2013 Arizona Drought Preparedness Annual Report

For Water Year 2013: October 1, 2012 – September 30, 2013

Submitted to the Arizona Governor's Office
November 26, 2013

PROTECTING ARIZONA'S WATER SUPPLIES *for* ITS NEXT CENTURY

2013 Arizona Drought Preparedness Annual Report

Acknowledgements

The Arizona Department of Water Resources wishes to thank the State Drought Monitoring Technical Committee and the Local Drought Impact Groups for contributions to this report.

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Introduction

Realizing the need for drought preparedness in Arizona, a Governor's Drought Task Force was created in 2003 and the *Arizona Drought Preparedness Plan* (ADPP) developed. The ADPP was adopted in 2004 and its continued implementation ordered in 2007 (EO 2007-10). The ADPP established a framework to monitor drought, improve understanding of drought impacts, and determine mechanisms for limiting future vulnerability. The Arizona Department of Water Resources coordinates these activities and prepares the *Arizona Drought Preparedness Annual Report* each year. The *2013 Arizona Drought Preparedness Annual Report* covers the drought conditions and preparedness activities for the 2013 water year, from October 1, 2012 through September 30, 2013.

1. Drought Status Summary

A. Winter Precipitation

The winter of 2013 (Figure 1) was marginally wetter than the winter of 2012 (Figure 2) in both the Salt and Verde watersheds and the upper Colorado River Basin. This winter followed two extremely dry winters, both within Arizona and in the Colorado Basin. Unlike the two previous winters that were affected by La Niña, this winter was neutral, but the Colorado, Salt and Verde watersheds only received 70% of normal precipitation while western and southern Arizona had less than 50% of normal precipitation. While it could have been worse, the precipitation did nothing to alleviate the cumulative water deficits in the reservoirs or aquifers. Temperatures this past winter were much warmer than average across many of the higher elevation areas in the White Mountains and the Mogollon Rim, leading to more winter rain and less winter snow.

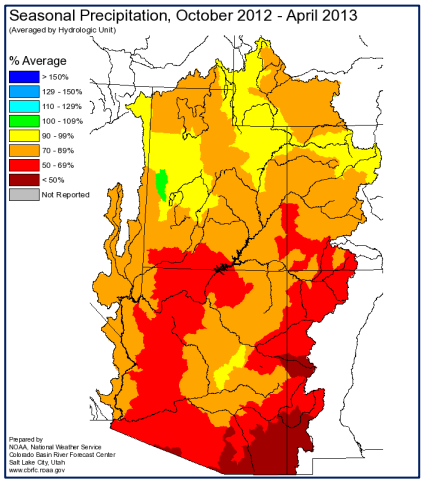


Figure 1. Precipitation Oct 2012 – Apr 2013.

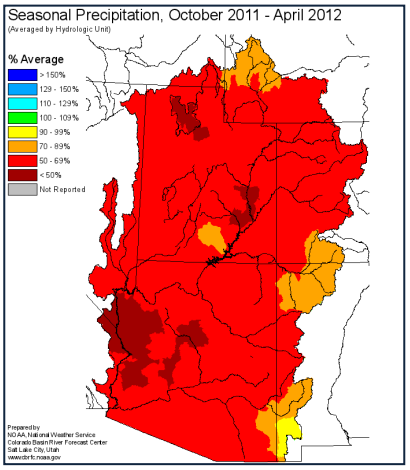


Figure 2. Precipitation Oct 2011 – Apr 2012

During the winter season (December 2012 through March 2013), snow accumulation was below normal across the state. Major storms early in the season brought the snowpack to above normal levels through January. However, for the remainder of the season, snow water equivalent levels remained below the 30-year median.

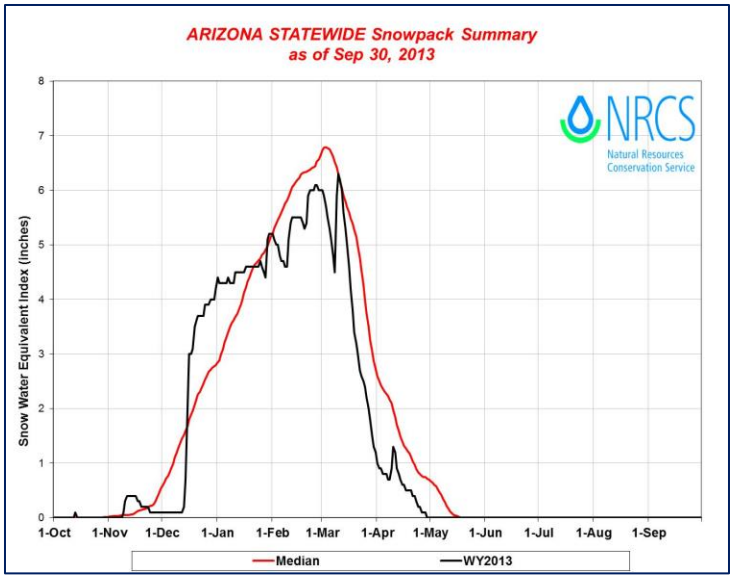
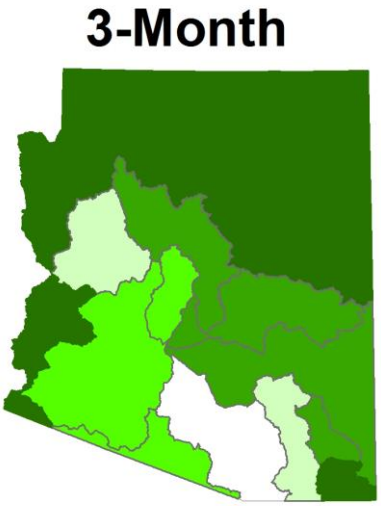


Figure 3. 2013 Snowpack summary according to data collected from the USDA Natural Resource Conservation Service.

B. Monsoon Precipitation

The 2013 monsoon (Figure 4 below to the left) was much wetter than average across the state, with the heaviest rainfall across the northern counties. Eastern Arizona also benefitted from the monsoon as the moisture track that began along the western border shifted to the east near the end of the monsoon. The driest watershed was the Santa Cruz, which received near average rainfall for the summer. This summer was much wetter than the 2012 monsoon (Figure 5 below to the right), which was slightly wetter than average, and it caused some improvement to the short-term drought. The only drawback was the timing, which was a little late for spring green-up on the rangeland. In parts of the Navajo Nation, the rangeland was parched during the first half of the monsoon, then a few heavy rain events caused flooding toward the end of the monsoon. While the moisture was welcome, the flooding was destructive.



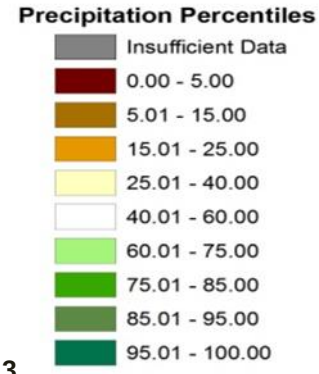


Figure 4. Precipitation Jul - Sep, 2013.

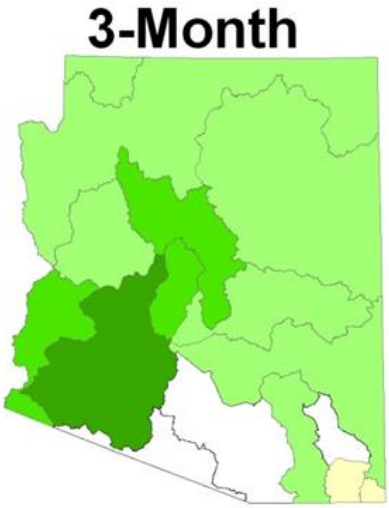


Figure 5. Precipitation Jul - Sep, 2012.

C. Drought Index Wells

Two ADWR groundwater index wells located in the southeastern part of the state have been identified as meeting criteria for drought index wells. Drought index wells serve as a qualitative supplement to existing drought indicators and help establish drought status for watersheds where either precipitation or stream flow data are lacking. USGS Climate Response Network observation well criteria can be found at USGS Groundwater Watch.

– ***Lower San Pedro Watershed Groundwater Index Well***

The 2013 groundwater level trend for the Lower San Pedro transducer well site (Figures 6 and 7) correlates with long-term drought conditions with an overall decline in water levels, although seasonality patterns similar with previous years are observed. Annual fluctuations are observed with increases in water levels typically during summer precipitation events. Continuous water level monitoring began in June 2007 with a depth to water (DTW) below land surface (bls) of 32.21 feet (ft). Since this time, a spike observed on August 7th 2007 of 29.11 ft bls remains the highest water level recorded while the lowest DTW was recorded this past year on July 4th 2013 at 33.85 ft bls.

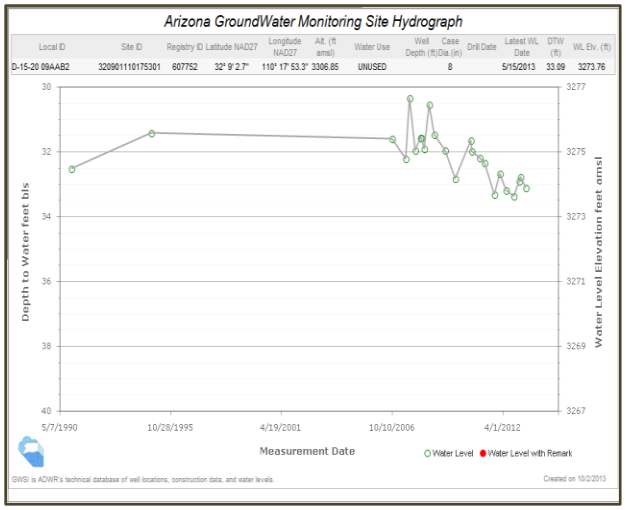


Figure 6 . **Discrete Groundwater Levels for Drought Index Well in the Lower San Pedro Watershed.**

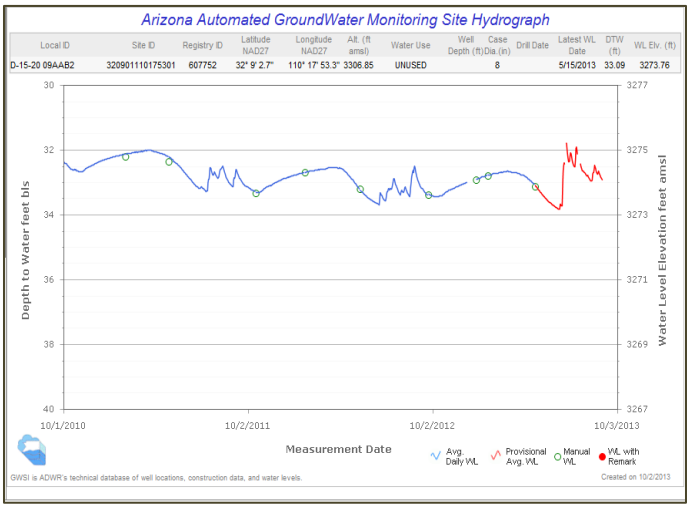


Figure 7. **Daily Groundwater Levels for Drought Index Well in the Lower San Pedro Watershed.**

– ***Whitewater Draw Watershed Groundwater Index Well***

Groundwater levels for the Whitewater Draw transducer site for 2013 rose significantly as indicated by the hydrographs in Figures 8 and 9, correlating with improvements in short-term drought conditions from extreme to abnormally dry. Continuous water level monitoring began in April 2009 with at depth to water (DTW) below land surface (bls) of 4.76 feet (ft). Since this time, the highest water level recorded was on October 15th 2013 of 3.08 ft bls while the lowest DTW at this site was recorded on September 13th 2012 at 18.35 ft bls.

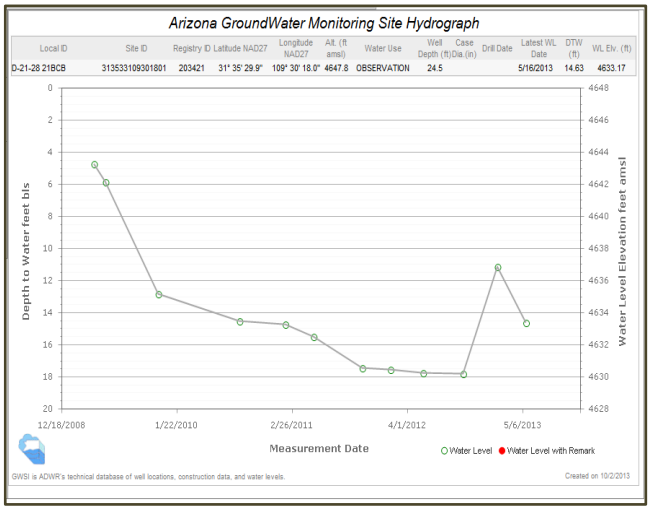


Figure 8. **Discrete Groundwater Levels for Drought Index Well in the Whitewater Draw Watershed**

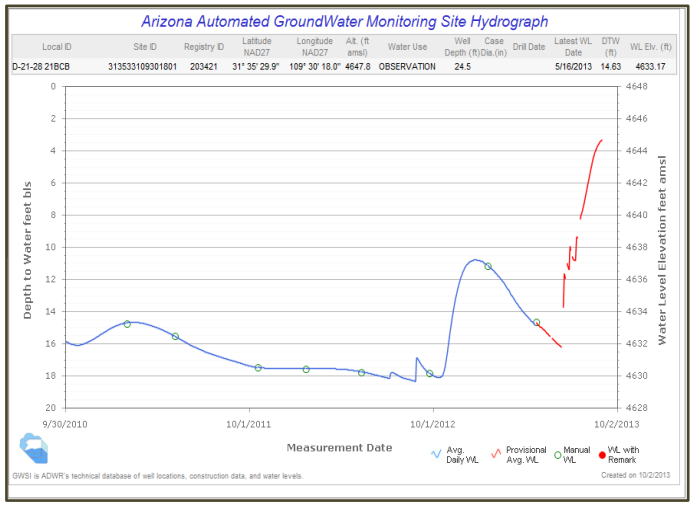


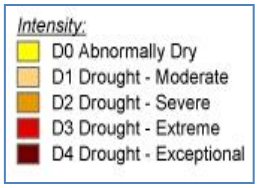
Figure 9. **Daily groundwater levels for drought index well in the Whitewater Draw Watershed**

D. Drought Status Changes

Arizona's drought status is updated each week on Thursday (short-term drought status) and seasonally at the end of each quarter (long-term drought status).

–*Short-term Drought Status*

The state is heading into winter with an improved drought status over a year ago. This year 15% of the state has no drought (Figure 10), and none of the state is in extreme drought (D3), whereas a year ago 6% of the state, in the northeast, had extreme drought (Figure 11). And, a year ago 98% of Arizona was in moderate drought (D1) or worse, while this year 62% is at D1 or worse. The impact of the monsoon can be seen when the current status (Figure 10) is compared to the pre-monsoon condition in Figure 12. At that time 23% of the state was at extreme drought (D3) or worse, and 74% of Arizona was in severe drought (D2) or worse.



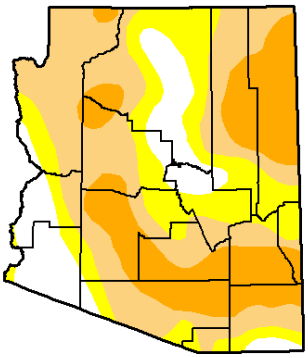


Figure 10. 2013 Short-term drought status: October 22, 2013.

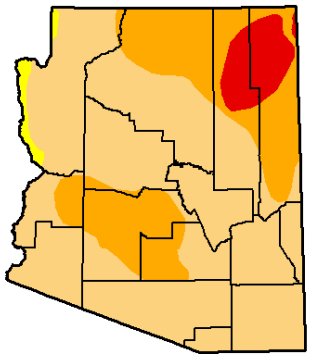


Figure 11. 2012 Short-term drought status: October 23, 2012.

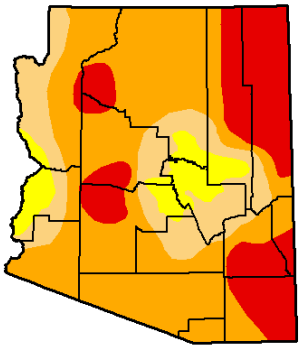


Figure 12. Short-term drought status: June 25, 2013

–*Long-term Drought Status*

For the long-term, conditions now are improved in the Salt and Santa Cruz watersheds mostly due to the wet summer. The Lower Gila improved to abnormally dry as a result of a single winter storm that dropped significant precipitation on the northern portion of that watershed. The Little Colorado and San Pedro watersheds are in worse condition, moderate and severe drought, respectively, due to the dry winter.

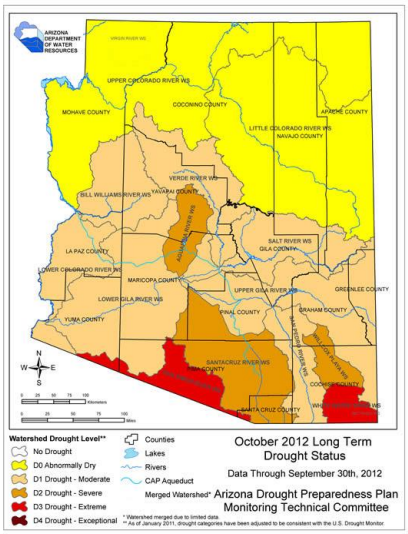


Figure 13. Long-term drought status: October 2012.

Category
No Drought
D0 - Abnormally Dry
D1 – Moderate Drought
D2 – Severe Drought
D3 – Extreme Drought
D4 – Exceptional Drought

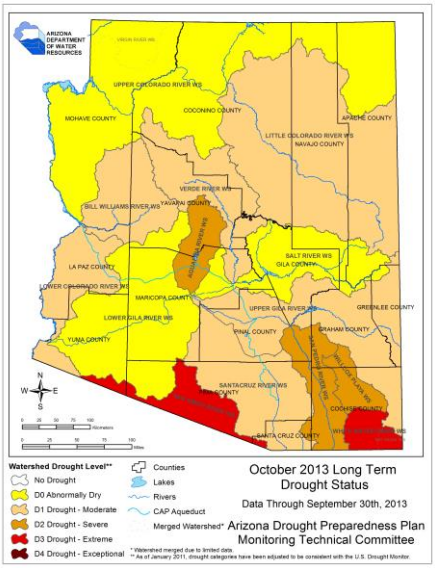


Figure 14. Long-term drought status: October 2013.

Table 1. Number of Watersheds in Each Drought Category			
Category	**2011**	**2012**	**2013**
No Drought	0	0	0
D0 - Abnormally Dry	2	2	3
D1 – Moderate Drought	3	7	6
D2 – Severe Drought	6	3	3
D3 – Extreme Drought	4	3	3
D4 – Exceptional Drought	0	0	0

E. Water Year Summary

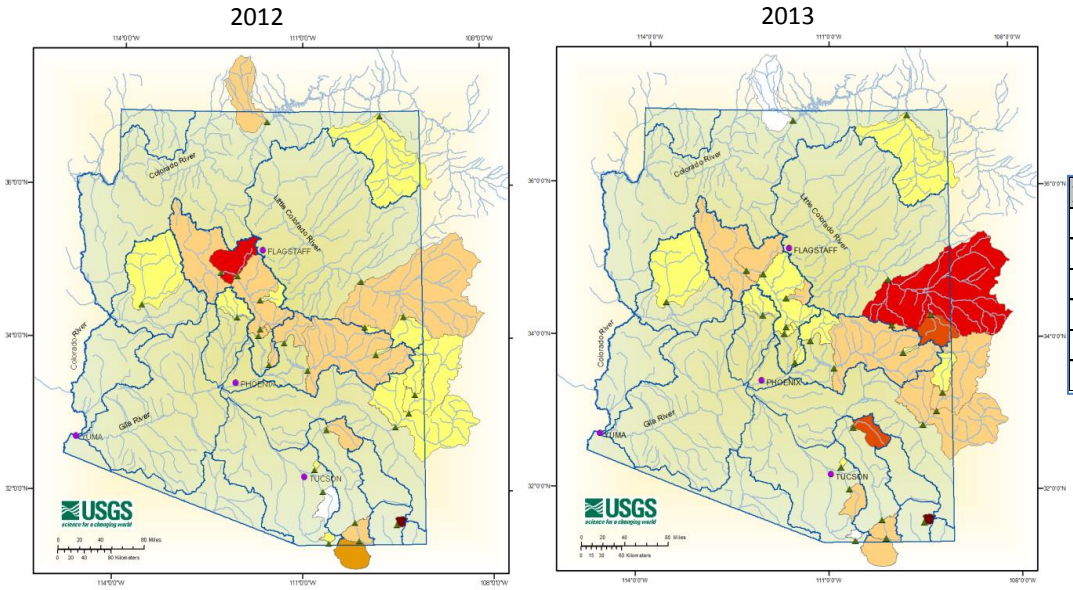
- ***Cumulative Precipitation***

Cumulative precipitation for Water Year 2013 was about normal throughout the mountainous areas of Arizona, ranging from a low of 99 percent of average in the San Francisco-Upper Gila River Basin to a high of 107 percent of average in the Little Colorado River Basin.

Table 2. Water Year 2013 Precipitation (as of September 20, 2013)	
Major Basin	Percent of 30-year Average Precipitation
Salt River Basin	102%
Verde River Basin	101%
San Francisco-Upper Gila River Basin	99%
Little Colorado River Basin	107%

- ***Streamflow***

Drought status as indicated by streamflow data shows no net change for all basins from 2012 to 2013. Basins that changed drought status did so by only one or two drought categories. Out of the 26 basins; ten remained at the same level, eight increased, and eight decreased in drought. On the other hand in regards to size of area impacted, in 2012 only 5% of the of the total area monitored had drought categories greater than severe whereas in 2013 that number had grown to almost 25% (mostly due to the Little Colorado River basin in Eastern Arizona).



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	

Figure 15. As determined by USGS stream gages, overall drought condition shows no net change from 2012 to 2013.

F. Outlook for 2013- 2014

–*Winter 2013-2014*

Sea surface temperatures across the central and eastern equatorial Pacific Ocean (a proxy for El Nino/La Nina) have been nearly normal for the past year. Thus, the El Nino Southern Oscillation (ENSO) regime has not been a factor in weather patterns across the Southwest since the winter La Nina of 2011-2012. Climate models offer varying forecasts for ENSO status in the coming months, ranging from weak El Nino to weak La Nina conditions. The most likely scenario is a continuation of ENSO neutral conditions throughout the entire 2013-2014 winter season. Thus, there is little evidence that any larger scale El Nino or La Nina will influence the weather patterns this year.

The official outlooks from NOAA's Climate Prediction Center depict the chances of temperatures and precipitation being in the above normal, near normal, or below normal categories. The outlook for January-March 2014 shows slightly better chances for above average temperatures during this three-month period. The precipitation outlook shows slightly enhanced chances for precipitation to fall in the below normal category, with the stronger signals in the southeastern part of the state. The temperature forecast probabilities are correlated with trends over the past 10 years versus the longer 30-year average, in addition to longer term dynamic model forecasts. The precipitation outlook is supported by climate models which have displayed skillful forecasts for the region, and the presence of a negative Pacific Decadal Oscillation measure in the central North Pacific Ocean (warmer than normal waters) which can lead to drier than typical winter weather in the Southwest United States.

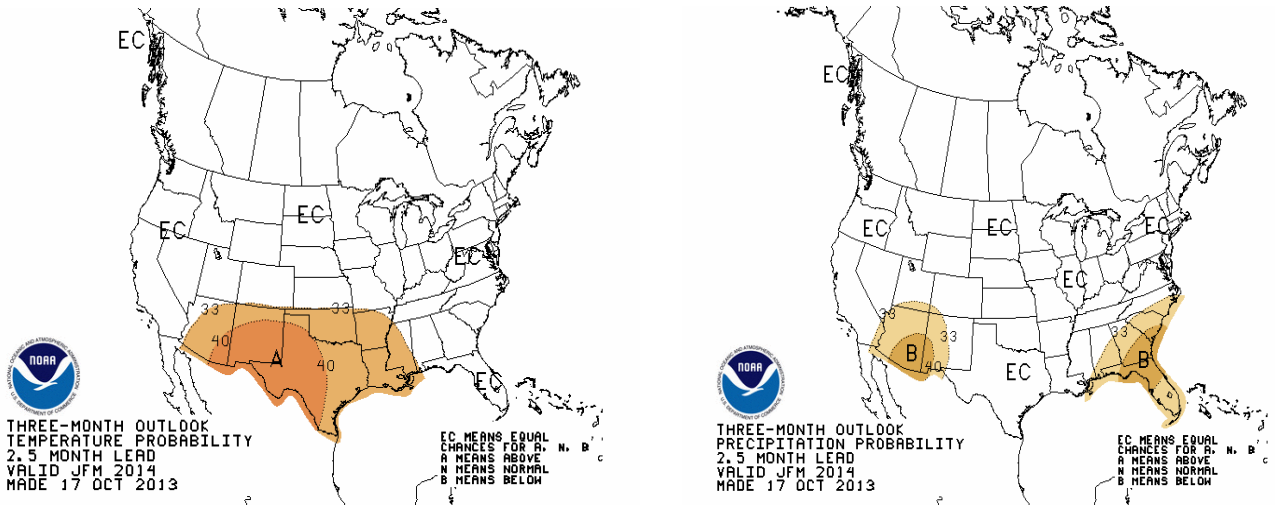


Figure 16. Climate Prediction Center outlooks for temperature (left) and precipitation (right) for January – March 2014. Shading indicates increased chances of being above or below normal.

–*Summer 2014*

The Climate Prediction Center's outlook for June-August 2014 shows much better chances that the average temperature during these three months will be above normal statewide. This outlook is based primarily in recent trends over the past 10 years versus the longer term 30-year average. The precipitation outlook shows no discernible signal during this period. That is, there are equal chances for the 2014 monsoon season to have above, below, or near normal rainfall. This is very typical for our monsoon season where thunderstorm activity can be localized, and is not influenced by larger scale climate signals (the prospect for either an El Nino or La Nina developing by Summer 2014 is highly uncertain at this point).

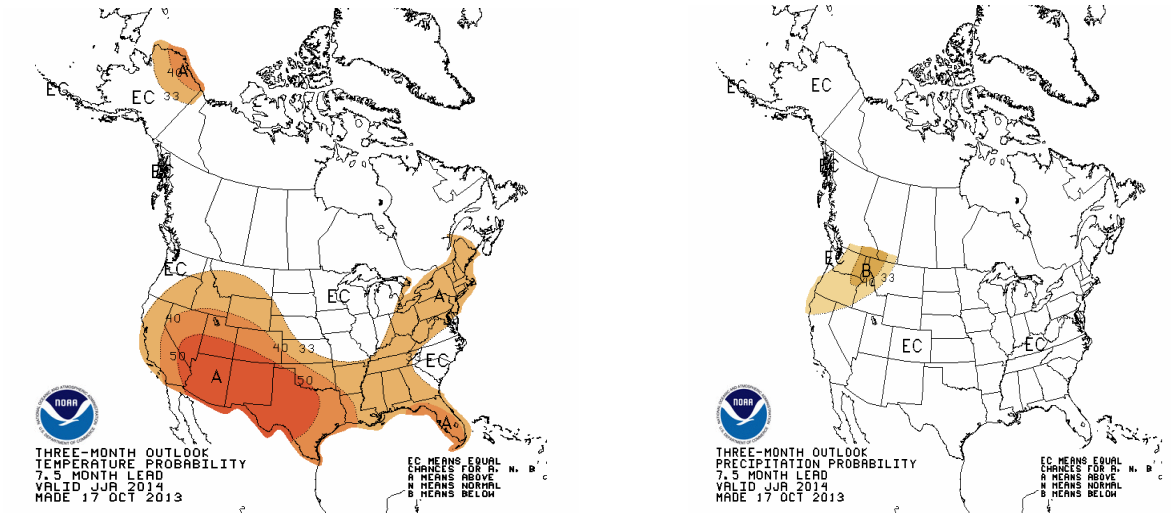


Figure 17. Climate Prediction Center outlooks for temperature (left) and precipitation (right) for June – August 2014. Shading indicates increased chances of being above or below normal.

2. Drought Declarations and Designations

The Arizona Department of Water Resources and the Drought Interagency Coordinating Group participate in the process for Drought Emergency Declarations and Disaster Designations for the state.

A. Disaster Designations

A Secretarial disaster designation allows farm operators in both primary and contiguous disaster areas to be considered for assistance from the Farm Service Agency. As of summer 2012, the USDA is using information provided to 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 faster and more flexible assistance to farmers and ranchers.

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

January 9, 2013: Apache, Maricopa, Navajo and Pinal Counties were designated as primary natural disaster areas due to recent drought. Eight counties were named as contiguous disaster counties -- Coconino, Gila, Graham, Greenlee, La Paz, Pima, Yavapai and Yuma.

June 5, 2013: Santa Cruz and Yuma Counties were designated as primary disaster areas, and Cochise, La Paz, Maricopa and Pima counties were designated as contiguous disaster areas.

June 12, 2013: Apache County was designated as a contiguous disaster area as a result of the designation of Montezuma County, Colorado as a primary disaster area.

June 19, 2013: La Paz and Yuma Counties were designated as contiguous disaster areas as a result of the designation of Imperial County, California as a primary disaster area.

B. Drought Emergency Declarations

A Drought Emergency Declaration has been in effect in Arizona since 1999. The current declaration, PCA 99006, issued by the Governor in June 1999 was continued by Executive Order 2007-10. The Drought Interagency Coordinating Group has been responsible for

recommendations to the Governor about drought declarations. 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.

3. Drought Preparedness Plan Implementation Highlights

A. Drought Planning for Community Water Systems

Drought planning requirements and water use reporting regulations were recommended in the ADPP and established by the state legislature in 2005 for the purpose of reducing community water systems' drought vulnerability and providing a means for the state to gather water use data. ADWR provides assistance to water providers in meeting these requirements through web-based resources, online reporting tools and phone or in-person consultations. In 2013, the ADWR planning and data management division was able to assign a full time employee to implement and manage Community Water System programs, thus slightly improving the shortage of staff experienced from 2010 through 2012.

Arizona's ~800 community water systems are required to submit a System Water Plan every five years. The System Water Plan includes a Water Supply Plan, Conservation Plan and Drought Plan. The first reporting years were 2007 for large systems and 2008 for small systems, and the first five-year updates were due in 2012 and 2013. Community water systems are also required to submit an annual water use report each year. The Annual Report includes information on water pumped or diverted, water received, water delivered to customers, and effluent used or received.

Staff is developing a user-friendly method to provide System Water Plan data to the public. The information will at first be available as summary reports, but future plans include the development of online queries and reports. The type of data sets may include emergency water supplies, drought stages and triggers, sources of water supply, conservation measures implemented, mandatory conservation or management measures, rate structures, subsidence, groundwater levels and spatial information.

B. Local Drought Impact Group Efforts

Local Drought Impact Groups (LDIGs) participate in monitoring, education and mitigation on a local level, mainly through cooperative extension and county emergency management programs. Initial planning efforts included ten LDIGs, and eight LDIGs have been active in the past. Since 2008, LDIG focus has been entirely on drought impact monitoring and reporting in an effort to reduce strain on resources, however, only Mohave County and Pima County are currently active. See the Appendix for Pima County and Mohave County annual reports.

C. State Drought Monitoring Technical Committee Efforts

The State Monitoring Technical Committee (MTC) is responsible for gathering drought, climate, and weather data and disseminating that information to 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 Gary Woodall, Meteorologist-in-Charge of the National Weather Service Phoenix Office.

–*Communicating Drought Status*

Improving the accessibility of drought information to resource managers, state decision-makers and the public is a primary goal of the MTC and ADWR. To further communication, information is updated on the ADWR Drought Status webpage on a weekly, monthly and quarterly basis:

Weekly - The MTC confers weekly to advise the U.S. Drought Monitor authors on the current conditions in Arizona and makes recommendations about the position of 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, the ADWR 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 U.S. Drought Monitor's maps for the past four weeks. 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. This report incorporates the 24-, 36- and 48-month precipitation and streamflow percentiles for major Arizona watersheds (i.e., 4-digit U.S. Geological Survey Hydrologic Unit Code). 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 in May (for January – March), August (for April – June), November (for July – September) and February for October – December.)

The monthly and quarterly reports serve as an information resource for the public and as a planning tool for resource managers developing mitigation and response strategies.

– ***Arizona DroughtWatch***

Arizona DroughtWatch is a volunteer, drought- impact monitoring program that was developed in 2009 to systematically collect qualitative observations of drought impacts to support drought status determination and local drought vulnerability assessments. Although only partially functional at this time, the web-based reporting system will allow observers to create accounts and submit impact observations. The observations will be summarized and displayed anonymously in maps and tables on the open website, and will be linked automatically to the National Drought Impacts Reporter.

– ***Community Collaborative Rain Hail and Snow (CoCoRaHS) Network***

Arizona joined the CoCoRaHS network in 2009 so that our volunteer citizen precipitation observers could communicate their precipitation measurements to the National Weather Service along with over 10,000 observers from other states. CoCoRaHS also collects drought impacts reports, enabling our 835 observers in Arizona to efficiently add their drought impact observations to their precipitation observations. Drought data is intended to go directly to the Drought Impacts Reporter. The data collected are important in our drought monitoring as well as flood warning. In addition to the urban centers in Maricopa County (362 observers) and Pima-Pinal counties (288 observers), there are 51 observers in Cochise County, 48 in Yavapai County, and at least one observer in every other county.

– ***Center for Integrated Solutions to Climate Challenges***

The State Climatologist is now affiliated with the Center for Integrated Solutions to Climate Challenges within the Walton Sustainability Solutions Initiatives, part of the Global Institute of Sustainability at Arizona State University. The Center is working to improve communication of climate science and make the research results accessible to decision makers at all levels. The most pressing issues are drought and the urban heat island, which can be used as proxies for climate change, as we work on solutions for both adaptation and mitigation.

– ***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, and maintains a statewide network of about 120 automated groundwater monitoring sites and an ORACLE database that contains field-verified data such as water levels, location, and other well specific information. The Section also collects water level measurements and data for land subsidence studies and aquifer storage monitoring.

– ***Calculating the Standardized Precipitation Index***

A new monthly gridded Standardized Precipitation Index dataset has become available and we will explore the possibility of calculating the drought directly from the gridded data which will allow us

to generate a higher resolution map that does not depend on watershed boundaries. How quickly this can be accomplished is a resource issue as there have been cutbacks on the State Climate Office.

– ***Funding and Resource Needs***

The MTC has identified the following three funding and resource needs, the second two previously stated in the 2007 through 2011 annual reports:

1. **Use gridded precipitation data to create gridded SPI maps and a gridded drought status map, using the same calculations for drought status currently used for watershed level mapping***.* The gridded maps will provide smoother transitions across the state rather than the abrupt watershed boundaries. The results should be more reflective of the DM maps and will help with our 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 the counties are having the worst drought problems. *Estimated cost*: $7,500

2. **Development of a strategic plan to identify data gaps and monitoring needs*.*** Arizona's current network of meteorological and hydrological observations for drought monitoring lacks sufficient spatial resolution to accurately characterize drought status at the local level requested by stakeholders throughout the state. Improving the spatial, temporal and altitudinal resolution of Arizona's drought monitoring network will improve the Committee's ability to serve the needs of Arizona stakeholders, including the local drought impact groups. In particular, Arizona faces the following conspicuous data gaps:
   - Complete lack of soil moisture monitoring
   - Few high elevation meteorological monitoring stations
   - Constantly decreasing network of streamflow gages

   Although the MTC has identified these data gaps in general terms, it is imperative to conduct a systematic evaluation in order to characterize and prioritize these numerous data and observation gaps. A strategic plan, with carefully considered criteria for prioritization, is essential for making state funding requests and for taking advantage of federal funding opportunities. The MTC recommends funding to develop a strategic plan, conduct data and observation gap analyses, and document priority locations using geographic information system technology. *Total cost: $9,000*

3. **Incorporation of groundwater data for drought status determination***.* ADWR evaluates groundwater level changes around the state, however, further analysis is needed to determine what role drought plays in these observed changes. Drought index wells serve as a qualitative supplement to existing drought indicators and help establish drought status for watersheds where either precipitation or stream flow data are lacking. The Basic Data Unit would like to use groundwater in a quantitative manner, perhaps by a modified Palmer index, though the groundwater level signature may include influences other than a climate response such as pumping or artificial recharge, and we have not had the time to research the specifics that would determine the suitability of each well site with regards to percentile analysis. The MTC plans on further assessment of statewide groundwater index wells to identify and incorporate data that meet the criteria for drought index wells. Incorporating groundwater level trend data will be critical in determining future drought conditions and impacts on water supply. *Total cost: $38,000 per year.*

D. 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 meetings include a review of statewide monitoring efforts and drought status, water supply updates, rangeland conditions, forest health and the impacts of drought on wildlife. At both the

November 2012 and May 2013 meetings, the ICG recommended to the Governor that the state's Drought Emergency Declaration (PCA 99006) and the Drought Declaration for the State of Arizona issued May 2007 (Executive Order 2007-10) be continued. The presentations and subsequent decisions are on the ADWR web site.

4. Conservation Program Highlights

ADWR's integrated conservation program includes regulations, assistance, outreach and education. ADWR promotes and encourages the wise and efficient use of water throughout Arizona by developing conservation tools and resources, assisting Arizona communities and water providers, collaborating with regional and national partners, and participating in outreach activities. At the current time, one part-time staff member assists in these and other efforts. The 2013 state Water Awareness Month (WAM) campaign website included "Eye on Drought", a section with useful drought-related tips and resources for the public. A soon-to-be-launched spin-off from WAM, the Water Awareness Arizona website, will include conservation and drought information all year long. ADWR is providing municipal and industrial conservation data and information to the groups working on the next steps phase of the Colorado River Basin Water Supply and Demand Study released December 12, 2012.

5. Appendix

❖ Mohave County Local Drought Impact Group 2013 Annual Report

Earlier this year, the LDIG Steering Committee recommended to the Mohave County Board of Supervisors that the structure of the LDIG be changed. It was recommended that the BOS appointed Steering Committee be dissolved and that the LDIG itself continue as an advisory group, open to public membership as before, to the Mohave County Division of Emergency Management and the County Extension Office. The Emergency Management Coordinator and County Extension Agent would continue as LDIG Co-Coordinators. This recommendation was approved by the BOS.

The LDIG has not formally met since the new structure went into effect. The drought monitors have continued to submit monthly reports to the Emergency Management Technician, who compiles them but has been unable to send them to DroughtWatch due to the system being down.

Individual members have been working on vegetation map overlays for the drought monitoring zones established by the LDIG for use as trigger points for mitigation actions for the various drought severity levels within those zones.

The county experienced extremely dry conditions last spring and into July. Annual plants had dried up and perennials were stressed in many areas. Surface water was extremely low; some ranchers experienced 30% forage loss and had to remove cattle from grazing. Severe conditions were due to lack of rainfall and high winds. Mohave County enforced fire and fireworks prohibitions on June 16 in areas above 2000' in elevation, and dry lightning ignited the Dean Peak Fire in late June that resulted in 150 home evacuations in the Pine Lake and Pinion Pines communities, although no homes were ultimately lost. An unusually active monsoon season in many areas resulted in forage and other vegetation recovery and alleviation of the dry conditions. Increased erosion was observed in some areas due to the previous dry conditions and fire caused vegetation removal.

❖ Pima County Local Drought Impact Group 2013 Annual Report

The Pima County Local Drought Impact Group (LDIG) and 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. LIDG meets bimonthly to monitor the short- 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 "Extreme." Each "Stage" declaration within the county triggers drought stage reduction measures.

Since 2006, LDIG has explored 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, El Niño Southern Oscillation (ENSO) and other climate weather patterns in relation to their effect on drought conditions and climate variability in the Southwest. For a list of presentations and agendas, please visit Pima County's LDIG website at: LDIG website

The study of tree ring growth, especially at the University of Arizona's Tree-Ring Laboratory, has been used to reconstruct flows in the Colorado River and to identify periods of drought as far back as 800 A.D., by comparison, precipitation records began in 1880. This data is being used to understand the extent, frequency, duration and severity of drought in the Southwest.

LDIG also monitors the status of the summer monsoon season and convenes roundtable discussions of drought and water conservation outreach programs.

IMPACTS

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. We are seeing more invasive species like Bermuda grass and tamarisk and fewer birds, Gila Topminnows and aerial arthropods[1]. There is also a significant decrease in ephemeral stream flows.

In the spring, the Colorado River Basin had 83 percent of the 30-year average snow accumulations. Lakes Mead and Powell levels have been dropping as the snowmelt runoff had not yet begun. In March, Lake Powell was 48.5 percent full or 11.8 million acre-feet (maf) and Lake Mead was 53 percent full or 13.71 maf.

The 2012/13 water year (October 2012 to September 2013) was the third driest year on record in the Colorado River Basin. The Bureau of Reclamation (BOR) recently completed the *Colorado River Basin Water Supply and Demand Study* which shows a projected 3.5 maf deficit between supply and demand in the year 2060.

In September, the in-flow to Lake Powell for water year 2013 was 4.3 maf – 40% of average (1981-2010). Lake Mead is currently 33 feet above the shortage declaration trigger of 1,075 foot elevation. Based on the BOR Colorado River Study, the earliest likelihood of a Shortage Declaration is 2016.

Tucson's "winter" season was the 40th coldest and 39th wettest. Precipitation was 0.05 inches above average (2.78") and the average monthly temperature was 1.8^{0}F below average (51.4ºF). On January 22, there was a record of low of 17ºF and record rainfall on January 26. Tucson International Airport (TIA) recorded .71" (the old record was .67" in 1985). Compared to the last 25 years, the Tucson area ranked 2nd for the number of freezing temperature days – 23.

The summer in Tucson saw the hottest June on record – everyday at least 100º and little precipitation (0.03" at TIA, 0.24" is the normal for June. There was a little break in July; precipitation was above average and widespread (2.63" at TIA/normal is 2.45"). August was hot and dry with 13 consecutive days of 100º temperatures or hotter. Precipitation measured at TIA was 0.48" (normal is 2.39").

Tucson International Airport recorded 6.69" for the water year ending September 30. The normal is 10.83" – the Tucson area was more than 4" below normal for that period.

[1] *Drought and Arizona Rivers – Looking into the Past and Thinking about the Future, Kelly Mott Lacroix*, May 8, 2013 LDIG Presentation Drought and Arizona Rivers

Cumulative drought stress degrades forest viability as prolonged heat and dry conditions create abundant and explosive fuel for wildfire. Combined with frontal weather patterns producing sustained winds and peak gusts, the potential for critical "Fire Weather" days (relative humidity below 15%, winds above 19mph, high/extreme fire danger) is expected to increase.

Additional reactions to drought/climate change conditions include earlier spring flight of butterflies, earlier snowmelt in the Rockies influencing the timing of sub-alpine blooms, yellow-bellied marmots emerge earlier from hibernation and migrant birds arrive earlier creating food source mismatches. Drought conditions affect bloom time of desert adapted plants and the timing of egg laying in Mexican jays.

Cienega Creek experienced record breaking drought conditions in the summer of 2013. On an annual walk through in June, there was 25% less flow than the same time last year. The perennial flow has been reduced to 0.93 mile, the lowest flow on record and 0.31 mile shorter than June 2012.

The 2013 Monsoon has provided some relief from drought especially south and east of Pima County in Douglas/Cochise County. However, Pima County is in a declared Drought Stage 1 the same as the major water providers in the area.

This is a manufactured anomaly compared to the Drought Impact maps produced by *U.S. Drought Monitor and distributed by ADWR's Drought Monitoring Technical Committee. The Monitoring Technical Committee determines the drought status for each watershed by comparing the precipitation and streamflow percentiles for the past 24, 36 and 48 months to a 40-year historical record.*

To be better prepared for prolonged drought conditions and their impacts, what may be needed is a County-wide vulnerability assessment to monitor drought impacts, identify appropriate response measures and improve drought resiliency.

Entity	Drought Declaration
Pima County	Stage One
City of Tucson	Stage One
Town of Oro Valley	Stage One
Town of Marana	Stage One
Metropolitan DWID	Stage One
Community Water of Green Valley	Stage One

Given the probability of continued warming and an unpredictable forecast for precipitation, annual ENSO weather trends and climate records, the county ordinance and drought management plan should be revisited to facilitate improved implementation and communication to the public and affected groups ahead of worsening drought conditions and associated impacts.

DROUGHT ABATEMENT EFFORTS

Pima County is continuing its diligence in drought abatement efforts. Several organizations, such as C2E (Conserve to Enhance), urges water conservation that translates into donations to support environmental enhancement. C2E participants have saved 1.9 million gallons (5.8 acre feet) of water from January 2011 through September 2012.

In 2010, Pima County and the City of Tucson completed a *Water/Wastewater Study Action Plan* and are in Year Three of its implementation. Actions underway during 2013 included an update to the City of Tucson's *Drought Preparedness and Response Plan*, increased reclaimed water system efficiencies, increased use of renewable sources of water including reclaimed water and Central Arizona Project water and model city/county building codes that reduce the water/energy footprint in new and renovated buildings.

Several conservation and loss reduction mechanisms are in place to ease a shortage on the Colorado River, including:

- Yuma Desalting Plant that could deliver contracted water to Mexico
- Brock Reservoir – a temporary storage for water that was ordered but not used, could be delivered at a later date
- Vegetation Management – the reestablishment of low water using native vegetation and non-native plant reduction/eradication
- Public outreach on the impacts of a shortage declaration on the Colorado River on water supplies
- Increased underground storage of Colorado River water in the Tucson Active Management Area
- Increased use of reclaimed water supplies
- The City of Tucson's eight rebate programs are estimated to generate about 788 acre feet per year in water savings and have banked over 2,400 acre feet over the last five plus years.