CITY OF TUCSON WATER DEPARTMENT

ANNUAL DROUGHT MONITORING REPORT

June 15, 2010



CITY OF TUCSON WATER DEPARTMENT
ANNUAL DROUGHT MONITORING REPORT
June 18, 2010

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Acknowledgements

Cover art: Ana Cota-Robles, photos Ries Lindley

Report staff: Tom Arnold, Ries Lindley, Karen LaMartina, Linda Smith





MEMORANDUM

DATE: June 25, 2010

TO: Richard Miranda
Deputy City Manager

FROM: Jeff B. Biggs
Director
Tucson Water Department

SUBJECT: Continuation of Stage 1 Drought Response for the Tucson Water Service Area

Background

Tucson Water staff developed a Drought Preparedness and Response Plan (Plan) in 2006 to comply with state legislation passed during the 2005 legislative session. Mayor and Council approved the Plan in November 2006, and it was then submitted to the Arizona Department of Water Resources (ADWR) as required by A.R.S. §45-342. Mayor and Council subsequently passed an implementation ordinance (No. 10380) in early 2007 to provide enforcement authority for the Plan.

The Plan recognizes that drought impacts do not occur suddenly or without warning and acknowledges that with proper planning and review it is unlikely the community will find itself in an emergency situation caused solely by drought. To ensure this, the Plan calls for annual reporting on the potential impacts of local or regional drought on the Utility's water resources and system characteristics along with a departmental recommendation regarding the appropriate drought response stage to ensure system reliability. The attached drought monitoring report summarizes the results of Tucson Water's procedures to review both regional and local system indicators of potential impacts from drought on the Utility's service area. For the third consecutive year since the Plan was adopted the Utility's recommendation is a continuation of the response measures outlined in the Plan for a Stage 1 Drought Response.

Recommendation to Continue Stage 1 Drought Response; Drought Response Indicators

ADWR's guidance document for drought response plan development stresses the statutory requirement for drought response indicators to be directly tied to a water provider's water resource availability. The guidance document also addresses the development of indicators for infrastructure reliability, based on specific system characteristics. For Tucson Water, water resource availability requires review of both regional (Colorado River) and local conditions that may impact supplies, whereas evaluation of infrastructure reliability primarily requires review of the potable and reclaimed water distribution systems (local system indicators).

Tucson Water's regional indicators include severe or sustained drought on the Colorado River watershed, up to and including declared shortages on the river, and a drought status above normal for the Santa Cruz Watershed as determined by the Arizona Drought Monitoring report issued

monthly by the Arizona Drought Preparedness Monitoring Technical Committee overseen by ADWR staff.

Snowmelt from the Colorado River watershed provides runoff into Lakes Powell and Mead, the reservoirs most critical to Arizona's Central Arizona Project (CAP) deliveries. Much of the Colorado River basin snowpack was less than 50 percent of normal as of June 2010, and the watershed remains in a 10-year drought. Combined Powell and Mead reservoir storage is higher than it was at the same time last year. Based on these factors, the U.S. Bureau of Reclamation declared a 'normal' (no shortage) water year for the 2009 water year (October 1, 2008 through September 30, 2009).

Closer to home, winter storms produced slight improvements to Arizona drought conditions in Tucson's Santa Cruz Watershed, resulting in a long-term prediction of "abnormally dry," the same long-term classification as last year.

Tucson Water's local system drought impact indicators include measures of aquifer storage, potable and reclaimed water production capability (i.e.: water supplies and the ability to deliver them where needed), and gallons per capita per day (GPCD) use. All local system indicators have shown improvements from the 2008 report with the exception of reclaimed production capacity, which is slightly less than it was a year ago. Customer demand, or GPCD, continues to drop - currently reflecting 140 GPCD compared to the 151 GPCD reported in the 2008 report. While GPCD is not a "drought indicator" per se, monitoring GPCD allows the Utility to better assess whether drought response measures previously implemented are having the desired affect. Tucson Water's declining GPCD in the face of long-term drought indicates both the responsiveness and general drought awareness of our customers.

Based on the 2009 monitoring report, Tucson Water recommends that a Stage 1 Drought Response be continued for the Tucson Water Service Area. The focus of a Stage 1 response from a community perspective is to communicate information about drought to our customers and emphasize water use efficiency. Additional measures may include voluntary self-audit programs for commercial, multi-family, and industrial users. City departments also are encouraged to continue improving the management of their water use from an efficiency perspective.

Attachment: Annual Drought Monitoring Report - 2010

cc: Christopher Avery, Fernando Molina, Karen LaMartina

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Background

Tucson Water submitted the City of Tucson Water Department's Drought Preparedness and Response Plan (http://www.ci.tucson.az.us/water/drought-intro.htm) to the Arizona Department of Water Resources (ADWR) in December 2006 in accordance with state legislation passed during the 2005 legislative session (see A.R.S § 45-342). Mayor and Council approved the Plan on November 28, 2006 and an implementation ordinance (No. 10380) providing enforcement authority was approved on March 20, 2007. The annual drought monitoring report is an outcome of Plan implementation procedures Tucson Water staff follows to determine the impacts of the long-term drought on the Utility's water resources and distribution system

The Plan establishes four drought response stages, outlines an action plan for responding to potential drought-related impacts on Tucson Water's system and water supplies, and addresses the issue of emergency supplies. The Plan demonstrates the success of the long-term financial investment the community has made in securing and implementing use of renewable water resources such as Colorado River water via the Central Arizona Project and treated effluent through the reclaimed water system. That investment, coupled with on-going system evaluation and water resource planning, provides considerable reliability to withstand the impacts of sustained drought on Tucson Water's supplies and system and is recognized in the Plan's drought response stages.

The Plan discusses the statutory requirement for tying water system characteristics and water resource availability to multi-staged drought response. Tucson Water's regional indicators are severe or sustained drought on the Colorado River watershed, including declared shortages on the Colorado River; and a drought status above normal for the Santa Cruz Watershed, which includes Tucson. Local indicators are measures of aquifer storage, potable and reclaimed water production capacity, and gallons per capita per day use by Tucson Water customers.

This report provides the outcome of staff's assessment of these indicators, followed by a drought response stage recommendation for 2010. In addition, this year's report includes a brief discussion of drought preparedness planning and how it relates to climate change.

Drought in the Western United States

The Arizona drought preparedness plan defines drought as a *sustained, natural reduction in precipitation that results in negative impacts to the environment and human activities.* Arizona, like much of the western and southern United States, remains in a multi-year drought.

Summer 2009 'La Nina' rains were not as plentiful in Arizona as hoped. The U.S. Drought monitor listed short-term drought conditions in much of the state and for all of Pima County as 'severe' as recently as January 2010. Winter 'El Nino' rains in February and March improved conditions to 'Abnormally Dry,' except for Arizona's most northern reaches. Although the State is seeing short-term benefits from the winter's rains, it has not brought an end to the decade-long drought. As it shifts its dependence on groundwater to surface water, Tucson Water relies on Colorado River supplies from the Central Arizona Project, which depends on healthy winter snowpack in the Upper Colorado River Basin. As such, the Utility closely monitors annual snowpack conditions.

In recent years scientists have made a clear link between drought and climate variability and have speculated as to whether drought events will become more of the "normal" weather patterns in southwestern regions of the United States. But, as Tucson Water's Plan states, drought is not a rapid onset condition, and each region reacts differently according to the condition of its watershed and water supply, delivery system and backup supplies.

Drought, its Relationship to Climate Variability and the City's Efforts to Monitor Climate Change

Tucson Water's drought response, water resource, and water distribution system planning is an ongoing process. Successful planning requires periodic updates of any written plans. In the case of the Drought Preparedness and Response Plan, Arizona statute requires an updated plan every five years. (The next update is due in 2011.) However, between required updates, changes must be made as well to reflect gained knowledge and experience and to address changing conditions. With time and research providing a better understanding of climate change, it has now become clear that drought and climate variability too must be considered in any long-term planning effort.

<u>What is Climate Variability?</u>
In its October 2007 newsletter, the National Weather Service (NWS — part of the National Oceanic Atmospheric Organization, NOAA) defines climate variability as *a long-term shift in the statistics of the weather* (including its averages). The NWS states that the last decade of the 20th century and the beginning of the 21st century have been the warmest period since instrumentation began recording global temperatures in the mid-19th century. Climate variability is normal and large-scale climate changes have occurred in the Earth's past. But human-induced change also is a likely cause. Naturally-occurring gases such as carbon dioxide and water vapor trap heat in the atmosphere, because of the greenhouse effect. The current level is the highest in the past 650,000 years. Burning of fossil fuels such as oil, coal, and natural gas also add carbon dioxide, as well as other greenhouse gases, to the atmosphere. The 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IOCC) states most of the observed increase in the globally averaged temperature since the mid-20th century is very likely due to human-caused greenhouse-gas concentrations.

The U.S. Global Change Research Program in its 2009 report "Global Climate Change Impacts in the United States" writes that climate variability in the Southwest is among the most rapidly-occurring in the nation, more than the global average in some areas. Climate variability in the Southwest is especially troublesome, the report states, because this region continues to lead the nation in population growth. One result is less spring snowpack and snowmelt to augment the Colorado River, a water resource the City of Tucson depends on.

Climate variability affects the environment. The increased sedimentation and turbidity from more intense flood events will cause reservoirs to become shallower, warmer, and more eutrophic. These unwanted results may require planning for invasive species management (e.g., quagga mussels), protecting threatened and endangered species, and assuring water quality. These environmental concerns will also have impacts on people and their quality of life.

Although climate variability is normal, new understanding of its current implications from such credible sources as those mentioned above suggests it will likely be more severe in the future. These implications have been considered in recent planning efforts at Tucson Water, and will become formalized in updates to Tucson Water's *Drought Preparedness and Response Plan* in the future.

The City of Tucson continues to prepare for the possibility of climate change. The Climate Change Advisory Committee, a group of citizen stakeholders, meets monthly to advance the City's readiness for climate change adaptation and mitigation. One of its principal functions is the development of a Climate Change Mitigation and Adaptation Plan.

Tucson Water itself is involved in regional climate-change studies coordinated through various universities, including the University of Arizona and Arizona Sate University. Tucson Water is a cooperator in a project known as "Knowledge to Action: An Assessment of the Transfer of Climate Science to Decision Making." This program is funded by the Climate Program Office of NOAA . The University of Arizona is the principal investigator, and one of the products of the program will be a set of guidelines for integrating climate science with decision making.

Tucson Water is also a workshop partner in "Planning for Climate Change through an Integrative Approach to Water-planning, Climate Downscaling, and Robust Decision-Making." This effort too is aimed, in part, at making climate science accessible and useful for water utilities. Workshop series partners include the U.S. Bureau of Reclamation, Arizona Water Institute, CLIMAS (University of Arizona), City of Phoenix, Central Arizona Project, Arizona State University's Decision Center for a Desert City, and others.

Ultimately, Tucson Water is researching ways to integrate climate science into its planning program. A great deal of Tucson Water's planning efforts are intended to mitigate for future uncertainty. To the extent that climate science can be applied to that

goal, it will be an important tool for assuring the community of a sustainable water supply for the future.

Status of Regional Indicators

- **Colorado River Status**

Clearly, the Colorado River water delivered through the Central Arizona Project is a vital resource to the Tucson Water service area. More than half of Tucson Water's annual water demand is met through this renewable surface water resource, and Colorado River water will provide even more of the water supply to meet this demand in future years. By 2012, Tucson Water expects to meet all its potable demands with its CAP allotment. Snow melt and runoff from the Upper Colorado Basin provide supplies to Lakes Powell and Mead, the reservoirs most critical to Arizona Colorado River deliveries (see figure A-1).

Figure A-1: The Colorado River system in Arizona with Lakes Mead and Powell and the CAP aqueduct.

The Natural Resources Conservation Service (NRCS) monitors nearly 2,000 stations in the West using automated and manual snow telemetry (SNOTEL) stations. Stations provide precipitation, snow depth, snow water content (defined as 'snow water equivalent,' the amount of water contained in the snowpack if the snowpack at the SNOTEL site melted all at once), and air temperature data. More than 100 SNOTEL sites are monitored above Lake Powell for the Upper Colorado River Basin.

Figure A-2 depicts snow conditions in the upper Colorado snowshed. As of early June, most of the snowshed was well below normal. Total snowpack for the entire upper

Colorado is shown in Figure A-3. Of the four years depicted, two exhibit a sudden loss of snow in May, and the remaining years, 2008, and 2010, show more persistence in the snowpack. Although this years snowpack has hovered at about 70 or 80 percent of normal, the improved persistence of the snowpack may prove helpful to supplies on the River.

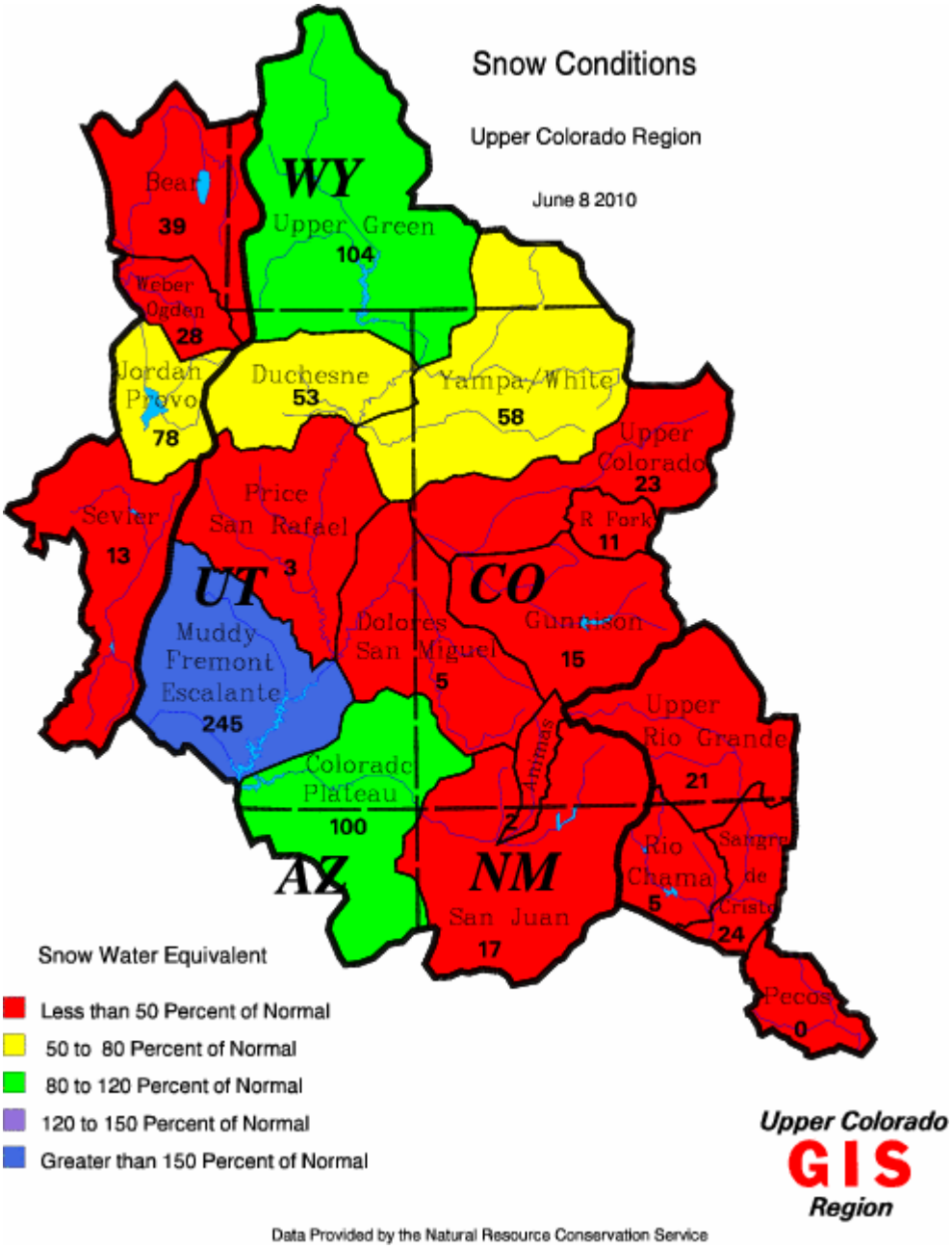

Figure A-2: Snow Conditions, upper Colorado River region, June 8, 2010. (http://www.usbr.gov, U.S. Bureau of Reclamation from data provided by the Natural Resource Conservation Service.

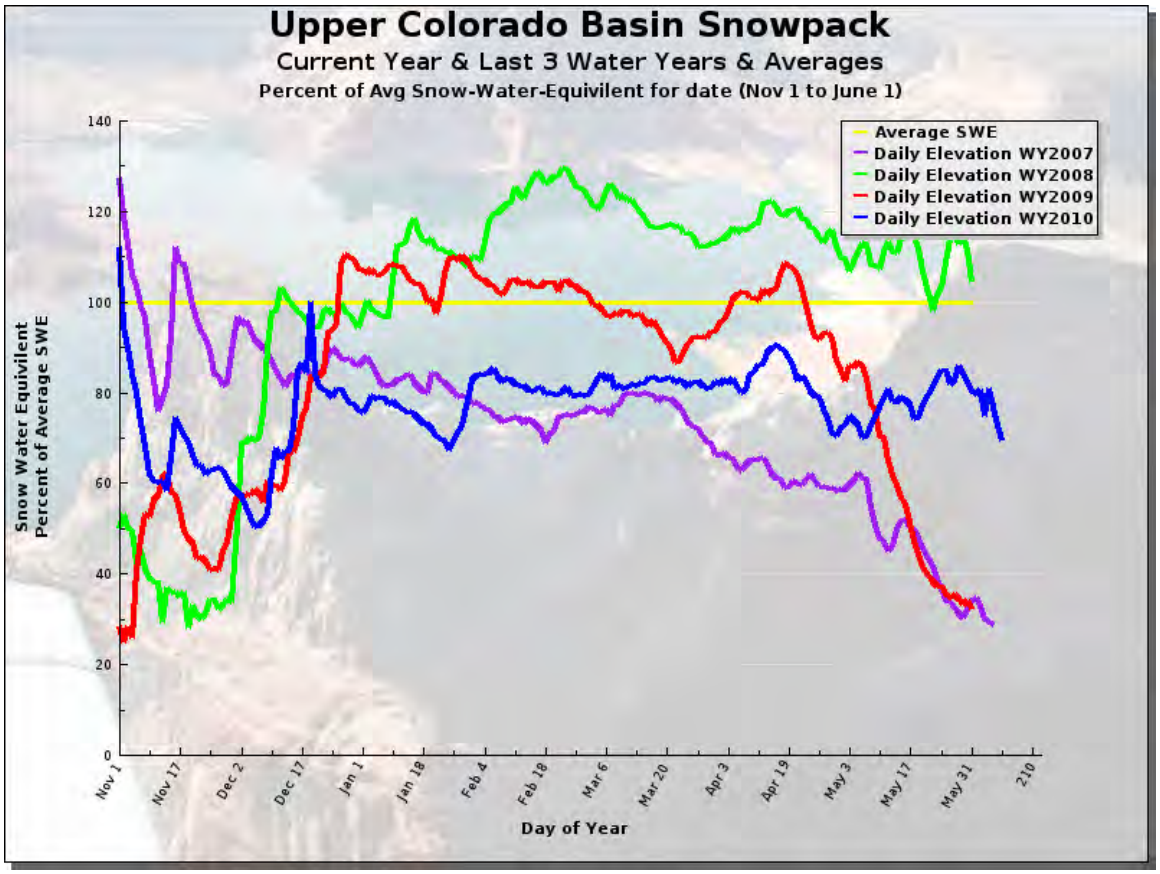

Figure A-3: Upper Colorado Basin Snowpack, current year, last three water years, and averages. (http://www.water-data.com, Copyright Summit Technologies, Inc.1999 – 2010)

Using data like these, the Secretary of the Interior, through the U.S. Bureau of Reclamation, annually determines the condition of the Colorado River for the coming water year (from October to September) as surplus, normal, or average. In its 2010Annual Operating Plan the Bureau did not declare a shortage on the river for the 2009 water year (Annual Operating Plan for Colorado River Reservoirs, U.S. Bureau of Reclamation, December 2009). In the Upper Colorado River Basin during water year 2009, the overall precipitation accumulated through September 30, 2009 was approximately 95 percent of average based on the 30-year average for the period from 1971 through 2000 ("Drought in the Upper Colorado River Basin," U.S. Bureau of Reclamation).

The Natural Resource Conservation Service National Water and Climate Center reported Lake Powell at 61 percent capacity as of the June 7, 2010, up from the previous two months). April 1 is the last date for which the National Resource Conservation Service and the Colorado River Basin Forecast Center issue streamflow forecasts for Arizona. For April 1, 2010, streamflows in Arizona had a 50 percent chance of being below normal. For Lower Colorado River Basin users,

like Arizona, the elevations of the large reservoirs are critical to determining shortages on the River. The water level elevation at Lake Powell as of June, 2010, was 3,630 of elevation, about the same as the 3644 feet of 2009 (see figure A-4). Lake Meade was at 1093 feet or about 42 percent of full pool.

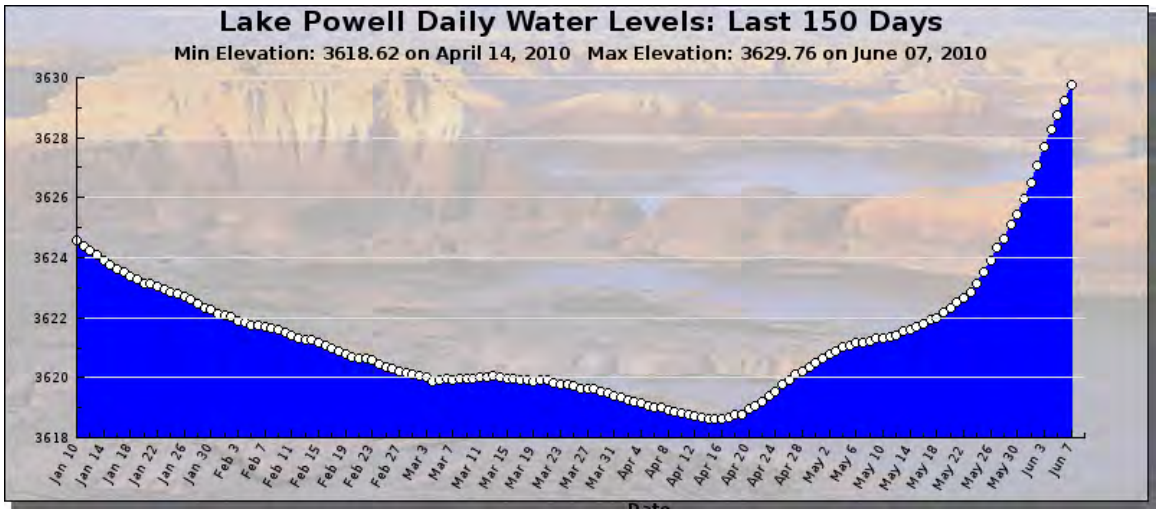

Figure A-4: Lake Powell daily water levels: last 150 days as of June 7, 2010. (http://www.water-data.com, Copyright Summit Technologies, Inc.1999 – 2010)

- **Santa Cruz Watershed Drought Status**

Another regional indicator Tucson Water staff utilize is the drought status for the Santa Cruz watershed, as determined by ADWR's Drought Monitoring Technical Committee. This information appears in the Committee's monthly Drought Monitoring Report on the ADWR website as well as the *Southwest Climate Outlook* newsletter produced by CLIMAS (Climate Assessment for the Southwest Project) at the University of Arizona. As of June 2010 improvements to Arizona drought conditions were reported, with much of the state showing improvement in its drought classification and the southern part of the state exhibiting no signs of drought.

The short-term improvement in drought level may be seen by comparing the short-term drought status in figure A-5 with long-term status in figure A-6. Despite these improvements, short- term (precipitation in last 12 months) and long- term (streamflow and precipitation records over the past four years) long-term drought status for the Santa Cruz Watershed, specific to Pima County, is still severe.



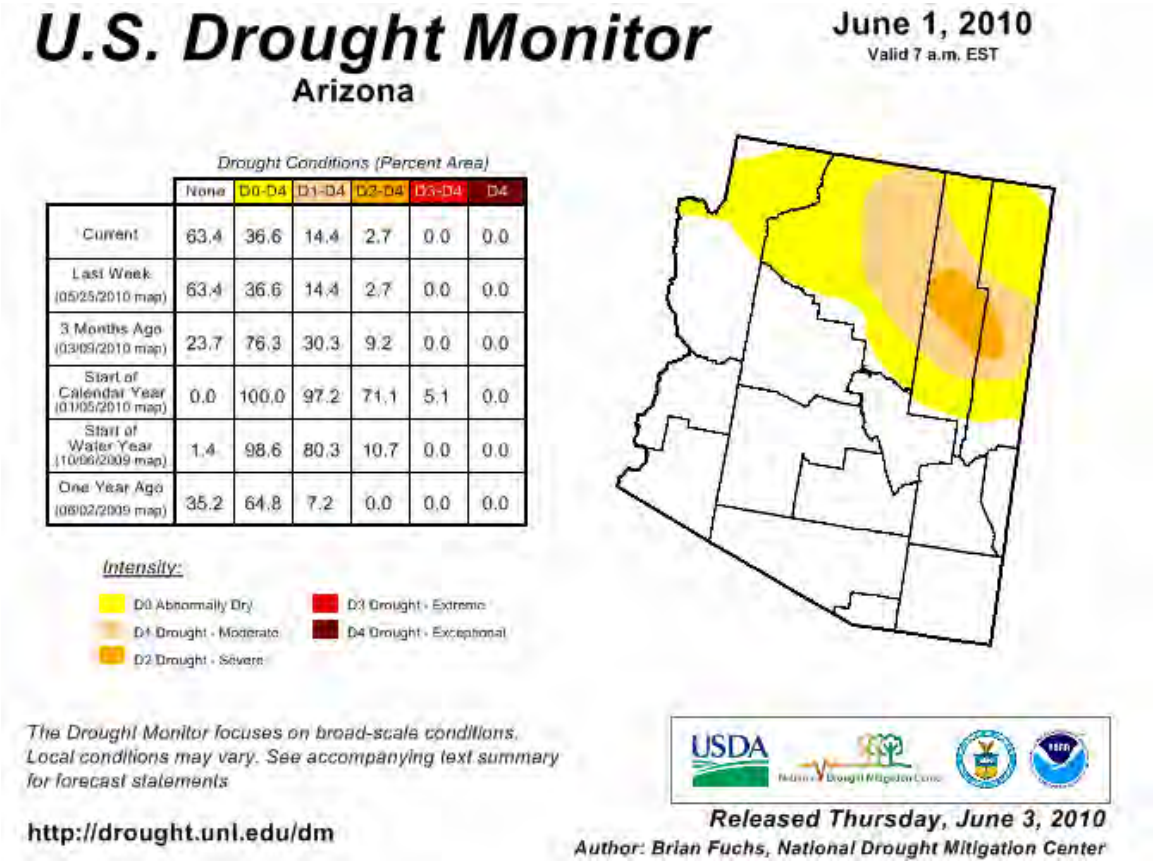

Figure A-5: Arizona short-term drought status. U.S. Drought Monitor results for Arizona as of June 3, 2010. (http://drought.unl.edu/DM/monitor.html National Drought Monitor Mitigation Center, a joint effort with National Oceanic and Atmospheric Administration and the U.S. Department of Agriculture.)



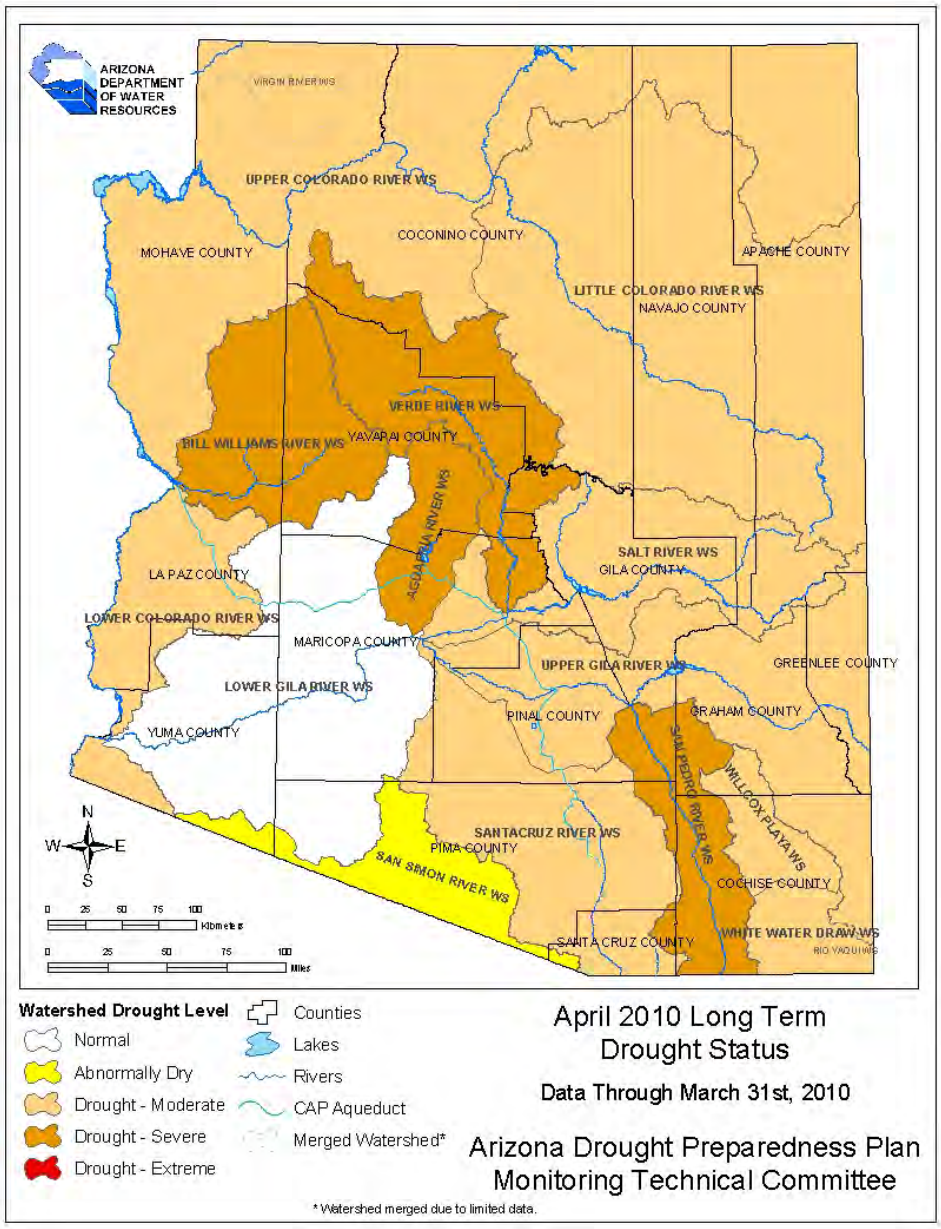

Figure A-6: Arizona long-term drought status as of March 31, 2010. (http://www.azwater.gov, Arizona Department of Water Resources)

Status of Local System Indicators

- **Aquifer Storage Index:**

The Aquifer Storage Index (ASI) captures the net effects on water table levels from pumping and from natural and artificial recharge. It is a measure of the change in water storage volume relative to a base year of 2000. Tucson Water's production wells are grouped into 11 regions of hydrologic similarity for this calculation. Each region is represented by one average water level, simplifying water level change comparison. (See figure A-7.)

2009 Aquifer Storage Index: The Aquifer Storage Index continues its dramatic improvement since 2003. This is due to continued increases in production from CAVSARP, storage at SAVSARP and falling demand for potable water, resulting in less use of mined groundwater as a percent of all potable demand.

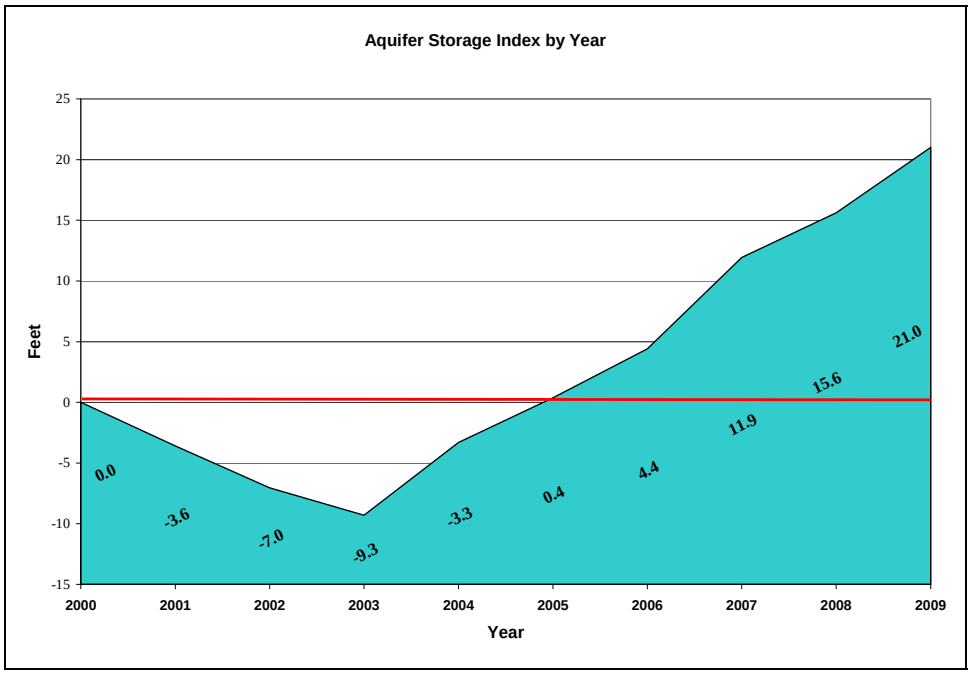

Figure A-7: Aquifer storage index by year, 2000-2009.

- **Potable Production Capacity Index(PPCI):**

The Potable Production Capacity Index (PPCI) is a ratio of potable production capacity available for the coming year (in millions of gallons per day, mgd) divided by the predicted maximum 30-day demand period for the upcoming year (in mgd). Data from Tucson Water's Well Status Report is the primary information source for the PPCI. An index score of "1.1" or higher is considered good; lower than 1.1 indicates some degree of system stress; less than one indicates that demand is expected to be greater than capacity and that excess demand will be met with storage.

Further expected declines in the peak 30 day demand period and stable production capacity has resulted in the PPCI forecast increasing to 1.40 for this annual update. Over that the last two years the maximum 30 day demand has come in well below the forecasted volume. Due to continued underlying weakness in the local economy the maximum 30 day demand could once again fall below the forecasted volume. As such, the forecasted PPCI of 1.40 represents a conservative estimate. (See figure A-8.)

Year	Forecast Production Capacity in Million Gallons	Forecast Maximum 30 Day Demand in Million Gallons	Forecasted PPCI	Actual Maximum 30 Day Demand in Million Gallons	Actual PPCI
2008	171.5	150.0	1.14	137.2	1.25
2009	184.2	148.1	1.24	126.5	1.46
2010	196.7	141.0	1.40		

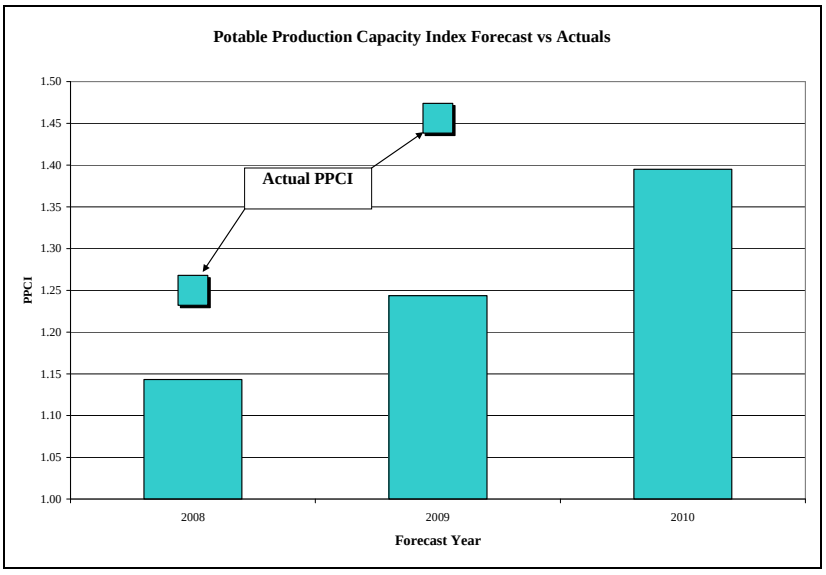

Figure A-8: Potable production capacity index, 2008-2010 and forecast maximum 30-day demand.

- **Gallons Per Capita Per Day:** 141 and trending downwards.

Gallons Per Capita per Day is the total potable water produced by Tucson Water for the previous year divided by the estimated service area population for that year. (See figure A-9.)



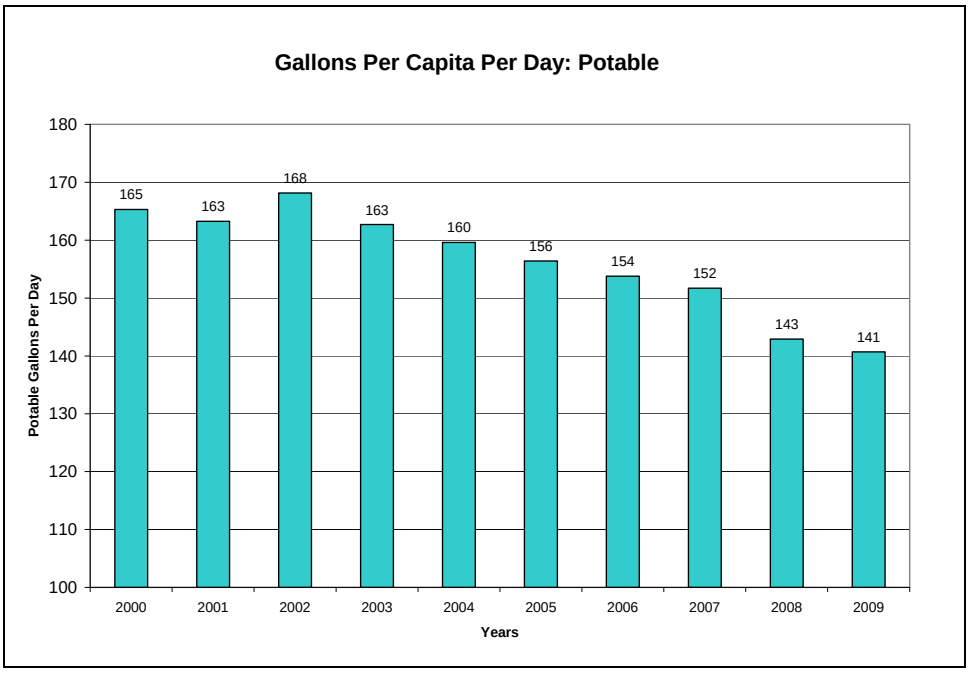

Figure A-9: Gallons per capita per day potable usage for Tucson Water, 2000-2009.

The source for potable water produced is the annual pumpage report prepared every March by Tucson Water staff for Arizona Department of Water Resources (ADWR). During 2009, the Water Department and the Arizona Department of Water Resources agreed on a new methodology for estimating the population since the 2000 Census. This has resulted in some changes in the per capita water usage as reported in previous years. (Previously staff simply increased the population by 2%. Now staff estimates the population based on the number of new housing units added each year. Given the downturn in the housing market, the adopted method will result in a lower population in the more recent years and thus a higher per capita water use.) The 2010 Census could result in a lower population than the population estimated using the data we have available. The current method relies on the 2000 Census vacancy rates, which are widely considered to be higher than they actually have been in recent years. If the population falls, the per capita water use will be higher than reported here. While the per capita water use may be higher than the 141 in the chart above, it is not expected to approach 150 and the trend will continue in the same direction, though it may be a little flatter. The results of the census are not expected to be available until well after this report is filed.

- **Reclaimed Production Capacity Index(RPCI):**

The RPCI is the ratio of maximum reclaimed water production capacity for the upcoming year to the peak day forecast for reclaimed water demand for the upcoming year. (See figure A-10.) While an index score of 1.0 indicates that the water system is functioning sufficiently, an index score of 1.1 indicates higher reliability.

Forecast Year	Production	Forecasted Peak Day	RPCI
2008	34.2	31.3	1.09
2009	33.5	31.8	1.05
2010	29.8	29.3	1.02

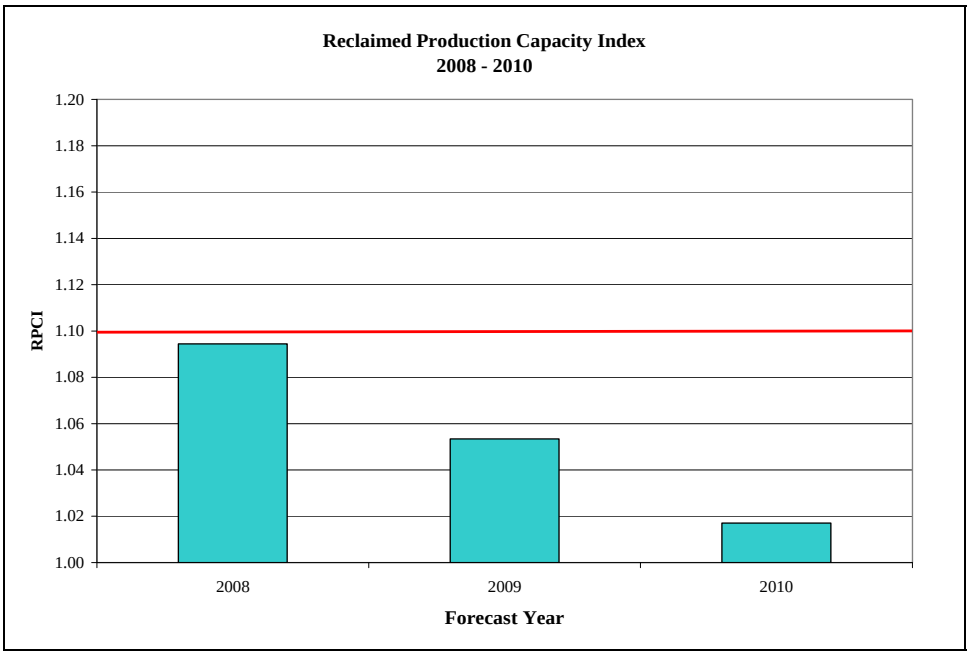

Figure A-10: Reclaimed production capacity index and forecasted peak day, 2008-2010.

Staff Recommendation on Drought Response Stage

Tucson Water's Drought Response Plan includes four response stages, with Stage 1 Response being the mildest (public education) and Stage 4 being the most stringent (water use restrictions) in terms of drought response measures.

A Stage 1 Drought Response was declared for the Tucson Water Service Area in April 2007 based on the indicators adopted in the drought response plan. A Stage 1 Drought Response was continued in April 2008 and again in 2009 based on staff's assessment of regional and local indicators and water system indexes.

Based on the annual review of regional and local system indicators, staff recommends that a Stage 1 Drought Response be continued in the Tucson Water service area in 2010.

The focus of Stage 1 response measures is to increase community awareness of drought and promote water use efficiency. Additional measures may include voluntary self-audit programs for commercial, multi-family, and industrial users. Tucson city departments initiated plans for a self-audit program in 2007 to determine if further efficiency

measures could be undertaken in day-to-day operations in city-owned or operated facilities. That effort is on-going at this time but has met with delays related to budget issues and loss of staff.

From a water system standpoint a Stage 1 response means changes in system operations or maintenance programs to reduce water loss. For example, Tucson Water continues its water loss control program, which includes a meter replacement and leak detection component.