APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF BOB ROSE

THE STATE OF TEXAS §
§
COUNTY OF TRAVIS §

Before me, the undersigned authority, personally appeared Robert H. Rosenzweig, also known as Bob Rose, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct.

3. I, Bob Rose, am an individual residing in Austin, Texas.

4. I am the Chief Meteorologist for the Lower Colorado River Authority (LCRA). I have held this position since 1995. I have worked as a meteorologist in Texas for 30 years. A true and correct copy of my resume, detailing my prior work history and education, is attached hereto under Tab 1.

5. As part of my duties at the LCRA, I regularly review and summarize short-term and long-term weather predictions and drought indices for the Central Texas region. My opinion is based on my experience in the field and a review of data and forecasts from the National Weather Service's Climate Prediction Center, National Oceanic and Atmospheric Administration's (NOAA's) Earth System Research Laboratory, Texas State Climatologist Dr. John Nielsen-Gammon, and Research Scientist Gregory J. McCabe.

6. Extraordinary drought conditions have gripped much of Texas, including the Colorado River basin, for more than four (4) years, dating back to October of 2010. The drought has been unprecedented relative to the long-term climate record in a number of ways: record low precipitation, extreme, record-setting summer heat and enormous wildfires. The drought conditions include both meteorological drought (taking into account rainfall and temperature) and hydrologic drought (taking into account streamflow and evaporation).

7. Rainfall. According to the Texas State Climatologist, Dr. John Nielsen-Gammon, on a statewide basis, rainfall during the 12 month period from Oct. 1, 2010 to Sept. 30, 2011 was the lowest ever recorded, dating back to 1895. (Available at http://climatexas.tamu.edu/files/2011_drought.pdf.) My review of rainfall data indicates the following:

a) Total average rainfall across Texas from Oct. 1, 2010 to Sept. 30, 2011 was 11.18 inches, just 38 percent of the long-term average. This is much lower than the previous record of 13.91 inches occurring between October 1955 and September 1956.

b) Total average rainfall across Texas in 2012 was 24.10 inches, 2.98 inches below normal.

c) Total average rainfall across Texas in 2013 was 26.02 inches, 1.06 inches below normal.

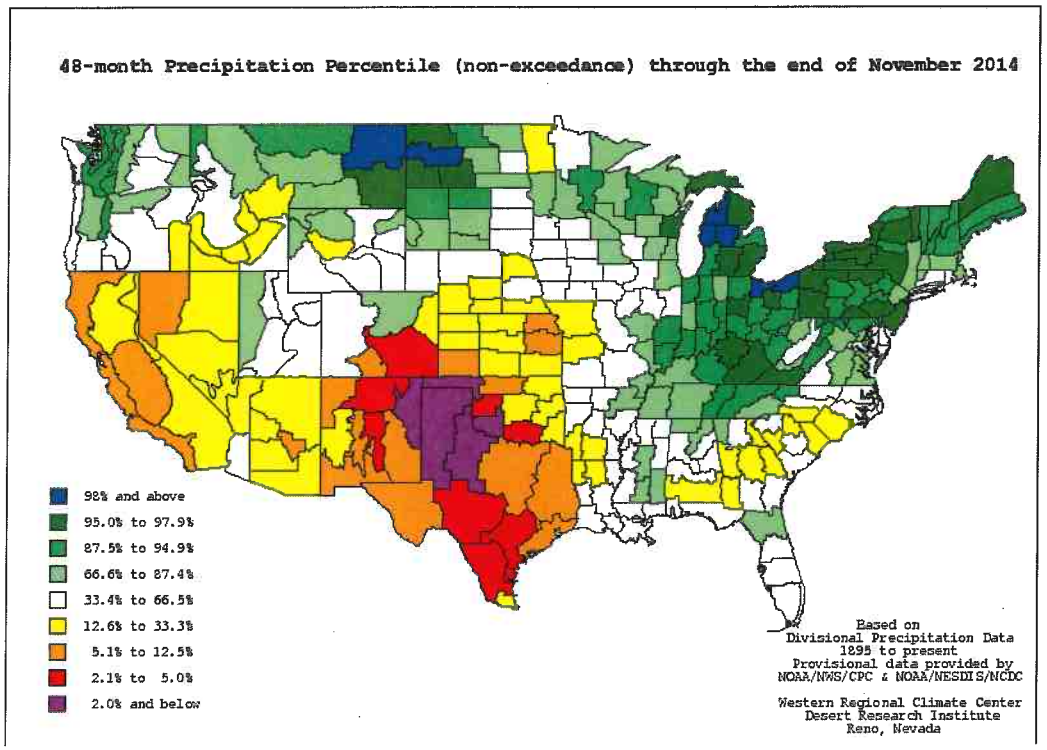
d) While 2014 started off unusually dry, significant rains occurred in the spring and fall months bringing totals closer to normal. The annual statewide rainfall totaled 24.01, 3.07 inches below normal, the 34th driest on record, dating back to 1895. (Available at http://www.ncdc.noaa.gov/temp-and-precip/climatological-rankings/index.php?periods%5B%5D=12&parameter=pcp&state=41&div=0&month=12&year=2014 last visited on May 13, 2015.)

e) Statewide rainfall for the four-year period from November 2010 to October 2014 was well below normal, totaling 86.56 inches. This was 21.95 inches below normal, or 80 percent of normal. This is the 4th driest four-year period beginning in November on record dating back to 1895. (Available at http://www.ncdc.noaa.gov/temp-and-precip/climatological-rankings/index.php?periods%5B%5D=48&parameter=pcp&state=41&div=0&month=10&year=2014 last visited Dec. 15, 2014.)

f) According to data provided by NOAA's Western Regional Climate Center, the 48 month rainfall from November 2010 to October 2014 across the Hill Country and Central Texas regions fell within the 2.1 to 5.0 percentile for precipitation. In other words, similar 48-month rainfall periods during the period of record were lower than the current period only about two to five percent of the time. *See* Figure 1 below. (Available at http://www.wrcc.dri.edu/cgi-bin/spiFmap.pl?per48 last visited Dec. 15, 2014.)

g) Rainfall has increased across Texas during the first four months of 2015. According to data from the National Center for Environmental Information, statewide rainfall from January 1 through April 30 measured 11.12 inches, 4.02 inches above normal. This period ranks as the 12th wettest such period on record. (Available at http://www.ncdc.noaa.gov/temp-and-precip/climatological-rankings/index.php?periods%5B%5D=4&parameter=pcp&state=41&div=0&month=4&year=2015 last visited May 7, 2015).

Figure 1. National Precipitation Percentiles for 48-month period ending November 2014



8. Recent rain events and corresponding runoff and inflows to the Highland Lakes have been compared to events from 2007. The sporadic nature of rain events has produced well below average runoff over the past four years. (*See* Affidavit of Ryan Rowney.)

   a) Heavy, widespread rainfall in the Llano River and San Saba River watersheds above the Highland Lakes on Sept. 19 and 20, 2013 averaged two to three inches, with some rain gages reporting totals as high as six or seven inches.

   b) Two heavy rain events occurred during October 2013, but both of these events occurred primarily downstream of the watershed to the Highland Lakes. The first event occurred on October 12 and 13, producing up to a foot of rain over southwest Austin and southwest Travis County. The second event occurred on October 30 and 31, producing widespread totals of 8 to 12 inches over parts of Travis, Hays and Comal Counties. The majority of the runoff from both rain events drained into the Colorado River below Austin.

   c) Two notable rain events occurred across the Hill Country and Central Texas regions during November 2014. The first event on November 4, 5 and 6th produced a steady light to moderate rain with totals of 2 to 3 inches. The second event, occurring on November 21 and 22 produced moderate to heavy rain with totals in the range of 1-3 inches.

   d) A rain event on March 20 through 22, 2015 included widespread rainfall above the Highland Lakes averaging 1 to 2.5 inches, with heavier rainfall totals below the Highland Lakes.

e) Two notable rain events also occurred in March 2007. The first event, occurring March 11 and 12 caused widespread moderate to heavy rain across the Hill Country and Central Texas regions, with totals of 2 to 4 inches. The second rain event occurred on March 26 and 27 with widespread moderate to heavy rain. This event also produced fairly widespread totals of 2 to 4 inches across the Hill Country and Central Texas.

f) An analysis of 2014 rainfall across the Hill Country indicated the rain was very sporadic in nature, with long gaps of several weeks between most significant rain events. In addition, there were very few intense rain events with totals of 2 inches of more in a 24-hour period. In fact, data from Llano, showed only 1 day out of the entire year contained a 24-hour total of at least 2 inches. Meanwhile, an analysis of rainfall across Central Texas and the middle Texas coast showed 2014 rainfall was less sporadic and more frequent evenly distributed compared to the Hill Country. More intense rain events occurred as well. For example, Austin reported a 24-hour rainfall total of 6.64 inches on September 17th. The highly sporadic nature of the Hill Country rains was a major factor in limiting any significant drought improvement across the Colorado River watershed in 2014.

9. According to the early May U.S. National Drought Monitor, a product of the National Weather Service, the U.S. Department of Agriculture, and the National Drought Mitigation Center, much of the Texas Hill Country and Highland Lakes watershed was designated as being in "moderate to severe drought," the first and second of four drought classifications. Parts of Llano, Gillespie and Kerr Counties were shown to be in extreme drought, the third of four drought classifications. All of Central Texas and the coastal plains region were shown to be drought free due to generous rains in March and April. Note, the Drought Monitor does not specifically depict the state's hydrologic drought, which is considerably worse than depicted. (*See* http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?TX last visited May 7, 2015)

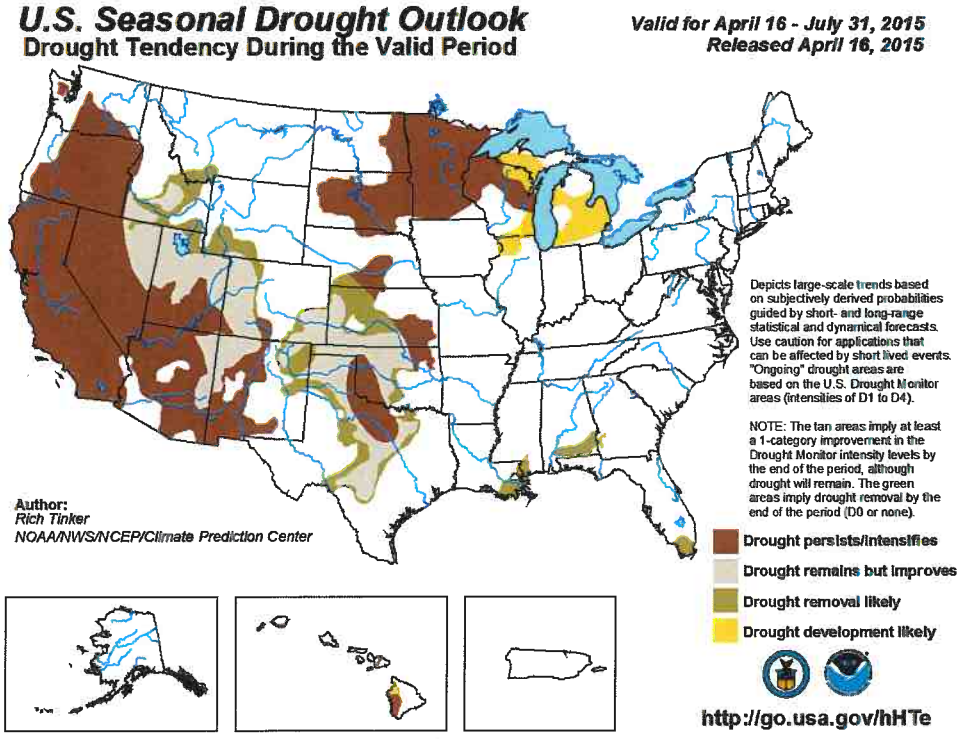
10. Heat. Another factor that has contributed to the severity of the ongoing drought has been the unprecedented heat. For Texas, the average temperature between June 1 and August 31 of 2011 was the hottest summer average temperature ever recorded in Texas and the second hottest summer average temperature for any state in the U.S., dating back to 1895. Summer 2011 was also, by far, the hottest summer on record for Austin. Statewide, calendar year 2011 was the second hottest year ever recorded and the hottest year on record for Austin. The combination of well below normal rainfall and unprecedented heat created some of the most severe drought conditions ever recorded. (*See* http://www.ncdc.noaa.gov/sotc/drought/2011/9, last visited July 1, 2013 and http://www.srh.noaa.gov/images/ewx/wxevent/sum2011.pdf, last visited July 1, 2013.) These conditions even surpassed the drought conditions of the 1950s. The unprecedented hot temperatures combined with numerous sunny days to create much higher than normal losses from evaporation. Abnormally warm

temperatures also continued in 2012. Statewide, the summer of 2012 was the 10th hottest summer on record. And it was the 11th hottest summer on record for Austin. Statewide, 2012 tied with 1921 for the warmest year ever recorded in Texas history. For Austin, summer temperatures in 2012 were the 9th warmest on record. Summer temperatures for Austin in 2013 were the 5th warmest on record. Summer temperatures for Austin in 2014 were milder than most recent years, ranking as the 34th warmest on record.

11. Weather Forecast Sources. In developing my forecast, I have relied on various sources, including the National Weather Service's Climate Prediction Center, NOAA's Earth Science Research Laboratory, Texas State Climatologist John Nielsen-Gammon, and Gregory McCabe, Research Scientist.

a) The National Weather Service's Climate Prediction Center (CPC) 3-Month Drought Outlook calls for drought improvement and possible drought elimination across the Hill Country, Central Texas and middle Texas coastal regions between the months of May and July. *See* Figure 2.

Figure 2.

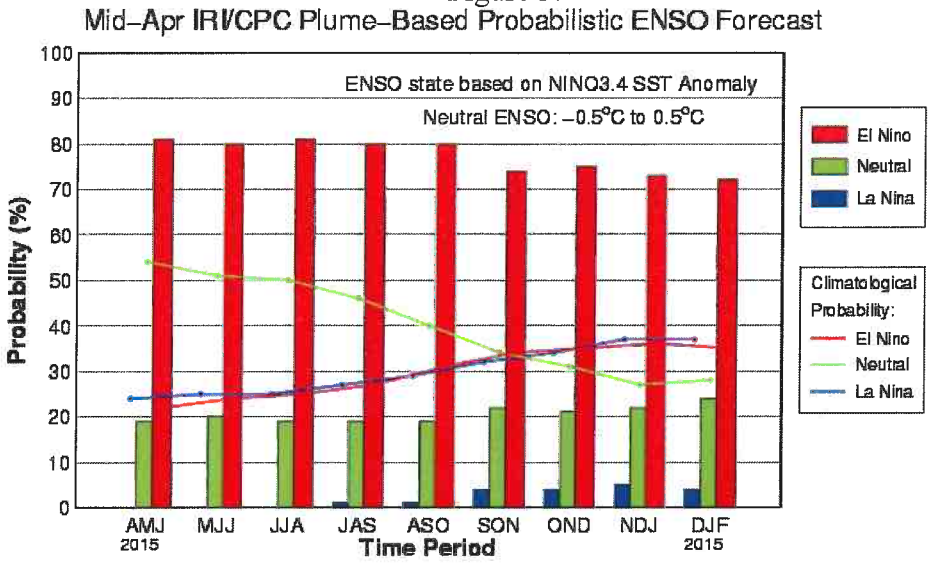


According to CPC forecasters, "In the central and southern Plains, drought improvement or removal is generally expected, with a few notable exceptions. The May-July forecast favors above-normal rainfall across Texas, the central and southern High Plains, and the western tiers of Oklahoma, Kansas, and Nebraska. Most of the central and southern Plains

should anticipate some improvement or removal of drought by the end of July, with a couple of exceptions". (Available at http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_discussion.html.)

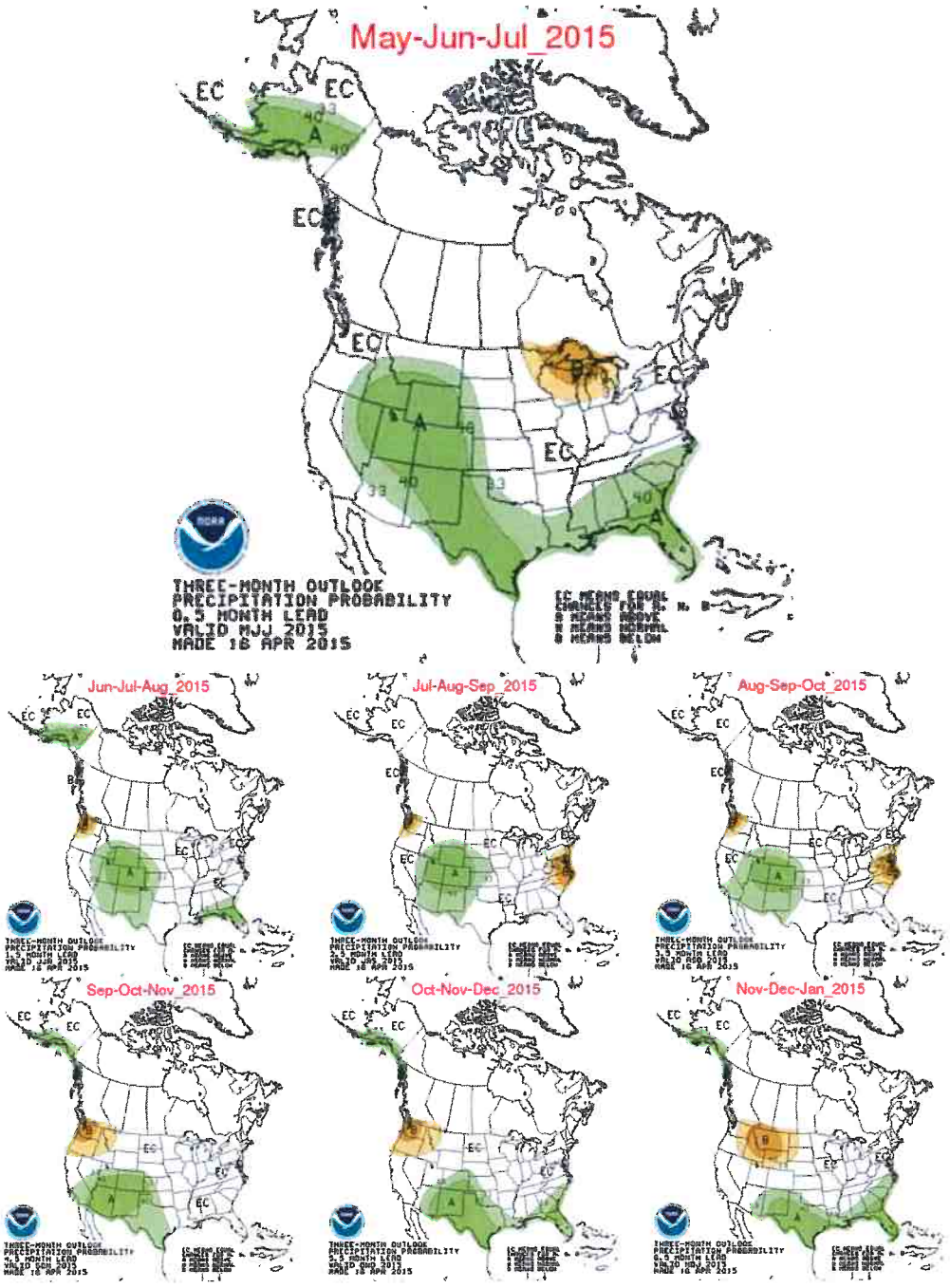
The International Research Institute, a partner of the National Weather Service's Climate Prediction Center, forecasts an 80 percent probability El Niño conditions will persist through summer. A 70 percent chance for continued El Niño conditions is forecast this fall and winter. (*See* Figure 3, available at http://iri.columbia.edu/our-expertise/climate/forecasts/enso/current (last visited May 7, 2015.)

Figure 3.



b) The latest National Weather Service precipitation outlook calls for above normal precipitation across Central and South Texas through early summer. Equal chances for above, below, or near normal precipitation are forecast late summer but a trend back to above normal rainfall is forecast this upcoming fall and winter. *See* Figure 4. Climate Prediction Center forecasters state: "The May-June-July precipitation outlook depicts elevated odds for above median seasonal total precipitation for much of the Great Basin, Rockies and Southwest, and eastward along the southern tier of the Contiguous US to include parts of the southeast. Correlations with (the) PDO (Pacific Decadal Oscillation) and Niño 3.4 indices along with dynamical model guidance support the forecast in the west and for Alaska while model guidance was the primary driver for the outlook in the southeast. As the outlooks proceed from October-November-December 2015, the typical wintertime El Niño impacts are introduced into the outlooks (through February-March-April 2016), albeit low probabilities. These include favored above median precipitation along the southern tier of the contiguous U.S. from November-December-January 2015-2016 through February-March-April 2016." (*See* http://www.cpc.ncep.noaa.gov/products /predictions/90day/fxus05.html last visited May, 7, 2015.)

Figure 4. National Weather Service Precipitation Outlook

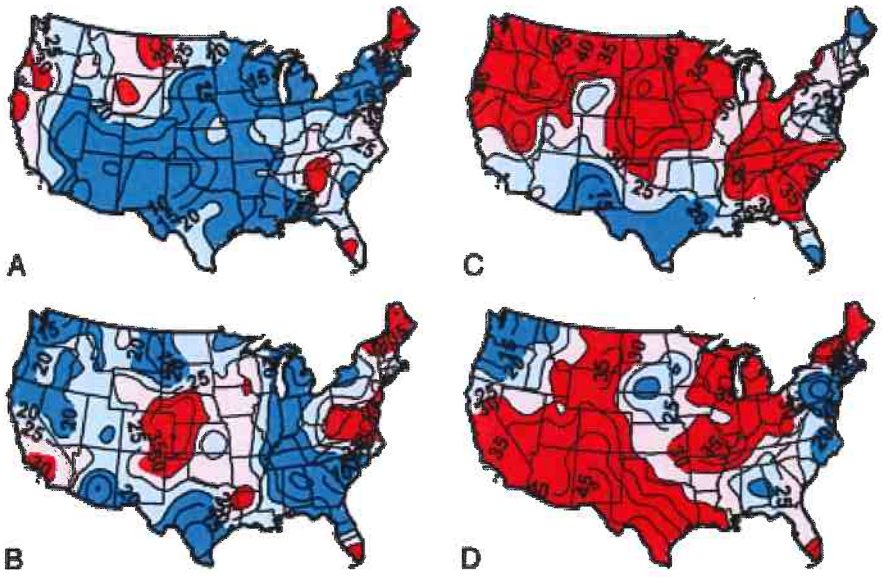


c) Well above normal sea surface temperatures are currently in place in the tropical Pacific, stretching from the west coast of South America to beyond the International Date Line. These sea surface temperatures are consistent with the development of a moderate El Niño. Most long-range climate forecast models indicate tropical Pacific waters will remain well above the threshold for El Niño through the upcoming fall and winter. An El Niño

watch remains posted. NWS forecasters state "By the end of March 2015, weak El Niño conditions were reflected by above-average sea surface temperatures (SST) across the equatorial Pacific and by the expected tropical atmospheric response. Subsurface temperature anomalies increased substantially during the month (of March) in response to a downwelling oceanic Kelvin wave, which resulted in strong positive subsurface anomalies across most of the Pacific. Consistent with ocean-atmosphere coupling, enhanced convection shifted eastward to the central equatorial Pacific, while low-level westerly wind anomalies continued over the western equatorial Pacific and upper-level easterly wind anomalies continued in the central Pacific. Also, both the traditional and the equatorial Southern Oscillation Index (EQSOI) remained negative during the month. Collectively, these features reflect weak El Niño conditions. Compared to last month, more models predict El Niño (3-month values of the Niño-3.4 index equal to or greater than 0.5 degrees C) to continue throughout 2015. These forecasts are supported by the increase in subsurface temperatures, enhanced convection over the Date Line, and the increased persistence of low-level westerly wind anomalies. However, model forecast skill tends to be lower during the Northern Hemisphere spring, which limits the forecast probabilities of El Niño through the year. At this time, there is also considerable uncertainty as to how strong this event may become." (*See* http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.html last visited May 7, 2015.) El Niños typically cause a pattern of above normal rainfall across Central Texas during the fall, winter and spring months. But the El Niño influence often weakens during summer.

d) In 2004, McCabe et. al. published a statistical study of drought frequency in the lower 48 states versus the PDO and Atlantic Multidecadal Oscillation (AMO). (*See* Figure 5, below, available at http://www.pnas.org/content/101/12/4136.long.) Over the past year, a belt of warm water developed across the eastern Pacific Ocean, from the Gulf of Alaska south to Mexico. These warmer waters across the eastern Pacific changed the phase of PDO from negative to positive. At the same time, waters in the North Atlantic Ocean cooled, changing the phase of the AMO from positive to negative. Oceanic conditions in both the Atlantic and Pacific Oceans seem to influence long-term drought conditions within the United States. Scientists monitoring both oceans have been able to match the changing phases of multi-decadal oscillations within each ocean to the presence or absence of drought across the U.S. McCabe pointed out the difference between the dust bowl drought in the 1930s when the PDO and AMO were both positive and the multi-year drought of the 1950s over the south central and southwestern U.S. when the PDO was cold and the AMO was warm.

Figure 5. Drought probability for the four classes of Pacific Decadal Oscillation and Atlantic Multidecadal Oscillation



A is Cold (-) AMO and Warm (+) PDO. B is Cold (-) AMO and Cold (-) PDO.
C is Warm (+) AMO and Warm (+) PDO. D is Warm (+) AMO and Cold (-) PDO.

The Pacific and Atlantic Oceans have been indicative of classification D from 2010-2014, suggesting persistent drought for Texas and the southwestern United States. McCabe in 2004 wrote, "Should the current positive AMO (warm North Atlantic) conditions persist into the upcoming decade, we suggest two possible drought scenarios that resemble the continental-scale patterns of the 1930s (positive PDO) and 1950s (negative PDO) drought."

As of early 2015, the current state of the Atlantic and Pacific Oceans is now indicative of classification A, suggesting a change to a wetter pattern across Texas and the southern Plains states.

12. Weather Forecast. Based on my experience and a review of data and forecasts from the sources listed above, it is my opinion a general pattern of above normal rainfall will be in place across Central and South Texas this spring and also in the upcoming fall and winter due to the development and persistence of El Niño. While the rain may trend close to normal this summer, it looks to trend back above normal this fall. Historical analogs show a good correlation with above normal rainfall across Texas during the fall and winter months and a moderate or strong El Niño. From a meteorological standpoint, this wetter forecast should cause continued drought improvement across the basin.

13. Further affiant sayeth not.

Bob Rose
BOB ROSE, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 12th day of May, 2015.

TABETHA JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2018

Tabetha Jaske
Notary Public in and for the State of Texas

My Commission Expires: 1-11-2018

Tab 1

BOB ROSE

P.O. Box 220
Austin, TX 78767-0220
bob.rose@lcra.org

EDUCATION

Texas A&M University, College Station, Texas
Bachelor of Science in Meteorology 1979.

PROFESSIONAL EMPLOYMENT

Jan 1995 to Present — *Chief Meteorologist,* **Lower Colorado River Authority, Austin, Texas**

- Responsible for the daily forecast of weather conditions and temperatures affecting the Lower Colorado River Authority's power generation, electrical transmission, flood control and water supply operations.
- Produce a daily weather blog about Central Texas weather: http://www.lcra.org/water/conditions/weather/weather_column.html
- Write daily operational weather briefs to keep all departments of LCRA apprised of expected weather conditions.
- Provide advance notice significant weather event e mails to emergency management officials, county judges along with city and state agencies.
- Present a bi-weekly video weather blog about Central Texas weather. Give numerous talks to various civic groups and organizations about the weather.
- Provide weather information to a number of newspapers and media outlets across Central Texas about regional weather.

Feb 1988 to Jan 1995 — *Meteorologist,* **KVUE-TV (ABC), Austin, Texas**

- Responsible for the morning and midday newscasts for 4 years, weekend newscasts for 3 years.
- Prepared a weekly astronomical report called Skywatch, and did occasional science and environmental reporting.

Sep 1978 to Jan 1988 — *Weekend Meteorologist,* **KBTX-TV, Bryan, Texas (ABC/CBS).**

- Responsible for the forecasting, preparation and presentation of the 10 PM weekend weathercasts.

PROFESSIONAL MEMBERSHIPS

Member, American Meteorological Society. TV Seal #501, AMS Certified Broadcast Meteorologist.
Member, Austin-San Antonio chapter, American Meteorological Society
Currently serving on the Board for Private Sector Meteorology with the American Meteorological Society

RELATED ACTIVITES:

A regular contributor to the National Drought Monitor.
Member of the Southern Climate Impacts Planning Program (SCIPP)
Travis and Williamson County Coordinator for CoCoRaHS