daily median depth-to-water.

2.F. Drought Declarations

A Drought Emergency Declaration has been in effect in Arizona since 1999. The current declaration, PCA 99006, was issued by the Governor in June 1999 and continued by Executive Order 2007-10. The declaration maintains the State's ability to provide emergency response if needed, and enables farmers and ranchers to obtain funding assistance through the Farm Service Agency if they experience significant production losses due to drought.

The Drought Interagency Coordinating Group (ICG) is responsible for providing recommendations to the Governor regarding drought declarations based on presentations and discussions at the spring and fall ICG meetings (see 3.B).

2.G. Disaster Designations

A disaster designation from the Secretary of the U.S. Department of Agriculture (USDA) is necessary for farm operators in both primary and contiguous disaster areas to be considered for assistance from the Farm Service Agency.

The USDA uses the U.S. Drought Monitor to help determine designations. Extreme (D3) or Exceptional (D4) drought conditions qualify as automatic designations, while severe (D2) drought for eight consecutive weeks during the growing season qualifies for nearly automatic designation. This "Fast Track" authority designation process delivers fast and flexible assistance to farmers and ranchers.

The following disaster designations by the U.S. Department of Agriculture occurred this water year:

- November 9, 2016: One county (Graham) was named as a primary disaster county, which resulted in the designation of seven contiguous counties in Arizona, due to an excessive hail storm.
- February 24, 2017: Two counties (La Paz and Mohave) were named as contiguous disaster counties, resulting from the designation of 24 counties in California as primary disaster counties.
- March 6, 2017: Two counties (La Paz and Yuma) were both designated as primary disaster counties; the four contiguous disaster counties (Maricopa, Mohave, Pima and Yavapai) also received disaster designations.
- March 6, 2017: Two counties (La Paz and Yuma) were named as contiguous disaster counties, which was the result of the designation of one county in California as a primary disaster county.
- March 16, 2017: One county (La Paz) was named as a contiguous disaster county, which was the result of the designation of 16 counties in California as primary disaster counties, due to severe winter storms.

2.H. Drought Status Changes

Arizona's drought status is continually monitored and updated. The short-term drought status is updated weekly and monthly. The long-term drought status is updated seasonally at the end of each quarter.

Short-term Drought Status

At the start of the Water Year the State was quite dry after a very dry El Niño winter of 2015-16, and a disappointing monsoon season (**Fig. 11**). The 2016-17 winter through April was quite wet across the western U. S. and the northern two-thirds of the State received sufficient rain and snow to alleviate short-term drought (**Fig. 12**). Southern Arizona did not receive as many winter storms and remained warm through the winter.

Spring was quite dry in southern Arizona, which prevented any short-term drought improvement. By the time the monsoon activity began, the moisture deficits were significant, and the monsoon rainfall was not sufficient to make up the deficits in south central and southwestern Arizona, even though Tucson had the wettest July ever with 6.80" of rain. Much of Graham and Cochise Counties had frequent rain showers and short-term drought was eliminated there by the end of the summer (**Fig. 13**).

Northern Navajo and Apache Counties were in good shape through the winter, but the relatively dry spring and summer brought abnormally dry conditions back by September. By the end of 2017 water year, 37% of the State had no drought condition, 62.49% was abnormally dry and 10.69% was in moderate drought.

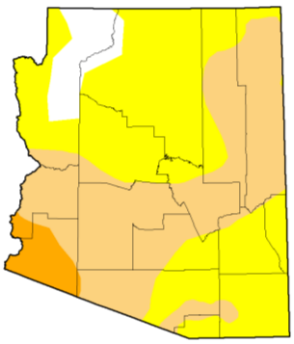


Figure 11. Sep. 27, 2016 short-term drought status

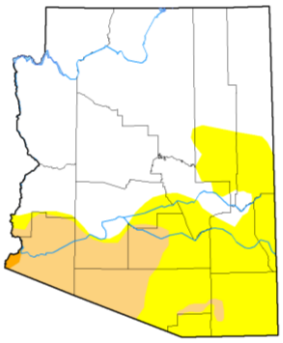


Figure 12. Apr. 26, 2017 short-term drought status

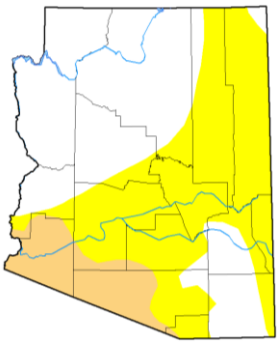


Figure 13. Sep. 27, 2017 short-term drought status

Level	Description	Percentile	Color
	No Drought	>30	
D0	Abnormally Dry	21-30	
D1	Moderate	11-20	
D2	Severe	6-10	
D3	Extreme	3-5	
D4	Exceptional	0-2	

Long-term Drought Status

Long-term drought status has been determined using two different methods. One is the traditional watershed method, the "Standardized Precipitation Index" (SPI), which is calculated from watershed-average precipitation and streamflow rankings. The other is the gridded method, the SPI and "Standardized Precipitation–Evaporation Index" (SPEI), which is calculated from gridded precipitation data (see section 3.A for more information on the Gridded Method).

The traditional watershed-average method shows the long-term status is relatively unchanged over the past year, with the western watersheds out of drought and the eastern watersheds Abnormally Dry (D0) (**Fig. 16 & Fig. 17**). San Pedro Watershed degraded to Moderate Drought (D1), and Verde River Watershed improved to Abnormally Dry. Bill Williams and Salt River Watersheds improved from Abnormally Dry to No Drought. The number of watersheds in each drought category over the last three years, as of October, can be seen in **Table 2.**

Based on the current methodology for assessing drought in Arizona, the State has been easing out of drought for the past two years. However, while the drought appears to be easing, it is not over, since the reservoirs are only about 65% full, and the groundwater aquifers have not recovered to their pre-drought levels. Though the long-term maps incorporate streamflow, not all watersheds have sufficient streamflow data to be included, so they are depicted based solely on the standardized precipitation index.

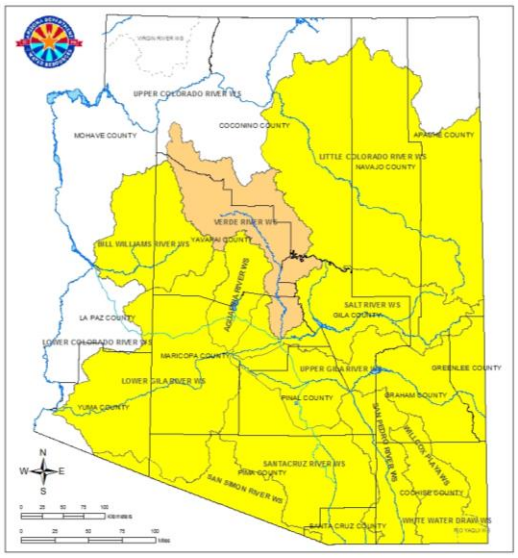


Figure 14. Long-term drought status as of Oct. 2016.

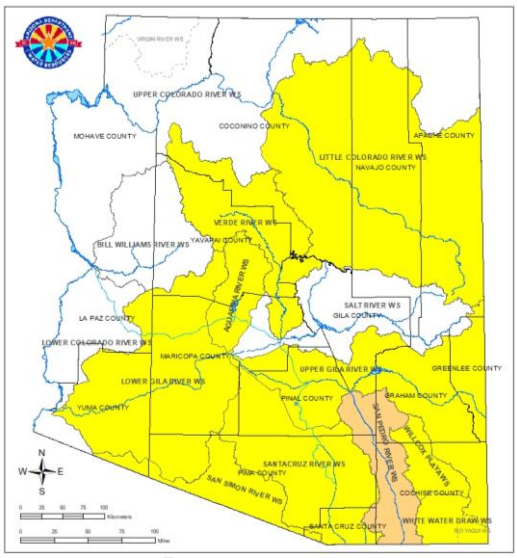


Figure 15. Long-term drought status as of Oct. 2017.

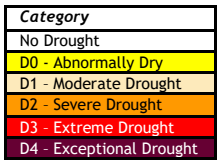


Table 2. Number of Watersheds in Each Drought Category

Category	2015	2016	2017
No Drought	6	3	5
D0 - Abnormally Dry	8	11	9
D1 – Moderate Drought	1	1	1
D2 – Severe Drought	0	0	0
D3 – Extreme Drought	0	0	0
D4 – Exceptional Drought	0	0	0

The SPI graph (**Fig. 16**) shows the changes in drought over time: Short-term drought conditions (0 – 15 months) are at the bottom, and longer-term drought conditions (48 – 60 months) are near the top. The bottom bar graph shows the monthly anomalies with green being wetter than average and brown being drier than average.

Across the top of the SPI graph there are two wet long-term periods, the first from 1981 through spring of 1988, followed by a short abnormally dry period from spring 1990 through the summer of 1992. The second wet period began in the winter of 1992 and continued through the winter of 1994 when the current long-term drought began. The most intense period of the current drought for Arizona was 2002 through 2004, however, the long-term drought continues in the State. There is some easing in the short-term at the bottom right of the graph, and the current long-term drought is also slightly easing. This is not enough to determine if the easing will continue through the next several years to make up for the current deficit. One relatively wet winter is insufficient to bring the State out of drought and the current dry conditions in the fall could reduce the effective runoff in spring if the soil remains dry before the first snow. For more information about how the graph can be used to correlate precipitation and drought impacts, visit the University of Arizona Climate Science Application Program website at: http://cals.arizona.edu/climate/misc/spi/spicontour.png.

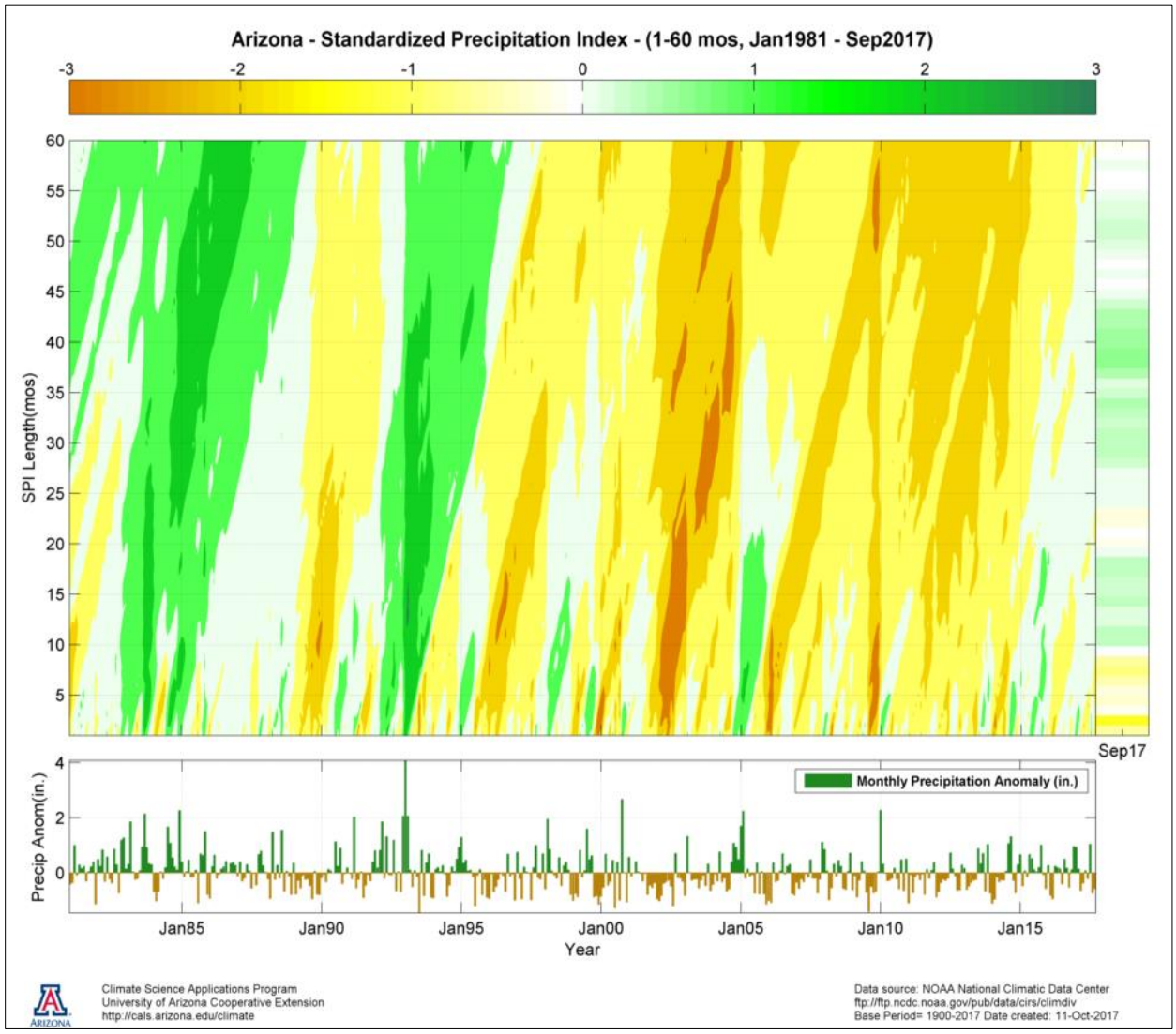


Figure 16. Standardized precipitation index and precipitation anomalies.

2.I. Outlook for Water Year 2018

Winter 2017-2018

Pacific Ocean temperatures near the equator are once again falling below average this autumn and winter (i.e. La Niña). Unlike last year where La Niña was weakening heading into the winter, this La Niña phase may be strengthening during the height of the winter season. At this point, there is better than a 60% chance of La Niña forming and persisting through the winter with more neutral conditions developing towards spring 2018.

The eventual strength of this La Niña phase may ultimately determine the likelihood of drier than normal weather this winter. A weak La Niña is the most likely outcome this year and may only have limited influence on weather systems entering Arizona (much like last winter 2016-17). A more moderate La Niña is still possible though less likely and would tilt the odds much more definitively towards a drier winter. At this point, there are conflicting signals regarding the ultimate magnitude and influence of this La Niña. These varied potential outcomes in La Niña strength lead to a limited predictive capability for winter 2017-18 rain and snow forecasts across Arizona.

The official outlooks from NOAA's Climate Prediction Center (**Fig. 17**) for January-March 2018 show a much better chance that the average temperature will fall in the above normal category. This is supported not only by forecast models and the influence of La Niña, but more so the fact that Arizona winters are distinctly trending warmer over the past 10-20 years. The precipitation outlook depicts a slight tilt in odds towards the drier than average category. This is primarily a result of the La Niña forecast this winter. Should La Niña conditions become stronger through the fall and winter, these odds may lean even more towards the drier than average side.

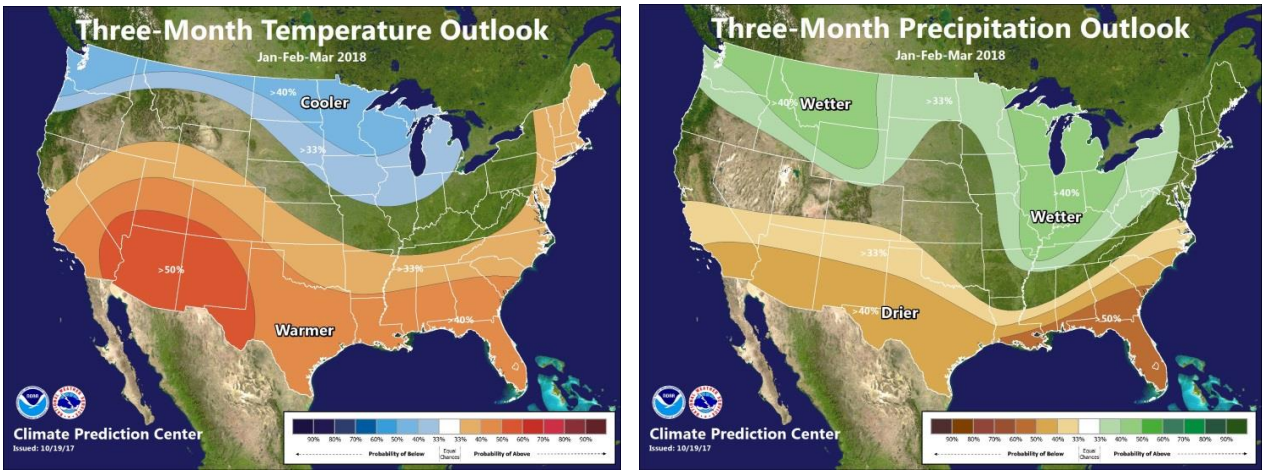


Figure 17. Climate Prediction Center outlooks for temperature (left) and precipitation (right) for January – March 2018. Shading indicates the increased odds of being above or below normal. EC indicates Equal Chances of above, below, or near normal.

Summer 2018

The Climate Prediction Center's outlook for July-September 2018 (**Fig. 18**) shows much better chances that the average temperature during these three months will be above normal. This outlook is based almost exclusively on clear trends over the past 10-20 years versus the longer term 30-year average. The precipitation outlook shows no dependable forecast signal during this period over Arizona. That is, there are equal chances for the 2018 monsoon season to have above, below, or near normal rainfall. This is common for the Southwest monsoon where

thunderstorm activity is typically very localized and not influenced by larger scale climate signals.

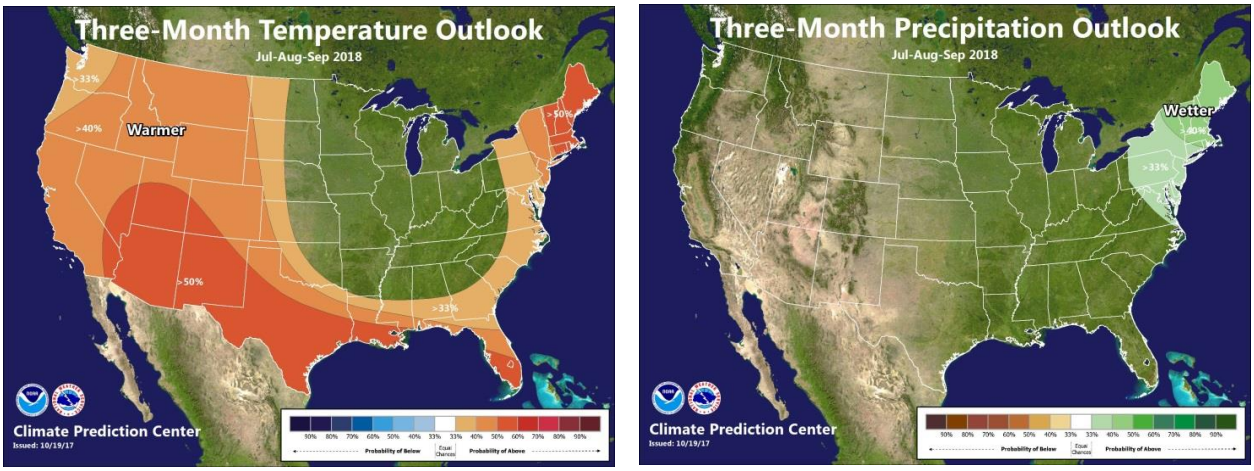


Figure 18. Climate Prediction Center outlooks for temperature (left) and precipitation (right) for July – September 2018. Shading indicates the increased odds of being above or below normal. EC indicates Equal Chances of above, below, or near normal.

3. Drought Preparedness Plan Implementation Highlights

3.A. State Drought Monitoring Technical Committee Efforts

The Arizona Drought Monitoring Technical Committee (MTC) is responsible for gathering drought, climate, and weather data, and disseminating that information to water and land managers, policy-makers and the public. Specifically, the MTC prepares the short- and long-term drought status reports, briefs the ICG on drought conditions, and provides assistance to Local Drought Impact Groups (LDIGs). The two co-chairs are Nancy Selover, State Climatologist, and Mark O'Malley, National Weather Service, Phoenix Office.

Communicating Drought Status

The MTC and ADWR coordinate to achieve the primary goal of improving the accessibility of drought information to resource managers, State decision-makers and the public. To further communication, information is updated on the ADWR Drought Status webpage on a weekly, monthly and quarterly basis as follows:

Weekly - The MTC confers weekly with: The National Weather Service offices that cover Arizona; Flood Control Districts; LDIGs; water and rangeland managers; agricultural extension offices; and others who observe and report drought impacts. This is done to advise the U.S. Drought Monitor authors on the State's current drought conditions and provide recommendations on the drought boundaries for Arizona. The U.S. Drought Monitor is the official record of drought for Federal drought relief claims. Information used by the MTC in advising the Drought Monitor authors includes numerous drought indices, precipitation and stream flow data, and impacts data. Every Thursday, ADWR's Drought Status webpage automatically updates with the latest U.S. Drought Monitor map of Arizona.

Monthly - At the end of each month, the MTC produces a web-based, short-term drought status update based on the U.S. Drought Monitor's maps for the past four weeks, with an explanation of how drought conditions have changed in Arizona over the preceding month. An email with the latest map and summary is sent to interested parties.

Quarterly - The MTC meets on a quarterly basis and produces a long-term drought status map and summary report using watershed precipitation averages to calculate the SPI. This report incorporates the 24-, 36- and 48-month precipitation and streamflow percentiles for major Arizona watersheds (i.e., 4-digit USGS Hydrologic Unit Code (HUC)). Vegetation indices, snowpack, temperature, reservoir levels, and county-scale drought impact information are used to verify or modify the result of the calculations. The long-term drought status reports are posted on the ADWR website and disseminated via email seasonally: in May (for January – March); August (for April – June); November (for July – September); and February (for October – December).

The MTC is currently evaluating gridded SPI and SPEI data to create higher resolution drought maps for the long-term drought status. The data sets incorporate a much longer time period, so they are not so heavily biased toward drought years, and they convey the spatial variation across watersheds that the averaging method does not. Currently, the SPI alone shows very little drought across the State (which is contrary to the impact data) and the SPEI alone shows worse drought conditions than the impact data reflect. The impact data and observations suggest some combination of the two indices, which is currently being explored.

The gridded maps will provide smoother transitions across the State rather than the watershed boundaries. The results should be more reflective of the Drought Monitor maps and will facilitate internal decision making. Even though drought declarations may be made at the county level, the higher resolution data will provide better information about which parts of individual counties are having the worst drought problems. Below are examples of the gridded maps (**Fig. 19**).

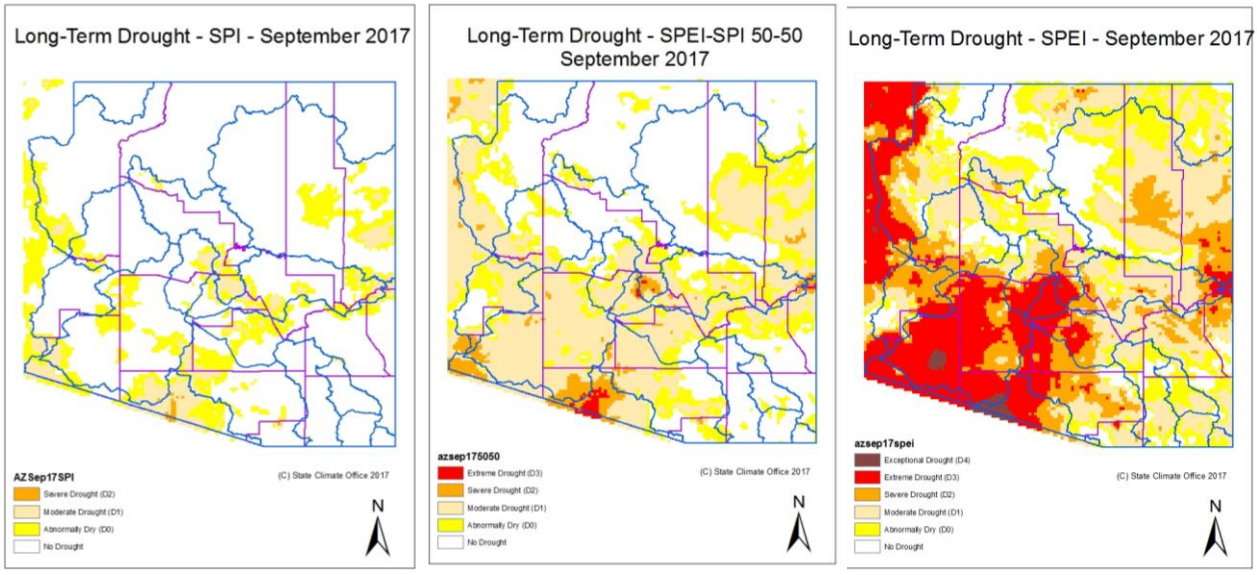


Figure 19. Long-term drought maps based entirely on SPI, a combination of both SPI and SPEI, and entirely on SPEI. These maps are being evaluated to determine what combination of these two indices best reflects the long-term drought status across the State.

Arizona DroughtView

DroughtView, a University of Arizona program that replaced DroughtWatch, is an online tool for collecting drought impact data that incorporates several remote sensing and climate drought monitoring products. The tool can be used to track high-resolution (~250m) changes in remotely sensed 'greenness' (Normalized Differenced Vegetation Index) data collected on a bi-weekly basis from the NASA MODIS satellite. This index can be particularly useful for tracking changes in rangeland conditions related to livestock forage production and forest drought stress which

can indicate longer-term drought impacts and wildfire risk. For more information, visit the University of Arizona DroughtView website at http://droughtview.arizona.edu/.

Community Collaborative Rain, Hail, and Snow (CoCoRaHS) Network

The CoCoRaHS network of citizen precipitation observers in Arizona continues to expand. There is a new drought impact reporting tool called "Condition Monitoring" where some of the 1,270 observers in Arizona are adding weekly observations of the condition of vegetation, water bodies and wildlife that reflect drought impacts. Since the observers simply note the conditions they observer every week, they do not require extensive training to provide useful information.

Drought Detection for Ranch-Scale Tools

Drought creates both production and legal risks to ranches as they typically rely on federal lands for 50-90% of their forage, and policies for these rangelands dictate responses regarding herd reduction, reduced access to forage, and a lengthy approval process to change infrastructure and management. The patchy spatial distribution of drought in Arizona means that some ranches experience drought while others do not. However, the spatial resolution of drought information is too coarse to represent this difference among ranches.

Mike Crimmins, an MTC Member, and his team held three workshops and developed two online tools to support the deployment of rain gauges for ranchers and federal managers in Arizona to more precisely detect drought at the ranch-scale. Workshop participants indicated these new precipitation monitoring tools will help reduce production and legal risk by focusing responses only on drought-affected ranches.

ADWR Drought Index Wells

ADWR's Field Services Section collects groundwater levels statewide from approximately 1,800 index wells, including the State's two drought index wells. ADWR also monitors aquifer storage and maintains a statewide network of roughly 120 automated groundwater monitoring sites and an ORACLE database that contains field-verified data including discrete water level measurements, location, and other well specific information.

In 2015, ADWR staff developed a Monitoring Well Network Optimization Plan, which in part will focus on the identification of additional drought monitoring index wells within the State. Water level data from continuous monitoring sites statewide will be reviewed and evaluated with respect to meeting criteria for the USGS Climate Response Network. Drought index wells identified will be integrated with USGS Climate Response Network monitoring sites in Arizona.

Drought Impact Reports from State and Federal Agencies

Drought impact data is used by the MTC in its efforts to correlate drought conditions with precipitation and streamflow data. Impact information is received from hydrologists, researchers and other field staff from the Bureau of Land Management, USGS, U.S.D.A. Natural Resources Conservation Services, Arizona Department of Forestry and Fire Management, Arizona Game and Fish Department, Arizona State Parks, Native American Communities and other state and federal groups.

The U.S.D.A. Arizona Natural Resources Conservation Service (NRCS) submits a water year report (Appendix A), which identifies the impacts of drought on range and farmland. The 2017 survey sent to all NRCS field offices in the State describes drought impacts on dryland farming, irrigation water supply, rangeland water supply, rangeland forage supply, and rangeland precipitation. Losses of crop production, shortages of water supply, and shortages of forage were reported.

MTC Presentations and Workshops

Drought & Heat Waves Forum, September 16, 2017

Einav Henenson, ADWR Drought Program Coordinator, attended a day-long citizen forum on drought and heat waves resilience in the Arizona Science Center in Phoenix to provide drought related information to participants. Hosted by the Arizona State University and the Arizona Science Center, the forum engaged public participants representing Maricopa County's demographic diversity through visualizations and discussion to learn about the hazards drought and extreme heat present to communities and strategies to deal with those hazards.

Climate Change & Public Health Strategic Planning, August 7, 2017

Einav Henenson attended the Climate Change and Public Health Strategic Planning Workshop in the Maricopa County Department of Public Health (MCDPH) Building in Phoenix, which is a part of an on-going effort by the MCDPH to create and implement countywide activities for adaptation and mitigation to climate change and its effects on public health.

Intermountain West Drought Early Warning System Meeting (IMW DEWS), June 14, 2017

Dr. Nancy Selover, State Climatologist, attended the Intermountain West Drought Early Warning Systems (IMW DEWS) meeting at University of Colorado, Boulder, to coordinate with the other Four Corner States for consistent drought depiction. This was a follow up to the September 2016 meeting in Oracle, Arizona. The IMW DEWS has been piloted in Utah, Colorado and Wyoming and was recently expanded to include Arizona and New Mexico.

Forth National Climate Assessment Regional Engagement Workshop, February 21, 2017

Dr. Selover, Einav Henenson and James Meza of State Parks attended the Regional Engagement Workshop at the University of Arizona at Tucson, intended to collect input on climate related impacts of concern from a broad array of regional stakeholders that can then be integrated into the Forth National Climate Assessment. The focus of the Workshop was on climate related issues, suggested case studies, populations of concern, progress and success stories, etc.

Drought Summit, December 9, 2016

Einav Henenson presented on the Arizona Drought Program including drought preparedness activities, at the Drought Summit in Las Vegas, Nevada, hosted by the National Groundwater Association and the Irrigation Association. The Summit provided attendees with different States' perspectives on drought management issues and strategies.

3.B. Interagency Coordinating Group Efforts

The Interagency Coordinating Group (ICG) has met biannually since 2006 and advises the Governor on drought status, impacts, and any necessary preparedness and response actions.

The November 2016 meeting included a review of 2016 drought status, winter 2016-2017 weather outlook, 2016 wildfires review, 2016 forest and woodland health, the impact of the ongoing drought on wildlife, Colorado River Water supplies update as well as an overview of the Colorado River Lower Basin Drought Contingency Plan (LBDCP) efforts and intrastate Drought Contingency Plan Plus (DCP Plus) efforts.

The May 2017 meeting included a review of 2016-2017 winter precipitation, Summer 2017 and winter 2017-2018 weather outlook, 2017 wildfire season outlook, water supply updates for the Salt River and Verde River Watersheds as well as the Colorado River, and updates on ongoing water conservation efforts on the Colorado River.

At both the November 2016 and May 2017 meetings, the ICG recommended continuation of the Drought Declaration for the State of Arizona (Executive Order 2007-10) and the Drought Emergency Declaration (PCA 99006).

The presentations and subsequent decisions are on the ADWR ICG webpage.

3.C. Drought Planning for Community Water Systems

Drought planning requirements and water use reporting regulations were recommended in the 2004 Arizona Drought Preparedness Plan and established by the State Legislature in 2005 to help Community Water Systems (CWS) reduce their vulnerability to drought and water shortages. These reports provide a means for the State to gather water use data and offer assistance to CWSs that need it.

All CWS in the State (approximately 800) are required to submit a Drought Preparedness Plan to ADWR every five years. The Drought Preparedness Plan is part of the required System Water Plan (SWP), which also includes a Water Supply and Conservation Plans. The drought plan requires water systems to describe their drought stages and triggers, emergency sources of water, customer communication strategies, and other planning actions.

ADWR provides assistance to water providers in meeting these requirements through web-based resources, online reporting tools and phone or in-person consultations. To date, ADWR has received Initial System Water plans from 671 CWSs and Updated plans from 515 CWSs. The number of annual water use reports received from systems located outside the State's Active Management Areas (AMAs) can be seen in **Table 3**. (Annual water reports have been required for systems inside the AMAs since the passage of the 1980 Groundwater Act.)

Table 3: Annual Water Use Reports Received from CWS Located Outside Active Management Areas

	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Number (and percent) of reports received out of total active CWSs for that year:	372/466 (80%)	389/465 (84%)	383/462 (83%)	382/468 (82%)	382/461 (83%)	394/461 (85%)	390/469 (83%)	383/484 (79%)	396/481 (82%)	387/463 (84%)
Percent of non-AMA population represented by CWS reports received:	92%	96%	97%	96%	93%	97%	96%	95%	96%	97%

3.D. Local Drought Impact Group Efforts

Local Drought Impact Groups (LDIGs) participate in monitoring, education and local mitigation, mainly through cooperative extension and county emergency management programs. Initial planning efforts included 10 LDIGs, and as many as eight LDIGs have been active in the past. Since 2008, in response to local fiscal and staffing limitations, LDIG focus has been entirely on drought impact monitoring and reporting. Currently, Pima County and Mohave County have active LDIG programs. See **Appendix B** for the Mohave County LDIG report **and Appendix C** for the Pima County LDIG Report.

3.E. Colorado River Drought Planning Efforts

The Colorado River is a highly variable system, subject to dramatic change in runoff from year to year. In general, the average annual natural flow of the Colorado River at Lee's Ferry over the 110-year period (water years 1906 through 2015) has averaged around 15 MAF, but has ranged from as little as 5.4 MAF to as much as 25.4 MAF in a single year. Based on tree ring studies, the 16-year period starting in 2000 ranks as the fifth driest 16-year period in the last 1,200 years. As a result, water levels in Lake Mead, the primary storage reservoir for the Lower Basin States, and the entire Colorado River System reservoirs have been declining and projections indicate that this may continue into the foreseeable future.

In December 2007, the Secretary of the Interior adopted the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (2007 Interim Guidelines). The 2007 Interim Guidelines created a novel approach to Colorado River operations that incentivized conservation and augmentation through the creation of Intentionally Created Surplus (ICS). In addition, the Guidelines defined the criteria for shortages in the Lower Basin based on elevations in Lake Mead, implemented closer coordination of operations of Lake Powell and Lake Mead, and preserved flexibility to deal with further challenges such as climate variability and deepening drought.

More recent drought mitigation planning efforts include the Pilot System Conservation Program (PSCP) and the Lower Basin Drought Memorandum of Understanding (MOU) agreements. The PSCP involves water agencies from both the Upper and Lower Colorado River Basins that agreed to jointly fund water conservation projects in both the upper and lower basins to benefit the Colorado River system. The purpose of the Lower Basin MOU was to generate additional water to be left in Lake Mead to reduce the risk of reaching critical reservoir elevations. Both programs were voluntary and were initiated in 2014. Reclamation estimated that approximately 72,000 acre-feet of water has been conserved from the PSCP and approximately 500,000 acre-feet from the MOU through 2016.

Lower Basin Drought Contingency Plan

In December 2015, the three Lower Basin States of California, Nevada and Arizona (represented by ADWR), along with Reclamation developed a Drought Contingency Plan (DCP) to reduce the risk of Lake Mead falling to critical elevations that would lead to draconian reductions in water deliveries. The Lower Basin States agreed to consult with their respective stakeholders regarding possible implementation of the DCP.

Under the DCP, Arizona and Nevada would begin reducing water deliveries earlier than previously agreed. Reclamation would also agree to conserve water in the Colorado River system. Additionally, California would agree for the first time to reduce its deliveries should Lake Mead reach a certain elevation.

Arizona DCP Plus

During Fiscal Year 2017, ADWR continued with outreach to educate stakeholders and develop a plan to implement the DCP within Arizona. In November 2016, Arizona had developed an implementation plan, referred to as DCP Plus, that allowed for the conservation of additional water in Lake Mead by Arizona water users, beyond that called for in the DCP, to reduce the likelihood of shortages through 2021.

Despite delays, ADWR has moved forward to protect Lake Mead. ADWR is continuing to work with stakeholders to reach consensus on DCP Plus. Recently, the State of Arizona through ADWR entered into a partnership with Reclamation, the Gila River Indian Community, the City of Phoenix, and the Walton Family Foundation to achieve comparable volumes of conservation to those identified in DCP Plus for calendar year 2017.

3.F. Arizona Water Initiative Activities

The Arizona Water Initiative (Water Initiative) was implemented through Executive Order 2015-13 on December 16, 2015, establishing the Governor's Water Augmentation Council (GWAC) and the Planning Area Process. The goal of the Water Initiative is to build on the past work done when creating Arizona's Strategic Vision for Water Supply Sustainability (Strategic Vision) to continue the Arizona legacy of proactive strategic water planning by working with key stakeholders statewide.

Governor's Water Augmentation Council (GWAC)

The GWAC investigates long-term augmentation strategies for the State, while exploring additional water conservation opportunities, identifying infrastructure needs, and reporting on policy direction or statutory changes to take Arizona into the future. GWAC membership includes a wide array of experts including water providers and leaders in Arizona agriculture, mining, agribusiness, homebuilding, watershed groups and government. ADWR Director Tom Buschatzke serves as chairman of the Council. During the first year of meetings, the GWAC created four committees to address a variety of specific water planning issues across the State. Below are the recommendations from these committees from the 2017 Annual Report:

Desalination Committee: Continue to evaluate areas for feasibility of a desalination project, and then collaborate with local and regional stakeholders within the identified project area. Discuss funding opportunities with the Finance Committee and secure land and water contracts with the approval of ADWR.

Long-Term Water Augmentation Committee: Consider projected Planning Areas with the greatest imbalances. Create a budget proposal for a project to establish a portfolio of statewide augmentation options. If the project were approved and funded, provide project oversight until completion. A significant component of the project will be discussion of the proposed portfolio in each Planning Area to determine if the augmentation options identified are desirable.

Recycled Water Committee: Recommend the Arizona Department of Environmental Quality (ADEQ) end the prohibition on direct potable reuse. Evaluate the need for an amendment to current law that provides that 50% of effluent stored in managed underground storage facilities shall be credited to a storer's long-term storage account. Review and evaluate the statute related to a 2025 sunset clause on the ability to create long-term credits from effluent. Discuss the potential for changing the term "effluent" to "recycled water."

Finance Committee: Identify financing barriers/limitations for water augmentation projects. Propose general funding options. Propose funding options for specific projects identified by other committees.

Planning Area Process

While the most populated areas of the State are subject to stringent groundwater management, have mandatory water conservation requirements, and generally have access to diverse water supply portfolios, most of rural Arizona relies exclusively on groundwater as its primary water source, and lacks comprehensive groundwater management regulation. The lack of targeted groundwater management along with the effects of the ongoing drought can result in water supplies being more stressed in some areas of rural Arizona.

As a part of the Planning Area Process portion of the Governor's Arizona Water Initiative, ADWR has committed additional resources to evaluating water supply and demand imbalances in each of the 22 Planning Areas identified in the Arizona's Strategic Vision for Water Supply Sustainability Report. This process allows local stakeholders to participate in development of

better water demand information and a consensus-driven set of solutions for future water supply and demand imbalances.

The West Basins, Cochise, and Northwest Basins Planning Areas (**Fig. 7**) have been the focus of the Planning Areas Process for the 2016 and 2017 calendar years.

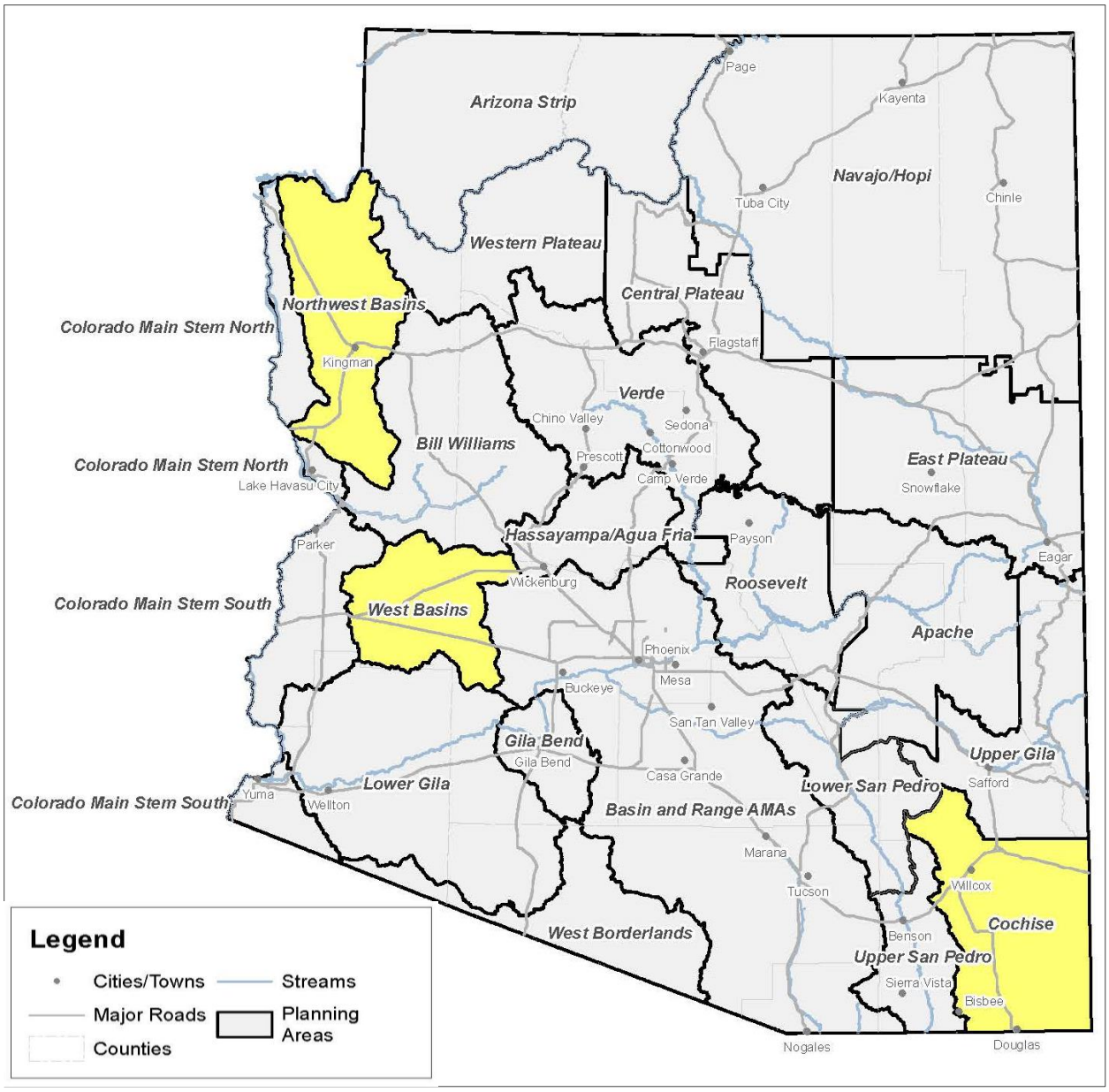


Figure 7. Arizona Water Initiative Planning Areas. The West Basins, Cochise and Northwest Basin are highlighted.

West Basins Planning Area

The West Basins Planning Area is located in the central western portion of the State and is comprised of the Butler Valley, McMullen Valley, Ranegras Plain, Tiger Wash, and Harquahala Valley Groundwater Basins. The Planning Area is within portions of La Paz, Yuma, Yavapai, and Maricopa Counties. Communities within the Planning Area include Aguila in the northeast, Brenda in the southwest, and Vicksburg, Hope, Harcurvar, and Salome in the central portion of the Planning Area.

Stakeholders have expressed concerns about declining water levels and the impacts of groundwater pumping associated with agricultural use on domestic wells. It has been reported that residential wells have gone dry, requiring residents to haul water. Seasonal residents have expressed concerns regarding their inability to provide input on any new regulations because they are not registered to vote in Arizona. Residents are also concerned about potential pumping related to groundwater transportation, as withdrawal of groundwater for transportation to active management areas is authorized in three out of the five basins in the Planning Area.

Cochise Planning Area

The Cochise Planning Area is located in the southeast corner of Arizona. It is comprised of the Sulphur Springs, San Simon, and San Bernardino Valleys, covers portions of Cochise and Graham Counties, and consists of the Willcox, Douglas, and San Bernardino Valley Groundwater Basins and the San Simon Valley Sub-basin.

The economy in the Cochise Planning Area is dominated by agriculture, with an emerging wine industry. With minimal surface water availability, agriculture is largely reliant on groundwater for irrigation. Many parts of the Planning Area have experienced declines in groundwater levels and are in a state of overdraft. Land subsidence and earth fissures are present in some areas and there have been local reports of wells going dry.

Northwest Basins Planning Area

The Northwest Basins Planning Area is located in the far northwest portion of Arizona and covers an area of approximately 3,882 square miles. The Planning Area is located solely within Mohave County, and encompasses close to 29% of the land area within the county. The groundwater basins in the Planning Area include the Detrital, Hualapai, Meadview and Sacramento Basins. Most of the land within the Planning Area is owned and managed by federal agencies, including the Bureau of Land Management, which accounts for nearly 50% of land ownership within the Planning Area (1,937 square miles).

Groundwater serves as the primary water source for the Northwest Basins. The largest municipality, the City of Kingman, operates two wastewater treatment plants which together have a permitted capacity of 5.72 Million Gallons per day (6,407 acre-feet). With the exception of the Colorado River to the north and western borders, the Northwest Basins have no perennial streams within the Planning Area.

Residents have expressed concern over the recent large-scale agriculture operations along the Stockton Hill Road area of the Hualapai Basin, as well as proposed agriculture in the Sacramento Basin. ADWR will conduct a Water Level Survey for the Northwest Basins Planning Area starting in the Winter of 2018.

The Planning Area Process will focus on analysis of the 22 Planning Areas identified in the Strategic Vision and will allow local stakeholders to participate in development of better water demand information and a consensus-driven set of solutions for future water supply and demand imbalances. ADWR will work closely with each Planning Area to identify issues that are resulting in demand and supply imbalances and to develop strategies that are likely to be successful in addressing them.

The West Basins, Cochise, and Northwest Basins Planning Areas have been identified as the focus of the Planning Areas Process for the 2016 and 2017 calendar years. ADWR is currently developing a schedule for the remaining Planning Areas.

More information regarding the Governor's Arizona Water Initiative is available at: http://www.azwater.gov/AzDWR/Arizona_Water_Initiative/index.htm.

3.G. ADWR Outreach & Assistance

Governor's Water Solutions Conversation

Increased risks of reductions of Arizona's Colorado River supplies, spurred by a relentless drought on the Colorado River, and declining groundwater levels in certain areas of the State are issues that require immediate attention. Governor Doug Ducey asked his leadership team to work with the Arizona Department of Water Resources to critically examine the status of Arizona's water laws and to identify ways to deal with these and other issues.

The Governor's team developed the Governor's Water Solutions Conversation, a process that has brought together water users and community leaders to improve water management in the State, improve the health of Lake Mead, and ensure that the State of Arizona speaks with a clear, unified voice when addressing Colorado River matters with other states and the federal government.

The Arizona Legislature plays a vital role in this process, and after gaining the insights and recommendations of the members of that body, the Governor anticipates that a practical, smart, and robust legislative package will emerge – one that will improve Arizona's water future for current and future generations.

ADWR Leadership Outreach

During water year 2017, Tom Buschatzke, ADWR Director, and Clint Chandler, ADWR Assistant Director, actively promoted drought preparedness efforts and activities around the State not only by leading many of these efforts, but also by discussing and presenting on these activities to a wide array of stakeholders, groups and organizations such as those listed below. Their discussions included topics such as Governor Ducey's Arizona Water Initiative, Arizona's water resource challenges, probabilities of a Lower Colorado River Basin shortage, and drought contingency planning. ADWR is committed to transparency and is passionate about providing water information to interested parties.

- Arizona Chamber Environmental Summit, August 10, 2017
- CLE Arizona Water Law Conference, June 25, 2017
- Arizona Forward, June 14, 2017
- World Water Congress Special Session, May 31, 2017
- Agribusiness & Water Council of Arizona Annual Meeting and Water Conference, May 19, 2017
- American Council of Engineering Companies of Arizona Water Committee, March 30, 2017
- Water Education Foundation - Executive Briefing, March 23, 2017
- Greater Phoenix Chamber of Commerce Agriculture, Environment and Water Committee, March 7, 2017
- Water Resources Research Center Annual Conference, March 28, 2017
- Arizona Chamber of Commerce and Industry Public Affairs Committee, March 3, 2017
- Arizona Forward Natural Resources Committee, March 1, 2017
- Family Farm Alliance Annual Conference, February 23, 2017
- Doctrine & Practice – Drought & Deals, Western Water Law CLE International, February 9, 2017
- Arizona State Senate Committee on Natural Resources, Energy and Water, January 23, 2017
- Arizona House of Representatives Committee on Natural Resources, Energy and Water, January 19, 2017
- Agriculture & Water Council, January 12, 2017

- Water Utilities Association of Arizona, January 4, 2017
- Arizona Agribusiness Roundtable, December 12, 2016
- Yarnell Water Improvement Association Annual Board Meeting, November 18, 2016

ADWR Communication Activities

ADWR promotes and encourages efficient use of water throughout Arizona by developing conservation tools and resources, assisting Arizona communities and water providers, presenting on drought and conservation issues and solutions, collaborating with regional and national partners, and participating in outreach activities. Staff provides materials and answers inquiries from the public, businesses, press, water professionals, students, researchers, and others about water conservation and drought. Below are a few highlighted efforts and activities by ADWR staff during the 2017 Water year that promoted water conservation and awareness:

Arizona Drought Program Website Redesign

As part of ADWR's website redesign process, the Arizona Drought Program webpages were completely revamped. Redundant or outdated pages were removed, and other applicable information was added to improve the relevancy of the site and the accessibility to drought information. The Drought Program website (https://new.azwater.gov/drought) now includes these pages: Drought Overview, Drought Status, Monitoring Technical Committee, Interagency Coordinating Group, Local Drought Impact Groups, Arizona Drought Planning, Drought Preparedness Plan & Annual Reports, Drought Frequently Asked Questions and Drought Resources.

Arizona Water News

ADWR's *Arizona Water News*, a new weekly newsletter featuring articles regarding the latest in Arizona and Colorado River issues, was launched in March 2016. The newsletter articles allow stakeholders to stay up-to-date on the latest happenings regarding Arizona water. Since its launch *Arizona Water News* articles have received over 26,700 views. Visit this link to read past news articles: https://new.azwater.gov/news.

Arizona Water Facts Website

On June 1, 2016 ADWR launched Arizonawaterfacts.com. This website is dedicated to promoting Arizona's success in managing its water resources, presenting current water resource challenges, and planning for the future. Arizona Water Facts is intended to build confidence in our water resources – a necessity for fostering a thriving economy and for a healthy livelihood.

Water Awareness Month,

ADWR has coordinated Arizona's Water Awareness Month campaign since the Governor's executive order in 2008. In 2017, ADWR conservation personnel participated and exhibited Water Awareness Month and conservation information. In addition, personnel distributed free educational materials through social media, Arizonawaterfacts.com and other platforms.

Appendix A

Arizona Natural Resources Conservation Services (NRCS)

2017 Drought Report

USDA Natural Resources Conservation Service

Arizona 2017 Forage Loss Report

Precipitation was highly variable across the State for the year resulting in continuation of drought conditions for most of the State. Summer monsoons moisture benefited the northwestern and central parts of the State the most and resulted in slightly improved forage conditions as compared to last year's estimated 28% forage loss. The driest areas appear to be in the northern and eastern portions (Navajo, Apache and portions of Coconino counties) and southwestern areas (Yuma, Pinal, Maricopa, La Paz, and parts of Pima counties) of the State.

NRCS uses Major Land Resource Areas (MLRAs) to differentiate major ecological regions and their climate and vegetation subdivisions within the State. Forage loss estimates for each of the Major Land Resource Areas in Arizona are shown in **Fig. A-1** and **table A-1** to the right. Because of the sample size, the forage loss estimates are generally reliable at the MLRA or State level.

NRCS evaluated 2017 forage production and losses in Arizona from range study data and local Field Office Drought Reports. NRCS has 24 Field Offices located throughout the State. The District Conservationists and staff from these offices provide the on-the ground knowledge and observations to support the report. Based on the above information, the average forage production across Arizona was approximately 77% of normal for 2017.

Figure A-1. Arizona Major Land Resources Areas

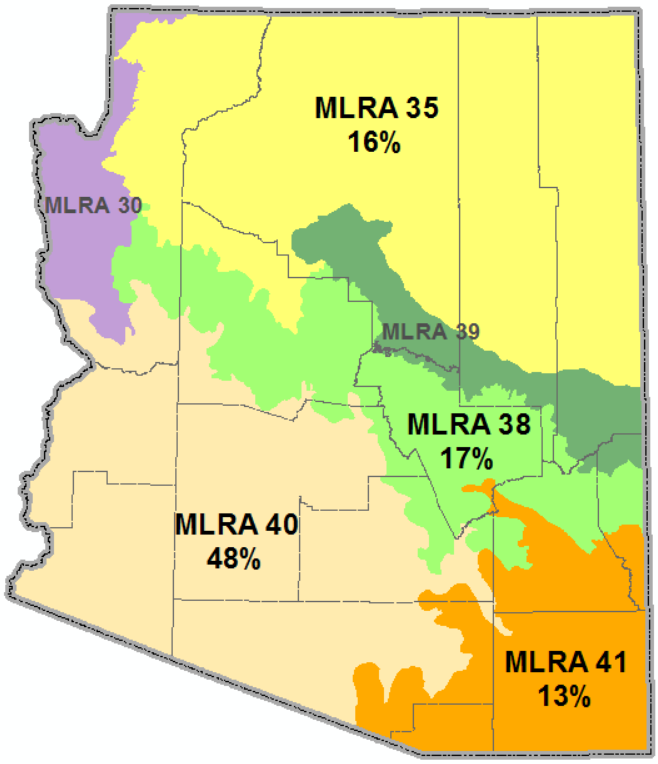


Table A-1. Arizona 2017 Forage Loss

MLRA	MLRA Name	% Forage Loss
30	Mohave Basin & Range	No Report
35	Colorado Plateau	16%
38	Mogollon Transition	17%
40	Sonoran Desert	48%
41	Southeastern Basin & Range	13%
39	AZ and NM Mountains	No Report
	Statewide Average	23%

Figure A-2. Offices Reporting Livestock Forage

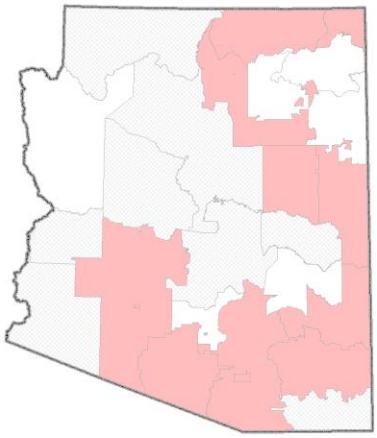


Figure A-3. Offices Reporting Livestock Water

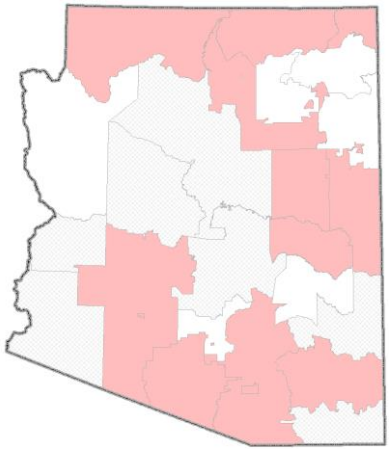
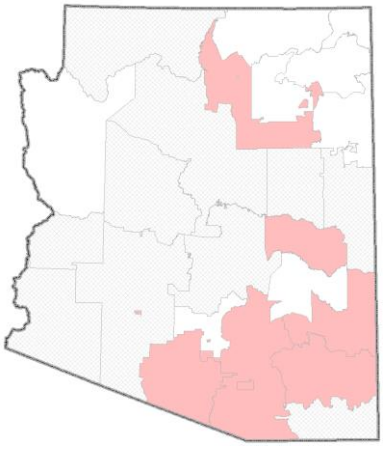


Figure A-4. Offices Reporting Impacted



2017 Drought Conditions

As part of the report, NRCS Field Offices were asked to report on the status of livestock forage. Of the 18 offices that responded, 10 offices reported livestock forage shortages (**fig. A-2**). The offices with shortages reported reduced livestock numbers with a range of 10-25% below established carrying capacities. This is slightly improved from last year estimates of 20-40%

Livestock water shortages (**fig. A-3**) were indicated from 11 of 18 offices that reported throughout the State. Field Offices estimate about 27% of the rangeland currently has no livestock water. Dirt ponds, water harvesting catchments, springs, and wells were all impacted by water shortages, although the monsoon did help to replenish some supplies. It was estimated that about 15% of Arizona livestock operators are currently hauling water. Lastly, 9 offices reported ranchers kept rainfall gauges. In those nine Field Office areas, about 30% of ranchers who kept rainfall gauges reported below average precipitation this past year.

Several Field Offices reported impacted irrigated and dryland crops water shortages (**fig. A-4**) due to drought conditions. Crop production losses ranging from 10% to 80% were expected with dryland crops affected the most. Crops affected include corn, cotton, beans, alfalfa, melons, irrigated pasture, and small grains. Affected water sources included wells, direct diversion from streams and reservoirs.

Appendix B

Mohave County
Local Drought Impact Group
2017 Annual Report

Mohave County Local Drought Impact Group

Annual Report 2017

Introduction

This report summarizes the Local Drought Impact Group activities conducted in Mohave County in 2017. The LDIG is an informal advisory body to the Mohave County Risk and Emergency Management Department and the County Extension Office.

Status of Drought

No areas of Mohave County are classified by the U.S. Drought Monitor as being in the abnormally dry or drought categories, and no significant short-term impacts are occurring as of the end of 2017 water year. However, long term drought conditions still exist.

Drought Impacts

Winter moisture delayed the onset of drying conditions this year. Areas in the Arizona Strip north of the Colorado River and in southern parts of the county experienced abnormally dry or drought conditions prior to the onset of the late monsoon. In general, the west side of the county was very dry in comparison to the east side; the monitoring station near Yucca southwest of Kingman registered the second driest monsoon season in 53 years. However, no significant agricultural impacts were experienced this year.

Rapidly drying conditions led to a greatly increased fire danger in the county and caused the implementation of open fire restrictions by the BLM and the county in late June. Numerous small fires occurred, but no major fires developed; significant but spotty rainfall in late July mitigated the danger enough to allow removal of restrictions.

Most areas of the county experienced significant, at times heavy, monsoon rainfall which further mitigated drought conditions. Although short-term drought has been mitigated, long-term drought conditions still continue across the county, particularly manifesting in the drying up of natural springs.

The Colorado River water supply remains an ongoing concern, however water levels in Lake Meade did not drop this year to the point where mandatory conservation measures had to be implemented, and forecasts indicate that this condition may prevail in the next year.

Drought Related Actions

No drought response or mitigation measures are currently in effect. The Mohave County Alert Flood Warning System, with sensor stations throughout the county, continues to provide near real time precipitation and stream flow information. The County Extension Office continues to receive and forward drought impact reports from other agencies and the ranching community.

County Extension Agent Andrew Brischke worked with Mike Crimmins from the University of Arizona, NOAA, and the local ranching community to update the impact reporting form and schedule as well as recruit additional impact monitors for the county network.

Appendix C

Pima County
Local Drought Impact Group
2017 Annual Report

Pima County Local Drought Impact Group (LDIG)

2017 Annual Report

The Pima County Local Drought Impact Group (LDIG) has been an active component of County operations since 2006 when the Board of Supervisors adopted the Drought Response Plan and Water Wasting Ordinance (Chapter 8.70).

LDIG consists of water providers and local, state and federal agencies that have an interest in the cause and effect of drought conditions in Pima County. LDIG meets bimonthly to monitor the short-term and long-term drought status, discuss drought impacts and coordinate drought declarations and responses.

The County's Drought Response Plan and Water Wasting Ordinance established a four-stage trigger category that corresponds to the Arizona Drought Monitor Report and their declaration of a watershed drought condition from "Abnormally Dry" to "Exceptional Drought." Each "Stage" declaration within the county triggers drought stage reduction measures.

LDIG explores the impacts of drought on various sectors in Pima County including agricultural water use, ranching, wildfire, hydrology, and flooding. Because many water providers depend on Central Arizona Project water, LDIG also monitors the status of the Colorado River, ENSO, and other climate weather patterns in relation to their effect on drought conditions and climate variability in the southwest. LDIG also monitors the status of the summer monsoon season and convenes roundtable discussions of drought and water conservation outreach programs. For a list of presentations and agendas, please visit Pima County's LDIG site: webcms.pima.gov/cms/one.aspx?portalId=169&pageId=70243.

Weather (NWS-Tucson)

In Pima County, this year began following a record warm and dry fall season that would lead into a warm, dry winter season. October 2016 was the warmest on record and November temperatures approached record, but a series of Pacific weather systems brought cooling though below average rain. Fall 2016 was the warmest on record and 0.55" drier than normal. December 2016 saw continued warmth and several Pacific weather systems that brought slightly above average rain, 1.08", a surplus of 0.15".

January 2017 started with winter storms, cooling and localized rain. In between Pacific storm systems, high pressure increased temperatures before a return to storm pattern. Rainfall was 0.24" above average. Temperatures increased, and rainfall dropped in February, which was the 8th warmest and 29th driest on record with a rain deficit of 0.66". This completed the 2016-17 winter season as the 4th warmest and 49th wettest recorded.

March was hottest on record and dry, 0.52" below normal. Average high temperatures were 9.1° above normal. Again, more warmth (4th) and no measurable rain in April. Heat continued into the first half of May, but Pacific storms brought significantly cooler temperatures with little rain. May ended as the 24th warmest and 10th driest with only 0.02" of rain. These months combined for the 2nd warmest and 10th driest spring.

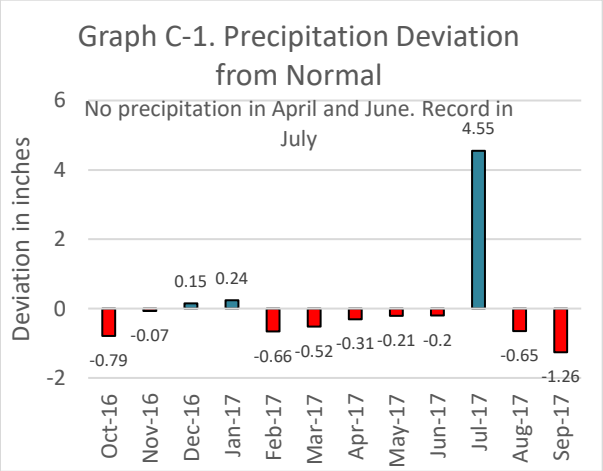
June was the hottest recorded and went on to break numerous temperature records as dangerous heat waves spread across the west. As is expected, June was dry with no rainfall. July was the wettest on record and this example of weather extremes included a tornado warning for Marana as severe monsoon thunderstorms poured down a record 4.55" surplus of rain, totaling 6.80" for July. The monsoon pattern faltered after, with August 0.65" drier and heat returning, ranking the month as 8th warmest. The summer overall was the 4th hottest and 5th wettest. Dryness continued in September with a rainfall deficit of 1.26" and above normal temperatures. The monsoon season ranked as 5th warmest and 11th wettest.

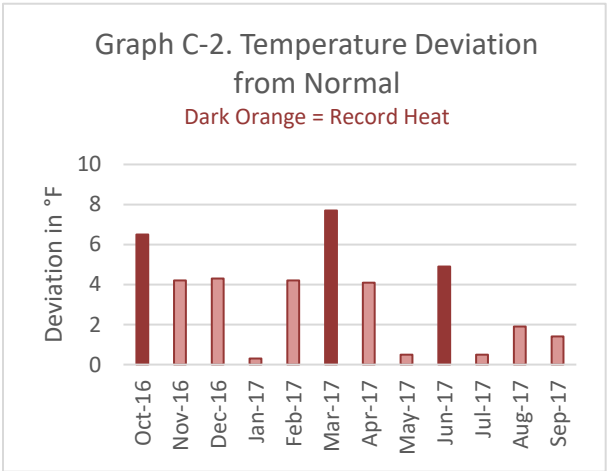
Precipitation (in inches, recorded at Tucson Intl. Airport)

	Oct16	Nov16	Dec16	Jan17	Feb17	Mar17	Apr17	May17	Jun17	Jul17	Aug17	Sep17
Precip	0.10	0.50	1.08	1.18	0.20	0.21	0.00	0.02	0.00	6.80	1.74	0.03
Norm	0.89	0.57	0.93	0.94	0.86	0.73	0.31	0.23	0.20	2.25	2.39	1.29
D+/-	-0.79	-0.07	+0.15	+0.24	-0.66	-0.52	-0.31	-0.21	-0.20	+4.55	-0.65	-1.26
C	-0.79	-0.86	-0.71	-0.47	-1.13	-1.65	-1.96	-2.17	-2.37	+2.18	+1.53	+0.27
Rank	39th Dry	58th Wet	37th Wet	36th Wet	29th Dry	43rd Dry	---	10th Dry	---	**1st Wet**	52nd Dry	11th Dry

Average Temperature (in ˚F, recorded at Tucson Intl. Airport)

	Oct16	Nov16	Dec16	Jan17	Feb17	Mar17	Apr17	May17	Jun17	Jul17	Aug17	Sep17
Temp	77.5	64.0	56.2	52.9	59.5	67.8	71.1	76.5	89.7	87.5	87.2	83.0
Norm	71.0	59.8	51.9	52.6	55.3	60.1	67.0	76.0	84.8	87.0	85.3	81.6
D+/-	+6.5	+4.2	+4.3	+0.3	+4.2	+7.7	+4.1	+0.5	+4.9	+0.5	+1.9	+1.4
Rank	**1stHot**	6thHot	7thHot	33rdHot	8thHot	**1stHot**	4thHot	24thHot	**1stHot**	31stHot	8thHot	14thHot





2016-2017 Season Ranking (NWS-Tucson)

	Winter	Spring	Summer	Monsoon
Precip Ranking	49th Wet	10th Dry	5th Wet	11th Wet
Temp Ranking	4th Warm	2nd Warm	4th Warm	5th Warm

In summary, the weather in Pima County for water year 2017 was hotter than average with below normal monthly precipitation, except in July. Every month had above normal temperatures with record heat in October, March and June and nine months were below normal in precipitation with no rain measured in April and June, while July received record precipitation. Despite July's significant rain, the water year ended only 0.27" in surplus with a total of 11.86" (11.59" being normal).

Pima County Drought (USDM)

Short Term: The water year started with a mix of Moderate drought in western Pima County and an eastern pocket of Abnormally Dry. This condition persisted until May 2017 when continued dryness caused Moderate Drought conditions to expand across the entire county. Eastern Pima County returned to Abnormally Dry in July given monsoon rains and has remained in that state, ending the year with little improvement since it started.

Long Term: Like last year, the Santa Cruz and San Simon Watersheds in Pima County began and ended the water year in Abnormal Dry condition.

The summary below reflects County-wide short- and long-term drought status:

	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17
Short Term	Abnorm-Mod	Abnorm-Mod	Abnorm-Mod	Abnorm-Mod	Abnorm-Mod	Abnorm-Mod	Abnorm-Mod	All Mod	All Mod	Mod-Abnorm	Mod-Abnorm	Mod-Abnorm
Long Term	Abnorm Dry	Abnorm Dry	Abnorm Dry	Abnorm Dry	Abnorm Dry	Abnorm Dry	Abnorm Dry	Abnorm Dry	Abnorm Dry	Abnorm Dry	Abnorm Dry	Abnorm Dry

Colorado River Basin & Central Arizona Project (CAP)

Several water providers are taking delivery of water from the Central Arizona Project. Tucson Water has the largest CAP annual municipal allocation in the State: 144,172 acre-feet. Metropolitan Domestic Water Improvement District, the Town of Oro Valley and others have smaller CAP allocations. Agricultural users and the Tohono O'Odham Nation in Pima County also have access to and use CAP water. Consequently, the drought status of the Colorado River and the potential for a shortage declaration is of interest to these sectors.

Inflow into Lake Powell was slightly above average, as snowpack was helped by atmospheric river storm systems.

Unregulated inflow into Lake Powell (MAF)		
Observed April-July 2017	8.173	114%
Observed August	0.446	89%
Observed September	0.196	48%
Projected WY 2017	12.23	113%

Every month Reclamation releases their 24-Month Study which provides operational announcements and near-term projections. The study released in August 2017 stated, most importantly, there will be no shortage in 2018 and that the water release from Lake Powell to Lake Mead for water year 2018 (October 2017 to September 2018) will initially be 8.23 MAF with a potential April 2018 adjustment to 9.0 MAF. The operating tier for water year 2018 is the Upper Elevation Balancing Tier. Forecast below:

Unregulated inflow into Lake Powell (MAF)	
Forecast WY 2018 – Most Prob	9.76
– Min Prob	6.00
– Max Prob	17.50

Forecast Elev	Lake Mead	Lake Powell	Powell Release
– Most Prob	1,076.04	3,632	9.0 MAF
– Min Prob	1,073.47	3,607	9.0 MAF
– Max Prob	1,127.78	3,654	13.8 MAF

Drought Contingency Plan

ADWR, Central Arizona Project, stakeholder groups and other Basin states, have undertaken several conservation programs with the intent of slowing the declining elevation of Lake Mead. The draft Lower Colorado Basin Drought Contingency Plan would overlay the 2007 Interim Guidelines for Lakes Mead and Powell operation during Lower Basin shortage. Should Lake Mead's elevation drop to or below 1025' there is a risk that CAP would suffer "catastrophically" deep reductions.

By taking additional cuts to Colorado River deliveries ahead of the existing tiered shortage plan, Reclamation and Lower Basin states hope to avoid a rapid decline in Mead's supply. These earlier and deeper reductions have been modeled and predict to slow or arrest decline. Most importantly, the proposal includes California and Mexico sharing in the reductions- currently California enjoys senior rights and would not have to reduce its allocation from Mead in any shortage. State legislative action will be necessary for adoption.

ADWR is pursuing an intrastate DCP, called DCP+, that would further reduce the probability of a Tier 1 shortage by setting annual conservation target based on projected shortage probabilities. With greater conservation participation by the Municipal & Industrial sector, the significant impact to the agricultural sector utilizing CAP's Agricultural Settlement Pool would be moderated.

As part of system conservation efforts, in 2017 the City of Tucson left 26,000 AF, or approximately 20% of its allocation, in Lake Mead.

Impacts in Pima County

<u>Cienega Creek</u>

The 32 shallow groundwater areas in Pima County are important for riparian areas that are dependent on groundwater. Sustained drought conditions can adversely impact groundwater levels if nearby well owners pump more groundwater to mitigate drought effects on their property.

Cienega Creek, in eastern Pima County, continues to show the impacts of sustained drought. Pima Association of Governments' (PAG) drought reporting uniquely depicts the localized drought impacts on a shallow groundwater dependent system, important for habitat and rural residents dependent on this water source. Streams and rivers are rare exceptionally productive systems in the arid landscape of Arizona that are especially sensitive to changes in water availability. With long term support and interest from its member jurisdictions, PAG has consistently monitored the shallow groundwater-dependent riparian area of Cienega Creek Preserve on a monthly and quarterly basis since 1989 and reported the findings to ADWR for compilation into state records.

PAG documented pre-monsoon (May/June) conditions in the *Riparian Health Assessment, 2017*:

Since 2010, Cienega Creek's seasonal baseflow has ranged from approximately one to four miles within the course of a year, while Davidson has ranged from zero to just under one mile.

In 2017, PAG observed a decrease in Cienega Creek's perennial flow extent following improvement in 2016. This year, June creek flows were present in 15% of the 9.5-mile monitoring area, which had flowed perennially in 1985. This result fits the long-term downward trend, but is improved since record lows were observed between 2011 and 2015. Davidson Canyon saw an increase, with the second highest perennial flow observed since 2006. Davidson results include the length of both flowing segments and phreatic pools.

Agua Caliente Park

Agua Caliente Park, located northeast of Tucson, has historic and cultural significance and supports 150,000 visitors annually. The park's focal point is a natural artesian spring that feeds a creek and produces an abundant variety of oasis vegetation and a habitat for native species. The natural spring has been historically pumped to feed a pond which produces a recreational element for neighborhood residents and park visitors. Over the last several years, water levels have decreased to levels where pumping was ineffective, and eventually failed to keep the pond filled. Plastic liners have been installed in both ponds to limit seepage. Well pumping could only sustain one pond after failure of the spring but with both liners and improved hydrology it may be feasible to keep two ponds filled at least part of the year. The improvements will help reduce groundwater pumping.

Drought Response Actions

Pima County continues its efforts to respond to drought conditions and support organizations such as Conserve to Enhance (C2E) which urges water conservation that translates into donations to support environmental enhancement. C2E participants have saved 10 million gallons of water since the program inception in 2011, through conservation strategies ranging from behavioral changes to rainwater harvesting installations. C2E has awarded funding to local neighborhood projects totaling approximately $100,000 in investment. Recent school projects offer an opportunity to engage students in continuing water conservation education.

The Conservation Effluent Pool (CEP) is an effluent allocation set aside pursuant to intergovernmental agreements between the City of Tucson and Pima County for use in riparian restoration projects. In previous years, a CEP taskforce, coordinated by the Community Water Coalition, identified thirteen candidate projects for CEP effluent allocations. The projects are prioritized into three groups: immediate potential, strong potential, and long-term potential.

In 2010, Pima County and the City of Tucson completed the Water & Wastewater Infrastructure, Supply and Planning Study. An important outcome of the study was the 2011-2015 Action Plan for Sustainability. This final year of the action plan has been implemented, a final report card itemized successful completion toward shared goals and recommendations. Pima County will continue reporting on water resource management activities that advance the Action Plan and water sustainability efforts.

In addition to the Water & Wastewater Infrastructure, Supply and Planning Study, Pima County prepared the Water Resources Asset Management Plan (WRAMP) in 2012, a distinct water resource planning process to guide the County in maximizing all its water assets. WRAMP includes directives to maintain an up-to-date central database of all water rights, wells, and map. It will also inspect wells and develop strategic plans for the County's reclaimed water, long term storage credits and surface and groundwater rights. An annual report is provided to the Board of Supervisors.

An Underground Storage Facility (USF) application was completed for the County Avra Valley Water Reclamation Facility (WRF) Black Wash project. This recharge facility is now operational, replenishing the aquifer and earning long term storage credits. A Green Valley USF is pending due to additional hydrologic study.

The Lower Santa Cruz Living River Project, funded by an EPA grant, is a monitoring strategy and reporting tool evaluating water quality and environmental improvement along the effluent dependent habitat and wetlands, providing better understanding of beneficial impact from upgraded effluent production. The final third year report indicates WRF improvements have increased infiltration by 19,600 AF compared to the 2013 infiltration rate, with a decrease in effluent flow extent and habitat. A large reduction in ammonia has removed a barrier to

increased aquatic life. These benefits and impacts are a result of ROMP project upgrade to metropolitan WRF's. With the Living River report series finalized, development of a Lower Santa Cruz River Management Plan is underway starting with a public input process.

Last year, Pima County Office of Emergency Management reviewed all hazard risk profiles to include drought and its impacts in the Multi-Jurisdictional Hazard Mitigation Plan, which establishes a comprehensive county-wide, all-hazards structure to provide for successful and well-organized coordination of Pima County mitigation activities. This year, Pima County and surrounding jurisdictions approved the plan.

As of now, the region's water providers and other entities with established drought plans are at Drought Stage 1 or its equivalent (voluntary reductions).