OMB Number: 4040-0004
Expiration Date: 8/31/2016

Application for Federal Assistance SF-424

* 1. Type of Submission:
- [ ] Preapplication
- [x] Application
- [ ] Changed/Corrected Application

* 2. Type of Application:
- [x] New
- [ ] Continuation
- [ ] Revision

* If Revision, select appropriate letter(s):

* Other (Specify):

* 3. Date Received: 06/25/2015

4. Applicant Identifier:

5a. Federal Entity Identifier:

5b. Federal Award Identifier: R15AS00046

State Use Only:

6. Date Received by State:

7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: Texas Water Development Board

* b. Employer/Taxpayer Identification Number (EIN/TIN): 74-2378168

* c. Organizational DUNS: 0912099780000

d. Address:

* Street1: 1700 North Congress Avenue

Street2:

* City: Austin

County/Parish:

* State: TX: Texas

Province:

* Country: USA: UNITED STATES

* Zip / Postal Code: TX: 78701

e. Organizational Unit:

Department Name: Water Science and Conservation

Division Name: Administration

f. Name and contact information of person to be contacted on matters involving this application:

Prefix: Dr.

* First Name: Dinali

Middle Name: Nelun

* Last Name: Fernando

Suffix:

Title: Natural Resources Specialist

Organizational Affiliation: Texas Water Development Board

* Telephone Number: 512-475-0454

Fax Number:

* Email: nelun.fernando@twdb.texas.gov

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

A: State Government

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

Bureau of Reclamation

11. Catalog of Federal Domestic Assistance Number:

15.514

CFDA Title:

Reclamation States Emergency Drought Relief

*** 12. Funding Opportunity Number:**

R15AS00046

* Title:

WaterSMART: Drought Resiliency Project Grants for Fiscal Year 2015

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

Add Attachment | Delete Attachment | View Attachment

*** 15. Descriptive Title of Applicant's Project:**

Drought-On: tool for the early warning of impending summer drought over Texas

Attach supporting documents as specified in agency instructions.

Add Attachments | Delete Attachments | View Attachments

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: Texas

* b. Program/Project: Texas

Attach an additional list of Program/Project Congressional Districts if needed.

Add Attachment | Delete Attachment | View Attachment

17. Proposed Project:

* a. Start Date: 10/01/2015

* b. End Date: 09/30/2017

18. Estimated Funding ($):

* a. Federal	144,762.50
* b. Applicant	0.00
* c. State	144,762.50
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	289,525.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

☐ a. This application was made available to the State under the Executive Order 12372 Process for review on .

☐ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

☒ c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes," provide explanation in attachment.)**

☐ Yes ☒ No

If "Yes", provide explanation and attach

Add Attachment | Delete Attachment | View Attachment

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☒ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix: Mr.

* First Name: Kevin

Middle Name:

* Last Name: Patteson

Suffix:

* Title: Executive Administrator

* Telephone Number: 512-463-7848

Fax Number:

* Email: kevin.patteson@twdb.texas.gov

* Signature of Authorized Representative: Kevin Patteson

* Date Signed: 06/25/2015

BUDGET INFORMATION - Non-Construction Programs

OMB Number: 4040-0006
Expiration Date: 06/30/2014

SECTION A - BUDGET SUMMARY

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Drought-On: tool for the early-warning of impending summer drought over Texas		$ 144,762.50	$ 144,762.50	$	$	$ 289,525.00
2.						
3.						
4.						
5. Totals		$ 144,762.50	$ 144,762.50	$	$	$ 289,525.00

Standard Form 424A (Rev. 7- 97)
Prescribed by OMB (Circular A -102) Page 1

SECTION B - BUDGET CATEGORIES

6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY (1)	(2)	(3)	(4)	Total (5)
	Drought-On: tool for the early-warning of impending summer drought over Texas				
a. Personnel	$ 82,834.56	$	$	$	$ 82,834.56
b. Fringe Benefits	20,841.18				20,841.18
c. Travel	4,000.00				4,000.00
d. Equipment	0.00				
e. Supplies	0.00				
f. Contractual	96,000.00				96,000.00
g. Construction	0.00				
h. Other	0.00				
i. Total Direct Charges (sum of 6a-6h)	203,675.74				$ 203,675.74
j. Indirect Charges	85,849.26				$ 85,849.26
k. TOTALS (sum of 6i and 6j)	$ 289,525.00	$	$	$	$ 289,525.00
7. Program Income	$ 144,762.50	$	$	$	$ 144,762.50

Authorized for Local Reproduction

Standard Form 424A (Rev. 7- 97)
Prescribed by OMB (Circular A -102) Page 1A

SECTION C - NON-FEDERAL RESOURCES

(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e)TOTALS
8. WaterSMART: Drought Resiliency Project Grants for Fiscal Year 2015	$	$ 144,762.50	$	$ 144,762.50
9.				
10.				
11.				
12. TOTAL (sum of lines 8-11)	$	$ 144,762.50	$	$ 144,762.50

SECTION D - FORECASTED CASH NEEDS

	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	$ 99,375.37	$ 31,366.64	$ 31,366.64	$ 18,255.36	$ 18,386.73
14. Non-Federal	$ 99,375.37	31,366.64	31,366.64	18,255.36	18,386.73
15. TOTAL (sum of lines 13 and 14)	$ 198,750.74	$ 62,733.28	$ 62,733.28	$ 36,510.72	$ 36,773.46

SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT

(a) Grant Program	FUTURE FUNDING PERIODS (YEARS) (b)First	(c) Second	(d) Third	(e) Fourth
16. WaterSMART: Drought Resiliency Project Grants for Fiscal Year 2015	$ 45,387.13	$	$	$
17.				
18.				
19.				
20. TOTAL (sum of lines 16 - 19)	$ 45,387.13	$	$	$

SECTION F - OTHER BUDGET INFORMATION

21. Direct Charges: 203675.74

22. Indirect Charges: 85849.26

23. Remarks:

Authorized for Local Reproduction

Drought-On: tool for the early warning of impending summer drought over Texas

Nelun Fernando
Texas Water Development Board
1700 North Congress Avenue
Austin
TX 78701
e-mail: nelun.fernando@twdb.texas.gov
phone: 512-475-0454
fax: 512-936-0816

Table of Contents

Technical proposal

Drought-On: tool for the early warning of impending summer drought over Texas

1. Executive Summary

June 24, 2015
Texas Water Development Board
Austin, Travis County, Texas

Strong summer droughts over the Southern Great Plains region are often characterized by rapid intensification in the late-spring and early-summer. Decreased rainfall in these drought years are coupled with strong increases in summertime temperature extremes, as was the case with the 2011 drought over Texas and the Great Plains drought in 2012. Dynamic climate models failed to predict these droughts. Ninety-two percent of strong summer droughts over Texas and the Southern Great Plains are characterized by anomalously low rainfall in the boreal spring (March–May). Dry springs cause anomalous high pressure systems and anticyclonic flow in the prevailing wind system, which lead to subsidence in the atmosphere. Such subsidence persists through much of the summer and inhibits convective rainfall. We built and tested a process-based empirical model to predict summer droughts over the Southern Great Plains based on persistent drought-inducing atmospheric circulation patterns and surface dryness in spring. The statistical model can predict summer droughts over the region in spring with skill levels acceptable to decision makers. In this project, we propose to automate the drought forecast model and provide probability forecasts of average May–July rainfall in each county in Texas. The forecasts will be made from January 15 through May 1 of each year. The forecasts will, in effect, be summer drought forecasts with 6-month (January initial conditions), 5-month (February initial conditions), 4-month (March initial conditions), and 3-month (April initial conditions) lead times. We also propose to extend the drought forecast tool to provide probabilistic forecasts of average May–July evaporation from reservoirs in Texas, and to provide experimental probabilistic forecasts of average May–July storage for major reservoirs in Region L (South Central Texas) of the Texas Water Development Board's regional water planning areas. All three tasks aim to increase drought resilience within Texas by providing the advanced information necessary for drought preparedness planning, and by providing guidance information on the likelihood of reservoir storage dropping below drought trigger levels. This information could set in place drought response stage restrictions as defined in drought contingency plans of water user groups in Texas. The tool will be made available to the public through the Water Data for Texas website. The project will help decrease vulnerability to drought by giving water managers flexibility in times of low water supply. The project fits within the Task B-type projects – i.e. Projects to Improve Water Management through Measurement, Modeling and Tools – listed as eligible for funding under Reclamation's Drought Resiliency FOA.

The project length is two years and the estimated completion date is September 30, 2017.

2. Background data

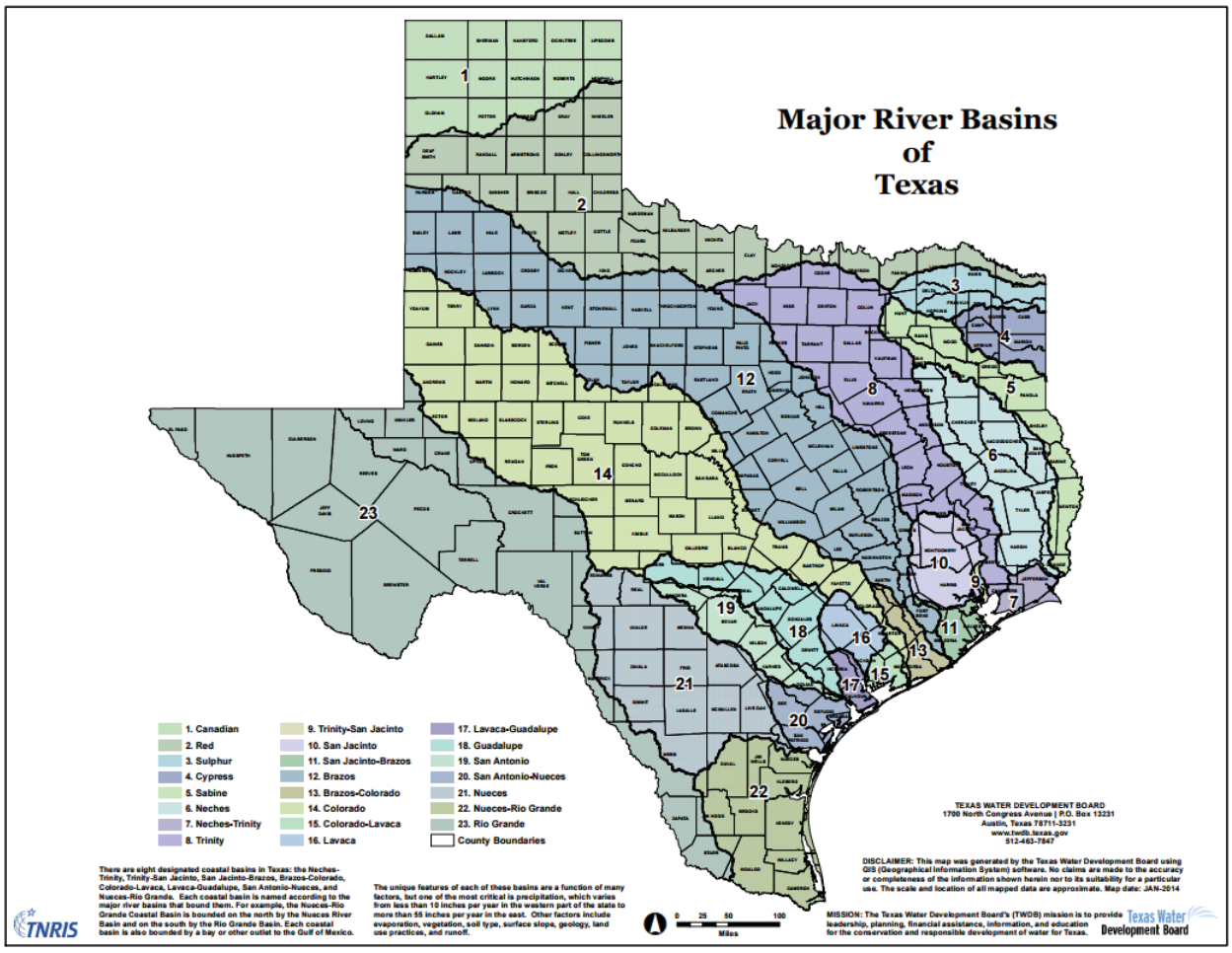


Figure 1: Map of the study area – i.e. Texas – and major river basins and counties in the state.

The annual statewide water use in 2013 was estimated at 14.5 million acre feet (http://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/data/TexasStatewideReport_6_12_15_Revision.pdf). Water demand is projected to increase to 18.4 million by 2020 and 19.2 million in 2020 (2012 State Water Plan). Current water users (percent of total use) include: municipal (27%), manufacturing (10%), mining (2%), steam-electric (4%), livestock (2%), and irrigation (56%). Irrigation is the primary use. Major crops cultivated include: corn, rice, wheat, sorghum, cotton, forage hay pasture, sugarcane, and alfalfa.

Existing water supply in Texas is defined as the amount of water that can be supplied with existing permits, contracts, and infrastructure during a repeat of the 1950s drought of record. Existing supply was estimated to be 17 million acre feet in 2010. Existing sources of water are surface water, groundwater, and reuse water.

The Texas Water Development Board (TWDB) is the state agency tasked with developing and securing water for the state. The TWDB prepares a state water plan, based on 16 regional water

plans, addressing the needs of all water user groups in the state during a repeat of the drought of record. In response to the 2011 drought over Texas, the Texas Administrative Code § 358.3 (1) on Guidance Principles for the State Water Plan Development was modified to state that: "The state water plan shall provide for the preparation for and response to drought conditions". These rule changes require all regional water plans to have a chapter dedicated to drought response information, activities, and recommendations.

Past working relationships with USBR

Project Title	USBR Principal Investigator	Status
Developing a temporary emergency drought planning tool	Michelle Chapman	Tool completed USBR Austin has submitted an abstract to the Texas Water Forum III at UT-Austin
Developing a deterministic model for cleaning reverse osmosis membranes	Katharine Dahm	Model development and literature review are ongoing
Developing a cost curve for brackish groundwater desalination in Texas	Andrew Tiffenbach	Project will be completed 12/2013. TWDB will be asked to provide feedback on project reports and graphs.
Comparing the performance of NF and RO membranes for desalinating brackish groundwater in Texas	Katie Guerra	Project will be completed 12/2013. TWDB will be asked to provide feedback on project reports and graphs.
An innovative constructed wetland design for attenuating endocrine disruptor compounds (EDCs) from reclaimed wastewater	Michelle Chapman	Looking for additional funds to implement the project. Future site visit being planned. Design being reviewed.
Variable source salinity desalination	Michelle Chapman	Final report was completed and submitted to the technical panel for review. Currently, incorporating comments. (2009-2011)

The Texas Water Development Board is a member of the Texas State Drought Preparedness Council. The Bureau of Reclamation is a Federal Agency Partner on the Drought Preparedness Council.

3. Technical project description

Introduction

Strong summer droughts over the U.S. Southern Great Plains region (110°W-92°W and 24°N-40°N) are often characterized by rapid intensification in the late-spring and early-summer. The decreased rainfall in these drought years are coupled with strong increases in summertime temperature extremes, as shown, for example, by the 2011 drought over Texas and the 2010 Great Plains drought. Dynamic climate models did not predict these summer droughts [Seager et al., 2014; Hoerling et al., 2013; Kumar et al., 2013]. They are also unable to provide more skill than that provided by the autocorrelation of rainfall anomalies permits, particularly during summer over the U.S. Great Plains [Quan et al., 2012]. This is in part due to model limitations in representing summer thunderstorms and land-surface feedbacks, which occur at scales much smaller than the current spatial resolution of climate models, and due to models underestimating rainfall variance [Kam et al., 2014]. By contrast, climate models are more reliable in capturing the variability in large-scale circulation features and temperature during winter and spring.

What causes drought onset over the US Southern Great Plains? Our prior drought research based on observational data indicates that severe-to-extreme summer drought events over Texas are preceded by dry springs [Fernando, 2014]. The phenomenon of dry springs preceding strong summer droughts was also documented earlier by Namias [1982] for the U.S. Great Plains. The strongest drought events that occurred over the southern Great Plains since 1948 show some salient characteristics. A marked decrease in rainfall from April through July is led by sharp increases in temperature at the surface and at 700 hectopascals, and a decrease in relative humidity in April. These changes lead to strong convective inhibition energy (CIN) — a numerical measure in meteorology indicating the negative energy available in the environment to prevent development of convective weather systems — in April and May. It is also accompanied by an increased geopotential height and persistent negative vorticity (indicating subsidence) at mid-to higher levels of the atmosphere from April to June. The persistence of rainfall anomalies from winter through early-spring leads to significant cumulative soil moisture deficits, a reduction in evapotranspiration, and an increase in sensible heating to balance the decrease in evapotranspiration. This leads to increased temperature at the surface. Drought years with persistent rainfall anomalies from winter through spring are characterized by strong westerly winds in April, particularly at 850 hectopascals (approximately 1 kilometer above the surface). These winds advect warm dry air eastwards over Texas from the Mexican plateau. Dry air advection, and the associated cap inversion, cause an increase in temperature at 700 hectopascals, and sharp increases in convective inhibition in April and May. These anomalous conditions are also the main causes of drought in the summer of Texas [Myoung and Nielsen-Gammon, 2010].

Droughts in Texas are generally associated with colder than normal sea surface temperatures in the equatorial Pacific corresponding to La Niña events [Ropelewski and Halpert 1986; 1987; Schubert et al., 2009]. La Niña-induced cooler SST anomalies are usually established in the fall, which contribute to winter drought over Texas. This is because a La Niña event induces the poleward displacement of the sub-tropical jet stream, which deflects winter storm tracks to the north of their climatological

location and causes a reduction of precipitation over the U.S. Southern Great Plains [Eichler and Higgins, 2006; Kousky and Ropelewski, 1989]. The reduction in winter precipitation leads to soil moisture deficits and increased surface temperature. The increase in surface temperature in turn leads to 1000-500 hectopascals geopotential height thickness over the southern United States, which could explain the presence of a mid-tropospheric high in the spring over the region.

However, La Niñas do not always cause summer droughts. Historically, about 11 percent of La Niña-induced winter droughts over Texas ended in spring. Those that persisted through spring tended to develop into severe [-1.2 ≤ Standarized Precipitation Index ≤ -1.5] to extreme droughts (Standardized Precipitation Index ≤ -1.5) in summer [Fernando et al., manuscript submitted, 2015].

What causes the persistence of a summer drought, once it is established? Many studies have emphasized the importance of regional land-atmosphere feedbacks in affecting drought persistence [Lyon and Dole, 1995; Hong and Kalnay, 2002]. Dry soils represent the cumulative impact of deficit precipitation and provide a positive feedback, further enhancing precipitation deficits [Mueller and Seneviratne, 2012]. Modeling analyses identified the Central United States, including much of Texas, as an area of strong coupling between soil moisture and precipitation [Koster et al., 2004]. Fernando et al. [manuscript submitted, 2015], in investigating whether drought memory is due to the persistence of remote forcing or due to land surface feedbacks, found that dry soil moisture anomalies over the South Central United States might have a stronger influence on positive 500 hectopascals height anomalies 2 to 3 weeks later than that of remote forcing in the late-spring/early-summer.

Building on the above understanding of the causes that initiate and maintain persistent drought, we used the following circulation and land surface fields in spring (April, March, and average March through May) to build a statistical model to predict cumulative summer rainfall (e.g. May through July seasonal rainfall or July SPI6):

a) Geopotential height at 500 hectopascals
b) Difference in temperature at 700 hectopascals and surface dewpoint (proxy for convective inhibition, Myoung and Nielsen-Gammon, 2010)
c) Soil moisture

We find that summer droughts (depicted using either the six-monthly Standardized Precipitation Index for July or May through July rainfall) over the southern Great Plains region can be predicted with skill levels acceptable to decision makes (~60 percent or higher) using large-scale circulation and land surface moisture fields in April. The best skill is achieved when using April initial conditions of the three predictor variables – i.e. 500 hectopascals geopotential height, difference in temperature between 700 hectopascals and dewpoint at the surface, and soil moisture – to predict summer drought.

The early warning indicator is able to capture the spatial pattern and magnitude of past drought events and non-drought events well. It exceeds baseline predictability over most of Texas and Oklahoma. Categorical seasonal forecasts (that is, probabilistic estimates of whether a season will

be below-, near- or above-normal) from the indicator provide added information on drought susceptibility from the six-month lead time onwards over Texas. In all model realizations, we find that the grid points with the highest skill scores lie within Texas. Of interest is the ability of the indicator to forecast the 2011 drought event even at six-month (January) lead time (Figure 2). The indicator forecast for summer 2014, initialized in April 2014, showed abnormally wet conditions and matches observed conditions better than the forecast from NOAA's Climate Prediction Center[1].

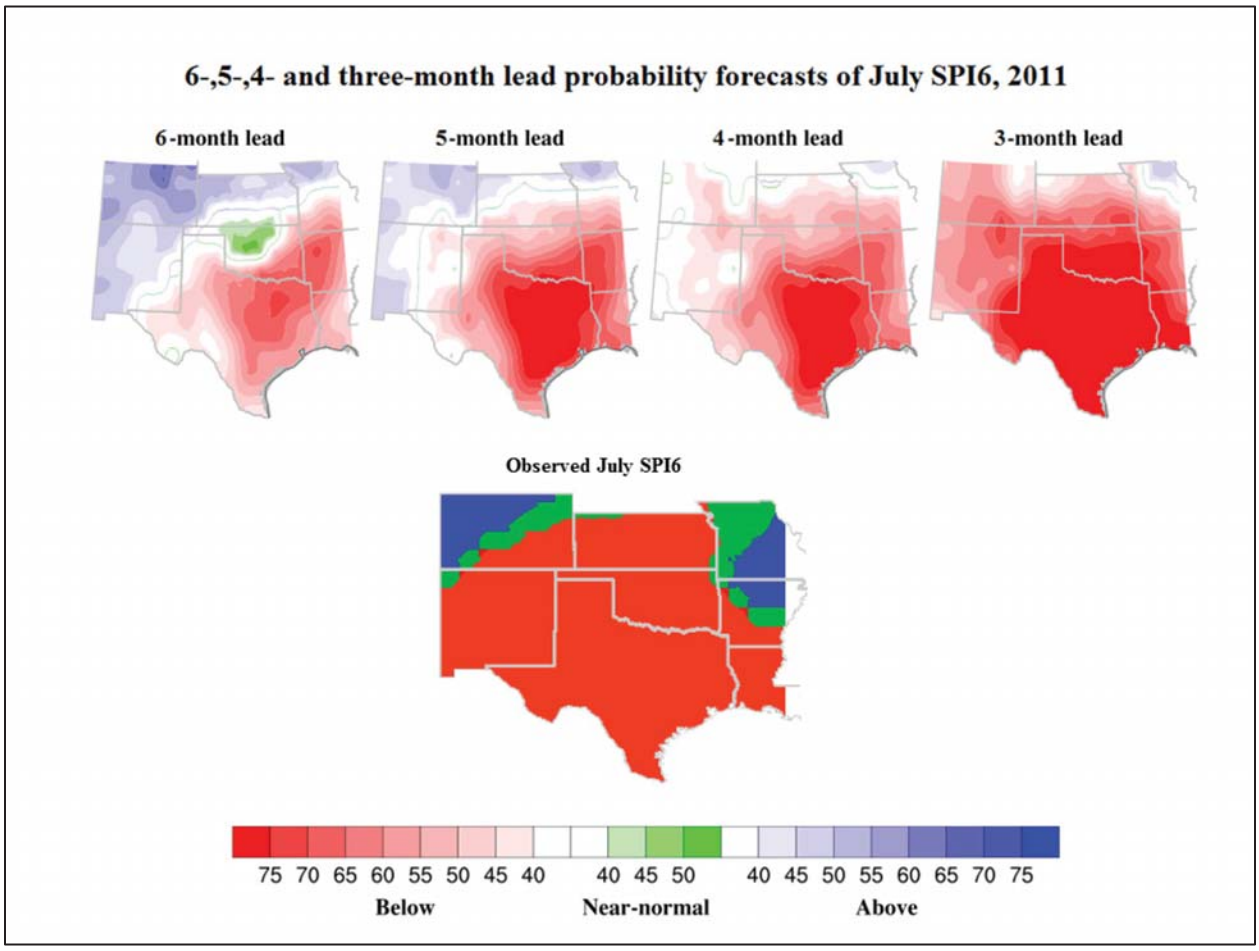


Figure 2: Six- to three-month lead categorical forecasts of the 6-monthly Standardized Precipitation Index for July (SPI6) in 2011 (top, from left to right), and observed July SPI6 in 2011 (bottom).

Given the performance of the experimental drought early warning indicator over Texas, we propose to develop a tool to automate the provision of real-time summer drought forecasts from January onwards over Texas. The tool will be made available to the public through the Water Data for Texas web site (www.waterdatafortexas.org).

[1] http://www.twdb.texas.gov/publications/reports/technical_notes/doc/TechnicalNote15-02.pdf

Specific activities

Task 1: Automation of the drought forecast tool

We will provide probability forecasts of average May–July rainfall for each county in Texas. The forecasts will be updated on a bi-weekly basis. The forecasts will be made from January 15 through May 1 of each year and will be drought forecasts with 6-month (January initial conditions), 5-month (February initial conditions), 4-month (March initial conditions), and 3-month (April initial conditions) lead times. The forecasts will be provided, using on-the-fly calculations, through a dedicated link on the Water Data for Texas website. The forecasts will also be incorporated in the monthly update made by the Texas State Drought Preparedness Council's Drought Monitoring and Water Supply Committee, which is chaired by the TWDB, in its monthly water conditions report to the Council. We will also explore the possibility of including the drought forecast information in the Drought Preparedness Council's recommendations for the Drought Proclamation made by the Governor of Texas (for an example of the proclamation see: http://gov.texas.gov/news/proclamation/20768).

Task 2: Extension of the drought forecast tool to provide experimental probabilistic forecasts of average May–July evaporation from reservoirs in Texas

We will provide experimental probability forecasts of average May–July evaporation from each major reservoir in Texas. The forecasts will be updated on a monthly basis. Forecasts will be made from January 30 through May 1 of each year and will be drought forecasts with 6-month (January initial conditions), 5-month (February initial conditions), 4-month (March initial conditions), and 3-month (April initial conditions) lead times. The forecasts will be provided, using on-the-fly calculations, through a link on the 'Reservoirs' page on the Water Data for Texas website.

Task 3: Provision of experimental probabilistic forecasts of average May–July reservoir storage for the major reservoir in Region (South Central Texas).

We will provide experimental reservoir storage forecasts for each major reservoir in Region L. Prior to generating the forecasts, we will estimate seasonal water use and/or other factors such as inflow that affect the reservoir water budget. The forecasts will be in the form of storage probabilities and provide guidance information on the likelihood of storage dropping below trigger levels, which could set in place drought response stage restrictions as defined in drought contingency plans for Region L. The forecasts will be provided through an additional 'forecast' tab on the reservoir storage page, on the Water Data for Texas website, for each major reservoir in Region L.

Datasets and methods

Data:

We will use the Climate Forecast System version 2 (CFSv2) forecasts [Saha et al., 2014] for the three-month (3.5), two-month (2.5), and one-month (1.5) lead times of April 500 hectopascals geopotential height, temperature at 700 hectopascals, 2-meter dewpoint temperature and 0–10cm depth liquid volumetric soil moisture. The training data from 1982–2010 are from the Climate Forecast System Reanalysis and Reforecasts archive and the data from 2011-2014 were from the 6-hourly CFSv2 realtime data. The latitudinal means are removed from the 500 hectopascals geopotential height data.

We will use monthly 1˚x1˚ rainfall from the Climate Prediction Center's global land precipitation dataset (Chen et al., 2002) to derive seasonal rainfall for MJJ for the period 1982-2014. All data fields cover the domain 24N-40N and 110W to 92W. We will derive the values for the 254 counties in Texas by aggregating the grid cells that fall within each county.

Historical lake evaporation data will be obtained from TWDB's 1° x 1° monthly precipitation and lake evaporation dataset (http://www.twdb.texas.gov/surfacewater/conditions/evaporation/index.asp). Historical water use survey data available at the TWDB will be used in the estimation of seasonal water use from major reservoirs in Region L. We will also use historical reservoir storage data maintained by the TWDB and the drought trigger storage levels identified in the drought contingency plans of water user groups in TWDB's Regional Water Planning Group L with major reservoirs as one of its surface water supply sources.

Methods:

We list the methodology adopted for the standalone version of the drought forecast. The steps listed below will be automated for the operational tool.

All fields are converted to standardized anomalies, using the base period 1982–2012, prior to analysis. Original predictor inputs could have multi-collinearity, noise, and variance irrelevant to the drought prediction. Therefore, we first apply Multivariate Empirical Orthogonal Function Analysis (EOF) to the three predictor fields as a way to filter out noise and highlight the most coherent spatial and temporal variances. Empirical Orthogonal Function analysis is a data compression technique such that a dataset containing a large number of samples is reduced to a dataset that captures the dominant modes (or correlated variance), which explain a large fraction of the squared total co-variance among these fields. The new variables are linear combinations of the original variables and represent the highest possible proportion of co-variability found in the original dataset [Wilks, 2006]. We retained the first two EOF modes, accounting for at least 70 percent of the variance in the predictor fields, to minimize the potential multicollinearity of the original predictor fields. The two retained EOF modes are linear combinations of the three predictor variables and represent the highest fraction of co-variability in the original predictor fields. The two EOF modes we retained are subjected to Rotated Empirical Orthogonal Function Analysis (REOF, Richman 1986).

We input the spatial loadings of the rotated EOF modes as predictor variables to a Canonical Correlation Analysis (CCA) model. The predictand variable is summer rainfall (i.e. seasonal average MJJ rainfall). CCA identifies a sequence of pairs of patterns in two multivariate datasets. Linear combinations of the original data are produced by projecting the original data onto the identified patterns. New variables — known as "canonical variates" — that maximize interrelationships between the two data sets are then identified [Wilks, 2006, pg. 509]. CCA can be used as a statistical forecasting technique if one of the input data fields is observed prior to the other field (e.g. the predictand or the 'y' field) [von Storch and Zwiers, 2002]. Such application of CCA has been undertaken in forecasting SSTs [Landman and Mason, 2001], in predicting seasonal temperatures over land [Shabbar and Barnston, 1996], and in predicting ENSO episodes [Barnston and van den Dool, 1993].

We used the Climate Predictability Tool (CPT, http://iri.columbia.edu/our-expertise/climate/tools/cpt/) to run the CCA model. Forecast skill assessment was undertaken using cross-validation [Michaelson, 1987; Barnston and Ropelewksi, 1992] over a 24 year training period from 1982 through 2005. We used a cross validation window of three years. The strength of the predictor fields was assessed based on the goodness-of-fit between the cross-validated forecasts and the observation time series. Goodness-of-fit is a measure of the average correlation between the cross-validated forecasts and the observation time series. The measure is reported for every possible combination of predictor and predictand modes. When the goodness-of-fit value is closer to 1 the correlation between the predictor and predictand fields is stronger.

4. Evaluation criteria

V.A.1 Evaluation Criterion A – Project Benefits

- **How will the project build long-term resilience to drought? How many years will the project continue to provide benefits?**
  The project will provide forecasts of impending intense summer drought over Texas. These forecasts will be provided from January of each year going out to April, such that the information on impending drought risk over a given county in Texas will be available with lead times of 6 months. By providing early warning of drought risk, the project will be implementing a tool aiding drought preparedness planning.

  While the initial project timeline is two years, the information technology infrastructure that will be built through the project will result in an operational tool that will access data in realtime and provide forecast updates on the fly continuously. We see the tool as something that will continue to provide information relevant to drought preparedness for many years longer than the project's life time.

  We anticipate continuous tool improvements so that the product could be improved – both in terms of the skill of the forecasts and the spatial resolution of the product – with the incorporation of new data with finer spatial resolution and data from new satellite missions dedicated for the monitoring of soil moisture, etc. We will collaborate with Prof. Rong Fu, who was the key partner from the University of Texas at Austin in the design and implementation of the standalone drought forecast tool, on improvements to the forecast tool.

- **Will the project make additional water supplies available? If so, what is the estimated quantity of additional supply the project will provide and how was this estimate calculated? What percentage of the total water supply does the additional water supply represent?**
  No, the project will not make additional water supplies available. However, the forecast tool might provide information that will allow water managers to extend existing supplies.

- **Will the project improve the management of water supplies? Will the project make new information available to water managers? If so, what is that information and how will it improve water management? What is the estimated quantity of water better managed as a result of the project and how was this estimate calculated? What percentage of the total water supply is being better managed? Also provide a brief qualitative description of the degree/significance of anticipated water management benefits.**
  The project will help improve the management of water supplies during times of drought. Each water user group in the state of Texas is required to identify its sources of water and have a drought contingency plan, with well-defined quantitative drought response triggers, for managing the water needs supplied by each water source. Water user groups are also required to have a drought Water Management Strategy (drought WMS) that identifies how a reduction in water use is to be implemented when the source reaches certain drought response trigger

levels. Such drought Water Management Strategies are temporary measures used to reduce water demand during a drought (TWDB State Water Plan, 2012).

This project will provide advance information of the impending risk of drought by county. Linking the forecast to reservoir storage levels will provide the water user groups with the likely risk of water storage dropping below certain drought response thresholds. Such early information would allow water managers to effect water conservation measures – e.g. enacting outdoor lawn water restrictions – earlier on. This would help minimize the reduction in available water supply as the summer approaches and extend the time before further water use restrictions, as determined by drought trigger levels, need to be implemented. Such an implementation plan would minimize the economic impacts resulting from the non-delivery of committed water supplies from a given source.

V.A.2 Evaluation Criterion B – Drought Planning and Preparedness

The Texas State Drought Preparedness Council, on page 32 of its 2014 Drought Annex (https://www.txdps.state.tx.us/dem/CouncilsCommittees/droughtCouncil/droughtAnnex.pdf, included in appendix), states that: "Although drought is a slow moving incident, public information on forecasted or persistent drought conditions and impacts is extremely vital. The release of timely, consistent and effective public information helps all Texans understand threats, potential impacts, available services, funding options and timelines for response and recovery." The drought forecast tool proposed by the project is clearly relevant to the Drought Preparedness Council's Drought Annex.

Drought management as a water management strategy is an interim strategy designed to meet near-term needs through demand reduction until long-term water supply measures are implemented. Such a strategy typically targets a reduction in municipal water demand. In the long-term it increases water use efficiency and serves more users. New rules adopted for TWDB's water planning process in 2012, requires all regional water planning groups to include a chapter dedicated to drought response information, activities, and recommendations. The water planning regions are required to seek better information on drought action-triggers, and to provide recommendations for each existing water source (triggers and responses). We provide the Drought Management Chapter from the 2016 South Central Texas Initially Prepared Plan as an appendix to this application to demonstrate that the project is clearly supported by this plan. The project fits within Section 7.2, on Current Drought Preparations and Response, in the provision of early warning on the impending likelihood of drier than normal conditions in counties within Region L and of drought trigger levels of surface water reservoirs being reached. We also attach the Drought Contigency Plan for the Guadalupe-Blanco River Authority, one of the water user groups in Region L, which manages the operations of Canyon Lake (a source of surface water identified in the regional plan), to demonstrate how the project will provide reservoir storage forecasts useful for Section 9.1 (page 7) on 'Triggering Criteria for Initiation and Termination of Drought Response Stages for Canyon Reservoir'. The reservoir storage forecasts

will be designed for each major reservoir in Region L based on the drought trigger thresholds. Thus, the forecast product will be probabilistic information on whether storage levels will be above or below prior-defined drought trigger thresholds.

These plans are developed in collaboration with all water user groups in the region, according to regional water planning guidelines provided by the TWDB. Water planning is carried out on the basis of ensuring that water demand within the state can be met given a repeat of the 1950s drought of record. Regional water planning groups do, however, have the leeway to develop their individual plans considering droughts that may be potentially worse than the 1950s drought of record.

- **Describe how the proposed project is prioritized in the referenced drought plan.**
  Drought management is a prioritized water management strategy for a number of water user groups in Region L, as listed in the 'Prioritizations of Recommended Water Management Strategies in the 2011 Regional Water Plans (as of February, 2015)'
  (see: pages 49-55 in
  http://www.twdb.texas.gov/swift/priority/doc/20150202_Final_Regional_Prioritizations.pdf, and included in appendix).

V.A.3 Evaluation Criterion C – Severity of Actual or Potential Drought Impacts

- **Indicate whether the proposed project area is currently experiencing drought or has the potential for experiencing drought in the future**
  Texas has just come out of a four-year long drought, which the Texas State climatologist has described as the second worst drought on record.

- **If the proposed project area is not experiencing drought at the time you submit your application, describe the impacts of past drought events and the frequency of past drought occurrences**
  In 2011, Texas suffered the worst drought in recent decades. Drought conditions lasted for more than a year and covered five states over the southern United States. The economic impact of this drought on Texas is estimated at 7.6 billion dollars (Fannin 2012) primarily from crop and livestock losses. Dry conditions were also accompanied by record heat in the summer with a mean June through August (JJA) temperature of 30.4 °C, exceeding the long term mean by 2.9 °C (Hoerling et al. 2013).

  The rapid spring intensification of the 2011 drought caused statewide reservoir storage to drop to 58% in November 2011, the lowest since 1978 [Texas Water Development Board 2010; Texas Water Development Board 2011a and 2011b]. The quick depletion of water storage within a year caught water managers by surprise because the state reservoir system was designed to withstand multi-year droughts, such as the 1950s drought of record (Fernando et al., 2015). Texas has experienced 14 severe-to-exceptional summer droughts, as indicated by the 12-

monthly Standardized Precipitation Index (McKee et al., 1993) for August (August SPI12) being less than -1.2, over the period 1895–2014 (Fernando et al., 2015). The 2011–2015 drought saw reservoir storage drop to record low levels, particularly over west and south-central Texas. This prompted historic rulings. For example, the Lower Colorado River Authority, which manages the Lakes Travis and Buchanan in the south-central region of the state, cut off interruptible water from these lakes in 2012, 2013, and 2014, because of record low storage in both reservoirs. Such measures affected downstream irrigation customers near the Texas coast.

- **Describe any projected increases to the severity or duration of drought in the project area resulting from climate change. Provide support for your response (e.g., reference a recent climate change analysis, if available)**
  Tree ring records indicate that Texas has experienced droughts of longer duration, in the pre-instrumental record extending back to 1500, than the 1950s drought of record (Cleveland et al., 2011). Texas has just come out of a four-year long intense drought, making it the second worst drought on record. If it had persisted for two more years it would have vied for first place on the worst-drought-in-the-instrumental-record spectrum. The paleoclimate record, and recent drought and pluvial episodes, indicate that the climate of Texas is highly variable and droughts with durations and intensities exceeding the 1950s drought of record could occur in the future due to natural climatic variability.

- **Describe ongoing or potential drought impacts to specific sectors in the project area if no action is taken (e.g., impacts to agriculture, environment, hydropower, recreation and tourism, forestry, etc.), and the severity of those impacts:**
  The 2012 State Water Plan estimates that if recommended water supply projects and management strategies are not implemented, the state would need an additional 8.3 million acre feet of additional water by 2060. The annual economic losses from not meeting the water supply needs could result in a reduction in income of approximately $11.9 billion annual if drought conditions approach the drought of record. The economic loss would include over a million lost jobs.

V.A.4 Evaluation Criterion D – Nexus to Reclamation

The project is closely related to Reclamation's new Drought Response Program. By providing an operational tool for the early warning of summer drought over Texas, the project will establish a mechanism through which various stakeholders in the water, agriculture, energy, and emergency management sectors of the state can prepare in advance for potential water reductions to be expected with drought onset. Such a mechanism promotes a proactive approach to drought, which places the project well within the goals of Reclamation's Drought Response Program.

The project will be based in Texas, which is within the geographic purview of Reclamation's Oklahoma-Texas Area Office. Reclamation manages the operations of the Twin Buttes Reservoir, which provides part of the municipal water requirements of the City of San Angelo. The Twin Buttes reservoir falls within Region F of TWDB's regional water planning groups (http://www.twdb.texas.gov/waterplanning/rwp/regions/f/index.asp) and is identified as a surface water source Region F's regional water plan (http://www.twdb.texas.gov/waterplanning/rwp/plans/2016/IPP/F/Region_F_2016_IPPV2.pdf).

V.A.5 Evaluation Criterion E – Project Implementation

- Describe the implementation plan of the proposed project. Please include an estimated project schedule that shows the stages and duration of the proposed work, including major tasks, milestones, and dates.

Project timeline

	Year 1												Year 2											
Tasks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
1																								
2																								
3																								

Major tasks and milestones

Major tasks and milestones	Date
Task 1:	
Milestone 1: Provision of 3-month lead bi-weekly probability forecasts of average May–July rainfall for each county in Texas through a tool on the Water Data for Texas website	April 2016
Milestone 2: Incorporation of 3-month lead probability forecasts of average May–July rainfall for each county in Texas in the monthly update made by the Texas State Drought Preparedness Council's Drought Monitoring and Water Supply Committee in its monthly water conditions report to the Council	May 2016
Milestone 3: Provision of 6-month, 5-month, and 3-month lead time bi-weekly probability forecasts of average May–July rainfall	January to April 2017
Task 2:	
Milestone 4: Provision of experimental 3-month lead probability forecasts of average May–July evaporation from each major reservoir in Texas	May 2016
Milestone 5: Technical report on the predictability of seasonal reservoir evaporation over Texas using statistical forecasting techniques	July 2016
Milestone 6: Provision of 6-month, 5-month, and 3-month lead time probability forecasts of average May–July evaporation from reservoirs through a link on the 'Reservoirs' page on the Water Data for Texas website.	January 2017
Task 3:	
Milestone 7: Compile seasonal (specifically, May–July) water use estimates from reservoirs in region L. This milestone will be used in the calculation of reservoir mass balance estimates needed to provide seasonal storage forecasts.	March 2017
Milestone 8: Provision of experimental forecast average May–July reservoir storage probabilities for reservoirs in Region L, which will serve as guidance information on the likelihood of storage dropping below reservoir storage trigger levels identified in drought contingency plans for region L (South Central Texas) through a link on the Water Data for Texas website.	May 2017
Milestone 9: Technical report on lessons learned in the provision of forecast average May–July reservoir storage probabilities for drought preparedness planning	August 2017

5. Performance measures

We hope to quantify the project's performance by using the following measures:

1. Number of hits on the drought forecast tool (an increased interest in the tool will be gauged by calculating the percentage increase in the number of hits each consecutive year after the drought tool is operationalized). We will interpret a 5–10 percent increase per year as an increased adoption of the tool by decision makers.

2. Number of technical inquiries received each quarter related to the drought forecast tool.

3. Number of references to the drought and reservoir forecast tools in drought contingency plans of water user groups in plans related to Fifth Cycle of Regional Water Planning in Texas covering the period 2017–2021.

References

Barnston, A. G. and H. M. van den Dool (1993), A degeneracy in cross-validated skill in regression-based forecasts, Journal of Climate, 6(5), 963-977.

Barnston, A. G. and C. F. Ropelewski (1992), Prediction of ENSO episodes using canonical correlation analysis, Journal of Climate, 5(11), 1316-1345.

Fannin, B. (2012). Updated 2011 Texas agricultural drought losses total $7.62 billion. AgriLifeTODAY 21.

Cleaveland, M. K., Votteler, T. H., Stahle, D. K., Casteel, R. C., & Banner, J. L. (2011). Extended chronology of drought in south central, southeastern and west Texas. *Texas Water Journal*, *2*(1), 54-96.

Eichler, T. and W. Higgins (2006), Climatology and ENSO-related variability of North American extratropical cyclone activity, Journal of climate, 19(10), 2076-2093.

Fernando, D. N. (2014), Assessing the precursors, persistence and predictability of drought over Texas, Texas Water Development Board Contracted Report, Austin, Texas.

Fernando, D.N., Kingtse C. Mo, Rong Fu, Adam Bowerman, Bridget R. Scanlon, Ruben S. Solis, Lei Yin, Robert E. Mace, John R. Mioduszewski, Tong Ren, and Kai Zhang (2015), What caused the spring intensification and winter demise of the 2011 drought over Texas?, *submitted to Climate Dynamics*.

Hoerling, M., A. Kumar, R. Dole, J. W. Nielsen-Gammon, J. Eischeid, J. Perlwitz, X.-W. Quan, T. Zhang, P. Pegion, and M. Chen (2013), Anatomy of an Extreme Event, J. Clim. 26(9): 2811-2832.

Hoerling, M., J. Eischeid, A. Kumar, R. Leung, A. Mariotti, K. Mo, S. Schubert and R. Seager (2014), Causes and predictability of the 2012 Great Plains drought, Bulletin of the American Meteorological Society, 95(2), 269-282.

Hong, S.-Y. and E. Kalnay (2002), The 1998 Oklahoma-Texas drought: Mechanistic experiments with NCEP global and regional models, Journal of climate, 15(9), 945-963.

Kam, J., J. Sheffield, X. Yuan and E. F. Wood (2014), Did a skillful prediction of sea surface temperatures help or hinder forecasting of the 2012 Midwestern US drought?, Environmental Research Letters, 9(3), 034005.

Koster, R. D., P. A. Dirmeyer, Z. Guo, G. Bonan, E. Chan, P. Cox, C. Gordon, S. Kanae, E. Kowalczyk and D. Lawrence (2004), Regions of strong coupling between soil moisture and precipitation, Science, 305(5687), 1138-1140.

Kousky, V. E. and C. F. Ropelewski (1989), Extremes in the Southern Oscillation and their relationship to precipitation anomalies with emphasis on the South American region, Revista Brasileira de Meteorologia, 4(2), 351-363.

Kumar, A., M. Chen, M. Hoerling and J. Eischeid (2013), Do extreme climate events require extreme forcings?, Geophysical Research Letters, 40(13), 3440-3445.

Landman, W. A. and S. J. Mason (2001), Forecasts of near-global sea surface temperatures using canonical correlation analysis, Journal of Climate, 14(18), 3819-3833.

Lyon, B. and R. M. Dole (1995), A diagnostic comparison of the 1980 and 1988 US summer heat wave-droughts, Journal of climate, 8(6), 1658-1675.

McKee, T. B., N. J. Doesken, and J. Kleist (1993). The relationship of drought frequency and duration to time scales. Preprints, Eighth conf. on Applied Climatology. Anaheim, CA, AMS, 179-184.

Michaelsen, J. (1987), Cross-validation in statistical climate forecast models, Journal of Climate and Applied Meteorology, 26(11), 1589-1600.

Mueller, B. and S. I. Seneviratne (2012), Hot days induced by precipitation deficits at the global scale, Proceedings of the national academy of sciences, 109(31), 12398-12403.

Myoung, B. and J. W. Nielsen-Gammon (2010), The convective instability pathway to warm season drought in Texas. Part I: The role of convective inhibition and its modulation by soil moisture, Journal of Climate, 23(17), 4461-4473.

Namias, J. (1982), Anatomy of Great Plains protracted heat waves (especially the 1980 US summer drought), Monthly Weather Review, 110(7), 824-838.

Quan, X.-W., M. P. Hoerling, B. Lyon, A. Kumar, M. A. Bell, M. K. Tippett and H. Wang (2012), Prospects for dynamical prediction of meteorological drought, Journal of Applied Meteorology and Climatology, 51(7), 1238-1252.

Richman, M. B. (1986), Rotation of principal components, Journal of climatology, 6(3), 293-335.

Ropelewski, C. F. and M. S. Halpert (1986), North American precipitation and temperature patterns associated with the El Niño/Southern Oscillation (ENSO), Monthly Weather Review, 114(12), 2352-2362.

Ropelewski, C. F. and M. S. Halpert (1987), Global and regional scale precipitation patterns associated with the El Niño/Southern Oscillation, Monthly weather review, 115(8), 1606-1626.

Saha, S., S. Moorthi, H.-L. Pan, X. Wu, J. Wang, S. Nadiga, P. Tripp, R. Kistler, J. Woollen and D. Behringer (2010), The NCEP climate forecast system reanalysis, Bulletin of the American Meteorological Society, 91(8), 1015-1057.

Saha, S., S. Moorthi, X. Wu, J. Wang, S. Nadiga, P. Tripp, D. Behringer, Y.-T. Hou, H.-y. Chuang and M. Iredell (2014), The NCEP climate forecast system version 2, Journal of Climate, 27(6), 2185-2208.

Schubert, S., D. Gutzler, H. Wang, A. Dai, T. Delworth, C. Deser, K. Findell, R. Fu, W. Higgins and M. Hoerling (2009), A US CLIVAR project to assess and compare the responses of global climate models to drought-related SST forcing patterns: overview and results, Journal of Climate, 22(19), 5251-5272.

Seager, R., L. Goddard, J. Nakamura, N. Henderson and D. E. Lee (2014), Dynamical Causes of the 2010/11 Texas–Northern Mexico Drought, Journal of Hydrometeorology, 15(1), 39-68.

Shabbar, A. and A. G. Barnston (1996), Skill of seasonal climate forecasts in Canada using canonical correlation analysis, Monthly weather review, 124(10), 2370-2385.

Texas Water Development Board (2010), Texas Water Conditions (September 2010).http://www.twdb.texas.gov/publications/reports/waterconditions/twc_pdf_archives/2010/twcSep2010.pdf

Texas Water Development Board (2011a), Texas Water Conditions (November 2011). http://www.twdb.texas.gov/publications/reports/waterconditions/twc_pdf_archives/2010/twcNov2011.pdf

von Storch, H., Zwiers, F.W. (2002), Statistical analysis in climate research, Cambridge University Press.

Wilks, D. S. (2006), Statistical Methods in the Atmospheric Sciences, 2nd ed., 463 pp., Academic Press.

Environmental Compliance

- Will the project impact the surrounding environment (e.g., soil [dust], air, water [quality and quantity], animal habitat)? Please briefly describe all earth-disturbing work and any work that will affect the air, water, or animal habitat in the project area. Please also explain the impacts of such work on the surrounding environment and any steps that could be taken to minimize the impacts.
  No, the project will not impact the surrounding environment

- Are you aware of any species listed or proposed to be listed as a Federal threatened or endangered species, or designated critical habitat in the project area? If so, would they be affected by any activities associated with the proposed project?
  Yes, there are federally listed threatened and endangered species in the project area. The full list is available at http://www.keepingtexasfirst.org/species/listed.php. They would not be affected by any of the activities associated with the proposed project.

- Are there wetlands or other surface waters inside the project boundaries that potentially fall under CWA jurisdiction as "Waters of the United States?" If so, please describe and estimate any impacts the project may have.
  Yes, there are wetlands and surface waters within Texas that could potentially be classified as "Waters of the United States". The project does not have any foreseeable impact on these water bodies.

- When was the water delivery system constructed?
  Not applicable.

- Will the project result in any modification of or effects to, individual features of an irrigation system (e.g., headgates, canals, or flumes)? If so, state when those features were constructed and describe the nature and timing of any extensive alterations or modifications to those features completed previously.
  No.

- Are any buildings, structures, or features in the irrigation district listed or eligible for listing on the National Register of Historic Places? A cultural resources specialist at your local Reclamation office or the State Historic Preservation Office can assist in answering this question.
  Yes, there are. A complete listing by county is available at:
  http://www.nationalregisterofhistoricplaces.com/tx/state.html

- Are there any known archeological sites in the proposed project area?
  Yes, there are.

- Will the project have a disproportionately high and adverse effect on low income or minority populations?
  No.

- Will the project limit access to and ceremonial use of Indian sacred sites or result in other impacts on tribal lands?
  No.

- Will the project contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area?
  No.

TWDB staff commitment

N. Fernando – 9 months (3 months in first year)

R. Solis – 1.8 months (0.8 months in first year)

Y. Yang – 3.6 months (1.6 months in first year)

J. Zhu – 3.6 months (1.6 months in first year)

Contractors

Programmer – 6 months (in first year)

Drought Annex

State of Texas Emergency Management Plan

April 2014

This document is intended to provide guidance and is not prescriptive or comprehensive. Use judgment and discretion to determine the most appropriate actions at the time of an incident. These guidelines do not override local or regional plans, but are designed to complement those planning activities.

This document does not prohibit any jurisdiction from implementing additional requirements or operating procedures within that jurisdiction.

Table of Contents

Preface

Drought is one of the most complex natural hazards due to its slow-moving nature, ability to persist for years and its cascading effects. Drought is a recurring hazard in Texas that causes devastation to the state's agricultural industry, depletes water supply reservoirs and provides fuel for wildfires, making it extremely dangerous and costly.

This annex describes activities that help minimize the potential impacts of drought and its cascading effects on industry, the water supply and public health and safety. It outlines an effective mechanism for proactive monitoring and assessment, as well as a coordinated state response to reduce the impacts of a prolonged and severe drought.

Long term mitigation and water management strategies are addressed in the Texas Water Development Board's (TWDB) State Water Plan and are not a part of this document.

This document complies with Homeland Security Presidential Directive 5 (HSPD-5) *Management of Domestic Incidents* and Presidential Policy Directive 8 (PPD-8) *National Preparedness* and takes into account the needs of the whole of community. The state and organizations involved operate within the principles of the National Incident Management System (NIMS) in support of the National Response Framework (NRF).

Section V.B and VI of the **State of Texas Emergency Management Plan**, in accordance with NIMS and relevant NRF guidelines, are the foundation for emergency response and recovery operations in Texas.

Using This Document

This document is part of the State of Texas Emergency Management Plan. This section explains how this annex integrates with the plan and how and where to find additional supporting information.

This document is not designed to be read from cover to cover. Use this page to quickly find the information you need.

When you see a reference arrow (↗), look at the bottom of the page for a hyperlink to additional information from the State of Texas.

For an explanation of the acronyms and terms in this document please refer to the **State of Texas Acronyms and Terms (STAT) Book**.

This document is an annex to the State of Texas Emergency Management Plan, which is composed of a basic plan, functional annexes, hazard annexes and support annexes and is designed to integrate vertically with local, regional, tribal and federal plans.

All sections of the plan contain links to related information. Each section should be considered as part of one comprehensive document available online at http://www.txdps.state.tx.us/dem.

Overview and Purpose

Successful drought response operations assist with the rapid restoration of essential functions while protecting residents from drought impacts. This planning document defines a standardized statewide approach to response operations for drought.

Goal

Establish a framework for the state of Texas to conduct an effective, coordinated and timely response to drought that minimizes potential negative impacts.

Objectives

- Define the drought hazard and provide an overview of drought characteristics, types, definitions, stages of severity and impacts.
- Identify methods of data collection and analysis to help with early drought detection and determine drought severity.
- Define drought indicators that help determine when statewide drought response activities should begin or end and take appropriate actions.
- Define decision making, information sharing and coordination strategies and explain how local, state, federal and private entities coordinate when responding to drought.
- Provide assignments of responsibilities for key stakeholders.

Audience

- State Drought Preparedness Council and committee members
- State Emergency Management Council representatives
- Personnel assigned to the State Operations Center (SOC)
- Emergency management field personnel
- Decision makers serving drought prone areas
- Public/private water suppliers and utility providers
- Critical infrastructure, private sector partners, and non-governmental organizations

Planning Assumptions

- Local jurisdictions will have exhausted all resources before requesting additional assistance from disaster district committees.
- When state resources are depleted, assistance may be sought from other states and the federal government
- Early drought detection and ongoing coordination are critically important in the monitoring and assessment and response and recovery phases and may lessen drought impacts
- Certain water systems are required by Title 30 of the Texas Administrative Code Chapter 288.30 to have drought contingency plans and water conservation plans.
- Preparedness, response, recovery and mitigation operations may occur simultaneously during a drought.
- Public and private water systems may or may not enforce the contingency stages of their drought plans during times of drought.

- Local governments and water suppliers are responsible for managing their water systems to ensure an adequate and safe water supply.
- Drought may be widespread and affect agriculture, public health and safety, ecological systems, municipal water supplies and critical infrastructure such as transportation systems, the state power grid and chemical plants and refineries.
- Hospitals, assisted living centers and other medical facilities have plans to maintain mandatory minimum potable water supplies in emergency situations.
- Severe and prolonged drought conditions may affect the capability of utility providers to ensure a steady potable water supply and reliable power generation.
- Drought may cause low reservoir levels, which can affect the ability of water suppliers to access water and treat drinking water to acceptable standards.
- Drought monitoring and assessment data is evaluated at various levels, including county and watershed levels.
- Water resources may be stressed during drought periods by a number of factors including an increase in population, unseasonably low precipitation, evaporation and groundwater extraction.
- The state may not provide bulk water to a water system during a prolonged outage due to drought.

Defining the Hazard

This section provides an overview of drought characteristics, definitions, timelines and impacts.

Drought hazards include depleted water supplies, wildfires and cascading impacts to critical infrastructure and key resources (CIKR). Impacts of these hazards vary greatly, depending on a drought's duration, intensity and geographic area. Although drought is slow-moving, it has proven to be extremely costly and may stress the response capabilities of affected local jurisdictions.

Drought is not considered a distinct incident and therefore does not linearly follow the traditional four phases of emergency management, namely mitigation, preparedness, response and recovery. Many drought response operations coincide with what have traditionally been classified as mitigation or long term recovery activities, such as establishing secondary water supplies, conservation efforts or drought assistance projects. This makes drought extremely difficult to respond to, as drought impacts may necessitate long-term commodity distribution and mass care measures. Because droughts may linger for years at a time, it is imperative that drought response be comprehensive and proactive to avoid public water systems running out of water.

Figure 1 Lake EV Spence 2011 courtesy of TPWD

Types of Drought

Drought is typically defined as a persistent and abnormal moisture deficiency having adverse impacts on vegetation, animals and the human population. There are several definitions and types of drought[1] as listed in the table below.

Drought Type	Description
Meteorological and Climatologic	Meteorological drought occurs when there is abnormally low precipitation over a specified period of time. The standards for drought conditions are based on regional climatology. Normally, meteorological measurements are the first indicators of drought.
Socioeconomic	Socioeconomic drought occurs when the demand for an economic good – such as water, food grains, fish and energy – exceeds supply due to a weather-related water supply shortfall.

[1] For more information, refer to Types of Drought on the National Drought Mitigation Center.

Drought Type	Description
Agricultural	Agricultural drought occurs when there is inadequate precipitation or soil moisture to sustain crops, livestock and forage production systems. The water deficit results in significant damage and economic loss to plant or animal agriculture.
Hydrological	Hydrological drought occurs when there are deficiencies in surface and subsurface water supplies, as measured by stream flow, lake, reservoir, snowpack and groundwater levels.

Drought Stages

There are five stages of drought, which incorporate all the types of drought previously mentioned. Drought stages in Texas correlate with the severity levels of the United States Drought Monitor. These are summarized below.

Stage	Impacts
D0 — Normal Conditions to Abnormally Dry	▪ Emerging drought conditions ▪ Short-term dryness ▪ Planting and growing slows in pastures ▪ Fire risk average or above average; high rangeland fire danger ▪ Lingering water deficits ▪ Pastures or crops not fully recovered when emerging from drought conditions ▪ Official drought not declared
D1 — Agricultural or Moderate Drought	▪ Some damage to crops ▪ Low levels of pastures, streams, reservoirs or wells ▪ High fire risk; burn bans may be in effect ▪ Some developing or imminent water shortages developing ▪ Drought preparedness council declares drought
D2 — Severe Drought	▪ Crop or pasture losses likely ▪ Fire risk very high; burn band in effect ▪ Water systems reporting to TCEQ of potentially having less than 180 days of potable water remaining ▪ Mandatory and/or voluntary water restrictions imposed ▪ Threats to CIKR include energy and agricultural sectors ▪ Emergency water threshold met ▪ Drought disaster may or may not be declared by the governor ▪ USDA Secretarial drought disaster declarations in effect for farmers and ranchers
D3 — Extreme Drought Emergency Conditions	▪ Major crop/pasture losses ▪ Extreme fire danger; burn bans in effect ▪ Multiple systems on 180 day high priority list ▪ Mandatory and/or voluntary water restrictions imposed ▪ Significant threat to CIKR sectors/potential national impacts ▪ Drought disaster is declared by proclamation of the governor

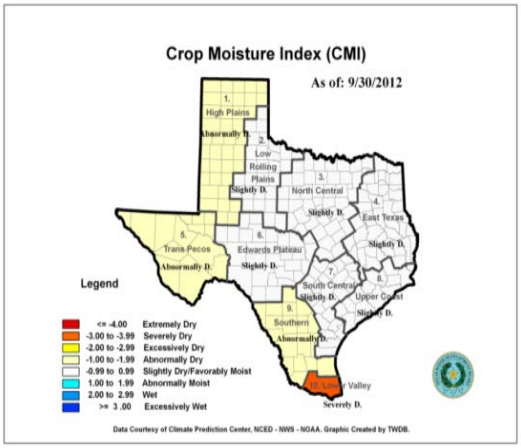
Stage	Impacts
D4 — Exceptional Drought Disaster Conditions	▪ Devastating widespread crop/pasture losses ▪ Exceptional fire risk; burn bans in effect ▪ Continued water restrictions imposed ▪ Multiple systems on 180 high priority list ▪ Extraordinary shortages of water in reservoirs, groundwater storage, streams and wells, creating water supply emergencies and a threat to public health and safety ▪ CIKR threats are present with cascading nationwide implications ▪ Drought disaster proclamation ongoing

Drought Indices

There are six indices that decision-makers use to assess the impact of a drought. Expert judgment and data analysis are required to fully understand each index. Each index is summarized below, followed by a table that compares the indices, identifies the severity indices levels and provides a general framework. The indices by themselves do not initiate response actions.[2]

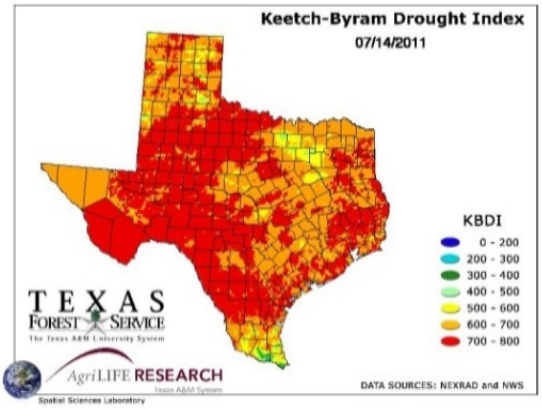
Crop Moisture Index

The Crop Moisture Index (CMI) is used to monitor week-to-week crop conditions across major crop- producing regions. The CMI reflects moisture supply and is based on a climate division's weekly mean temperature, weekly total precipitation, and the previous week's CMI. The CMI responds rapidly to changing conditions, and CMI maps can be used to compare moisture conditions at different locations. The CMI reflects moisture supply and is not used to assess long-term droughts. An example is shown on the right.

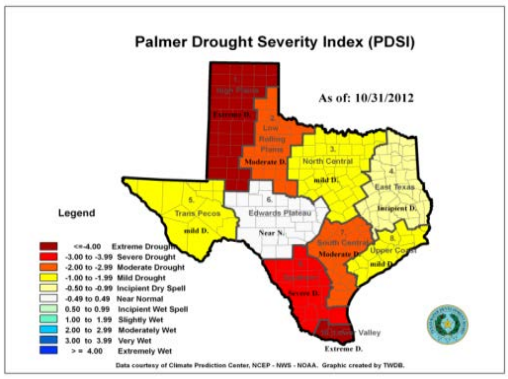


Keetch-Byram Drought Index

The Keetch-Byram Drought Index (KBDI) is used to determine forest fire potential. The index is based on daily water balance, temperature, precipitation and soil moisture. The index is interpolated manually by experts at TFS for counties across the state. An example is shown on the left.



[2] For more information, all Drought Indices can be found on Water Data for Texas website.

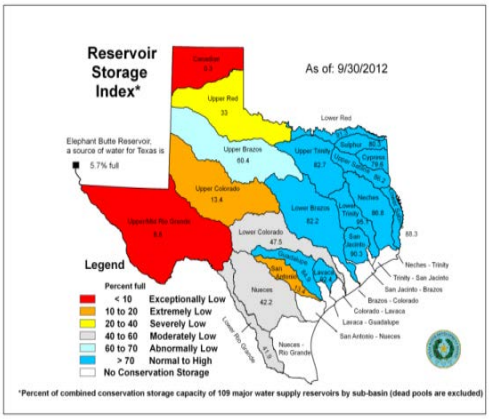


Palmer Drought Severity Index

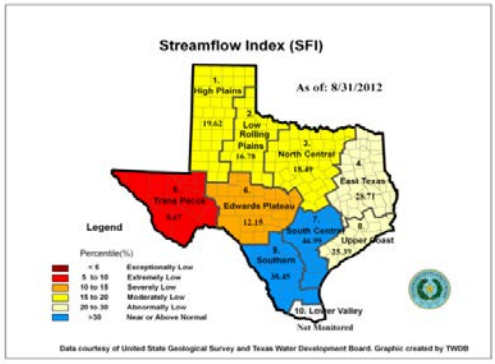
The Palmer Drought Severity Index (PDSI) is primarily used to reflect long-term drought, most accurately for non-irrigated cropland. The PSDI incorporates soil moisture and uses temperature precipitation data to calculate water supply and demand. The PDSI is calculated weekly and monthly. An example is shown on the left.

Reservoir Storage Index

The Reservoir Storage Index (RSI) is used to display how much combined water is available in the state's major water supply reservoirs divided by river basins. The RSI compares current data from active United State Geological Survey (USGS) and United States Army Corps of Engineers (USACE) gauges at 109 major water supply reservoirs or lakes with their normal storage or "conservation storage capacity", e.g. the volume between dead pool elevation and the conservation pool elevation. The RSI is expressed as a percentage. An example is on the right.



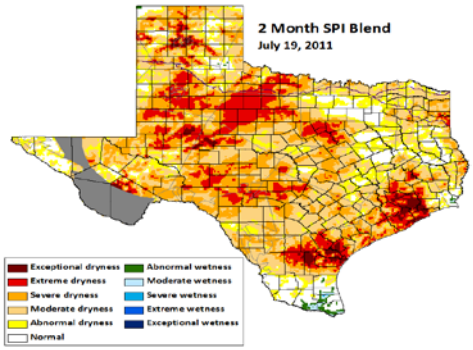
Streamflow Index



The stream flow Index (SFI) is also used to measure drought conditions and water quality and helps with calculating impact estimates. The SFI averages daily gauging and stream flow data collected from the 29 stream stations across the state. An example of the calculated SFI is shown on the left.[3]

Standard Precipitation Index

The Standard Precipitation Index (SPI) is used to determine whether drought exists. It measures the precipitation departure from "normal" over



[3] For more information on how the SFI is calculated, refer to the National Streamflow Information Program on the USGS website.

multiple time periods displaying short versus long term drought trends.

Drought exists when the SPI is negative and is considered “intense” when the SPI is -1.0 or lower. Drought ends when the SPI becomes positive. Each drought therefore has a duration defined by its beginning and end, and intensity for each month that the drought continues. An example of a 2 month short term SPI blend is shown above.

Quantified Indices

The table, below, shows the six drought indices’ range within the corresponding drought severity category. These indices are intended to provide a general framework and help define triggered response actions. The Drought Preparedness Council analyzes and interprets this information on at least a monthly to assist with timely decision-making.

Normal to No Drought

Index	Measurement
CMI	2 to 3+ (Excessively Wet/Wet)
KBDI	0-300 units
PDSI	-0.99 to >4.00
RSI	> = 70 (Normal to High)
SFI	> = 30 (Normal to High)
SPI	-0.50 to +2.0 and above (Near Normal to Exceptionally Moist)

D0 — Abnormally Dry

Index	Measurement
CMI	-0.99 to 1.99 (Slightly Dry/Favorably Moist/Abnormally Moist)
KBDI	300-400 units
PDSI	-0.50 to 0.49 (Incipient Dry Spell/Near Normal)
RSI	60-70% (Abnormally Low)
SFI	20-30% (Abnormally Low)
SPI	-0.79 to -.99 (Abnormally Dry)

D1 — Moderate Drought

Index	Measurement
CMI	-1.0 to-1.99 (Abnormally Dry)
KBDI	400-500 units
PDSI	-1.0 to -1.99 (Mild Drought)
RSI	40-60% (Moderately Low)
SFI	15-20% (Moderately Low)
SPI	-1.29 to -0.80 (Moderately Dry)

D2 — Severe Drought

Index	Measurement
CMI	-2.0 to-2.99 (Excessively Dry)
KBDI	500-600 units
PDSI	-2.00 to -2.99 (Moderate Drought)
RSI	20-40% (Severely Low)
SFI	10-15% (Severely Low)
SPI	-1.59 to -1.30 (Severely Dry)

D3 — Extreme Drought

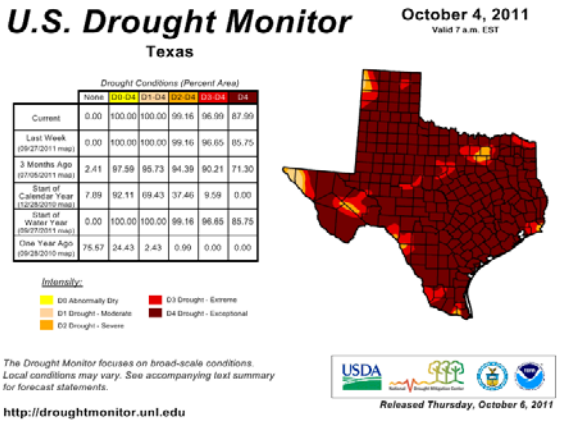
Index	Measurement
CMI	-3.0 to -3.99 (Severely Dry)
KBDI	600-700 units
PDSI	-3.0 to -3.99 (Severe Drought)
RSI	10-20% (Extremely Low)
SFI	5-10% (Extremely Low)
SPI	-1.99 to -1.60 (Extremely Dry)

D4 — Exceptional Drought

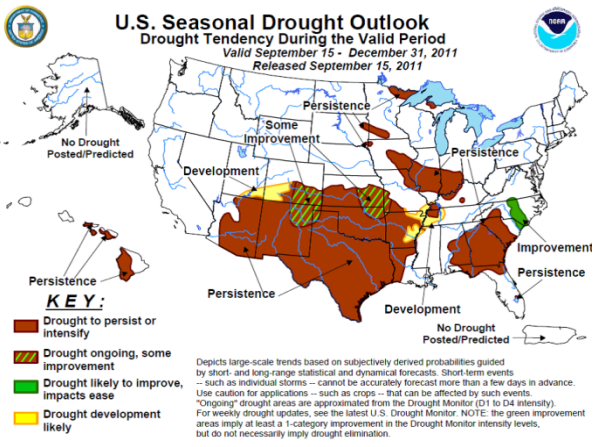
Index	Measurement
CMI	< = -4.0 (Extremely Dry)
KBDI	700-800 units
PDSI	< = -4.0 (Extreme Drought)
RSI	0-10% (Exceptionally Low)
SFI	< 5% (Exceptionally Low)
SPI	-2.0 and below (Exceptionally Dry)

Other Products

In addition to the six indices, the DPC considers the U.S. Drought Monitor, U.S. Seasonal Drought Outlook Map, the AgriLife agricultural index and other products from the National Oceanic and Atmospheric Administration Climate Prediction Center. Together these products provide current drought data, short and medium term climate forecast projections and acute impacts to the agricultural industry.



U.S. Drought Monitor



The U.S. Drought Monitor illustrates how local, regional, and national experts monitor current drought conditions. It is based upon multiple drought indicators, including various indices, outlooks, field reports, expert opinion and news accounts. The Office of the State Climatologist holds a weekly meeting with experts from across the state to gather the most comprehensive and accurate reflection of statewide drought conditions for publication in the U.S. Drought Monitor.

The U.S. Drought Monitor summary map identifies general drought areas, labeling droughts by intensity.[4]

[4] For more information, refer to the National Weather Service Climate Prediction Center on the NOAA website.

U.S. Seasonal Drought Outlook Map

The U.S. Seasonal Drought Outlook shows forecasted probabilities for ongoing drought in areas depicted in the U.S. Drought Monitor, as well as indicating where new drought may develop. It shows general, large-scale trends.

The Seasonal Drought Outlook takes into consideration current drought conditions, precipitation forecasts and projections, soil moisture models, seasonal climate anomalies such as the El Niño-Southern Oscillation and other models.

Texas A&M AgriLife Extension Service Agriculture Index

An agricultural index is developed and maintained by Texas A&M AgriLife Extension Service (AgriLife), in collaboration with United States Department of Agriculture National Agricultural Statistics Service (USDA-NASS), to assess current agricultural conditions. Representatives from AgriLife analyze and report on significant agricultural impacts across the state, including crops, livestock and pasture and range conditions. This index weighs in with the six drought indices listed above and a monthly report is submitted to the DPC for analysis.[5]

Impacts

Drought impacts the state in numerous ways, affecting the economy, population and ecosystems. Different parts of the state may experience different drought severity levels at different times. The various impacts of drought are summarized below.

Figure 2 Toledo Bend Reservoir after 2011 drought courtesy of TCEQ.

Depleted Water Supply

One of drought's most harmful effects is the depletion of available potable water supplies for human consumption. High temperatures, extreme evaporation rates, and lack of replenishing rainfall can rapidly deplete reservoirs and affect groundwater aquifers. When water levels in a reservoir fall too low it can become impossible to treat water to acceptable standards due to bacteria, high salinity, and other total dissolved solids, making the remaining water unusable for human consumption. Additionally, low water levels and poor stream flow threaten wildlife and delicate ecological systems.

As primary water sources become unavailable, water suppliers may need to turn to groundwater to supplement their water resources. However, groundwater in some areas may require substantial and often expensive treatment such as reverse osmosis, microfiltration or other methods to ensure the water is safe for human consumption. As water levels in aquifers are often not constant, recharge rates and excessive withdrawal from the water table can lead to groundwater resources being unreliable as a long-term secondary source of potable water. Other innovative

[5] For more information, refer to the State Drought Preparedness Council on Texas Department of Public Safety website.

water technologies are also being explored to extend and augment existing water supplies, such as desalination and water reuse methods.

Figure 3 Bastrop State Park Fire 2011 courtesy of TPWD.

Wildfires

Extended periods of warm and dry conditions may lead to an environment favorable for wildfires. Wildfires that occur during prolonged drought conditions pose an imminent threat to public health and safety as dead and drying vegetation provide high risk fuels and increased temperatures lead to depleted soil moisture creating prime conditions for more intensely burning and severe wildfires.

When the KBDI exceeds 500, Texas A&M Forest Service recommends the imposition of county burn bans. Depleted water supplies may also negatively impact the response capabilities of firefighters to combat wildfires in drought stressed areas.↗

Agriculture

More than 132 million acres in Texas are dedicated to production of agricultural crops, forages or livestock with a farm gate value in excess of $25 billion. Drought effects on agriculture are often the most acute and the first to develop. Dry vegetation, lack of irrigation water and depleted stock tanks can completely decimate entire crops and herds of livestock. In 2011 alone, Texas has suffered $7.62 billion dollars in agricultural losses due to drought.[6] In turn, the long-term effects of agricultural drought adversely affect the state's economy associated industries, communities and consumers in the form of higher commodity prices and possible food shortages.

Figure 4 Corn Crop in Burleson County, TX 2011.

Energy

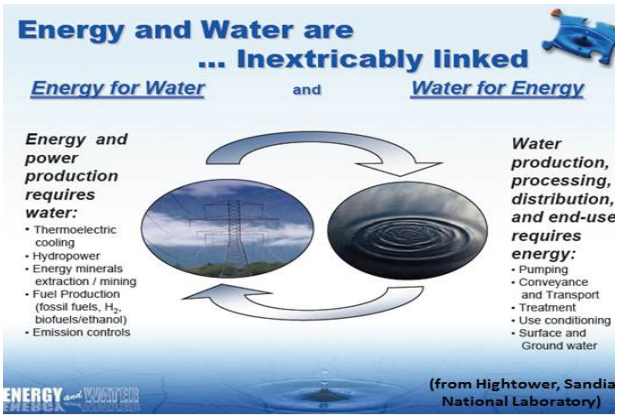
There can be significant impacts on the energy sector during a drought. Power plants, including nuclear facilities, rely almost entirely on surface water for cooling purposes and may become extremely vulnerable in drought conditions (Stillwell, et

---

↗ For more information on wildfires in the state of Texas, refer to the **State Wildland Fire Annex**.

[6] For more information, refer to Fannin, Blair. "Texas Agricultural Drought Losses Reach Record $5.2 Billion." *Texas A&M University, AgriLife Today*, 2011.

al. April 2009). As water becomes unavailable, or when it is available but too hot, power plants may be forced to close or reduce output, which can affect their ability to provide reliable energy generation.



At the same time that the supply of electricity may decrease, increased temperatures drive the demand for electricity to cool homes and businesses.[7] This can threaten the power grid as well as have devastating public health and safety consequences including heat exhaustion and heat stroke and potential for carbon monoxide poisoning from extended or improper use of backup generators.

A major component of the state's economy is the oil and gas industry. Water plays a vital role in ensuring methods of extracting, recovering and conveying supplies of energy producing commodities go uninterrupted. In times of prolonged and severe drought, the ability to produce and distribute these energy sources may be affected incurring state and nationwide cascading effects. The link between energy and water is depicted in the above graphic.

[7] For more information, refer to Today in Energy on the U.S. Energy Information Administration website.

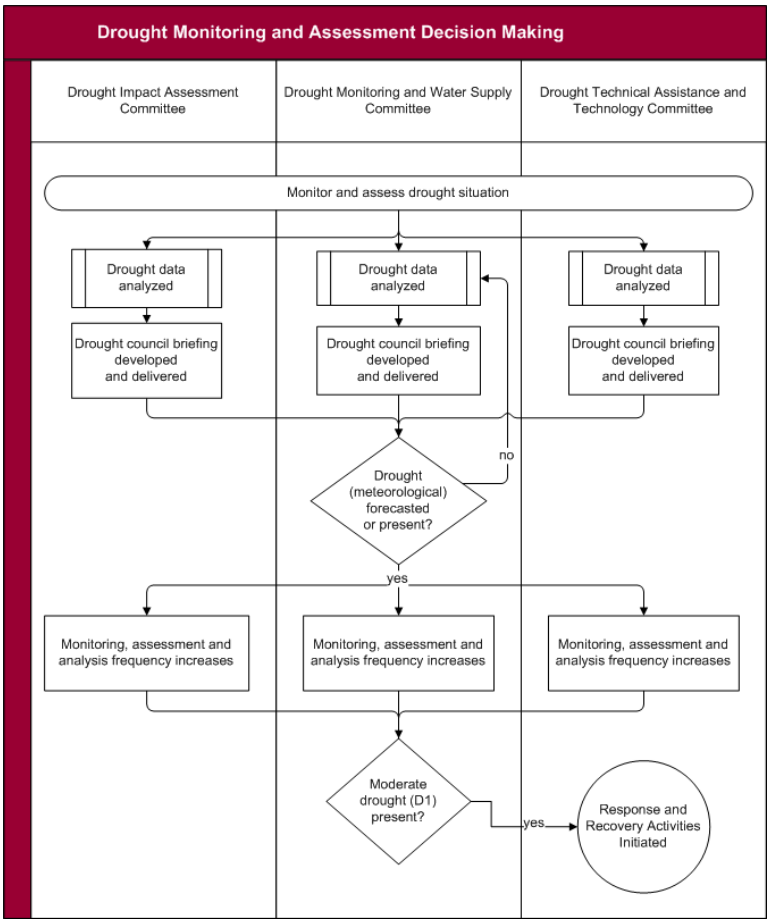
Decision-Making

This section identifies decision-making activities that result in drought response activities by state partners.

The Drought Preparedness Council (DPC) approaches coordination and decision-making in two phases: monitoring and assessment; and response and recovery. These phases complement the existing framework set forth by the Texas legislature and the State Emergency Management Plan, allowing for a streamlined, comprehensive approach to drought management.

Monitoring and Assessment

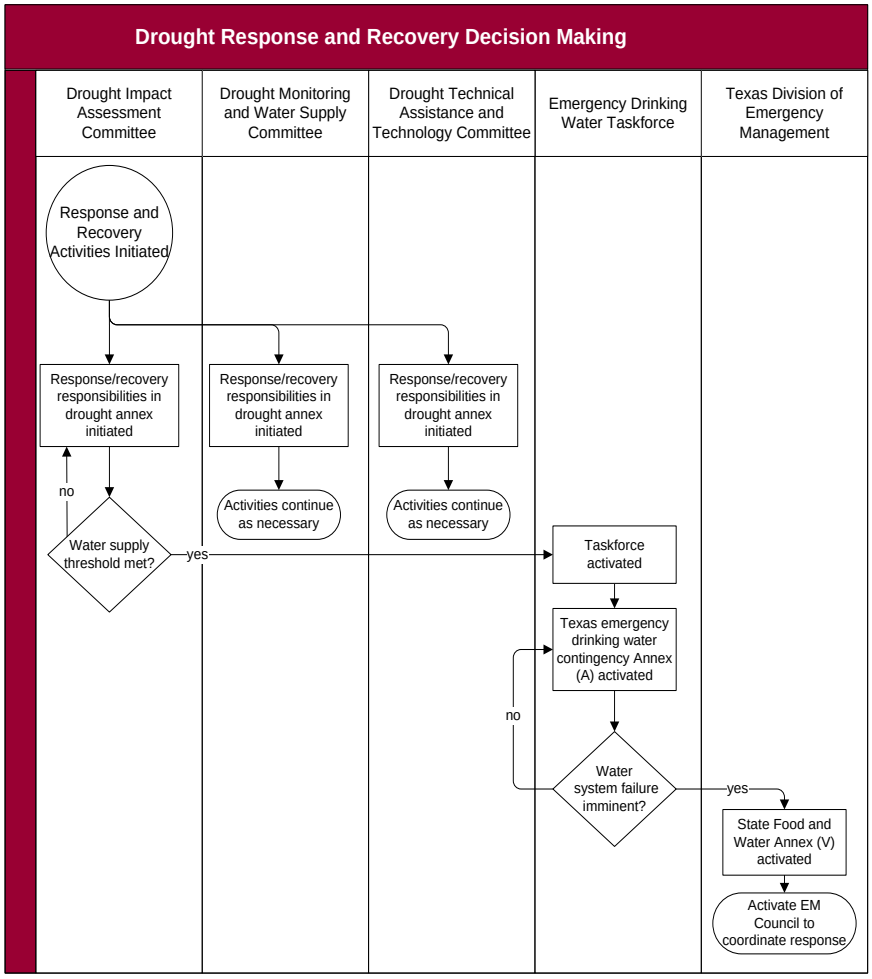
Monitoring and assessment operations allow for the timely dissemination of information between agencies and decision makers. The DPC uses the six drought indices and other methodologies as described in the Defining the Hazard section as their primary sources of information. The DPC analyzes and interprets this information, weighting the indices and ultimately assigning a drought severity level. Having access to real-time analysis of this information allows the state to take a proactive approach to emerging drought conditions. Accurate information helps to identify activities that can mitigate drought impacts.



Response and Recovery

A comprehensive state drought response requires thorough analysis of available data by the DPC as well as a council declaration of drought. The council advises the State Drought Manager of such conditions and initiates coordination for state response and recovery activities through the DPC, DPC subcommittees and coordinating members. Recovery actions may begin simultaneously with response activities.

The DPC provides constant recommendations for response and recovery actions because actions are dependent on timing, location, extent, water supply conditions and other subjective considerations. The DPC notifies partner agencies when an activation trigger has been met. Activation of the state drought response and recovery functions outlined in this document may be triggered in the following situations:



- Moderate/Agricultural drought conditions are identified and threaten to intensify or persist according to the six drought indices and US Drought Monitor, as interpreted by the DPC.
- The Governor or State Drought Manager directs activation.
- The DPC considers other factors and makes a recommendation for drought response and recovery actions to begin or continue.

The following table outlines potential actions taken at specific drought severity stages during statewide response and recovery operations.

Stage	Potential Actions
D0	The following actions may occur under normal to abnormally dry conditions: ▪ Drought Preparedness Council (DPC) monitors and assesses situation. ▪ DPC consults National Weather Service (NWS), State Climatologist, and others to discuss weather and climate trends. ▪ DPC reviews county level data for drought emergence. ▪ DPC issues monthly Drought Situation Report. ▪ DPC reviews lessons learned from previous drought periods. ▪ DPC has not declared an official drought.
D1	The following actions may occur under agricultural or moderate drought: ▪ DPC increases monitoring frequency.

Stage	Potential Actions
	▪ OSC and other entities assess climatologic data for indications that meteorological or climatologic drought is present and forecasted to persist. ▪ TDA and AgriLife assess the scope and intensity of drought impacts on agricultural conditions for indications that drought will persist or intensify. ▪ TDA and AgriLife initiate USDA Secretarial Disaster Designation process. ▪ DPC transitions to response phase. ▪ Water suppliers are requested to implement voluntary water-use restrictions. ▪ DPC declares an official drought.
D2	The following actions may occur under severe drought: ▪ Emergency Drinking Water Task Force activated for systems identified as potentially having less than 180 days of water remaining (Emergency Drinking Water Contingency Attachment 1 in effect). ▪ TCEQ establishes a 180 day High Priority List to track and offer assistance to water systems on High Priority list that have been severely impacted by persistent drought conditions. ▪ Water suppliers implement voluntary or mandatory water-use restrictions. ▪ TDA and AgriLife offer assistance and advice to farmers and ranchers affected. ▪ State Drought Manager may ask Governor for a Disaster Proclamation for drought. ▪ DPC engages private sector partners concerning threats to CIKR such as energy, petrochemical, and other sectors as needed. ▪ Governor may issue a drought disaster proclamation. ▪ USDA Secretarial drought disaster declarations are in effect for farmers and ranchers.
D3	The following actions may occur under extreme drought emergency conditions: ▪ Emergency Drinking Water Task Force meets on a weekly basis (or more frequently as needed) to offer support to water systems identified as potentially having 180 days or less of water remaining. ▪ State agencies may waive certain state regulations in response to public water supply emergencies with a gubernatorial drought disaster proclamation. ▪ Water suppliers implement voluntary or mandatory water-use restrictions. ▪ DPC agencies may increase drought education and outreach to affected regions. ▪ Drought JIC may be initiated for information sharing. ▪ DPC may promote increased outreach activities and provide workshops and technical assistance to water systems. ▪ DPC may engage in increased federal and private sector involvement considering impacts to CIKR. ▪ Governor declares a drought disaster by proclamation identifying every affected county in the state.
D4	The following actions may occur under exceptional drought disaster conditions: ▪ Affected water suppliers implement mandatory water-use restrictions. ▪ State Drought Manager, in coordination with the State Operations Center, may activate Food and Water Annex (V) of the State Emergency Management Plan to provide short-term support to water supply emergencies. ▪ Drought Technical Assistance and Technology Committee provides

Stage
recommendations for counties to remain or to be taken off of the Governor's Drought Disaster Proclamation every 30 days. ▪ State Drought Manager, in coordination with the State Operations Center, may activate the Mass Care Annex (C) of the State Emergency Management Plan. ▪ DPC will forward all requests for state assistance not able to be filled by the DPC through established emergency management system channels. ▪ State may request federal or interstate assistance through established emergency protocols.

Concept of Operations

The state may be required to perform several interrelated emergency functions in response to a drought. This section summarizes each function and highlights drought-specific considerations.

The state's planned response to drought involves numerous government agencies, nongovernmental and voluntary organizations, private sector, critical infrastructure and key resources stakeholders and other partners.

These entities work closely together to monitor emerging threats, coordinate resources to response to local needs, and assist with long-term recovery.

Drought Response Functions

The following table shows the core emergency functions used in response to a drought with possible notification times for activation (a = advisory), for directing resources to prepare to activate (b = alert), for moving resources in support of response operations (c = activation) and for when resources begin to response (d = onsite/operational).

The drought severity stages (D0-D4) correspond to the Advisory, Alert, Activation and Start of Operations for drought response functions. Drought incidents can be extremely slow-moving and may occur over the course of months or even years. Drought forecasting may be conducted months in advance while the state is still in "normal" conditions. Due to the uncertainty of drought conditions and the fact that different parts of the state experience differing severity stages, especially water supply emergencies, this timeframe may require immediate or delayed activations of the functions outlined in this section. Timelines in this planning document are expected to be inexact and are shown here only to provide a frame of reference.

Emergency Function (Annex)	Normal Conditions	Abnormally Dry/Emerging Drought Conditions	Moderate Drought	Severe Drought	Extreme Drought	Exceptional Drought/Disaster
	Normal	D0	D1	D2	D3	D4
Emergency Management (N)	d	d	d	d	d	d
Public Information (I)	d	d	d	d	d	d
Resource Support (M)	c	d	d	d	d	d
Animals/Agriculture (O)	b	d	d	d	d	d
Firefighting (F)	a	d	d	d	d	d
Recovery (J)	a	a	b	d	d	d
Energy (L)	a	a	b	c	d	d
Public Works/Engineering (K)	a	a	b	c	d	d
Volunteer/Donations Management (T)	a	a	b	c	d	d
Food & Water (V)	a	a	a	b	c	d
Health & Medical (H)	a	a	a	b	c	d
Shelter/Mass Care (C)	a	a	a	b	c	d

Drought-specific considerations for each function are described on the following pages. More comprehensive information on any function outlined in this hazard annex may be found in the corresponding functional annex within the State of Texas Emergency Management Plan by following the links provided.

Emergency Management

The Texas Division of Emergency Management (TDEM) coordinates statewide emergency response and facilitates the State Drought Preparedness Council (DPC) the overarching body dedicated to providing monitoring and assessment and response and recovery efforts for the state. The Chief of TDEM is the State Drought Manager and as such chairs the DPC and is responsible for coordinating statewide drought response activities.

The State Drought Preparedness Council

The Drought Preparedness Council meets at least on a monthly basis, regardless of drought conditions, to monitor and assess drought and support a robust and comprehensive response to drought. Council responsibilities are to:

- Assess and report drought monitoring and water supply conditions.
- Advise the governor on severe drought conditions.

- Recommend specific provisions for a defined state response to drought-related disasters.
- Ensure effective coordination among state, local, federal, tribal and private sector entities in drought response activities.
- Report to the state legislature regarding significant drought conditions.

The council includes local, regional, state, federal, academic partners, any personnel or agency designated by the governor and liaises with other partners as appropriate. The DPC is comprised of the following legislatively designated and gubernatorial appointed state agencies and members:

- Electric Reliability Council of Texas (ERCOT)
- Individual members appointed by the Governor
- Office of the Governor-Department of Economic Development and Tourism (EDT)
- Office of the State Climatologist (OSC)
- Public Utility Commission (PUC)
- Texas A&M AgriLife Extension Service (AgriLife)
- Texas A&M Forest Service (TFS)
- Texas Alliance of Groundwater Districts (TAGD)
- Texas Commission on Environmental Quality (TCEQ)
- Texas Department of Agriculture (TDA)
- Texas Department of Housing and Community Affairs (TDHCA)
- Texas Department of State Health Services (DSHS)
- Texas Department of Transportation (TxDOT)
- Texas Department of Public Safety- Texas Division of Emergency Management (TDEM)
- Texas Parks and Wildlife Department (TPWD)
- Texas State Soil and Water Conservation Board (TSSWCB)
- Texas Water Development Board (TWDB)

Coordinating Members

Coordinating members, though not an official part of the DPC, are an essential component of the council. These members may be federal agency partners, non-governmental agencies, volunteer organizations, public entities and academic community partners; they help provide an inclusive perspective on the effects of drought.

Federal Agency Partners

The DPC acts as the state's liaison with federal agencies promoting coordination at all levels of government in order to ensure a robust and comprehensive response effort to drought emergencies.

These partners include, but are not limited to:

- Federal Emergency Management Agency (FEMA)
- National Oceanic and Atmospheric Administration (NOAA) to include the National Weather Service (NWS) and National Integrated Drought Information System (NIDIS)
- United States Army Corps of Engineers (USACE)

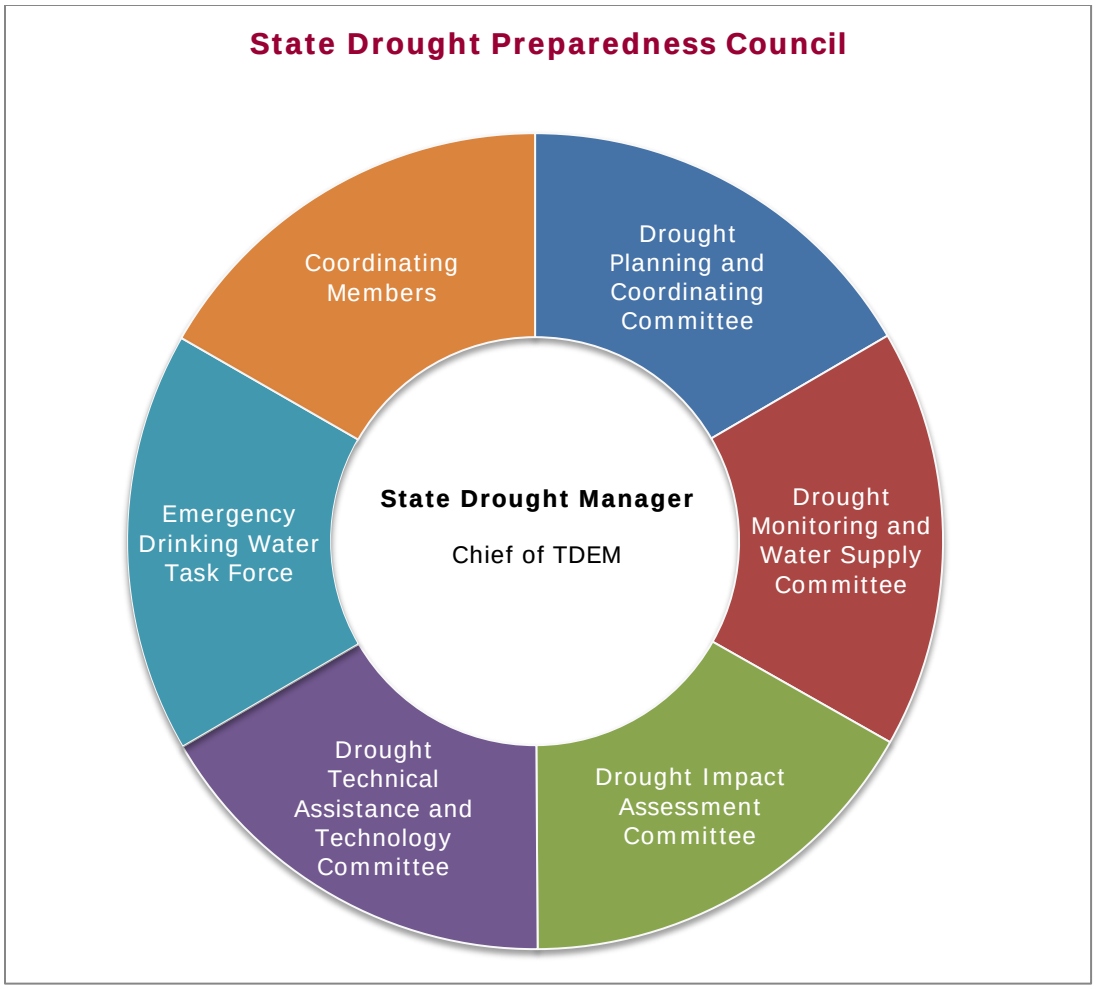
- United States Bureau of Reclamation (USBR)
- United States Department of Agriculture (USDA) to include the Farm Service Agency (FSA)
- United States Department of Housing and Urban Development (HUD)
- United States Geological Survey (USGS)

Other Entities

The DPC coordinates with other entities, including public agencies, volunteer organizations and academic institutions to support a diverse planning and coordinating body offering critical perspectives to drought response and water management. These partners include but are not limited to:

- Texas Military Forces (TxMF)
- Health and Human Services Commission (HHSC)
- National Voluntary Organizations Active in Disasters (NVOAD)
- Texas River Authorities
- University of Texas Center for Space Research (UTCSR)
- University of Texas Jackson School of Geosciences
- Southern Climate Impacts Planning Program (SCIPP) members

The DPC coordinates the state's drought response through four committees, and one specialized task force. Coordinating members serve the council by offering a whole community approach to drought planning and response.



Drought Impact Assessment Committee

The Drought Impact Assessment committee is chaired by TCEQ and coordinates information about statewide drought impacts across all sectors as well as appropriate mitigation and response actions. This committee is made up of agencies that have specific expertise to monitor and analyze the onset of drought and forecasted water supply, water use and water demand issues. This committee provides informed recommendations to the DPC, State Drought Manager, legislature and the governor to determine whether drought exists or is imminent. This committee also provides recommendations to reduce existing or potential impacts to the state's water supply, economy, industry, public health, energy, agricultural and natural resources sectors.

Drought Monitoring and Water Supply Committee

The Drought Monitoring and Water Supply Committee is chaired by the TWDB. The committee informs the DPC of climatologic, meteorological and hydrological drought conditions through the reporting of current and forecasted weather conditions and the six drought indices. The committee provides an analysis of the current drought indices, highlights improvements or degradations, and assesses water supply conditions.

Drought Technical Assistance and Technology Committee

The Drought Technical Assistance and Technology Committee is chaired by TWDB. TWDB, TCEQ, TDEM and the OSC analyze drought data, coordinate with regional water planning groups on drought issues and make recommendations for a county to either remain or be taken off a governor's drought disaster proclamation. The committee collaborates with academics and other partners to identify potential alternative and innovative water management solutions.

Emergency Drinking Water Task Force

Co-chaired by TDEM and TCEQ, the Emergency Drinking Water Task Force tracks water systems that have been identified as potentially having 180 days or less of potable water. The committee provides support to local water systems' efforts to secure dependable sources of water, locate funding resources, provide technical assistance, and assist with applying for grants or loans. Committee partners coordinate technical and financial assistance and outreach for contingency planning to drought impacted areas. See Emergency Drinking Water Contingency Attachment (A) for more information.

Drought Planning and Coordination Committee

The Drought Planning and Coordinating Committee is chaired by TDEM and conducts drought response planning and is responsible for providing updates to the State Drought Annex and State Emergency Drinking Water Contingency Annex (A). This committee is comprised of all designated DPC agencies, as well as all other coordinating member agencies and recommends specific revisions for a defined state response to a drought disaster.

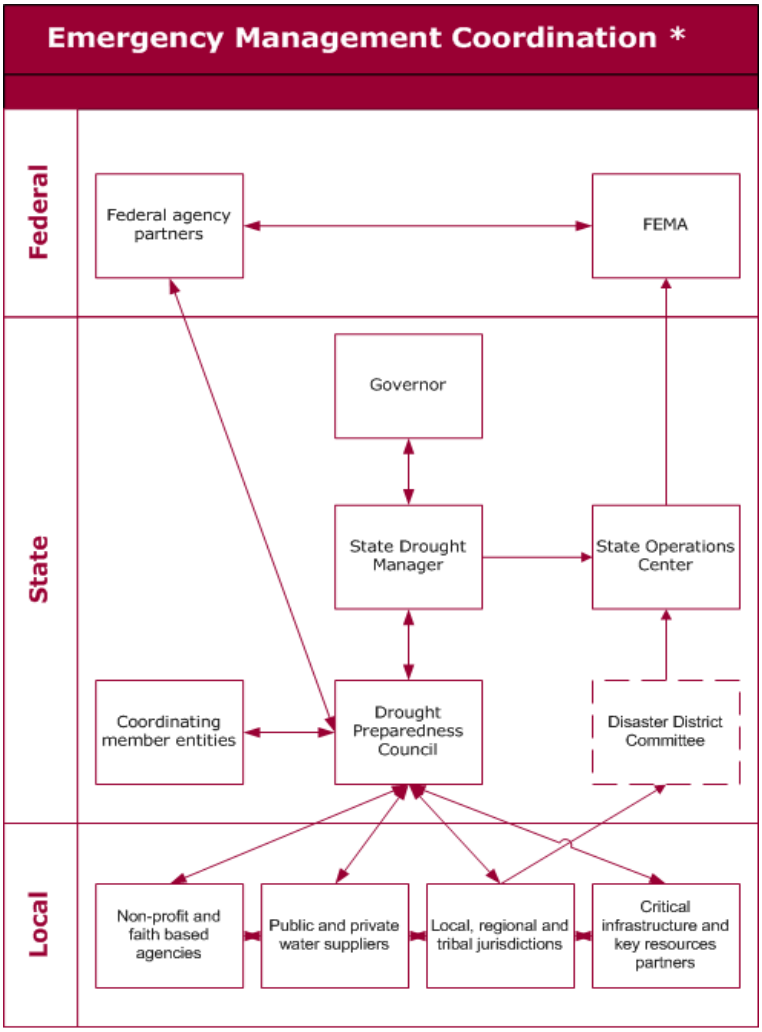
This image shows the various agencies of the DPC and their roles in the various committees on which they serve. To view this information in a table, for state agencies only, see the Agency/Organization Responsibilities section.

Committee Chair	C
Committee Member	M
State Drought Preparedness Council	
Federal Agency Partners	
Other Entities	

	Planning and Coordination	Monitoring and Supply	Impact Assessment	Technical Assistance	Emergency Drinking Water	Coordinating Members
AgriLife	M		M			
DSHS	M		M			
EDT	M		M			
ERCOT	M		M			
Governor Appointee	M					
HHSC	M					M
OSC	M	M		M		
PUC	M		M			
TAGD	M		M			
TCEQ	M	M	C	M	M	
TDA	M		M		M	
TDEM	C		M	M	C	
TDHCA	M		M			
TFS	M		M			
TPWD	M		M	M		
TSSWCB	M		M			
TWDB	M	C	M	C	M	
TxDOT	M		M			
FEMA						M
HUD						M
NOAA						M
USACE		M				M
USBR						M
USDA						M
USGS						M
Texas River Authorities	M					M
TXMF	M					M
UT - Jackson School of Geosciences	M			M		M
UTCSR	M			M		M
VOAD (National & TX)	M					M

Coordination Process

In periods of drought, the effectiveness of response hinges on timely and effective coordination among decision-makers, state agencies, tribal and federal partners, private stakeholders and the whole of community.



*This graphic represents coordination, not logistical processes for resource support. For resource request or STAR processes, please see the Resource Support section of this document.

As with all disasters, drought response begins at the local level. At the local level, drought may be identified by: the county judge, mayor, utility providers, extension agents, or other officials such as the emergency management coordinator (EMC). Cities, counties or water suppliers may enact the various stages of their drought contingency or water conservation plans. The local water supplier, by law, notifies TCEQ when a local drought exist requiring mandated water restrictions or the water supply is expected to potentially be exhausted in 180 days or less.

In turn, TCEQ reports the local drought conditions to the Drought Preparedness Council. The council, its subcommittees and the State Drought Manager then take a number of actions as follows.

- The Drought Preparedness Council and its members work together to:
  - Review and disseminate official agency-specific drought-related information for use by the press, radio, web, television and social media.
  - Participate in conference calls, meetings and workshops coordinated by TDEM, where new information is shared and drought response strategies are developed.
  - Participate in weekly conference calls run by the state climatologist, who gathers statewide input for the US Drought Monitor.
  - Hold emergency drought planning workshops across the state to engage local stakeholders.
- The Emergency Drinking Water Task Force provides support to water suppliers identified as potentially having 180 days or less of water. If this task force exhausts

its ability to provide support, the task force makes a recommendation to the DPC to seek support from the State Operations Center (SOC). In turn, the SOC may:
  - Activate the Food and Water Annex (V) and coordinate with identified state partners to provide short-term emergency drinking water.
  - Request assistance from FEMA when state resources are exhausted.
- The Technology and Technical Assistance Subcommittee considers whether to recommend that the governor issue a Drought Proclamation to add (or remove) a county. The subcommittee coordinates with TDEM's Recovery Section when developing recommendations.
- The DPC's State Drought Manager provides routine updates to the governor and state legislators. In addition, the State Drought Manager may pass along the Technology and Technical Assistance Subcommittee's recommendation to issue or remove a Drought Proclamation.

In addition to the coordination mechanism described here, it is possible that a local jurisdiction, after exhausting all local resources, may go directly to the Disaster District Committee (DDC) for assistance per the traditional emergency management request process. When the DDC exhausts local resources, the DDC would submit requests to the SOC. In turn, when state resources are exhausted, the SOC would request support from FEMA, including a possible Presidential Disaster Declaration.

Coordination Tools

The DPC uses a number of tools to gather and analyze data and reports. Together these help provide a common operating picture, allowing responders at all levels to make effective, consistent and timely decisions.

The following table provides a descriptive overview of each coordination tool.

Tool	Description
Drought Council Meetings	Drought council meetings are held every month regardless of drought conditions and are facilitated by TDEM. ▪ All subcommittees report on drought impacts affecting the different sectors. ▪ The state climatologist provides weather data and forecasting. ▪ Council shares any pertinent information and fulfills any requests from the governor, legislature, or State Drought Manager. ▪
Situation Report	TDEM compiles a monthly situation report to summarize current drought conditions and impacts, which is sent to the drought council, stakeholders, and is posted online. ▪ Explains the nature of the current threat. ▪ Describes current and forecasted situation. ▪ Specifies degradations or improvements from the previous month's conditions.
Emergency Drinking Water Task Force	The task force is chaired by TDEM and co-chaired by TCEQ and meets weekly during emergency and disaster drought conditions when the threshold of a water system self-reporting as potentially

Tool	Description
Meetings	having 180 days or less of available water and: ▪ Coordinates support for water systems that are placed on TCEQ's High Priority list. Provides updates on status of water systems projects.
Joint Information Center	Texas A&M AgriLife Extension Service may activate a joint information center that: ▪ Shares information between state agencies and coordinates public information releases. ▪ Meets weekly via conference call as recommended by the DPC.
Drought End of Year Report	Texas Division of Emergency Management publishes a drought End of Year report that: ▪ Summarizes the state's drought conditions and actions taken by the DPC over the past one year period.
Drought Biennial Report	Texas Division of Emergency Management publishes a drought biennial report due to the Texas State Legislature on January 15 of every odd numbered year that: ▪ Summarizes the state's drought conditions and actions taken by the DPC over the previous two years.
DPC Correspondence	When appropriate, the DPC sends official letters to drinking water suppliers, county judges, mayors and private sector partners providing notification of drought impacts, legislative changes and other drought related information.

Public Information

Although drought is a slow moving incident, public information on forecasted or persistent drought conditions and impacts is extremely vital. The release of timely, consistent and effective public information helps all Texans understand threats, potential impacts, available services, funding options and timelines for response and recovery.

DPC agencies and organizations with community relations, government relations and public affairs duties share responsibility for disseminating information to the public and the media during a drought. Public information must be accessible to the whole of community, including persons with disabilities or functional and access needs. Having the public fully aware of drought conditions, and water supply levels is instrumental in enacting drought contingency planning and enacting water conservation measures.

During a drought, a variety of accessible public messages are disseminated by various state agencies with the Texas A&M AgriLife Extension Service serving as the primary agency for a Statewide Drought Joint Information Center (JIC).

The checklist below outlines tasks carried out in support of the public information function.

Drought Public Information Checklist

Phase	Agency	Activity
D0 or Greater	TDA	Maintains information online about drought impacts to the agricultural sector and the hay hotline to assist farmers and ranchers in locating hay.
D1 or Greater	AgriLife	▪ Activates A&M AgriLife Communications radio, TV and online resources to support and assist with the dissemination of public information and education to County EMCs, local VOADs, rural and urban communities and businesses about current and forecasted drought disaster conditions[8]. ▪ Uses Extension Disaster Education Network (EDEN) community outreach materials through VOADs. ▪ Activates Drought JIC to serve as a clearinghouse for drought messaging information sharing and identify assistance programs available.
D2 or Greater	TxDPS-TDEM	Publishes the monthly Drought Situation Report on the TDEM website
	TCEQ	Conducts outreach and workshops to local water suppliers, local jurisdictions, and other partners.
	TWDB	Publishes water conservation strategies and materials.
	TDA	Provides reports and publications on drought information. Conducts public information campaigns showing drought impacts.
	OSC	Conducts outreach and workshops and provides current information to the public on drought, drought prediction, and climate variability.
D3 or Greater	DSHS	Delivers public health risk messaging tied to drought conditions.

The public information function falls under the Emergency Support Function (ESF) for External Affairs.↗

[8] For more information, refer to Texas Extension Disaster Education Network (EDEN) on the Texas A&M AgriLife Extension website.

↗ For more information on the ESF for External Affairs, refer to the **State Public Information Annex (I)**.

Resource Support

During a drought, the Drought Preparedness Council, the Emergency Drinking Water Task Force, the Texas Water/Wastewater Agency Response Network (TXWARN) and the Texas Water Infrastructure Coordination Committee (TWICC) all assist with resource coordination and deployment as needed. Public and private water systems look to the these sources to obtain resources to complete water projects such as interconnections, well field exploration, rehabilitating old wells, construction of desalination and water treatment plants.

In the event a drought is so severe that these groups cannot achieve resource coordination, traditional emergency management channels for resource requests and fulfillment take effect as described in the next section beginning with the local jurisdiction declaring a local emergency.

The Resource Request Process

Resources are provided primarily by local jurisdictions. If a jurisdiction has unmet resource needs, it may try to obtain the resource from the following entities:

1. Local nongovernmental or faith-based organizations.
2. Local contracts or private-sector partnerships.
3. Mutual aid agreements with nearby jurisdictions.
4. Pre-designated regional response teams or resources.
5. A regional multi-agency coordination center (MACC).
6. The Disaster District Committee (DDC).

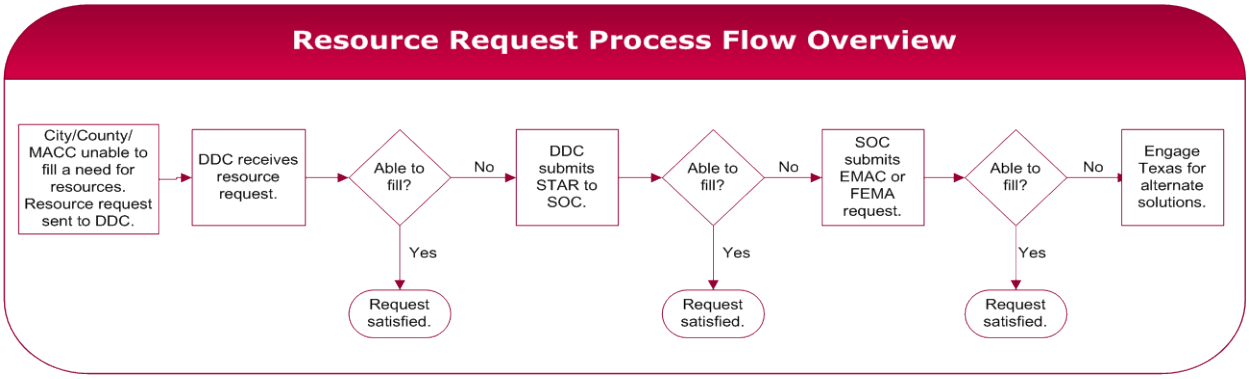
When a DDC receives a request for state assistance, the DDC provides the resource if it is available. If the resource is not available, the DDC submits a resource request to the SOC using a State of Texas Assistance Request (STAR) form.

The state may request assistance from EMAC member states or territories, federal support agencies and external partners.↗

Federal assistance relies on specific requests and priorities made by the state and becomes available once the state receives a presidential disaster declaration.

Although state and local governments have a wide variety of emergency response assets, emergency contracts are available to provide certain specialized emergency response equipment, supplies and services.

↗ For more information on assistance from EMAC members procedures, refer to the **State Logistics and Resource Management Annex (M)**.



Resource Support Checklist

The checklist below outlines tasks carried out in support of the resource support function during a drought incident.

Drought Resource Support Checklist

Phase	Agency	Activity
D1 — D4	TxDPS - TDEM	Coordinates with local jurisdictions and Disaster Districts to pre-identify RSA, DSA, CSA and POD locations and resource shortfalls.
D3 or Greater	TxDPS - TDEM	▪ Alerts partner agencies and contract vendors to prepare for activation of state contracts for: ▪ HHSC for water and ice. ▪ Portable restrooms, hand-washing stations and shower trailers. ▪ Pre-approved bulk water haulers.
	TCEQ	Identifies state pre-approved bulk water haulers.

Mass Care

An extreme prolonged drought may create a need for mass care services. These services may include the provision of temporary shelter and feeding. The mass care function falls under the ESF for mass care, housing and human services.↗

Food and Water

The state of Texas may not be able to provide bulk potable water for an indeterminate amount of time due to drought emergencies. Emergent responses to drought induced water shortages are addressed in the section on emergency drinking water.↗ Short-term, temporary and immediate responses to emergency

---

↗ For more information on the ESF for mass care, housing and human services, refer to the **State Mass Care Annex (C)**.
↗ For more information on drought induced water shortages, refer to the **Emergency Drinking Water Attachment.**

food, water and ice requirements cross several ESFs and are addressed in another annex,↗ where they are described in detail.

Health and Medical Services

Low water quality, extreme temperatures and possible power interruptions may all adversely affect public health, behavioral health and may affect the ability for medical institutions to function at acceptable standards. The primary agency for state support of these response efforts is the Texas Department of State Health Services.

Public Health Risk Communication

DSHS develops public health risk messages for the public in conjunction with appropriate Drought Council members.

Medical Services

DSHS coordinates and provides information to medical facilities that may be affected due to water shortages and poor water quality.

Drought Public Health and Medical Checklist

Phase	Agency	Activity
D3 or Greater	DSHS	▪ Conducts health and medical assessments in communities affected by drought conditions. ▪ Assists local governments in providing health and medical information to the public. ▪ Coordinates support to medical facilities affected by drought.

The Public Health and Medical Services function falls under the Emergency Support Function (ESF) for Public Health and Medical Services.↗

Animals and Agriculture

The livestock industry is a key segment of the state's economy, as Texas exports more than $1.5 billion in animals and animal products annually. Drought impacts to animals and agriculture are, by far, the most devastating to this industry and may have far reaching economic impacts within the state and across the nation.

An extreme or exceptional drought can cause a dramatic reduction in livestock herds, widespread loss of crops in the state and hay may be in very short supply as livestock feeding increases, and dry conditions reduce hay production. Ranchers may not have sufficient water in wells or stock ponds and their livelihoods and those in nearby communities can be threatened. The USDA may activate Secretarial Drought Disaster Declarations that activate federal assistance programs.

↗ For more information on short-term, temporary and immediate response requirements for food, water and ice, refer to the **State Food and Water Annex (V).**
↗ For more information on the ESF for public health and medical services, refer to the **State Public Health and Medical Services Annex (H)**.

Drought Animal and Agriculture Checklist

Phase	Agency	Activity
D0 — D4	TDA	▪ Provides public information and educational materials in response to drought and available recovery programs to farmers and ranchers. ▪ Activates hay hotline ▪ Maintains updated drought information on its website to assist farmers, ranchers, and agribusinesses.
	AgriLife	▪ Provides public information and educational materials in response to drought and available recovery programs to farmers and ranchers. ▪ Provides assistance, advice and outreach to farmers and ranchers. ▪ Maintains a state of readiness among food, agricultural, and environmental safety specialists and county agents to support public information and education addressing mitigation, economic loss, damage assessment, and recovery. ▪

The animals and agriculture function falls under the ESF for agriculture and natural resources.↗

Firefighting

Extreme and prolonged drought conditions can create a perfect storm of dead vegetation, dry soil, high temperatures, low precipitation and strained water availability to create a dangerous fire risk. Fire forecasting and burn ban notifications are vital during drought periods to prepare for and mitigate against devastating wildfires.

The checklist below outlines tasks carried out in support of the firefighting function.

Drought Firefighting Checklist

Phase	Agency	Activity
D0 — D4	TFS	▪ Provides fire forecasting and tree health assessments. ▪ Identifies which counties are under a burn ban.
D3 — D4	TFS	Conducts tree removal operations.

↗For more information on the ESF for agriculture and natural resources, refer to the **State Animals, Agriculture, and Food and Feed Annex (O)**.

The firefighting function falls under the Emergency Support Function (ESF) for firefighting.↗

Energy

Water and power are inextricably linked in the state of Texas. ERCOT coordinates with power companies and tracks drought ravaged areas and power generating facilities that may be affected.

The checklist below outlines tasks carried out in support of the energy function.

Drought Energy Checklist

Phase	Agency	Activity
D2 or Greater	ERCOT	Monitors for shortfalls in generation capacity due to increased demand and limited water availability.

The energy function falls under the Emergency Support Function (ESF) for energy.↗

Public Works and Utilities

Damage from severe drought can cause critical public works and utility infrastructure components to be out of service for extended periods of time. Disruption of services impacts the ability of key businesses to re-open and communities to function.

The checklist below outlines tasks carried out in support of the public works and utilities function.

Drought Public Works and Utilities Checklist

Phase	Agency	Activity
D2 or Greater	TCEQ	Provides technical assistance to local governments and water and wastewater utilities.
	TxDOT	Assesses damages and repairs state highways.

The public works and engineering function falls under the Emergency Support Function (ESF) for public works and engineering.↗

↗ For more information on the ESF for firefighting, refer to the **State Firefighting Annex (F)**.
↗ For more information on the ESF for energy, refer to the **State Energy Annex (L)**.
↗ For more information on the ESF for public works and engineering, refer to the **State Public Works and Engineering Annex (K)**.

Volunteer and Donations Management

TDEM is responsible for coordinating state volunteer and donations management functions. TDEM collaborates with National Voluntary Organizations Active in Disasters (NVOAD)s and other non-governmental agencies to develop community outreach programs, decision- making aids and water saving strategies. The checklist below outlines tasks carried out in support of the volunteer and donations management function.

Drought Volunteer and Donations Management Checklist

Phase	Agency	Activity
D3 or Greater	TxDPS - TDEM	▪ Reviews volunteer and donations plans for forecasted impacted jurisdictions. ▪ Collaborates with NVOADs and other non-governmental agencies to develop drought response strategies. ▪ Communicates with non-governmental/faith-based groups for donations management of bottled water and other commodities.

The volunteer and donations management function falls under the Emergency Support Function (ESF) for external affairs.↗

Recovery

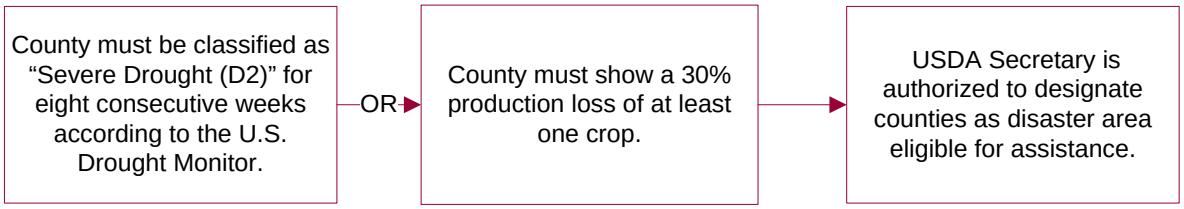
Planning for the recovery phase overlaps all drought monitoring, assessment and response operations. TDEM's Recovery Section administers drought disaster proclamation recommendations from the DPC to the governor's office every thirty days during a declared drought. In addition, the US Secretary of Agriculture is authorized to designate counties as disaster areas and make emergency loans to producers suffering losses in those counties and adjoining counties. These disaster designations are also used by the Farm Service Agency (FSA) as a requirement for disaster loan eligibility.

USDA Secretarial Drought Disaster Declaration Process

Drought declarations by the U.S. Department of Agriculture (USDA) occur after significant economic damage has been done by drought. The USDA uses the U.S. Drought Monitor as a tool to nearly automatically provide a disaster designation. Despite the automatic trigger, the state governor or Indian Tribal Council always has the ability to request a Secretarial Disaster Designation as needed. Producers may apply for low-interest emergency (EM) loans in counties named as primary or contiguous under a disaster designation.

↗ For more information on the ESF for external affairs, refer to the **State Volunteer and Donations Management Annex (T)**.

The Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency (EM) loans to producers suffering losses in those counties and in counties that are contiguous to a designated county.[9]



Presidential Disaster Declaration

The Stafford Act (§401) requires that: "All requests for a declaration by the President that a major disaster exists shall be made by the Governor of the affected state." TDEM prepares the declaration request for the governor's office, which then makes the request through FEMA Region VI. Tribal groups are exempted from this requirement. The checklist below outlines tasks carried out in support of the recovery function.[10]

Drought Recovery Checklist

Phase	Agency	Activity
D2 — D4	AgriLife	Provides information on available recovery programs.
	TDA	▪ Tracks UDSA secretarial drought disaster declarations in the state. ▪ Administers USDA Community Development Block Grant funds. ▪ Maintains Drought Resource Information Packet (DRIP) on website.
	TxDPS - TDEM	▪ Drafts governor drought disaster proclamation recommendation in coordination with the DPC. Updates every thirty days as recommended by Council. ▪ Updates available drought assistance program information.

The recovery function falls under the Emergency Support Function (ESF) for long-term community recovery.↗

[9] For more information, refer to Disaster Designation Process in U.S. Department of Agriculture Federal Register Volume 77.
[10] For more information, refer to Robert T. Stafford Disaster Relief and Emergency Assistance Act Sec. 401 in the FEMA website.
↗ For more information on the ESF for long-term community recovery, refer to the **State Recovery Annex (J)**.

Summary of Responsibilities

This section specifies the responsibilities of stakeholders with capabilities during drought preparedness, response and recovery.

All state Drought Preparedness Council (DPC) agencies and organizations that support drought response are responsible for the tasks listed below.

Agency Checklist

Use the following checklist to ensure all EMC responsibilities are addressed.

Phase	Task
Preparedness	▪ Determine staff requirements. ▪ Identify specific personnel who can fill extended emergency duty positions in the state operations center (SOC), agency emergency operation centers (EOCs), state medical operations center (SMOC), Disaster District emergency operations center, multi-agency coordination centers (MACCs), the Joint Field Office (JFO), field command posts, traffic control and/or reentry points. Ensure that the number of personnel identified is adequate. ▪ Train representatives in accordance with National Incident Management System (NIMS) requirements and ensure that these representatives are made aware of the capabilities of their parent organization to provide assistance and support and be prepared to provide recommendations. ▪ Ensure appropriate action guides and standard operating guides are developed and maintained. ▪ Develop and maintain contact lists and notification procedures. ▪ Develop lists of agency resources and update these lists at least quarterly; when these resources are paid for with federal funds, enter them into the Texas Regional Response Network (TRRN). ▪ Develop and maintain procedures for identifying, locating, committing, deploying and accounting for agency emergency support resources.
Response	▪ Assist with fulfilling intrastate and interstate mutual aid when possible. ▪ Provide situational and operational status reports in accordance with existing procedures and/or as requested by the primary agency. ▪ Support and coordinate accessibility and functional needs support services. ▪ Capture costs associated with losses from drought.

Agency / Organization Responsibilities

Some agencies provide personnel and/or equipment, while other agencies offer knowledge and expertise in working with response agencies, the vendor community, commercial organizations or associations that supply or restore services.

The following tables show stakeholder responsibilities organized by drought phase. Stakeholders are listed in alphabetical order.

Electric Reliability Council of Texas (ERCOT)

Phase	ERCOT Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Impact Assessment Committee Member
	  ▪ Planning and Coordinating Committee Member

Monitoring and Assessment	▪ Monitor and evaluate risk to electric generator availability in ERCOT due to drought effects on cooling water rights and supply. ▪ Keep the ERCOT Board informed of water supply issues. ▪ Communicate with at-risk generators regarding mitigation measures and contingency plans if drought affects their cooling water requirements. ▪ Provide timely information to the PUC and TCEQ regarding electric generator cooling water needs and risks to reliability of the ERCOT system if drought affects those needs.
Response and Recovery	▪ If the reliability of the ERCOT system is at risk, support necessary mitigation measures, including regulatory variances as appropriate. ▪ Implement existing emergency operation plans if needed to maintain reliability of the ERCOT system.

Health and Human Services Commission (HHSC)

Phase	HHSC Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Planning and Coordinating Committee Member
	  ▪ Coordinating member

Monitoring and Assessment	Serve as primary agency to coordinate Food and Water ESF 11 activities.

Office of the Governor - Department of Economic Development and Tourism (EDT)

Phase	EDT Responsibilities
All	▪ Drought Preparedness Council ▪ Impact Assessment Committee Member

Phase	EDT Responsibilities
	▪ Planning and Coordinating Committee Member
Monitoring and Assessment	▪ Report, in collaboration with the local economic development organizations, on drought impacts to the state's economic growth and tourism industries. ▪ Monitor the aggregate influence that drought conditions have on the ability to attract new and expanding businesses to the state. ▪ Assess the influence that drought conditions have on the creation of new jobs and capital investment being made in the state.

Office of the State Climatologist (OSC)

Phase	OSC Responsibilities
All	▪ Drought Preparedness Council ▪ Monitoring and Water Supply Committee Member ▪ Planning and Coordinating Committee Member ▪ Technical Assistance and Technology Committee Member
Monitoring and Assessment	▪ Provide and interpret drought forecasts and long-term outlooks. ▪ Coordinate statewide input to the US Drought Monitor. ▪ Provide current information to the public on drought conditions, drought prediction, and climate variability. ▪ Provide forecasting and real time information surrounding current or emerging drought conditions using a Texas- specific modified and blended Standard Precipitation Index (SPI) and other monitoring products. ▪ Provide county- level interpretation of US Drought Monitor Map and United States Seasonal Drought Outlook Map. ▪ Analyze and interpret short and long term meteorological and climate data.
Response and Recovery	Develop drought severity level designations for every county in Texas according to the "D" levels of the US Drought Monitor.

Public Utility Commission (PUC)

Phase	PUC Responsibilities
All	▪ Drought Preparedness Council ▪ Impact Assessment Committee Member ▪ Planning and Coordinating Committee Member

Texas A&M AgriLife Extension Service (AgriLife)

Phase	AgriLife Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Impact Assessment Committee Member
	  ▪ Planning and Coordinating Committee Member

Monitoring and Assessment	▪ Monitor and report on emerging agricultural drought conditions affecting the state's agricultural industry according to the Agricultural Assessment Index. ▪ Identify if agricultural drought conditions will persist or intensify. ▪ Meet with USDA and other entities to share drought information and identify trends. ▪ Share information with farmers and ranchers.
Response and Recovery	▪ Activate and maintain the statewide Drought Joint Information Center (JIC). ▪ Coordinate and monitor USDA Secretarial drought disaster declarations. ▪ Track and tabulate statewide agricultural losses. ▪ Communications personnel network with local media and manage educational programs to disseminate information to local communities. ▪ Distribute water conservation resource materials and demonstration capabilities in the areas of household consumption, landscape maintenance and for livestock (municipal, industrial and agricultural) uses. ▪ Use groundwater well expertise to assist in emergency efforts to develop alternative water resources. ▪ Maintain website with drought activity and farmer and rancher assistance information.

Texas A&M Forest Service (TFS)

Phase	TFS Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Impact Assessment Committee Member
	  ▪ Planning and Coordinating Committee Member

Monitoring and Assessment	▪ Interpret fire forecasting and assess wildfire risk for the state on both a long and short term basis. ▪ Monitor and report on tree health conditions. ▪ Update and maintain a map of statewide burn bans currently in effect.
Response and Recovery	▪ Provide continual updates on burn bans and active wildfires that may affect stressed water supplies. ▪ Report on real-time fire forecasting models. ▪ Provide tree removal and tree health assessments.

Texas Alliance of Groundwater District (TAGD)

Phase	TAGD Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Impact Assessment Committee Member
	  ▪ Planning and Coordinating Committee Member

Monitoring and Assessment	▪ Coordinate with groundwater districts to share information and develop groundwater management plans. ▪ Compile reports on groundwater conditions.
Response and Recovery	▪ Contact the local groundwater conservation district of affected jurisdictions and coordinate efforts with that district to ensure response activities work within the districts rules and regulations. ▪ Report on the drought contingency plan activations of each affected district.

Texas Commission of Environmental Quality (TCEQ)

Phase	TCEQ Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Emergency Drinking Water Task Force Member
	  ▪ Impact Assessment Committee Chair
	  ▪ Monitoring and Water Supply Committee Member
	  ▪ Planning and Coordinating Committee Member
	  ▪ Technical Assistance and Technology Committee Member

Monitoring and Assessment	▪ Maintain a database of public water suppliers including water source, service area, population, system capacity and water quantity and water quality measures. ▪ Maintain a watch list of community water systems that have implemented voluntary or mandatory water use restrictions. ▪ Help public water systems prepare required Drought Contingency Plans. ▪ Assist major surface water users' preparation of required Water Conservation Plans. ▪ Use the Water Availability Models (WAM) for Texas river basins to protect existing water rights and environmental flow standards as well as provide information for applicants for new or amended water rights. WAMs include information on water rights, water uses, and naturalized stream flows. The models account for all water rights that use state surface water in each river basin and are based on the priority doctrine.
Response and Recovery	▪ Update and report on the High Priority list (a list maintained by TCEQ to track water systems that have self-identified as potentially having 180 days or less of potable water available) and Watch List (a list maintained by TCEQ to track water systems suffering from drought conditions, but still maintaining greater than 180 days of potable water available) for affected water systems. ▪ Administer an expedited review of proposed system upgrades and

Phase	TCEQ Responsibilities
	alternative water supplies for drought-impacted public water systems. ▪ Assist with identifying water supply alternatives and potential system interconnections. ▪ Provide financial, managerial and technical (FMT) assistance for public water and wastewater systems in exploring alternative sources of water for non-potable uses (reuse), consolidation practices and other options. ▪ Administer an expedited review of drought-related water rights applications. ▪ Respond to consumer calls regarding water outages and drought-related problems. ▪ Monitor water quality parameters for drought related degradation. ▪ Coordinate drought outreach workshops for public water systems. ▪ Meet weekly to share agency information and report on agency activities. ▪ Facilitate the Emergency Drinking Water Taskforce (see Emergency Drinking Water Contingency Attachment (1).

Texas Department of Agriculture (TDA)

Phase	TDA Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Emergency Drinking Water Task Force Member
	  ▪ Impact Assessment Committee Member
	  ▪ Planning and Coordinating Committee Member

Monitoring and Assessment	▪ Provide updates on current drought impacts to the agricultural industry. ▪ Keep the agricultural industry and public informed of the latest drought information and any assistance available through press releases, the TDA web site, and the Disaster Resource Information Packet (DRIP). ▪ Coordinate and plan for the acquisition of hay resources. ▪ Conduct educational drought and water efficiency programs.
Response and Recovery	▪ Coordinate with the Emergency Drinking Water Task Force ▪ Liaise with federal agencies and other partners to provide support for ranchers and farmers. ▪ Maintain the hay hotline and hay waiver information ▪ Maintain TDA website with current federal farmer and rancher assistance information. ▪ Administer Community Development Block Grant (CDBG) funds for cities and counties named in a state or federal disaster declaration to obtain or fortify existing sources of potable water (Emergency Drinking Water Contingency Attachment (1).

Texas Department of Housing and Community Affairs (TDHCA)

Phase	TDHCA Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Impact Assessment Committee Member
	  ▪ Planning and Coordinating Committee Member

Monitoring and Assessment	Monitor and evaluate drought impacts on housing needs and rural areas across the state.

Texas Department of Public Safety (TxDPS) - Texas Division of Emergency Management (TDEM)

Phase	TDEM Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Emergency Drinking Water Task Force Chair
	  ▪ Impact Assessment Committee Member
	  ▪ Planning and Coordinating Committee Chair
	  ▪ Technical Assistance and Technology Committee Member

Monitoring and Assessment	▪ Facilitate monthly DPC meetings for information sharing amongst agencies. ▪ Publish monthly Situation Reports from the DPC on TDEM's website as a mechanism to supply timely and accurate assessments of drought impacts to state, local and federal partners and the whole community. ▪ Publish a Biennial Report to the State Legislature, due January 15th of every odd numbered year, relaying DPC activities and accomplishments. ▪ Provide outreach to local jurisdictions to share drought information via workshops, seminars and conferences. ▪ Network with local, state, federal and private partners to promulgate drought information sharing. ▪ Provide training and exercises as part of the state preparedness program focusing on the preparing of emergency management coordinators to respond to drought disasters. ▪ Coordinate with federal agencies as well as local and regional partners to develop drought planning and decision aids. ▪ Develop, maintain and distribute this annex.
Response and Recovery	▪ Coordinate short-term, immediate responses to potential public water supply emergencies through the various emergency support functions as identified in the State Emergency Management Plan. ▪ Coordinate emergency drinking water response actions in locating alternate sources of water as outlined in the Emergency Drinking Water Contingency Attachment (1) to this plan. ▪ Meet with local jurisdictions experiencing a potential water shortage emergency. ▪ Ensure federal agencies are kept current of the response situation. ▪ Organize public information, public outreach and drought education

Phase	TDEM Responsibilities
	incorporating the whole of community. ▪ Participates in Joint Information Center (JIC) and Joint Information System (JIS) activities. ▪ Encourage all state entities to promote voluntary water conservation ▪ Coordinate with the Public Utilities Commission (PUC) and the Electric Reliability Council of Texas (ERCOT) to identify power susceptibilities due to water shortages. ▪ Notify and engage private sector partners of current drought conditions and assess drought impacts on critical infrastructure and key resources to develop strategic response planning. ▪ Compile categories of drought related costs for the State ▪ Administer governor declared Drought Disaster Proclamation Recommendations.

Texas Department of State Health Services (DSHS)

Phase	DSHS Responsibilities
All	▪ Drought Preparedness Council ▪ Impact Assessment Committee Member ▪ Planning and Coordinating Committee Member
Monitoring and Assessment	▪ Formulate recommendations on water requirements for human consumption and general sanitation. ▪ Conduct surveillance for human health impacts from drought. ▪ Develop health risk reduction messages for distribution to the public.
Response and Recovery	▪ Collaborate with TCEQ on water quality issues upon request. ▪ Monitor the operational status of health care facilities in impacted areas.

Texas Department of Transportation (TxDOT)

Phase	TxDOT Responsibilities
All	▪ Drought Preparedness Council ▪ Impact Assessment Committee Member ▪ Planning and Coordinating Committee Member
Monitoring and Assessment	▪ Conduct environmental impact analysis for transportation projects. ▪ Conduct erosion control activities for roadways and special projects. ▪ Monitor and reports on road conditions and projects due to drought conditions.
Response and Recovery	▪ Repair and maintain state highways and infrastructure damaged by drought conditions. ▪ Administer the mowing and bailing of hay on the right-of-way to

Phase	TxDOT Responsibilities
	support agriculture. ▪ Issue permits and waivers for overweight vehicles involved in responding to drought-related emergency situations. ▪ Issue emergency and regular utility permits and approve temporary waivers for above ground water lines as appropriate. ▪ Assist in finding methods for transporting and distributing water during periods of emergency (See Emergency Drinking Water Contingency Annex (A)). ▪ Provide support to maintain recovery activities for drought-related emergencies. ▪ Capture costs associated with losses from drought. ▪ Cease all non-emergency roadway maintenance operations requiring large quantities of water.

Texas Military Forces (TXMF)

Phase	TXMF Responsibilities
All	▪ Drought Preparedness Council ▪ Planning and Coordinating Committee Member ▪ Coordinating Member
Response and Recovery	Provide bulk water transportation and bulk water purification capability estimates to the state in response operations addressing water shortages in accordance with ESF 6 Mass Care.

Texas Parks and Wildlife Department (TPWD)

Phase	TPWD Responsibilities
All	▪ Drought Preparedness Council ▪ Impact Assessment Committee Member ▪ Planning and Coordinating Committee Member ▪ Technical Assistance and Technology Committee Member
Monitoring and Assessment	▪ Conduct routine freshwater and coastal habitat assessments to determine the status of commercially, recreationally, and ecologically important species; determine the success of on-going management strategies and develop new strategies. ▪ Investigate fish kills, pollution, and harmful algal blooms in well-coordinated efforts with other appropriate state and federal agencies. ▪ Monitor the condition of habitat and key wildlife species throughout the state. ▪ Provide guidance and information to landowners and the general public on best management tools to cope with drought conditions and impacts on wildlife.

Phase	TPWD Responsibilities
Response and Recovery	▪ Provide access via state parks and other department holdings to sources of water to meet the water demands of municipalities and other water users. ▪ Provide information via website and media releases on the effects of drought on fish and wildlife resources and outdoor recreational opportunities, tips on how to help wildlife during drought, the status of harmful algal blooms, and fishery-related health advisories and closures. ▪ Work with other agencies and academics in rescue and recovery efforts to provide refuge for species of concern that are threatened by conditions resulting from extreme drought, such as insufficient stream flow and loss of habitat. ▪ Develop plans for reintroduction of species once conditions become more favorable. ▪ Restocks sport fisheries as determined from results of fishery surveys. ▪ Provide access to water in state parks for use in fire control.

Texas River Authorities

Phase	Texas River Authorities Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Planning and Coordinating Committee Member
	  ▪ Coordinating Member

Texas State Soil and Water Conservation Board (TSSWCB)

Phase	TSSWCB Responsibilities

All	▪ Drought Preparedness Council
	  ▪ Impact Assessment Committee Member
	  ▪ Planning and Coordinating Committee Member

Monitoring and Assessment	▪ Work with landowners, farmers, and ranchers to develop resource management plans that include water conservation and drought mitigation practices. ▪ Implement practices to increase irrigation efficiency through water quality and conservation programs.
Response and Recovery	Administer the Texas Water Supply Enhancement Program, through local soil and water conservation districts, to enhance state water resources.

Texas Water Development Board (TWDB)

Phase	TWDB Responsibilities
All	▪ Drought Preparedness Council ▪ Emergency Drinking Water Task Force Member ▪ Impact Assessment Committee Member ▪ Monitoring and Water Supply Committee Chair ▪ Planning and Coordinating Committee Member ▪ Technical Assistance and Technology Committee C
Monitoring and Assessment	▪ Publish current reservoir storage observations, drought indices information and forecasts available at: http://waterdatafortexas.org/reservoirs/statewide. ▪ Monitor and interpret hydrologic conditions, major water storage reservoirs and aquifers in the state using six indices ▪ Publish the monthly Texas Water Conditions Report available at: http://www.twdb.state.tx.us/surfacewater/conditions/report/index.asp
Response and Recovery	▪ Provide financial and technical assistance to water suppliers. ▪ Assist with providing technical assistance to water utilities and water authorities. ▪ Provide loans and loan forgiveness to local entities for water supply projects, water quality projects, flood control projects, agricultural water conservation projects, and groundwater districts. ▪ Assist in identifying alternative sources, transportation, and distribution of water. ▪ Assist in conducting a needs assessment, determining appropriate methods for financing emergency drinking water operations, and researching and evaluating innovative water technologies. ▪ Provide financial assistance to plan, provide and conserve water resources through grants and loans for regional planning, water supply projects and agricultural water conservation programs.

Texas Voluntary Organizations Active in Disasters (VOAD)

Phase	VOAD Responsibilities
All	▪ Drought Preparedness Council ▪ Planning and Coordinating Committee Member ▪ Coordinating Member

Authority

Strategic planning guidance and authorities governing the enactment and implementation of this annex are summarized below.

The following table presents specific sources, their relevance to this document, and hyperlinks to their online location.

Source	Relevance	Link
Texas Government Code Chapter 418.042	Describes provisions to be kept current by TDEM in the comprehensive state emergency management plan.	http://www.statutes.legis.state.tx.us/Docs/GV/htm/GV.418.htm#418.050
Texas Water Code Title 2. Water Administration Subtitle C. Water development	Directs TDEM, through the State Drought Manager, and the drought preparedness council to develop and implement a comprehensive state drought preparedness plan for mitigating the effects of drought in the state and periodically update the plan. The plan is to be separate from the State Water Plan.	http://www.statutes.legis.state.tx.us/Docs/WA/htm/WA.16.htm
House Bill 2660	Establishes the State Drought Preparedness Council, designates the state agencies that serve on the council, names the chief of TDEM as the state drought manager and outlines the overall responsibilities of the council.	http://www.legis.state.tx.us/tlodocs/76R/analysis/html/HB02660E.htm
SB 662	Identifies the members of the Drought Preparedness Council.	http://www.legis.state.tx.us/tlodocs/83R/analysis/html/SB00662I.HTM

Maintenance and Change

This section describes the process by which this document is maintained and updated.

Development

Section 418 of the Texas Government Code defines TDEM as the responsible agent for emergency planning and coordination in the state of Texas. As such TDEM is responsible for ensuring the appropriate development and distribution of this document and any changes thereto. In addition each Emergency Management Council agency is responsible for the development and maintenance of appropriate planning documents to address responsibilities assigned in this plan including standard operating guidelines.

Maintenance

TDEM authorizes and issues changes to this document until such time as it is superseded. This document and all attachments are living documents. Council member representatives are responsible for participating in plan reviews and are required to provide information concerning capability changes that impact their emergency management responsibilities.

TDEM coordinates the plan updating process and maintains the plan after receiving feedback and updates from partner agencies. According to Texas Government Code section 418.188 *Post Disaster Evaluation* state agencies, political subdivisions and interjurisdictional agencies are required to conduct an evaluation of their response to a disaster, identify areas of improvement, and issue a report of the evaluation to TDEM no later than 90 days after TDEM makes the request. That report may be translated into plan updates.

Training, Exercise and After Action Reports

The State of Texas Emergency Management Plan is exercised annually to provide practical, controlled and operational experience to those who have responsibilities. This requirement is applicable to the State Operations Center and each disaster district emergency operations center. Following the conclusion of any significant emergency, incident or exercise, lead agency representatives will conduct an after action report (AAR) of the group's activities during that emergency, incident or exercise. Support agencies will provide written or oral input and the lead agency representative will consolidate all inputs into a final written AAR.

Record Keeping

Lead and support agencies must ensure all records necessary for emergency management operations are obtainable, and that duplicate records are held at alternate locations.

Record of Changes

This section describes changes made to this document: when they were made, what they were, and who authorized them.

Use this table to record the following information:

- Change number, in sequence, beginning with 1
- Date change was made to the document
- Description of change and rationale if applicable
- Initials of person who made the change

Number	Date	Description	Initials

Contributors

This section provides a list of organizations and individuals who contributed to the development of this document.

This annex could not have been developed without the participation and collaboration of representatives from multiple organizations.

Agency	Name
American Red Cross	Liza Carol Chigos
Electric Reliability Council of Texas	Kent Saathoff
Federal Emergency Management Agency- Region 6	Wes Ireland
	David Pointon
Lower Colorado River Authority	Bob Rose
	Susana Thorne
National Weather Service	Barry Goldsmith
	Victor Murphy
Office of the State Climatologist	David Coates
	Brent McRoberts
	John Neilson-Gammon
Office of the Governor- Economic Development	Tad Curtis
Public Utility Commission	Regina Erales
Sandia National Laboratory	Mike Hightower
State Administrative Agency	Mike George
	Machelle Pharr
Texas A&M AgriLife Extension Service	Travis Miller
	Andy Vestal
Texas A&M Forest Service	Mike Dunivan
	Bob Koenig

Agency	Name
Texas Alliance of Groundwater Districts	Lori Mayfield
	David Van Dressar
Texas Commission on Environmental Quality	Linda Brookins
	Kelly Cook
	Derek Eades
	Alexander Hinz
	Elston Johnson
	Dale Kohler
	Christopher Loft
	Scott Swanson
Texas Department of Agriculture	Tom Entsminger
	Liz Serca
	Lance Williams
Texas Department of Public Safety - Texas Division of Emergency Management	Mike Bewley
	Mario Chapa
	Kiran Dhanji
	Valerie Erharhdt
	Jerry Huffman
	Jonathan King
	Dave Marquez
	Mike Miller
	Christopher Moore
	Patrick Mulligan
	Colleen O'Neal

Agency	Name
	John O'Valle
	Wade Parks
	Tony Pena
	Marty Penney
	Fernando Perez
	Chuck Phinney
	Tom Polonis
	Becky Pursur
	Ray Resendez
	Larry Shine
	Eric Shuey
	David Solis
	Dude Speed
	Gabriela Stermolle
	Miles Tollison
	Bill Wahlgren
Texas Department of State Health Services	Priscilla Boston
	Suzanne Burnham
	Shannon Smalls
Texas Department of Transportation	Gilbert Jordan
	Jeannie Lecklider
Texas Military Forces	Ruben Alonzo
	Tory House
Texas State Soil and Water Conservation Board	Richard Egg
Texas Parks and Wildlife Department	David Bradsby

Agency	Name
	Cindy Loeffler
Texas Water Development Board	Jorge Arroyo
	Brenner Brown
	Robert Mace
	Ruben Solis
	Yujuin Yang
The Salvation Army	Nancy Bass
United States Army Corps of Engineers	Paul Rodman
	Travis Stanford
United States Bureau of Reclamation	Jeffrey Gerber
United States Department of Agriculture	Susan Baggett
United States Geological Survey	Lynn Fahlquist
University of Texas at Austin	David Maidment
	Bridget Scanlon
	Gordon Wells

References

This section provides a full list of the sources and references cited throughout this document.

Climate Prediction Center Internet Team. *National Weather Service: Climate Prediction Center.* March 25, 2014. http://www.cpc.ncep.noaa.gov/.

Fannin, Blair. "Texas Agricultural Drought Losses Reach Record $5.2 Billion." *Texas A&M University, AgriLife Today*, 2011.

FEMA. "Section 401." *Robert T. Stafford Disaster Relief Emergency Asistance Act, as amended, and Related Authorities.* June 2007. http://www.fema.gov/pdf/about/stafford_act.pdf.

Hightower, Mike. "Energy and Water Are... Inextricably linked." In *Energy and Water: Energy-Water Science & Technology Research Roadmap*. Sandia National Laboratories, 2006.

King, Carey, Ian Duncan, and Michael Webber. *Water Demand Projections for Power Generation in Texas.* Ph.D. diss., University of Texas at Austin, 2008.

Reedy, Robert, and Bridget Scanlon. *Energy Reliability Related to Water Availability under Climate Extremes in Texas.* Ph.D. diss., University of Texas at Austin, n.d.

Stillwell, Ashlynn S., Carey W. King, Michael E. Webber, Ian J. Duncan, and Amy Harberger. "Energy-Water Nexus in Texas." *University of Texas at Austin*, April 2009.

Texas A&M AgriLife Extension. *Texas Extension Disaster Education Network (EDEN).* 2014. http://texashelp.tamu.edu/.

Texas Division of Emergency Management. *State Drought Preparedness Council.* 2013. http://www.txdps.state.tx.us/dem/CouncilsCommittees/droughtCouncil/stateDroughtPrepCouncil.htm.

Texas Water Development Board. "Water Data for Texas." *Texas Reservoirs.* 04 2014. http://www.waterdatafortexas.org/reservoirs/statewide.

U.S. Department of Agriculture. "Disaster and Drought Information." *USDA Emergency Preparedness and Response.* April 2014. http://www.usda.gov/wps/portal/usda/usdahome?navid=DISASTER_ASSISTANCE.

—. "Disaster Designnation Process; Final Rule." *77 Federal Register 135.* July 13, 2012. http://www.gpo.gov/fdsys/pkg/FR-2012-07-13/html/2012-17137.htm.

U.S. Department of Energy . *Today in Energy.* August 28, 2012. http://www.eia.gov/todayinenergy/detail.cfm?id=7730.

University of Nebraska-Lincoln: The National Drought Mitigation Center. *Types of Drought.* 2014. http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx.

For More Information

For more information on this annex contact Gabriela Stermolle, Planner, at Gabriela.Stermolle@dps.texas.gov.

Please direct general questions to Kiran Dhanji, Preparedness Section Administrator, at Kiran.Dhanji@dps.texas.gov.

www.tsdps.state.tx.us/dem/preparedness/plansunit.htm

Produced by the Texas Division of Emergency Management
Preparedness Section, Plans Team
www.txdps.state.tx.us/dem

7 Drought Management

Droughts are of great importance to the planning and management of water resources in Texas. Although droughts can occur in all climatic zones, they have the greatest potential to become environmental disasters in dry or arid regions such as Texas. It is not uncommon for mild droughts to occur over short periods of time in Texas; however, there is no concrete way to predict how long or severe a drought will be while it is occurring. The only defense available to drought prone Water User Groups (WUGs), such as those in Region L, is proper planning and preparation for worst case scenarios. This requires understanding of drought patterns and the historical droughts in the region.

Due to significant population growth throughout Texas, which is expected to continue in the Region L area based on TWDB projections, the demand for water has increased. With growing demand and the threat of climate change contributing to water scarcity, planning is even more important to prevent shortages, deterioration of water quality and lifestyle/financial impacts on water suppliers and users. This chapter presents information on Region L's drought preparedness including; regional droughts of record, current model drought contingency plans, emergency interconnects, and responses to local drought conditions.

7.1 Droughts of Record in the RWPA

7.1.1 Background

One of the best tools in drought preparedness is a thorough understanding of the drought of record (DOR), or the worst drought to occur for a particular area during the available period of record. However, there are many ways that the "worst drought" can be defined (degree of dryness, agricultural impacts, socioeconomic impacts, effects of precipitation, etc.). Regional water planning focuses on hydrological drought which is typically the types of drought associated with the largest shortfalls in surface and/or subsurface water supply. The frequency and severity of hydrological drought is often defined on a watershed or river basin scale, although it could be different from one area to the next, even within a planning region.

7.1.2 Current Drought of Record

In terms of severity and duration, the devastating drought of the 1950s is considered the drought of record for most of the state including the Region L planning area. By 1956, 244 of the 254 counties were considered disaster areas. This drought lasted almost a decade in many places and not only affected Texas, but other states throughout the nation as well. The 1950's drought has been used by water resource engineers and managers as a benchmark drought for water supply planning since the regional water planning process was implemented. Two recent droughts centered around 2008 and 2011 have been discussed but not widely accepted as potential new droughts of record for parts of the state.

For the Guadalupe-San Antonio River Basin within Region L, the drought of the 1950s remains the drought of record. In the upper portions of the river basin, the 1950's drought generally started in summer of 1947 and continued into early 1957. In the lower basin area near the Gulf Coast, the drought generally was a 3-year period between 1954 and 1956.

Until recently the 1950s drought was the drought of record for the Nueces River Basin as well. However, the 1990s drought was severe and prolonged enough that many believe it should be considered the new drought of record.

7.1.3 Drought Indicators

Water Availability Modeling

Engineers and planners often use surface water models to demonstrate the effects of historical droughts on water supply. Surface water effects are more readily observed than groundwater and reservoir supplies that were not built before historic droughts can be assessed using historic hydrology. The primary tool used to observe the performance of Region L reservoirs under historic drought conditions is TCEQ's Guadalupe-San Antonio River Basin Water Availability Model (GSA WAM). The GSA WAM is the same tool used to determine the available flow and firm yields of surface water projects in the RWP.

The GSA WAM model includes hydrologic information from 1934 through 1989 and supports the use of the 1950's drought as the drought of record for all Region L reservoirs. However, it has not been updated to include information from more recent periods of drought.

Drought Indices

Several Drought Indices have been developed to assess the effect of a drought through parameters such as severity, duration and spatial extent. The Palmer Drought Severity Index (PDSI) was one of the first comprehensive efforts using precipitation and temperature for estimating the moisture of a region. PDSI values greater than 0.49 correspond to wetter than normal conditions and values from -0.5 to 6 represent varying degrees of drought. Information is available for climate regions across the country through 2014, which makes the PDSI a helpful tool for analyzing droughts, not included in the GSA WAM.

Most of Region L lies in Texas Climate Divisions 7 and 9. A graph of yearly PDSI values for Texas Climate Division 7 and 9 show that while the 1908 and more recent drought in the early 21st century were severe, the drought of the 1950's was the most intense over a longer period of time, supporting the continued use of this drought as the drought of record for Region L (Figure 7.1-1).

Figure 7.1-1 Parmer Drought Severity Index: Division 7

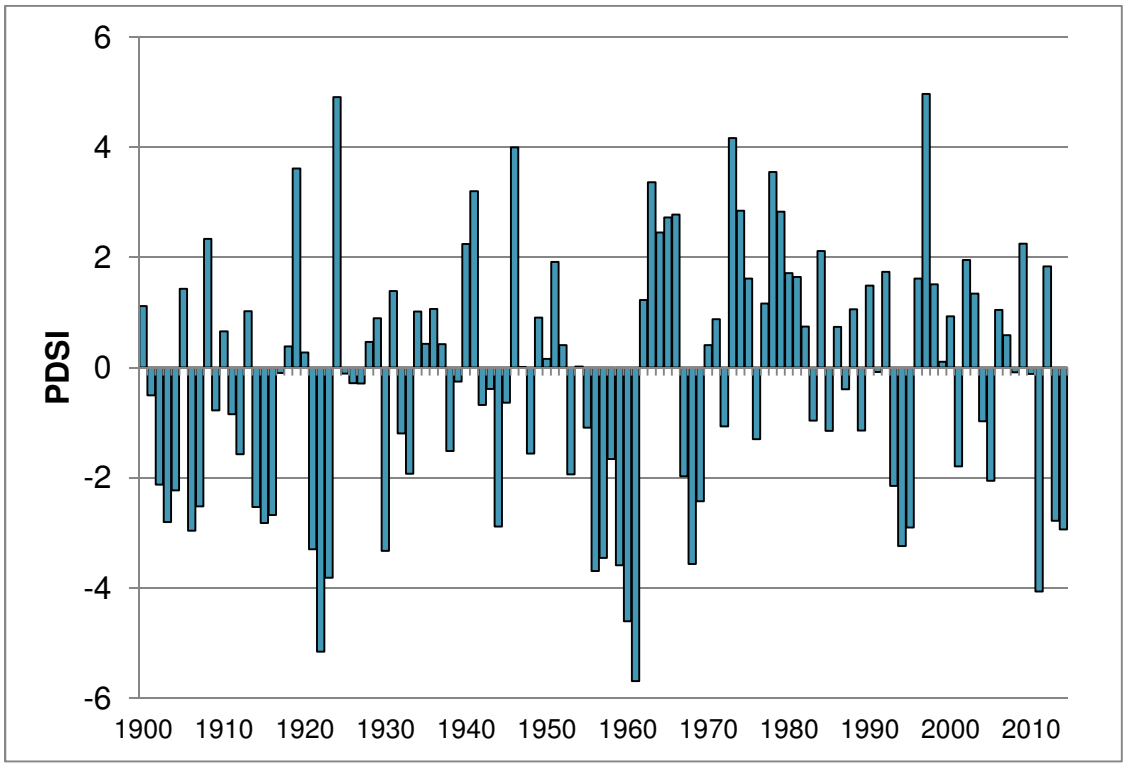
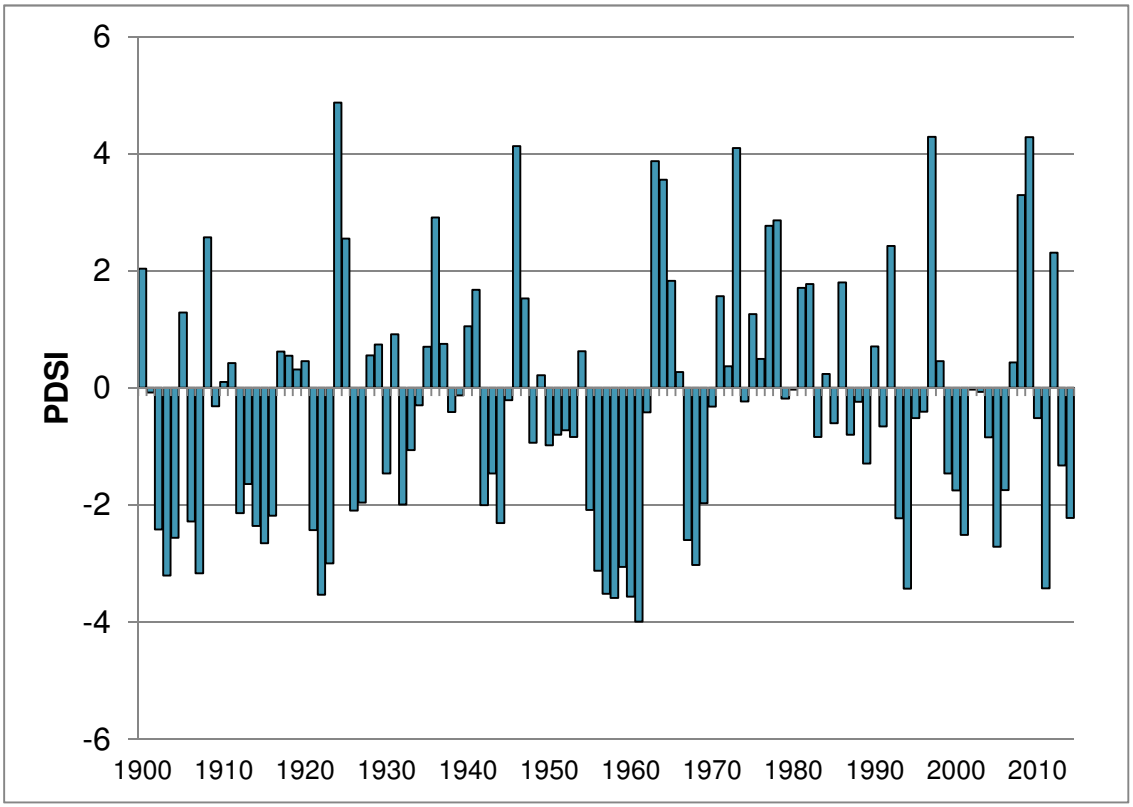


Figure 7.1-2 Parmer Drought Severity Index: Division 9



7.1.4 Recent Drought Discussion

Throughout the 2011 water year, a severe drought occurred from decreased precipitation resulting in substantial declines in streamflow throughout the state. Record high temperatures also occurred June through August leading to an increase in evaporation rates. The net evaporation was so high that by August 4, 2011, state climatologist John Nielson-Gammon declared 2011 to be the worst 1-year drought on record in Texas[1]. The 2011 water year statewide annual precipitation was 11.27 inches, more than 2 inches below the previous record in 1956 of 13.91 inches. While the 2011 water year drought was severe and can provide helpful information to water planners and managers throughout the state, the duration of the 1950's drought combined with the over all severity for almost a decade in region L suggests that it is still the best choice as the DOR for regional planning purposes.

7.2 Current Drought Preparations and Response

7.2.1 Current Drought Preparations and Responses

WUG Level Planning

All WUGs in Region L prepare for drought by participating in the regional planning process. The regional planning process attempts to meet projected water demands during a drought of severity equivalent to the drought of record. WUGs that provide accurate information to TWDB and consider recommendations accepted by the regional planning group should be able to supply water to customers throughout drought periods. In addition, all wholesale water providers and most municipalities develop individual drought contingency plans or emergency action plans to be implemented at various stages of a drought.

Basin Responses

Throughout Texas including the Guadalupe-San Antonio River Basin, water rights are issued under the prior appropriation system. During times of shortage, curtailment of water rights has become necessary in recent droughts. The South Texas Watermaster Program is responsible for managing surface water rights in an area in south central Texas based on "run of the river" rights. The program has jurisdiction over the Guadalupe-San-Antonio and Nueces River Basins, as well as the Lavaca River Basin. Five watermaster deputies will patrol the 50 counties in the jurisdictional area and enforce compliance with water rights.

7.2.2 Overall Assessment of Local Drought Contingency Plans

While you can not perfectly predict the timing, severity and length of a drought, you can safely assume that it is an inevitable component of the Texas climate. For this reason, it is critical to plan for these occurrences with policy outlining adjustments to use,

[1] Winters, K.E., 2013, A historical perspective on precipitation, drought severity, and streamflow in Texas during 1951–56 and 2011: U.S. Geological Survey Scientific Investigations Report 2013–5113, p.1 http://pubs.usgs.gov/sir/2013/5113

allocation, and conservation in response to drought conditions. Drought and other circumstances that interrupt the reliable supply or water quality of a source often lead to water shortages. When a water shortages occurs there is generally a greater demand on the already decreased supply as individuals attempt to keep lawns green etc. If this behavior is unaddressed there can be an increase in the rate of water supply depletion.

TCEQ requires all wholesale public water suppliers, retail public water suppliers serving 3,300 connections or more, and irrigation districts to submit drought contingency plans (DCPs). In accordance with the requirements of Texas Administrative Code §288(b), DCPs must be updated every 5 years and adopted by retail public water providers. The TCEQ defines a DCP as "A strategy or combination of strategies for temporary supply and demand management responses to temporary and potentially recurring water supply shortages and other water supply emergencies."[2] According to a TCEQ handbook[3] the underlying philosophy of drought contingency planning is that:

- While often unpreventable, short-term water shortages and other water supply emergencies can be anticipated,
- The potential risks and impacts of drought or other emergency conditions can be considered and evaluated in advance of an actual event; and, most importantly,
- Response measures and best management practices can be determined with implementation procedures defined, again in advance, to avoid, minimize, or mitigate the risks and impacts of drought-related shortages and other emergencies.

Model Drought Contingency plans are available on TCEQ's website; however, it is not possible to create a model DCP that will adequately address local concerns throughout the State of Texas. The conditions that define a water shortage can be very location specific because most communities in Region L rely primarily on local water supplies. For example, some communities rely on reservoirs that are regularly operated at full conditions; in this case a shortage could exist when the supplies are at 75 percent. Other reservoirs may rarely refill and be considered a concern at 25 percent capacity. Similarly, unique aquifer systems are considered at risk under location specific conditions. While the approach to planning may be different between entities all DCP's should include:

- Specific, quantified targets for water use reductions,
- Drought response stages,
- Triggers to begin and end each stage,
- Supply management measures,
- Demand management measures,
- Descriptions of drought indicators,
- Notification procedures,
- Enforcement procedures,
- Procedures for granting exceptions,

[2] http://www.twdb.texas.gov/conservation/training/archives/more-than-a-drop-workshop/doc/5_%20TCEQ%20Rules.pdf
[3] https://www.tceq.texas.gov/assets/public/comm_exec/pubs/archive/rg424.pdf

- Public input to the plan,
- Ongoing public education,
- Adoption of plan, and
- Coordination with regional water planning group.

For water suppliers such as those in Region L, the primary goal of DCP development is to have a plan that can ensure an uninterrupted supply of water in an amount that can satisfy essential human needs. A secondary but also important goal is to minimize negative impacts on quality of life, the economy and the local environment. In order to meet these goals, action needs to be taken quickly which is why an approved DCP needs to be in place before drought conditions occur.

In accordance with Texas Administrative Code (*Title 30 §288*), most Region L entities have submitted DCPs to TCEQ for implementation when local shortages occur. Region L was able to obtain DCPs for 17 WUGs and WWPs. These plans identify multiple triggers for initiation and termination of drought stages, responses to be implemented and reduction targets based on each stage. The plans also include information regarding public notification procedures and enforcement measures. Some WUGs or WWPs have included a method of granting a variance should the need arise. The most recent DCPs for each entity in Region L range in date from 2013 to 2015.

7.2.3 Summary of Existing Triggers and Responses

Through timely implementation of drought response measures, it is possible to meet the goals of the DCP by avoiding, minimizing, or mitigating risks and impacts of water shortages and drought. In order to accomplish this, DCP's are built around a collection of drought responses and triggers based on various drought stages. Stages are generally similar for all DCP's but can vary from entity to entity. Stage one will normally represent mild water shortage conditions and the severity of the situation will increase through the stages until emergency water conditions are reached and in some cases a water allocation stage is determined.

Region L compiled stage, trigger, and response information for 17 DCP's in the region including those from WWPs, WUGs and County-Other suppliers. The majority of the DCPs in the region have a Voluntary Stage I and Mandatory Stage II and III categories. Most Entities included a Stage IV, and a few entities specified a Stage V and/or Stage VI scenario. Target reductions, triggers and responses are included for most stages. Triggers and responses for Region L entities can be found in Appendix I.

7.3 Existing Interconnects

A goal of the regional planning process is to ensure a connected supply that meets or exceeds drought of record demands for the next 50 years. However, it is also important for regions to plan for emergency supplies in the event of a prolonged drought or an interruption/impairment of supply from an existing source. An interconnection between two collaborating municipal water user groups (WUGs) can serve as an alternative means of providing emergency drinking water in lieu of trucking in supply or other expensive options. In Compliance with Texas Administrative Code (TAC), Chapter 357

Regional Water Planning Guidelines, available information on existing major water infrastructure facilities that may be used for interconnections in event of an emergency shortage of water was collected.

For the Region L Water Planning Area, all municipal water user groups were sent a survey in 2013 regarding their water supply and use. As part of the survey, individual municipalities were asked to confirm or update information regarding the existence of emergency interconnects integrated with their system and the provider of the potential emergency supply. Of the 119 Municipal WUGs in Region L, 16 responded to the survey and only five reported having emergency interconnects. A second e-mail survey based on the template provided by the TWDB in the First Amended General Guidelines for Development of the 2016 RWPs was sent in 2015 to wholesale water providers and major municipal centers. Three entities returned the email survey contributing an additional seven emergency interconnects.

An interconnection study was completed by HDR for the Regional Water Alliance[4] (RWA) in 2009 that compiled information regarding existing interconnections and proposed several potential interconnections across the region. Of the 8 existing interconnects identified in this study, 5 had known pipe diameters. The TCEQ Texas Drinking Water Watch database (TCEQ database) was used as a final source of emergency interconnection information. 18 interconnects were noted from the TCEQ database bringing the total to 35 reported emergency interconnects from 4 sources. While this should not be considered a comprehensive list, it is the extent of information available at this time. Information on existing and potential interconnect supply capacity or location was not available from any source. Information on existing and potential interconnect supply source or location was not available from the surveys and reports available. In accordance with Texas Water Code §16.053(r) the information gathered is considered confidential and was submitted to the executive administrator, but not included in the regional plan.

7.4 Emergency Response to Local Drought Conditions or Loss of Municipal Supply

The regional and state water plans aim to prepare entities for worst case drought scenarios based on the drought of record as described in Chapter 7.1. However, entities may find themselves in a local drought or facing a loss of municipal supply. While rare, it is important to have a back up plan in case of infrastructure failure or water supply contamination. This is especially important for smaller entities that rely on a sole source of supply. While many entities and wholesale water providers have DCP's as described in Chapter 7.2, it is less common for small municipalities or county-other WUGs to have these emergency plans. An analysis of a broad range of emergency response options was performed for small WUGs with 2010 Census populations less than 7,500 and a sole supply source as well as for all County-Other WUGs in the Region.

A WUG relying on groundwater is considered sole source if all its supplies come from the same aquifer regardless of varying groundwater districts or combination of contractual and local development supplies. A WUG relying on surface water is considered sole

[4] HDR, "Regional Water Alliance Water System Interconnection Study", 2009.

source if their supply comes from one river intake or one reservoir, regardless of the number of contracts in place. A WUG with contract with most WWPs was not considered sole-source due to various supplies held by the WWPs. WUGs with both groundwater and surface water supplies were not included, with the exception of county-other entities.

A broad range of emergency situations could result in a loss of reliable municipal supply and it is not possible to plan one solution to meet any possible emergency, for that reason a range of possible responses were selected for each entity based on source type and location. WUGs were analyzed for potential additional fresh water and brackish water wells based on the existence of appropriate aquifers in the area. MAG availability was not considered since the wells are assumed temporary over the course of an emergency. WUGs with nearby surface water were analyzed for curtailment of junior water rights and for releases from upstream reservoirs. Additional yield availability was not analyzed for reservoir releases as in the case of a temporary, localized emergency, special arrangements can be made.

A nearby entity that could provide supply in the case of an isolated incident was identified for applicable WUGs and existing interconnects were noted if information was available. In addition, trucking in water was considered as a supply option under severe circumstances. Any infrastructure required for implementation of the options is also reported. A total of 72 entities were analyzed including 21 county-other WUGs. The results of this analysis are included in Table 7.4-1.

Table 7.4-1 Summary of Emergency Supply Options

Entity							Potential Emergency Water Supply Sources						Implementation Requirements		
County	WUG Name	Population (2010)	Source	Type	Population (2020)	Demand (2020)	Release From Upstream Reservoir	Curtailment of Junior Water Rights	Local Groundwater Well	Brackish Groundwater Well	Truck in Water	Supply from Nearby Entity	Known Existing Interconnect	Potential Entity Providing Supply	Type of Infrastructure Required
ATASCOSA	ATASCOSA COUNTY-OTHER		Various GW	GW	7,177	922		x	x		x	x		Benton City	Wells, Pipes
ATASCOSA	CHARLOTTE	1715	Carrizo-Wilcox Aquifer	GW	2,008	344			x		x	x		Benton City	Wells, Pipes
ATASCOSA	JOURDANTON	3871	Carrizo-Wilcox Aquifer	GW	4,532	959			x		x	x		Benton City	Wells, Pipes
ATASCOSA	LYTLE	2492	Edwards Aquifer	GW	2,985	577					x	x		SAWS	Pipes
ATASCOSA	MCCOY WSC	6645	Carrizo-Wilcox Aquifer	GW	7,679	952			x		x	x		Pleasanton	Wells, Pipes
ATASCOSA	POTEET	3260	Carrizo-Wilcox Aquifer	GW	3,817	472			x		x	x		Benton City	Wells, Pipes
BEXAR	ALAMO HEIGHTS	7031	Edwards Aquifer	GW	8,095	2,216					x	x		SAWS	Pipes
BEXAR	BEXAR COUNTY-OTHER		Blend	Blend	28,013	5,239		x	x		x	x		SAWS	Wells, Pipes
BEXAR	SHAVANO PARK	3035	Edwards Aquifer	GW	3,494	1,104					x	x	SAWS		
BEXAR	WATER SERVICES INC	2838	Trinity Aquifer	GW	4,629	746			x		x	x		SAWS	Wells, Pipes
BEXAR	WINDCREST	5364	Edwards Aquifer	GW	5,573	1,203					x	x		SAWS	Pipes
CALDWELL	CALDWELL COUNTY-OTHER		Blend	Blend	6,089	725		x	x		x	x		Lockhart/Luling	Wells, Pipes
CALDWELL	LULING	5411	Carrizo-Wilcox Aquifer	GW	6,682	954			x		x	x		Lockhart	Wells, Pipes
CALDWELL	MUSTANG RIDGE	861	Purchase from Creedmore-Maha	Blend	527	71			x		x	x		Buda	Wells, Pipes
CALDWELL	NIEDERWALD	565	Barton Springs Aquifer	GW	761	75			x		x	x		Buda	Wells, Pipes
CALDWELL	POLONIA WSC	5567	Carrizo-Wilcox Aquifer	GW	7,082	878			x		x	x	Lockhart		Wells, Pipes
CALHOUN	CALHOUN COUNTY WS	3209	Run-of-River (Guad - GBRA)	SW	4,401	356	x	x		x	x			GBRA	Wells,Pipes, Treatment
CALHOUN	CALHOUN COUNTY-OTHER		Gulf Coast Aquifer	GW	2,094	244			x	x	x	x		Port Lavaca	Wells,Pipes, Treatment
CALHOUN	POINT COMFORT	737	Lake Texana (LNRA)	SW	829	87		x		x	x			LNRA	Wells,Pipes, Treatment
CALHOUN	SEADRIFT	1364	Gulf Coast Aquifer	GW	1,534	256			x	x	x			GBRA	Wells,Pipes, Treatment
COMAL	COMAL COUNTY-OTHER		Blend	Blend	24,820	4,196		x	x		x	x		Canyon Lake WSC	Wells, Pipes
DEWITT	CUERO	6841	Gulf Coast Aquifer	GW	7,100	1,882	x		x		x			GBRA	Wells, Pipes
DEWITT	DEWITT COUNTY-OTHER		Gulf Coast Aquifer	GW	9,009	1,228	x		x		x			GBRA	Wells, Pipes
DEWITT	YORKTOWN	2092	Gulf Coast Aquifer	GW	2,171	383			x		x	x		Cuero	Wells, Pipes
DIMMIT	ASHERTON	1084	Carrizo-Wilcox Aquifer	GW	1,180	238			x		x	x		Carrizo Springs	Wells, Pipes
DIMMIT	BIG WELLS	697	Carrizo-Wilcox Aquifer	GW	759	121			x		x	x		Carrizo Springs	Wells, Pipes
DIMMIT	CARRIZO SPRINGS	5368	Carrizo-Wilcox Aquifer	GW	5,841	1,582	x		x		x				Wells, Pipes
DIMMIT	DIMMIT COUNTY-OTHER		Carrizo-Wilcox Aquifer	GW	3,095	426			x		x	x		Carrizo Springs	Wells, Pipes
FRIO	DILLEY	3894	Carrizo-Wilcox Aquifer	GW	4,340	1,025			x		x	x		Pearsall	Wells, Pipes
FRIO	FRIO COUNTY-OTHER		Carrizo-Wilcox Aquifer	GW	4,081	528			x		x	x		Pearsall	Wells, Pipes
GOLIAD	GOLIAD	1908	Gulf Coast Aquifer	GW	2,230	448			x		x				Wells, Pipes
GOLIAD	GOLIAD COUNTY-OTHER		Gulf Coast Aquifer	GW	6,197	758			x		x				Wells, Pipes
GONZALES	GONZALES COUNTY-OTHER		Carrizo-Wilcox Aquifer	GW	3,154	367			x		x	x		Gonzales	Wells, Pipes
GONZALES	NIXON	2385	Carrizo-Wilcox Aquifer	GW	2,620	408			x		x	x		SSLGC	Wells, Pipes
GONZALES	SMILEY	550	Carrizo-Wilcox Aquifer	GW	603	122			x		x	x		SSLGC	Wells, Pipes
GONZALES	WAELDER	1065	Queen City Aquifer	GW	1,170	201			x		x	x		Gonzales	Wells, Pipes
GUADALUPE	GUADALUPE COUNTY-OTHER		Blend	Blend	9,123	1,067		x	x		x	x		SSLGC	Wells, Pipes
HAYS	HAYS COUNTY-OTHER		Blend	Blend	16,777	2,062		x	x		x	x		San Marcos	Wells, Pipes
HAYS	MOUNTAIN CITY	648	Barton Springs Aquifer	GW	199	23					x	x		Kyle	Pipes
HAYS	PLUM CREEK WATER COMPANY	3875	Trinity Aquifer	GW	5,072	357			x		x	x		Kyle	Wells, Pipes
HAYS	WIMBERLEY	3550	Trinity Aquifer	GW	3,627	626			x		x				Wells, Pipes
HAYS	WIMBERLEY WSC	1450	Trinity Aquifer	GW	4,063	450			x		x				Wells, Pipes
HAYS	WOODCREEK	1457	Trinity Aquifer	GW	1,641	282			x		x				Wells, Pipes
KARNES	FALLS CITY	611	Carrizo-Wilcox Aquifer	GW	638	143			x		x				Wells, Pipes
KARNES	KARNES CITY	3042	Carrizo-Wilcox Aquifer	GW	3,172	595			x		x				Wells, Pipes
KARNES	KARNES COUNTY-OTHER		Various GW	GW	4,173	592		x	x		x				Wells, Pipes
KARNES	KENEDY	3296	Gulf Coast Aquifer	GW	3,437	1,352			x		x				Wells, Pipes
KARNES	RUNGE	1031	Gulf Coast Aquifer	GW	1,075	220			x		x				Wells, Pipes
KARNES	SUNKO WSC	3720	Carrizo-Wilcox Aquifer	GW	4,661	758			x		x				Wells, Pipes
KENDALL	KENDALL COUNTY-OTHER		Blend	Blend	22,092	2,696		x	x		x				Wells, Pipes
LA SALLE	COTULLA	3603	Carrizo-Wilcox Aquifer	GW	4,069	1,270			x		x				Wells, Pipes
LA SALLE	ENCINAL	559	Carrizo-Wilcox Aquifer	GW	632	145			x		x				Wells, Pipes
LA SALLE	LA SALLE COUNTY-OTHER		Carrizo-Wilcox Aquifer	GW	3,075	355			x		x	x		Cotulla	Wells, Pipes
MEDINA	CASTROVILLE	2680	Edwards Aquifer	GW	2,696	794					x	x		SAWS	Pipes
MEDINA	LACOSTE	1119	Edwards Aquifer	GW	1,281	127					x	x		SAWS	Pipes
MEDINA	MEDINA COUNTY-OTHER		Various GW	GW	9,699	1,257		x	x		x	x		Hondo	Wells, Pipes
MEDINA	NATALIA	1431	Edwards Aquifer	GW	1,638	281					x	x		Lytle	Pipes
MEDINA	YANCEY WSC	5543	Edwards Aquifer	GW	5,890	660					x	x	SAWS		
REFUGIO	REFUGIO	2890	Gulf Coast Aquifer	GW	3,009	574			x	x	x				Wells,Pipes, Treatment
REFUGIO	REFUGIO COUNTY-OTHER		Gulf Coast Aquifer	GW	3,103	370			x	x	x				Wells,Pipes, Treatment
REFUGIO	WOODSBORO	1512	Gulf Coast Aquifer	GW	1,575	258			x	x	x				Wells,Pipes, Treatment
UVALDE	SABINAL	1695	Edwards Aquifer	GW	1,852	445					x	x		Uvalde	Pipes
UVALDE	UVALDE COUNTY-OTHER		Various GW	GW	9,786	1,395		x	x		x	x		Uvalde	Wells, Pipes
VICTORIA	VICTORIA COUNTY-OTHER		Gulf Coast Aquifer	GW	26,070	3,050			x		x	x		Victoria	Wells, Pipes
WILSON	FLORESVILLE	6448	Carrizo-Wilcox Aquifer	GW	8,152	1,940			x		x				Wells, Pipes
WILSON	OAK HILLS WSC	4359	Carrizo-Wilcox Aquifer	GW	5,405	904			x		x				Wells, Pipes
WILSON	POTH	1908	Carrizo-Wilcox Aquifer	GW	2,412	387			x		x				Wells, Pipes
WILSON	STOCKDALE	1442	Carrizo-Wilcox Aquifer	GW	1,823	384			x		x				Wells, Pipes
WILSON	WILSON COUNTY-OTHER		Blend	Blend	12,592	1,493		x	x		x				Wells, Pipes
ZAVALA	CRYSTAL CITY	7138	Carrizo-Wilcox Aquifer	GW	8,063	1,702			x		x				Wells, Pipes
ZAVALA	ZAVALA COUNTY WCID 1	1200	Carrizo-Wilcox Aquifer	GW	0	0			x		x				Wells, Pipes
ZAVALA	ZAVALA COUNTY-OTHER		Carrizo-Wilcox Aquifer	GW	3,454	572			x		x				Wells, Pipes

7.5 Region Specific Drought Response Recommendations and Model Drought Contingency Plans

Region L acknowledges that DCPs are a useful drought management tool for entities with both surface and groundwater sources and recommends that all entitles consider adopting a DCP in preparation for drought conditions. The region also recommends that in accordance with TCEQ guidelines, entities update their DCPs every 5 years as triggers can change as wholesale and retail water providers reassess their contracts and supplies. Region L obtained 17 drought contingency plans from across the region. Six of these participating water providers and WUGs rely solely on surface water, one entity relied solely on groundwater and 10 of them utilize both sources to meet needs.

7.5.1 Drought Response Recommendations for Surface Water

Surface water accounts for approximately 16 percent of 2020 existing municipal supplies in Region L and is sold by five wholesale water providers. With such a variety of supply sources, it is difficult to create a set of triggers and responses that will fit the needs of each WUG in the regional planning area. Region L recognizes that supplies are understood best by the operators and suggests that WUGs without DCPs look to the DCPs of their water providers for these surface supplies.

For entities without DCPs supplying themselves with local surface water, Region L suggests reviewing the drought responses and recommendations used by similar entities in the region. An example of triggers and responses from the DCP for GBRA is presented below (Table 7.5-1). GBRA was selected as a representative example because they provide water to several entities throughout Region L and rely on various types of surface water triggers that can be applied throughout the Region. The DCP includes four water stages ranging from “Mild Water Shortage” to “Emergency Water Shortage”. The triggers depend on parameters such as storage levels, reservoir elevations, and system failures. The responses include categories ranging from home irrigation limits to pool and fountain restrictions.

Table 7.5-1 Example Surface Water Drought Contingency Plan Based On GBRA

Drought Stage	Trigger	Actions
Stage I – Mild Water Shortage	* Canyon reservoir is less than or equal to EL. 895 ft-msl * Comal Springs 24 hr. flow rate flow rate is at or below 250 cfs * Production at Lulling WTP is 2.5MGD or greater for 7 days *Flow at USGS #08172000 drops below 130 cfs	• No person may Waste Water • No person may wash an impervious outdoor ground covering • No person may use water for landscaping between 10 am and 8pm unless by hand help device or recycled water • Swimming pools must be at least 25% covered by an evaporative shield when not in use • Vehicles may only be washed at commercial locations or Monday and Friday before 10am or after 8 pm
Stage II – Water Warning	* Canyon reservoir is less than or equal to EL. 890 ft-msl * Comal Springs 24 hr. flow rate flow rate is at or below 200 cfs * Flow at USGS #08172000 drops below 80cfs	• All Stage I Actions • Irrigation limited to designated days 3 days a weeks during restricted hours unless hand held device used • Vehicle washing is only permissible by using a five gallon container and/or a hand held hose equipped with a quick shutoff nozzle on designated watering days or at a commercial location. • Water may not be used for ornamental fountains unless recycled
Stage III – Water Emergency	* Canyon reservoir is less than or equal to EL. 885 ft-msl *Comal Springs 24 hr. flow rate flow rate is at or below 150 cfs *Flow at USGS #08172000 drobs below 40 cfs	• All Stage I and II Actions • Irrigation limited to designated days 2 days a weeks during restricted hours unless hand held device used • Water may not be used for ornamental fountains • Vehicle washing is only permissible by using a five gallon container and/or a hand held hose equipped with a quick shutoff nozzle on designated watering days or at a commercial location.
Stage IV – Water Crisis	* Loss of capability to provide water service * Contamination of supply source * Drought of greater severity than the DOR *Comal Springs average 24 hr. flow rate flow Rate is at or below 100 cfs * Water ceses to flow past Zelder Dam	• All Stage I, II and III Actions • Irrigation limited to designated days 1 days a weeks during restricted hours unless hand held device used • Filling of new and existing pools is prohibited • Vehicle washing is only permissible at a commercial location.

7.5.2 Drought Response Recommendations for Groundwater

Groundwater accounts for approximately 84 percent of 2020 existing municipal supplies. Entities in Region L utilize both brackish and non-brackish wells in four major formations. With such a variety of supply sources it is difficult to create a set of triggers and responses that will fit the needs of each WUG in the regional planning area. Region L recognizes that supplies are understood best by the operators and suggests that WUGs without DCPs look to the DCP's of their water providers for these surface supplies.

For entities without DCPs supplying themselves with local groundwater, Region L suggests reviewing the drought responses and recommendations used by similar entities

in the region. An example of triggers and responses from the DCP for SAWS is presented below (Table7.4-1). SAWS was selected as a representative example because they are the largest provider of Groundwater to Region L. The DCP includes four water stages. The triggers depend on parameters such as supply and well levels. The responses include categories ranging from residential irrigation limits to commercial and irrigation use reductions.

Table 7.4-1 Based On SAWS

Drought Stage	Trigger	Actions
Stage I	Edwards Aquifer Level in the Index well J-17 falls to 660 ft msl.	• Irrigation limited to 1 day a week at restricted times unless by hand held device. • Cites encouraged to reduces water main flushing and to implement leak detection and survey repairs • Voluntary reduction on power production water • Pools must be covered by at east 25% evaporation block when not in active use. • Aesthetic water features prohibited • No person may wash an impervious outdoor ground covering • Golf cources, parks and fields must submit conservation plans • Customers are requested to minimize or discontinue non-essential water use.
Stage II	Edwards Aquifer Level in the Index well J-17 falls to 650 ft msl.	• Irrigation limited to 1 day a week at further restricted times unless by hand held device. • Hotels must offer “no linen exchange program” • Filling of pools is prohibited unless 30% from alternative source • Golf Courses have limited watering schedule and are charges surcharge in non-conforming.
Stage III	*Edwards Aquifer Level in the Index well J-17 falls to 640 ft msl. *Total supply is insufficient to meet demands and comply with regulations	• All actions listed in Stage II • Irrigation limited to 1 day every other week at restricted times unless by hand held device. • Hand Held watering limited to restricted times and three days a week • Hotels must limit linen exchange to once every 3 nights or entire stay. • New Landscape is only permited if less that 50% is turf • Golf Course must implement 30% use reduction
Stage IV	After a 30-day monitoring period once stage III is declared, the total supply is insufficient to meet demand while complying with regulations.	• All actions listed in Stages II and III • A surcharge is assessed on all irrigation accounts • A surcharge is assessed on all residential accounts • Only SAWS certified vehicle wash facilities can opperate • Additional restrictions including but not limited to ban on lawn watering with irrigation systems may be established at discretion of city council.

7.5.3 Model Drought Contingency Plans

TCEQ has prepared model drought contingency plans for wholesale and retail water suppliers to provide guidance and suggestions to entities with regard to the preparation of drought contingency plans. Not all items in the model will apply to every system's situation, but the overall model can be used as a starting point for most entities. Region L suggests that the TCEQ Model DCPs should be used in conjunction with drought contingency measures such as those listed above for Abilene and Thrall for entities wishing to develop a new DCP. The TCEQ model drought contingency plans can be found in Appendix I or on TCEQ's website:

(https://www.tceq.texas.gov/permitting/water_rights/contingency.html/#contents).

7.6 Drought Management WMS

Texas Administrative Code (TAC), Chapter 357 Regional Water Planning Guidelines, states that "Regional water plan development shall include an evaluation of all water management strategies the regional water planning group determines to be potentially feasible, including drought management measures including water demand management [357.7(a)(7)(B)]." As defined here, drought management means the periodic activation of approved drought contingency plans resulting in short-term demand reduction and/or rationing. This reduction in demand is then considered a "supply" source. Using this approach, an entity may make the conscious decision not to develop firm water supplies greater than or equal to projected water demands with the understanding that demands will have to be reduced or go unmet during times of drought. Using this rationale, an economic impact of not meeting projected water demands can be estimated and compared with the costs of other potentially feasible water management strategies in terms of annual unit costs.

A drought management analysis was completed that calculated the potential supply and cost of reducing the 2020 demand by 5, 10, 15 and 20 percent for all entities with needs in 2020. The methodology and results of this analysis can be found in more detail in Chapter 5.2.2. Region L recommends a 5 percent Drought Management strategy for those entities with needs in 2020. Table 7.6-1 shows the recommended 5 percent yield for the 28 entities with 2020 needs and the alternative yields for higher reductions.

Table 7.6-1 Drought Management Firm Yield

Entity	Yield (acft)			
	5%	10%	15%	20%
Alamo Heights	111	222	332	443
Asherton	17	34	51	68
Atascosa Rural WSC	80	160	239	319
Carrizo Springs	114	227	341	454
Castroville	40	79	119	159
Cibolo	267	534	801	1,069
Converse	127	254	380	507
Garden Ridge	83	166	249	332
Green Valley SUD	91	182	273	364
Hondo	103	205	308	411
Karnes City	31	63	94	125
Kenedy	71	142	213	284
Kirby	47	94	141	188
LaCoste	6	13	19	25
Leon Valley	93	186	279	372
Lockhart	113	225	338	450
Lytle	29	58	87	115
Martindale	9	19	28	37
Mountain City	1	2	4	5
Natalia	14	28	42	56
Niederwald	4	8	11	15
Sabinal	22	45	67	89
Shavano Park	160	320	479	639
Universal City	203	405	608	810
Uvalde	856	1,711	2,567	3,422
Victoria	60	120	180	241
Windcrest	33	66	99	132
Yancey WSC	111	222	332	443

San Antonio Water System (SAWS), who does not have a need in 2020, also requested to be included in the drought management analysis. SAWS prefers to utilize a multi-decadal approach to Drought Management. SAWS is considering a 5 percent demand reduction for 2020, a 12 percent demand reduction for 2040, and 16 percent demand reductions for 2050-2070. Table 7.6-2 shows the requested reductions and projected yields for SAWS throughout the planning period.

Table 7.6-2 SAWS Drought Management Analysis

	2020	2030	2040	2050	2060	2070
% Reduction	5%	12%	16%	16%	16%	16%
Yield (acft)	14,674	38,517	55,536	59,877	64,184	68,190

7.7 Other Drought Recommendations

7.7.1 Model Updates

It is of upmost importance that regional water planning groups have the most up to date information available to make decisions. The GSA WAM is used to determine both the drought of record and the firm yield of reservoirs, but has not been updated in almost 20 years. Region L recommends that the Texas Legislature approve a budget for TCEQ to pursue updating WAMs before the next regional planning cycle. This will be especially important if the duration of the recent drought continues or the severity increases.

7.7.2 Monitoring and Assessment

Region L recommends that all entities monitor the drought situation around the state and locally in order to prepare and facilitate decisions. Several state and local agencies are monitoring and reporting on conditions with up to date information. A few informative sources are listed below.

- San Antonio Water System Drought Restrictions: http://www.saws.org/conservation/droughtrestrictions/
- Guadalupe-Blanco River Authority Drought/Conservation: http://www.gbra.org/drought/default.aspx
- TWDB Drought Information: http://waterdatafortexas.org/drought/
- TCEQ Drought Information: https://www.tceq.texas.gov/response/drought
- Parmer Drought Severity Index: http://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/
- Regional Planning Group Information: http://www.regionltexas.org/

In addition, Region L supports the efforts of the Texas Drought Preparedness Council (DPC) and recommends that entities review information developed by the council. The Drought preparedness council was established by the legislature in 1999 and is composed of 15 representatives from several state agencies. The council is responsible for assessment and public reporting of drought monitoring and water supply conditions,

advising the governor on drought conditions, and ensuring effective coordination among agencies. The DCP is currently promoting outreach to inform entities of the assistance they can provide and looking for input as to how they can be more useful. Region L suggests that entities take advantage of the resources available to them through the DCP such as the Drought Annex which describes the activities that help minimize potential impacts of drought and outlines an effective mechanism for proactive monitoring and assessment and was published in 2014. More information on the DCP can be found on the Texas Department of Public Safety website (http://www.txdps.state.tx.us/dem/CouncilsCommittees/droughtCouncil/stateDroughtPrepCouncil.htm).

DROUGHT CONTINGENCY PLAN
FOR
GUADALUPE-BLANCO RIVER AUTHORITY

April 16, 2014

flowing solutions

TABLE OF CONTENTS

Drought Contingency Plan

DROUGHT CONTINGENCY PLAN
FOR THE
GUADALUPE-BLANCO RIVER AUTHORITY (GBRA)
April 16, 2014

Section 1.0 Declaration of Policy, Purpose, and Intent

In order to conserve the available water supply, to protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation, and fire protection, to protect and preserve public health, welfare, and safety, to minimize the adverse impacts of water supply shortage or other water supply emergency conditions and to protect environmental flows, the Guadalupe-Blanco River Authority (GBRA) adopts the following revised version of its Drought Contingency Plan (the Plan). This Plan applies to Canyon Reservoir stored water, GBRA's hydroelectric lakes and run-of-river water rights associated with the GBRA Luling water rights and lower basin water rights.

Section 2.0 Public Involvement

Opportunity for the public to provide input into this Plan is being provided by GBRA by means of a notice and a copy of the Plan posted on the GBRA website (www.gbra.org). A copy of the Plan is made available to all GBRA water supply customers for their comment, review and guidance. This Plan was adopted by the GBRA Board of Directors on April 16, 2014. Amendments or updates to this Plan will be done in open session of the GBRA Board of Directors Meeting that meets on the third Wednesday of every month. If any changes are made to the Plan, a copy of those changes will be made available to all customers.

Section 3.0 Wholesale Water Customer Education

GBRA will periodically provide wholesale water customers with information about the Plan, including information about the conditions under which each stage of the Plan is to be initiated or terminated and the drought response measures to be implemented in each stage. This information wi1l be provided by means of: 1) A copy of the Plan will be made available to all of GBRA water supply customers for their comment, review, and guidance. Notice of any changes to the Plan will be provided to all customers. 2) If any drought stage is initiated, GBRA will notify all customers indicating the particular stage and the actions it requires. 3) GBRA will continue to forward copies of educational materials, as they become available, to its customers.

Section 4.0 Coordination with Regional Water Planning Groups

The water service area of GBRA is located within the South Central Texas Region, (L). A copy of the Plan will be made available to all members of the South Central Texas Region group for their review and comment.

Section 5.0 Authorization

The GBRA General Manager, or his/her designee, is hereby authorized and directed to implement the applicable provisions of this Plan upon determination that such implementation is

necessary to protect public health, safety, and welfare. The General Manager, or his/her designee, shall have the authority to initiate or terminate drought or other water supply emergency response measures as described in this Plan.

Section 6.0 Application

The provisions of this Plan shall apply to all customers utilizing wholesale water provided by GBRA and to all persons taking water from GBRA's hydroelectric lakes. The terms "person" and "customer" as used in the Plan include individuals, corporations, partnerships, associations, and all other legal entities.

Section 7.0 Definitions

"Call" on water: customers request the release of water purchased from storage in Canyon Reservoir on an as-needed basis to meet periodic or drastic low-flow conditions.

Conservation: those practices, techniques, and technologies that reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water or increase the recycling and reuse of water so that a supply is conserved and made available for future or alternative uses.

Conservation Pool: water level in Canyon Reservoir between 800 feet mean sea level and normal operating elevation of 909 feet mean sea level in which GBRA has management responsibility and release.

Customer: individuals, corporations, partnerships, associations and all other legal entities utilizing water provided by GBRA from storage in Canyon Reservoir and persons taking water from GBRA's hydroelectric lakes.

Domestic water use: water use for personal needs or for household or sanitary purposes such as drinking, bathing, heating, cooking, sanitation, or for cleaning a residence, business, industry, or institution.

Drought of Record: the worst recorded drought since compilation of meteorologic and hydrologic data began. In terms of severity and duration, the drought of the 1950s is considered the drought of record in the Guadalupe River Basin.

Even number address: street addresses, box numbers, or rural postal route numbers ending in 0, 2, 4, 6, or 8 and locations without addresses.

Firm Yield: amount of water that should be considered available throughout a drought as severe as the Drought of Record.

Non-essential Water Use: water uses that are not essential, nor required for the protection of public, health, safety, and welfare, including:

(a) irrigation of landscape areas, including parks, athletic fields, and golf courses, except otherwise provided under this Plan;

(b) use of water to wash any motor vehicle, motorbike, boat, trailer, airplane or other vehicle;
(c) use of water to wash any sidewalks, walkways, driveways, parking lots, tennis courts, or other hard-surfaced areas;
(d) use of water to wash down buildings or structures for purposes other than immediate fire protection;
(e) flushing of gutters or permitting water to run or accumulate in any gutter or street;
(f) use of water to fill, refill, or add to any indoor or outdoor swimming pools or Jacuzzi-type pools;
(g) use of water in a fountain or pond for aesthetic or scenic purposes except where necessary to support aquatic life;
(h) failure to repair a controllable leak(s) within a reasonable period after having been given notice directing the repair of such leak(s); and
(i) use of water from hydrants for construction purposes or any other purposes other than fire-fighting

Odd numbered address: street addresses, box numbers, or rural postal route numbers ending in 1, 3, 5, 7, or 9 and locations without addresses.

Stored Water: water that is contained within the conservation pool of Canyon Reservoir and that GBRA has responsibility and release of under a water right granted by the Texas Commission on Environmental Quality.

TCEQ South Texas Watermaster (STWM): program that oversees the surface-water system of rivers and tributaries in a 50-county area in south central Texas; allow diversions as water is available and as it passes individual diversion points.

Section 8.0 Scope

GBRA supplies wholesale water to customers in its' service area through Certificates of Adjudication issued by the Texas Commission on Environmental Quality (TCEQ) authorizing the storage of firm water supply in Canyon Reservoir and run-of-river diversions at multiple locations in the Guadalupe River Basin. The scope of the Drought Contingency Plan must adhere to the findings of TCEQ's adjudication of GBRA's water rights.

The scope of the Drought Contingency Plan is limited to the curtailment of firm water supplies to insure that there is sufficient firm, uninterruptible water to meet projected demands for such water and to protect the environmental flows through a repetition of the Drought of Record. Firm, stored water is subject to curtailment only if it is determined that the drought in effect is worse than the Drought of Record.

In times of shortage of supply caused by drought or emergency, the TCEQ's South Texas Watermaster will determine when water rights holders must reduce or stop diversions of run-of-river water. GBRA, in accordance with Section 11.039 of the Texas Water Code, will curtail and distribute the available supply or run-of-river water among its water supply customers on a pro rata basis, so that preference is given to no one and all interruptible water supply customers

suffer alike.

Section 9.0 Canyon Dam and Reservoir Operation

Canyon Dam and Reservoir was completed in 1964 as a cooperative project that is jointly managed by GBRA and the U.S. Army Corps of Engineers. GBRA is responsible for reservoir water management and release within the "conservation pool", between 800 feet mean sea level (msl) and the normal operating elevation of 909 msl.

Canyon Reservoir delivers water to customers on a firm yield basis. GBRA has determined, based upon hydrologic and other studies performed by or for GBRA, the amount of stored water from Canyon Reservoir that can be committed and reserved by GBRA on a "firm" basis, meaning the amount that should be considered to be available throughout a drought as severe as the drought that occurred in the 1950's (also referred to as the "Drought of Record"). GBRA will review such studies and perform additional studies from time to time, and it will not commit to supply to its customers at any time a total amount of stored water on a firm basis in excess of the total amount determined by GBRA at that time that should be considered to be firm. However, reasonable conservation requirements under this Plan and other plans may be imposed at any time, including during periods of normal or wet climatic conditions, and curtailments of stored water may be triggered under this Plan during any severe drought, even if that drought is determined to be less severe than the Drought of Record. Curtailments of stored water may also be triggered under this Plan because of some other condition that significantly reduces the available firm water supply.

GBRA has developed a procedure for identifying a drought worse than the Drought of Record for Canyon Lake watershed. The GBRA Board of Directors will declare a drought worse than the Drought of Record when the following three conditions are simultaneously met: (a) drought at least 24 months (24 months since Canyon Reservoir was last full – 909' msl); and (b) the cumulative inflow deficit since the beginning of the drought exceeds the envelope curve for cumulative inflow deficits by at least 5% for six consecutive months and (c) the storage of Canyon Reservoir is less than elevation 885' msl (213,386 acre-feet or approximately 56% full). Historical inflow data for the contributing watershed of Canyon Lake was used in the development of this procedure.

Canyon Reservoir supplies stored water to cities, industries, and agricultural users under a permit issued by the Texas Commission on Environmental Quality (TCEQ). To many users Canyon storage is their sole source of water. These customers rely on daily releases of stored water to meet their demands. For others, Canyon Reservoir provides a dependable source of water during drought conditions and low river flows. These customers "call" for the release of stored water on an as-needed basis to meet periodic or drastic low-flow conditions.

With TCEQ's approval, GBRA can contract for stored water that will provide for an average annual use of stored water from Canyon, with a special condition that a greater maximum quantity of stored water can be used during any one critical year. This way the use of stored water is minimized, and an adequate water supply is available during short-term droughts. This is an example of the benefits of reservoir averaging.

Section 9.1 Triggering Criteria for Initiation and Termination of Drought Response Stages for Canyon Reservoir

The General Manager, or his/her designee, shall monitor water supply and/or demand conditions on a weekly basis and shall determine when conditions warrant initiation or termination of each stage of the Plan. Customer notification of the initiation or termination of drought response stages will be made by mail, fax, or telephone. The news media will also be informed.

The triggering criteria for Canyon Reservoir described below are based on a statistical analysis of the vulnerability of the water source under drought of record conditions.

Stage 1 - Mild Water Shortage Conditions

Requirements for initiation - GBRA will recognize that a mild water shortage condition exists when:

Water in storage in Canyon Reservoir is equal to or less than elevation 895 feet msl (274,800 acre-feet or approximately 72.5% full).

Requirements for termination - Stage I of the Plan may be rescinded when Canyon Reservoir returns to elevation 895 feet msl or greater for a period of 30 consecutive days. GBRA will notify its wholesale customers and the media of the termination of Stage I in the same manner as the notification of initiation of Stage 1 of the Plan.

Stage 2 - Moderate Water Shortage Conditions

Requirements for initiation - GBRA will recognize that a moderate water shortage condition exists when:

Water in storage in Canyon Reservoir is equal to or less than 890 feet msl (242,872 acre-feet or approximately 64% full).

Requirements for termination - Stage 2 of the Plan may be rescinded when Canyon Reservoir returns to elevation 890 feet msl or greater for a period of 30 consecutive days. Upon termination of Stage 2, Stage 1 becomes operative. GBRA will notify its wholesale customers and the media of the termination of Stage 2 in the same manner as the notification of initiation of Stage 2 of the Plan.

Stage 3 - Severe Water Shortage Conditions

Requirements for initiation - GBRA will recognize that a severe water shortage condition exists when:

Water in storage in Canyon Reservoir is equal to or less than 885 feet msl (213,386 acre-feet or approximately 56% full).

Requirements for termination - Stage 3 of the Plan may be rescinded when Canyon Reservoir returns to elevation 885 feet msl or greater for a period of 30 consecutive days. Upon termination of Stage 3, Stage 2 becomes operative. GBRA will notify its wholesale customers and the media of the termination of Stage 3 in the same manner as the notification of initiation of Stage 3 of the Plan.

Stage 4 - Emergency Water Shortage Conditions

Requirements for initiation - GBRA will recognize that an emergency water shortage condition exists when:

1. Mechanical or system failures occur, which cause unprecedented loss of capability to provide water service.

2. Natural or man-made contamination of the water supply source(s) occurs.

3. A drought of greater severity than the Drought of Record occurs. The GBRA Board of Directors will declare a drought worse than the Drought of Record when the following three conditions are simultaneously met: (a) drought at least 24 months (24 months since Canyon Reservoir was last full – 909' msl); and (b) the cumulative inflow deficit since the beginning of the drought exceeds the envelope curve for cumulative inflow deficits by at least 5% for six consecutive months and (c) the storage of Canyon Reservoir is less than elevation 885' msl (213,386 acre-feet or approximately 56% full).

Requirements for termination - Except for a drought of greater severity than the Drought of Record, Stage 4 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of 30 consecutive days. The GBRA Board of Directors will cancel a declaration of a drought worse than the Drought of Record if any of the following conditions are met: (a) the cumulative inflow deficit since the beginning of the drought is less than the envelope curve for cumulative inflow deficits by at least 5% for six consecutive months; or (b) the storage of Canyon Reservoir is greater than elevation 890' msl (242,872 acre-feet or approximately 64% full). GBRA will notify its wholesale customers and the media of the termination of Stage 4 of the Plan.

Section 9.2 Drought Response Stages for Canyon Reservoir

The General Manager, or his/her designee, shall monitor water supply and/or demand conditions and, in accordance with the triggering criteria for Canyon Reservoir set forth in Section 9.1 shall determine that mild, moderate, or severe water shortage conditions exist or that an emergency condition exists and shall implement the following actions:

Stage 1 - Mild Water Shortage Conditions

Goal: achieve a voluntary 5 percent reduction in comparison to the average monthly usage of contracted water from storage for that time period of the calendar year.

Supply Management Measures: In order to manage limited water supplies and/or reduce water demand during a mild water shortage condition, the General Manager, or his/her designee(s), will implement one or a combination of the following:

1) Contact USGS to confirm calibration and operation of all applicable stream gages.

2) Coordinate review of water use with the TCEQ's South Texas Watermaster (STWM). In times of shortage of supply caused by drought or emergency, the STWM will determine when water rights holders must reduce or stop diversions.

3) Implement water delivery procedures to improve efficiency of the delivery of water from storage.

Demand Management Measures:

1) The General Manager, or his/her designee(s), will contact wholesale water customers to discuss water supply and/or demand conditions and will request that wholesale water customers initiate voluntary measures to reduce water use.

2) The General Manager, or his/her designee(s), will provide a weekly report to news media with information regarding current water supply and/or demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.

Stage 2 - Moderate Water Shortage Conditions

Goal: achieve a voluntary 10 percent reduction in comparison to the average monthly usage of contracted water from storage for that time period of the calendar year.

Supply Management Measures: In order to manage limited water supplies and/or reduce water demand during a moderate water shortage condition, the General Manager, or his/her designee(s), will implement one or a combination of the following:

1) Contact USGS to confirm calibration and operation of all applicable stream gages.

2) Coordinate review of water use with the TCEQ's STWM. In times of shortage of supply caused by drought or emergency, the STWM will determine when water rights holders must reduce or stop diversions.

3) Implement water delivery procedures to improve efficiency of the delivery of water from storage.

Demand Management Measures:

1) The General Manager, or his/her designee(s), will initiate weekly contact with wholesale water customers to discuss water supply and/or demand conditions and the possibility of pro rata curtailment of water diversions and/or deliveries as

specified in Section 9.3.

2) The General Manager or his/her designee(s) will request wholesale water customers to initiate mandatory measures to reduce non-essential water use.

3) The General Manager, or his/her designee(s), will initiate preparations for the implementation of pro rata curtailment of water diversions and/or deliveries by preparing a monthly water usage allocation baseline for each wholesale customer according to the procedures specified in Section 9.3 of the Plan.

4) The General Manager, or his/her designee(s), will provide a weekly report to news media with information regarding current water supply and/or demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.

Stage 3 - Severe Water Shortage Conditions

Goal: achieve a voluntary 15 percent reduction in comparison to the average monthly usage of contracted water from storage for that time period of the calendar year.

Supply Management Measures: In order to manage limited water supplies and/or reduce water demand during a severe water shortage condition, the General Manager, or his/her designee(s), will implement one or a combination of the following:

1) Contact USGS to confirm calibration and operation of all applicable stream gages.

2) Coordinate review of water use with the TCEQ's STWM. In times of shortage of supply caused by drought or emergency, the STWM will determine when water rights holders must reduce or stop diversions.

3) Implement water delivery procedures to improve efficiency of the delivery of water from storage.

Demand Management Measures:

1) The General Manager, or his/her designee(s), will contact wholesale water customers to discuss water supply and/or demand conditions and will request that wholesale water customers initiate additional mandatory measures to reduce non-essential water use.

2) The General Manager, or his/her designee(s), will initiate pro rata curtailment of water diversions and/or deliveries for each wholesale customer according to the procedures specified in Section 9.3 of the Plan.

3) The General Manager, or his/her designee(s), will provide a weekly report to news media with information regarding current water supply and/or demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.

Stage 4 - Emergency Water Shortage Conditions

Whenever emergency water shortage conditions exist as defined in Section 9.1 of the Plan, the General Manager shall:

1. Assess the severity of the problem and identify the actions needed and time required to resolve the problem.

2. Inform the utility director or other responsible official of each wholesale water customer by telephone or in person and suggest actions, as appropriate to alleviate problems.

3. If appropriate, notify city, county, and/or state emergency response officials for assistance.

4. Undertake necessary actions, including repairs and/or clean-up as needed.

5. Prepare a post-event assessment report on the incident and critique of emergency response procedures and actions.

Section 9.3 Pro Rata Water Allocation for Canyon Reservoir

In the event that the triggering criteria for Canyon Reservoir specified in Section 9.1 of the Plan for Stage 4 — Emergency Water Shortage Conditions have been met, the General Manager is hereby authorized to initiate allocation of water supplies on a pro rata basis in accordance with Texas Water Code Section 11.039 and according to the following water allocation policies and procedures:

1. A wholesale customer's allocation for water from storage shall be based on the customer's average monthly use of contracted water from storage for that time period of the calendar year. The percentage will be set by resolution of the Board of Director's of GBRA based on the General Manager's assessment of the severity of the water shortage condition and the need to curtail water diversions and/or deliveries and may be adjusted periodically by resolution of the Board of Director's of GBRA as conditions warrant. Once pro rata allocation is in effect, water diversions by or deliveries to each wholesale customer shall be limited to the allocation established for each month.

2. The General Manager shall provide notice, by certified mail, to each wholesale customer informing them of their water usage allocations and shall notify the news media and the executive director of the Texas Commission on Environmental Quality upon initiation of pro rata water allocation.

3. Upon request of the customer or at the initiative of the General Manager, the allocation may be reduced or increased if, (1) the designated period does not accurately reflect the wholesale customer's average monthly use of contracted water from storage for that time period of the calendar year; (2) the customer with approval from GBRA agrees to transfer part of its allocation to another wholesale customer; or (3) other objective evidence demonstrates that the designated allocation is inaccurate under present conditions. A customer may appeal an allocation established hereunder to the Board of Directors of GBRA.

Section 10.0 Hydroelectric Lakes

CRITICAL PERIOD STAGES

The following critical period stages applies to the diversion of water other than contracted stored water that diverts and uses water from any of the GBRA Hydroelectric Lakes including:

Lake Dunlap	Comal/Guadalupe County
Lake McQueeney	Guadalupe County
Lake Placid	Guadalupe County
Lake Nolte	Guadalupe County
H4 (Lake Gonzales)	Gonzales County
H5 (Lake Wood)	Gonzales County

When the level of the spring flow rate from the Comal Springs, when measured at the Comal River, reaches the following levels:

Stage I

Applies on any day following a day when the average twenty-four (24) hour spring flow rate is **at or below 250 cfs**, **but greater than 200 cfs.**

When Stage I is in effect, the following restrictions apply:

1. No person may waste water, including allowing irrigation tailwater or water from vehicle washing at a residence to escape from that person's property.

2. No person may use water to wash an impervious outdoor ground covering such as a parking lot, driveway, street or sidewalk unless for health or safety reasons.

3. No person may use water for landscape watering between the hours of 10 a.m. and 8 p.m. However, landscape watering by means of a bucket, hand-held or soaker hose, or a properly installed drip irrigation system is permitted at any time. This subsection does not apply to reclaimed, reuse or recycled water.

4. Every person who owns or has possession of a swimming pool must cover the pool with an effective evaporation cover, screen or shield covering at least 25 percent of the surface of the pool when the pool is not in active use. Active use includes necessary maintenance that requires removal of the cover, screen or shields. Active use of public, commercial and apartment pools is whenever the pool is not officially closed.

5. No person may wash a vehicle at other than a commercial vehicle wash facility except on Monday and Friday, before 10 a.m. and after 8 p.m. Such washing must be done on a lawn or other pervious surface using a bucket or hand-held hose with an automatic shutoff nozzle.

Stage II

Applies on any day following a day when the average twenty-four (24) hour spring flow rate is **at or below 200 cfs, but greater than 150 cfs.**

When Stage II is in effect, the following restrictions apply:

1. All of the prohibitions applicable in Stage I apply in Stage II, except to the extent replaced by more restrictive conditions imposed by this stage.

2. Landscape watering is prohibited between 10 a.m. and 8 p.m., and is further restricted such that properties with an odd numbered address may landscape water only on Mondays, Wednesdays and Fridays and properties with an even numbered address may landscape water only on Tuesdays, Thursdays and Saturdays. However, landscape watering by means of a bucket, hand-held or soaker hose, or a properly installed drip irrigation system is permitted at any time. This subsection does not apply to reclaimed, recycled or reuse water.

3. No person may use water for an ornamental outdoor fountain or similar feature, unless the water is recycled and the only additional water used is to compensate for evaporative losses.

4. No person may wash a vehicle at other than a commercial vehicle wash facility except over a pervious surface area, during the above designated watering days and times with a hand-held hose with automatic shutoff nozzle or using a bucket.

The penalty for wasting water or any violation of Stage II restrictions as determined by the GBRA General Manager, or his designee, is $100 per day per violation.

Stage III

Applies on any day following a day when the average twenty-four (24) hour spring flow rate is **at or below 150 cfs, but greater than 100 cfs.**

When Stage III is in effect, the following restrictions apply:

1. All of the prohibitions applicable in Stages I and II apply in Stage III, except to the extent replaced by more restrictive conditions imposed by this stage.

2. Landscape watering is prohibited between the hours of 10 a.m. and 8 p.m. and is further restricted such that properties with an odd numbered address may landscape water on Mondays and Fridays, and those with an even numbered address may landscape water on Tuesdays and Saturdays. However, landscape watering by means of a bucket, hand-held hose or soaker hose, or a properly-installed drip irrigation system is permitted at any time. This subsection does not apply to reclaimed, recycled or reuse water.

3. No person may use water for an ornamental outdoor fountain or similar feature.
4. No person may wash a vehicle at other than a commercial vehicle wash facility except over a pervious surface area, during the above designated watering days and times with a hand-held hose with automatic shut-off nozzle or using a bucket.

The penalty for wasting water or any violation of Stage III restrictions, as determined by the GBRA General Manager, or his designee, is $100 - $200 per day per violation.

Stage IV

Applies on any day following a day when the average twenty-four (24) hour spring flow rate is **at or below 100 cfs, but greater than 50 cfs.**

When Stage IV is in effect, the following restrictions apply:

1. All of the prohibitions applicable in Stages I, II and III apply in Stage IV, except to the extent replaced by more restrictive conditions imposed by this stage.

2. Landscape watering is prohibited between the hours of 10 a.m. and 8 p.m. and is further restricted such that properties with an odd numbered address may landscape water on Mondays while those with an even numbered address may landscape water on Tuesdays. However, landscape watering by means of a bucket, hand-held hose or soaker hose or a properly installed drip irrigation system is permitted during the hours allotted for watering. This subsection does not apply to reclaimed, recycled or reuse water.

3. Filling of new and existing pools is prohibited unless at least 30 percent of the water is obtained from a source other than the GBRA hydroelectric lakes. Water may be used to replenish swimming pools to maintenance levels. Drainage of swimming pools is permitted only onto a pervious surface, or onto a pool deck where the water is transmitted directly to a pervious surfaced, only if necessary to:

    a. Remove excess water from the pool due to rain in order to lower the water to the maintenance level;
    b. Repair, maintain, or replace a pool component which has become hazardous; or
    c. Repair a pool leak.

4. Washing of vehicles is prohibited at other than a commercial vehicle wash facility.

The penalty for wasting water or any violation of Stage IV restrictions, as determined by the GBRA General Manager, or his designee, is $100 - $500 per day per violation.

Stage V

Applies on any day following a day when the average spring flow rate is **at or below 50 cfs.**

When Stage V takes effect an emergency condition exists and the GBRA General Manager shall convene an emergency session of the GBRA Board of Directors to consider emergency rules to further restrict uses or other appropriate action.

Termination of Restrictions

The GBRA General Manager, or his/her designee, may terminate the restrictions of a Stage when the condition listed as the triggering event for such Stage has ceased to exist for a period of thirty (30) consecutive days. Upon termination of the restrictions of the applicable Stage, the restrictions of the prior Stage become operative.

Section 11.0 GBRA Luling Water Rights and Operations

The GBRA Luling Water Rights authorize run-of-the-river diversion from the San Marcos River just upstream of Zedler Mill Dam in Luling. The majority of the flow in the San Marcos River at Luling is derived from spring flow of the San Marcos Springs with limited amounts of water contributed by the Blanco River, especially during the summer. GBRA pumps raw water from the San Marcos River to the GBRA Luling Water Treatment plant, which delivers treated water on a wholesale basis to both the City of Luling and the City of Lockhart. Water is delivered to Lockhart through almost 15 miles of 14" pipeline.

Section 11.1 Triggering Criteria for Initiation and Termination of Drought Response Stages for Luling Water Rights

The General Manager, or his/her designee, shall monitor water supply and/or demand conditions on a weekly basis and shall determine when conditions warrant initiation or termination of each stage of the Plan. Customer notification of the initiation or termination of drought response stages will be made by email, mail, or telephone. The news media will also be informed.

The triggering criterion to be monitored for determining drought response stages are the demand for treated water delivered to the Cities of Lockhart and Luling, the flow past the Zedler Dam in Luling as measured by the USGS Gauge #08172000, and the flow of the Guadalupe River over the GBRA Saltwater Barrier and Diversion Dam. These criteria were selected based upon reviewing historical water treatment plant demands and provisions contained within the water rights used to divert water from the San Marcos River.

Stage 1 – Mild Water Shortage Condition

Requirements for initiation – GBRA will recognize that a mild water shortage condition exists when water production at the GBRA Luling Water Treatment Plant for the City of Luling (not including the City of Lockhart demands) equals 2.5 MGD or greater for seven (7) consecutive days or when the average daily flow drops below 130 cfs at USGS Gauging Station #081720000.

Requirement for termination – Stage 1 of the Plan may be rescinded when the conditions listed as triggering events have ceased to exist for a period of 30 consecutive days.

GBRA will notify its wholesale customers and the media of the termination of Stage 1 in the same manner as the notification of initiation of Stage 1 of the Plan.

Stage 2 – Moderate Water Shortage Condition

Requirements for initiation – GBRA will recognize that a moderate water shortage condition exists when the average daily flow drops below 80 cfs at USGS Gauging Station #08172000.

Requirement for termination – Stage 2 of the Plan may be rescinded when the conditions listed as triggering events have ceased to exist for a period of 30 consecutive days (i.e., the flow at USGS Gauging Station #08172000 is greater than 80 cfs for 30 consecutive days). Upon termination of Stage 2, Stage 1 becomes operative, unless the trigger criteria for Stage 1 have not been met. GBRA will notify its wholesale customers and the media of the termination of Stage 2 in the same manner as the notification of initiation of Stage 1 of the Plan.

Stage 3 – Severe Water Shortage Condition

Requirements for initiation – GBRA will recognize that a severe water shortage condition exists when the average daily flow drops below 40 cfs at USGS Gauging Station #08172000.

Requirement for termination – Stage 3 of the Plan may be rescinded when the conditions listed as triggering events have ceased to exist for a period of 30 consecutive days. Upon termination of Stage 3, Stage 2 becomes operative. GBRA will notify its wholesale customers and the media of the termination of Stage 3 in the same manner as the notification of initiation of Stage 1 of the Plan.

Stage 4 – Emergency Water Shortage Condition

Requirements for initiation – GBRA will recognize that an emergency water shortage condition exists when any of the following occur:

1) A major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service; or

2) Natural or man-made contamination of the water supply source occurs.

3) Water ceases to flow past the Zedler Dam located in Luling, Caldwell County, Texas.

Requirement for termination – The emergency water shortage condition may be rescinded when the General Manger or his/her designee deems appropriate. GBRA will notify its wholesale customers and the media of the termination of the emergency shortage condition in the same manner as the notification of initiation of Stage 1 of the Plan.

Section 11.2 Drought Response Stages for Luling Water Rights

The General Manager, or his/her designee, shall monitor water supply and/or demand conditions and, in accordance with the triggering criteria set forth in Section 11.1, shall determine that mild, moderate, or severe water shortage conditions exist or that an emergency condition exists and shall implement the following actions:

Stage 1 – Mild Water Shortage Conditions

Target: Achieve a voluntary 5 percent reduction in daily water demand for each retail utility utilizing the GBRA Luling Water Treatment Plant.

Best Management Practices for Supply Management:

1) GBRA will encourage each wholesale water customer to utilize alternative water sources such as interconnections with another water system, groundwater, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.

2) The City of Luling has priority on water produced by the WTP up to 2.5 MGD. Water produced in excess of the needs of the City of Luling is delivered to the City of Lockhart. As Luling demand increases, water supplied to Lockhart will be reduced. The Chief Operator will notify the GBRA Division Manager for Hays and Caldwell Counties and the GBRA Lockhart Operations Manager of the reduction of available water to Lockhart and the Lockhart Operations Manager will cause increased production from the City of Lockhart groundwater system to supply adequate water to meet demand within the Lockhart distribution system. The Lockhart Operations Manager will notify the Public Works Director of the City of Lockhart of the decrease in water from the Luling WTP and the need to increase production from the groundwater system.

Water Use Restrictions for Reducing Demand:

1) The General Manager, or his/her designee(s), will contact wholesale water customers to discuss water supply and/or demand conditions and will request that wholesale water customers initiate voluntary measures to reduce water use (e.g. implement Stage 1 of the customer's drought contingency plan).

2) The General Manager, or his/her designee(s), will provide a weekly report to the news media with information regarding current water supply and/or demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.

Stage 2 – Moderate Water Shortage Conditions

<u>Target:</u> Achieve a 10 percent reduction in daily water demand for each retail utility utilizing the GBRA Luling Water Treatment Plant.

Best Management Practices for Supply Management:

GBRA will encourage each wholesale water customer to utilize alternative water sources such as interconnections with another water system, groundwater, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.

Water Use Restrictions for Reducing Demand:

1) The General Manager, or his/her designee(s), will initiate weekly contact with wholesale water customers to discuss water supply and/or demand conditions and the possibility of pro rata curtailment of water diversions and/or deliveries.

2) The General Manager, or his/her designee(s), will request wholesale water customers to initiate mandatory measures to reduce non-essential water use (e.g. implement Stage 2 of the customer's drought contingency plan).

3) The General Manager, or his/her designee(s), will initiate preparations for the implementation of pro rata curtailment of water diversions and/or deliveries by preparing a monthly water usage allocation baseline for each wholesale customer according to procedures specified in Section 11.3 of the Plan.

4) The General Manager, or his/her designee(s), will provide a weekly report to the news media with information regarding current water supply and/or demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.

Stage 3 – Severe Water Shortage Conditions

<u>Target:</u> Achieve a 15 percent reduction in daily water demand for each retail utility utilizing the GBRA Luling Water Treatment Plant.

Best Management Practices for Supply Management:

1) GBRA will encourage each wholesale water customer to utilize alternative water sources such as interconnections with another water system, groundwater, temporary use of a non-municipal water supply, use of reclaimed water for non-potable purposes, etc.

2) If flow drops below 40 cfs at the USGS Gauging Station #08172000, the GBRA Chief Engineer will notify the Division Manager for Hays and Caldwell Counties. The Division Manager will consult with GBRA staff to determine at what minimal rate the WTP can divert water and maintain minimum required flow at the USGS Gauging Station #08172000. The GBRA Luling WTP Chief Operator will cause the water treatment plant to operate at the reduced rate and the Division

Manager will inform the Public Works Directors of Lockhart and Luling of the reduced production rate.

Water Use Restrictions for Reducing Demand:

1) The General Manager, or his/her designee(s), will contact wholesale water customers to discuss water supply and/or demand conditions and will request that wholesale water customers initiate additional mandatory measures to reduce non-essential water use (e.g. implement Stage 3 of the customer's drought contingency plan).

2) The General Manager, or his/her designee(s), will initiate pro rata curtailment of water diversions and/or deliveries for each wholesale customer according to the procedures specified in Section 11.3 of the Plan if deemed appropriate.

3) The General Manager, or his/her designee(s), will provide a weekly report to the news media with information regarding current water supply and/or demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.

Stage 4 – Emergency Water Shortage Conditions

Whenever emergency water shortage conditions exist as defined in Section 11.1 of the Plan, the General Manager, or his/her designee(s), shall:

1) Assess the severity of the problem and identify the actions needed and the time required to solve the problem.

2) Inform the utility director or other responsible official of each wholesale water customer by telephone, email, or in person and suggest actions, as appropriate to alleviate problems (e.g., notification of the public to reduce water use until service is restored).

3) If appropriate, notify city, county, and/or state emergency response officials for assistance.

4) Undertake necessary actions, including repairs and/or clean-up as needed.

5) Prepare a post-event assessment report on the incident and critique of emergency response procedures and actions.

Section 11.3 Pro-Rata Allocation of GBRA Luling Water Rights

In the event that the triggering criteria specified in Section 11.1 of the Plan for Stage 3 - Severe Water Shortage Conditions have been met, the General Manager, or his/her designee(s), is hereby authorized to initiate allocation of water supplies on a pro rata basis in accordance with Texas Water Code Section 11.039. A provision will be included in every wholesale water

contract entered into or renewed after adoption of the plan, including contract extensions, that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code §11.039.

Section 12.0 Lower Basin Water Rights and Operations

GBRA operates a raw water delivery system that consists of waterworks located on the Guadalupe River at river mile #10 near Tivoli, Texas called the Lower Guadalupe Diversion Dam and Salt Water Barrier (or Barrier herein) and a river outtake structure (immediately upstream of the Barrier) and, further, an open channel diversion system that transports water by gravity flow from the river waterworks utilizing a constructed channel, the streambeds of Goff and Hog Bayous, and large diameter pipes to a pumping station located on the Dow Chemical Company plant property near Seadrift, Texas. After lifting the water by pumping, the water continues to flow through an open canal system, with one branch of the system ending at the GBRA Port Lavaca Water Treatment Plant.

GBRA's Lower Basin Water Rights, some of which are jointly owned with Dow Chemical Company are a major source of raw water supply for industrial users in Calhoun and Victoria Counties. Raw water conveyed by the GBRA canal system is diverted for agricultural users for irrigation and for the Aransas National Wildlife Refuge for ecological purposes. The canal system ultimately conveys raw water to the GBRA Port Lavaca Water Treatment plant, which supplies treated drinking water to the City of Port Lavaca, a majority of the drinking water to the Port O'Connor Improvement District, and all of the drinking water to the GBRA Calhoun County Rural Water Supply System.

Water for GBRA's municipal customers is secured by the Lower Basin run-of-river water rights and backed up with contracts for stored water from Canyon Reservoir. If drought or demand conditions fully engage all of the available GBRA run-of-river water supply, and the water demand continues to increase, then the further water demand will be satisfied by Canyon stored water rights. The Water Supply Division of GBRA, in coordination with the STWM, will determine when these trigger demand points occur, and will inform all GBRA customers affected.

Section 12.1 Triggering Criteria for Initiation and Termination of Drought Response Stages for Lower Basin Water Rights

The General Manager, or his/her designee, shall monitor water supply and/or demand conditions on a weekly basis and shall determine when conditions warrant initiation or termination of each stage of the Plan. Customer notification of the initiation or termination of drought response stages will be made by email, mail, or telephone. The news media will also be informed by the GBRA.

Stage 1 - MILD Water Shortage Conditions

Requirements for initiation: Customers shall be requested to voluntarily conserve water and adhere to the prescribed restrictions on non-essential water uses, defined in Section 7.0, when flow over the top of the Salt Water Barrier (at river mile 10) is 6 inches or less

for five consecutive days. The initiation of Stage 1 will also depend on the combined effect of two factors:

1) Demand of all GBRA and other permitted customers for surface water.
2) Available surface water flow from the Guadalupe River and its tributaries at river mile 10.

Requirements for termination: Stage 1 of the Plan may be rescinded when the condition listed as a triggering event (the operation of the Barrier to raise the pool level) ceases.

Stage 2 – MODERATE Water Shortage Conditions

Requirements for initiation: Customers shall be requested to comply with the requirements and restrictions on certain non-essential water uses defined in Section 7.0 of this Plan when Stage 1 conditions are active and in addition:

Sustained flow over the Barrier is not occurring. The initiation of Stage 2 will also depend on the combined effect of two factors:

1) Demand of all GBRA and other permitted customers for surface water.
2) Available surface water flow from the Guadalupe River and its tributaries at river mile 10.

Requirements for termination: Stage 2 of the Plan may be rescinded when the condition listed as a triggering event (no flow over the Barrier) ceases. Upon termination of Stage 2, Stage 1 becomes operative.

Stage 3 – SEVERE Water Shortage Conditions

Requirements for initiation: Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 3 of this Plan when Stage 2 conditions are active and in addition:

The release of stored water from Canyon Dam to meet customer demand in Calhoun County is being executed by GBRA, to supplement its run-of-river permitted supply available at the Barrier. Also, the General Manager may designate a Stage 3 trigger when voluntary actions by customers in Stage 2 are ineffective in reducing water usage.

The initiation of Stage 3 will depend on the combined effect of two factors:

1) Demand of all GBRA and other permitted customers for water from all sources.
2) Available surface water flow from the Guadalupe River and its tributaries at river mile 10.
3) Release of Canyon water for upstream customers.

Requirements for termination: Stage 3 of the Plan may be rescinded when the condition listed as a triggering event (the release of stored water for upstream customers from Canyon Dam) ceases. Upon termination of Stage 3, Stage 2 becomes operative.

Stage 4 – CRITICAL Water Shortage Conditions

Requirements for initiation: Customers shall be required to comply with the requirements and restrictions on certain non-essential water uses for Stage 4 of this Plan when Stage 3 conditions are active and in addition:

All municipal demand of GBRA customers in Calhoun County is being met by the permitted release of stored water in Canyon Dam.

The initiation of Stage 4 will depend on:

1) Demand of GBRA and other permitted customers for water from all sources.

2) The cessation of flow from one or both of the two major springs, Comal and San Marcos Springs (equivalent to the drought of record).

3) Encroachment of salt water from San Antonio Bay toward the Barrier and Calhoun Canal System through the bayous. Chlorides and salinity will be measured at the highway 35 bridge and the radial gates.

4) The call for water released from Canyon Reservoir for Calhoun County customers.

Requirements for termination: Stage 4 of the Plan may be rescinded when the conditions listed as a triggering event (the termination of spring flow and the sole use of stored water from Canyon Dam for Calhoun County customers) ceases. Upon termination of Stage 4, Stage 3 becomes operative.

Stage 5 – EMERGENCY Water Shortage Conditions

Requirements for initiation: Customers shall be required to comply with the requirements and restrictions for Stage 5 of this Plan when the General Manager or his/her designee determines that a water supply emergency exists based on:

1) Major water line breaks, or pump or system failures occur, which cause unprecedented loss of capability to provide water service; or

2) Natural or man-made contamination of the water supply source(s).

3) This condition may occur at any time and is not dependent on being preceded by Stages 1 through 4.

Requirements for termination: Stage 5 of the Plan may be rescinded when all of the conditions listed as triggering events have ceased to exist for a period of 3 (three) consecutive days.

Section 12.2 Drought Response Stages for Lower Basin Water Rights

The General Manager, or his/her designee, shall monitor water supply and/or demand conditions and, in accordance with the triggering criteria for Canyon Reservoir set forth in Section 12.1 shall determine that mild, moderate, severe, critical, or emergency water shortage conditions exist or that an emergency condition exists and shall implement the following actions:

Stage 1 – MILD Water Shortage Conditions

Goal: Achieve a voluntary reduction in total domestic water usage during each month of this stage by 5% in comparison to the average monthly usage for that time period of the calendar year.

Supply Management Measures: The GBRA will encourage each wholesale water customer to monitor end main water pressures and reduce input pressure if end pressure is excessive.

Demand Management Measures: The General Manager, or his/her designee, will initiate weekly contact with the wholesale water customers to discuss water supply and demand conditions and will request that wholesale water customers initiate voluntary measures to reduce water use.

Wholesale water customers are requested to practice water conservation and to minimize or discontinue water use for non-essential purposes.

Stage 2 – MODERATE Water Shortage Conditions

Goal: Achieve a voluntary reduction in total domestic water usage during each month of this stage by 10% in comparison to the average monthly usage for that time period of the calendar year.

Supply Management Measures: See Stage 1. The GBRA Port Lavaca Water Treatment Plant will encourage wholesale water customers to reduce flushing of mains to a minimum to meet regulatory requirements, and to monitor systems to insure timely response to leak repair.

Demand Management Measures**:**

1) The General Manager, or his/her designee, will initiate weekly contact with wholesale water customers to discuss water supply and demand conditions.

2) The General Manager, or his/her designee, will request wholesale water customers to initiate mandatory measures to reduce non-essential water use.

3) The General Manager, or his/her designee, will initiate preparations for the implementation of pro rata curtailment of water deliveries by preparing a monthly water usage allocation baseline for each wholesale water customer according to procedures specified in Section 12.3 of the Plan.

4) The General Manager, or his/her designee, will provide a weekly report to the news media with information regarding current water supply and demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.

All operations of the GBRA PLWTP shall adhere to the same water use restrictions for Stage 2 Response.

Stage 3 – SEVERE Water Shortage Conditions

Goal: Achieve a voluntary reduction in total domestic water usage during each month of this stage by 15% in comparison to the average monthly usage for that time period of the calendar year.

Supply Management Measures: See Stage 2. The GBRA Port Lavaca Water Treatment Plant will encourage the wholesale water customers to eliminate the flushing of mains unless required to decontaminate.

Demand Management Measures:

1) The General Manager, or his/her designee, will contact wholesale water customers to discuss water supply and demand conditions and will request that wholesale water customers initiate additional mandatory measures to reduce non-essential water use.

2) The General Manager, or his/her designee, will initiate pro rata curtailment of water deliveries for each wholesale water customer according to procedures specified in Section 12.3 of the Plan, if deemed appropriate.

3) The General Manager, or his/her designee, will provide a weekly report to the news media with information regarding current water supply and demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.

All operations of the GBRA PLWTP shall adhere to the same water use restrictions for Stage 3 Response.

Stage 4 – CRITICAL Water Shortage Conditions

Goal: Achieve a voluntary reduction in total domestic water usage during each month of this stage by 20% in comparison to the average monthly usage for that time period of the calendar year.

Supply Management Measures: See Stage 3. The GBRA Port Lavaca Water Treatment Plant will encourage the wholesale water customers to also, upon written notice, disconnect the water meters of willful violators if absolutely necessary to prevent the deliberate wasting of water.

Demand Management Measures**:**

1) The General Manager, or his/her designee, will contact wholesale water customers to discuss water supply and demand conditions and will request that wholesale water customers initiate additional mandatory measures to reduce non-essential water use.

2) The General Manager, or his/her designee, will initiate pro rata curtailment of water deliveries for each wholesale water customer according to procedures specified in Stage 12.3 of the Plan.

3) The General Manager, or his/her designee, will provide a weekly report to the news media with information regarding current water supply and demand conditions, projected water supply and demand conditions if drought conditions persist, and consumer information on water conservation measures and practices.

All operations of the GBRA PLWTP shall adhere to the same water use restrictions for Stage 4 Response.

Stage 5 – EMERGENCY Water Shortage Conditions

Goal: Achieve a 50% reduction in daily water use.

Supply Management Measures: See Stage 4. Also, contact the County Judge and / or the emergency management coordinator to initiate the use of the Community Alert Network (CAN), an automated phone dial up. Inform the County Sheriff's office, the City of Port Lavaca City Manager, the President of the Board of Directors of the Port O'Connor Improvement District, the President of the Board of Directors of the Calhoun County Rural Water Supply System.

Water Use Restrictions:

1) The General Manager, or his/her designee, shall assess the severity of the problem and identify the actions needed and the time required to solve the problem.

2) The General Manager, or his/her designee, will inform the responsible official of each wholesale water customer by telephone, email, or in person and suggest

actions, as appropriate to alleviate problems (such as; notifying the public to reduce water use until service is restored)

3) The General Manager, or his/her designee, will notify city, county, and/or state emergency response officials for assistance.
4) The General Manager, or his/her designee, will take any actions necessary, including repairs and/or clean-up as needed.

5) The General Manager, or his/her designee, will prepare a post-event assessment report on the incident and critique of emergency response procedures and actions.

Section 12.3 Pro-Rata Water Allocation for Lower Basin Water Rights

In the event that the triggering criteria specified in Section 11.1 of the Plan for Stage 3 - Severe Water Shortage Conditions have been met, the General Manager, or his/her designee(s), is hereby authorized to initiate allocation of water supplies on a pro rata basis in accordance with Texas Water Code Section 11.039. A provision will be included in every wholesale water contract entered into or renewed after adoption of the plan, including contract extensions, that in case of a shortage of water resulting from drought, the water to be distributed shall be divided in accordance with Texas Water Code §11.039. Customers with contracts for stored water from Canyon Reservoir may be subject to curtailment under the provisions of Section 9.3 of the Plan.

Section 13.0 Enforcement

The provisions of this Plan shall apply to all contracts and amendments for commitment of wholesale water executed after the date of approval of this Plan by the TCEQ and to diversions of water from GBRA's hydroelectric lakes, and shall be enforceable by the General Manager, or his/her designee, with assistance from the STWM.

Section 14.0 Variances

The General Manager, or his/her designee, may, in writing, grant a temporary variance to the pro rata water allocation policies provided by this Plan if it is determined that failure to grant such variance would cause an emergency condition adversely affecting the public health, welfare, or safety and if one or more of the following conditions are met:

1. Compliance with this Plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the Plan is in effect.

2. Alternative methods can be implemented which will achieve the same level of reduction in water use.

Persons requesting an exemption from the provisions of this Plan shall file a petition for variance with the General Manager within 5 days after pro rata allocation has been invoked. All petitions for variances shall be reviewed by the Board of Directors of GBRA, and shall include the following:

1. Name and address of the petitioner(s).

2. Detailed statement with supporting data and information as to how the pro rata allocation of water under the policies and procedures established in the Plan adversely affects the petitioner or what damage or harm will occur to the petitioner or others if petitioner complies with this Ordinance.

3. Description of the relief requested.

4. Period of time for which the variance is sought.

5. Alternative measures the petitioner is taking or proposes to take to meet the intent of this Plan and the compliance date.

6. Other pertinent information.

Variances granted by GBRA's Board of Directors shall be subject to the following conditions, unless waived or modified by the GBRA's Board or its designee:

1. Variances granted shall include a timetable for compliance.

2. Variances granted shall expire when the Plan is no longer in effect, unless the petitioner has failed to meet specified requirements.

No variance shall be retroactive or otherwise justify any violation of this Plan occurring prior to the issuance of the variance.

Section 15.0 Severability

It is hereby declared to be the intention of GBRA's Board of Directors that the sections, paragraphs, sentences, clauses, and phrases of this Plan are severable and, if any phrase, clause, sentence, paragraph, or section of this Plan shall be declared unconstitutional by the valid judgment or decree of any court of competent jurisdiction, such unconstitutionality shall not affect any of the remaining phrases, clauses, sentences, paragraphs, and sections of this Plan, since the same would not have been enacted by GBRA's Board of Directors without the incorporation into this Plan of any such unconstitutional phrase, clause, sentence, paragraph, or section.

RESOLUTION ADOPTING THE DROUGHT CONTINGENCY PLAN FOR GUADALUPE-BLANCO RIVER AUTHORITY

BE IT RESOLVED, that the Board of Directors of the Guadalupe-Blanco River Authority does hereby approve amendments to GBRA's Drought Contingency Plan and directs the General Manager to submit a copy of the Drought Contingency Plan, as amended, to the Texas Commission on Environmental Quality, to make improvements to the Drought Contingency Plan on a regular basis as consistent with sound water conservation management, and to administer and enforce the Drought Contingency Plan as approved and amended.

Adopted this the 16th day of April 2014.

Oscar H. Fogle, Chair
Board of Directors
Guadalupe-Blanco River Authority

Attest:

Rusty Brockman, Secretary-Treasurer
Board of Directors
Guadalupe-Blanco River Authority

Final Prioritizations of Recommended Water Management Strategies in the 2011 Regional Water Plans
REGION L

Unique ID #	Sponsor	Recommended Water Management Strategy (WMS) Name	Capital Cost ($)	Final Prioritization Score (max = 1,000)
1	BEXAR MET WATER DISTRICT	CRWA Wells Ranch project Phase I	$ -	938.33
2	CANYON REGIONAL WATER AUTHORITY	CRWA Wells Ranch project Phase I	$ -	938.33
3	CIBOLO	CRWA Wells Ranch project Phase I	$ -	938.33
4	CRYSTAL CLEAR WSC	CRWA Wells Ranch project Phase I	$ -	938.33
5	LA VERNIA	CRWA Wells Ranch project Phase I	$ -	938.33
6	BEXAR MET WATER DISTRICT	CRWA Wells Ranch project Phase II (including Gonzales County)	$ -	902.33
7	CANYON REGIONAL WATER AUTHORITY	CRWA Wells Ranch project Phase II (including Gonzales County)	$ 34,910,000	902.33
8	CIBOLO	CRWA Wells Ranch project Phase II (including Gonzales County)	$ -	902.33
9	GREEN VALLEY SUD	CRWA Wells Ranch project Phase II (including Gonzales County)	$ -	902.33
10	MARION	CRWA Wells Ranch project Phase II (including Gonzales County)	$ -	902.33
11	MARTINDALE WSC	CRWA Wells Ranch project Phase II (including Gonzales County)	$ -	902.33
12	SANTA CLARA	CRWA Wells Ranch project Phase II (including Gonzales County)	$ -	902.33
13	SCHERTZ	Regional Carrizo for SSLGC project expansion (including Gonzales County)	$ -	864.00
14	SELMA	Regional Carrizo for SSLGC project expansion (including Gonzales County)	$ -	864.00
15	IRRIGATION, ATASCOSA	Irrigation water conservation	$ -	862.74
16	ALAMO HEIGHTS	Edwards transfers	$ -	854.33
17	GARDEN RIDGE	Purchase from wholesale water provider (SSLGC)/redistribution of supplies	$ -	854.33
18	HONDO	Edwards transfers	$ -	854.33
19	KIRBY	Edwards transfers	$ -	854.33
20	LACOSTE	Edwards transfers	$ -	854.33
21	LYTLE	Edwards transfers	$ -	854.33
22	NATALIA	Edwards transfers	$ -	854.33
23	POINT COMFORT	Purchase from wholesale water provider (LNRA)/redistribution of supplies	$ -	854.33
24	SABINAL	Edwards transfers	$ -	854.33
25	UNIVERSAL CITY	Edwards transfers	$ -	854.33
26	UVALDE	Edwards transfers	$ -	854.33
27	WINDCREST	Edwards transfers	$ -	854.33
28	YANCEY WSC	Edwards transfers	$ -	854.33
29	MANUFACTURING, COMAL	Recycled water programs	$ 100,589,128	832.67
30	STEAM ELECTRIC POWER, ATASCOSA	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 4,808,000	832.33
31	AQUA WSC	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 1,984,000	824.33
32	KYLE	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ 86,417,021	824.00
33	MAXWELL WSC	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ -	824.00
34	MOUNTAIN CITY	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ 1,385,554	824.00
35	SAN MARCOS	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ 110,017,629	824.00
36	CRYSTAL CLEAR WSC	Regional Carrizo for SSLGC project expansion (including Gonzales County)	$ -	822.33
37	SCHERTZ-SEGUIN LOCAL GOVERNMENT CORPORATION	Regional Carrizo for SSLGC project expansion (including Gonzales County)	$ 28,189,000	822.33
38	CASTLE HILLS	Municipal water conservation	$ -	822.28
39	GONZALES COUNTY WSC	TWA Regional Carrizo (including Gonzales County)	$ -	816.00
40	TEXAS WATER ALLIANCE	TWA Regional Carrizo (including Gonzales County)	$ 313,060,000	816.00
41	WIMBERLEY WSC	Wimberley and Woodcreek water supply project	$ -	816.00
42	WOODCREEK	Wimberley and Woodcreek water supply project	$ -	816.00
43	WOODCREEK UTILITIES INC	Wimberley and Woodcreek water supply project	$ -	816.00
44	CASTLE HILLS	Local groundwater (Trinity Aquifer)	$ -	814.33

*Prioritizations are based on Uniform Standards developed and adopted by the HB4 Stakeholder Committee.
**Projects are ordered from highest to lowest score.

Final Prioritizations of Recommended Water Management Strategies in the 2011 Regional Water Plans
REGION L

Unique ID #	Sponsor	Recommended Water Management Strategy (WMS) Name	Capital Cost ($)	Final Prioritization Score (max = 1,000)
45	COUNTY-OTHER, MEDINA	Edwards transfers	$ -	814.33
46	EAST MEDINA SUD	Edwards transfers	$ -	814.33
47	HILL COUNTRY VILLAGE	Edwards transfers	$ -	814.33
48	HOLLYWOOD PARK	Edwards transfers	$ -	814.33
49	ATASCOSA RURAL WSC	Edwards transfers	$ -	812.67
50	CASTROVILLE	Edwards transfers	$ -	812.67
51	PLUM CREEK WATER COMPANY	GBRA mid basin (surface water)	$ -	812.00
52	WINDCREST	Municipal water conservation	$ -	804.44
53	ALAMO HEIGHTS	Municipal water conservation	$ -	793.97
54	MANUFACTURING, BEXAR	Recycled water programs	$ 196,094,169	792.67
55	SABINAL	Municipal water conservation	$ -	791.64
56	BEXAR MET WATER DISTRICT	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 44,372,000	790.67
57	IRRIGATION, MEDINA	Irrigation water conservation	$ -	789.33
58	SHAVANO PARK	Municipal water conservation	$ -	788.34
59	JOURDANTON	Municipal water conservation	$ -	785.38
60	CANYON REGIONAL WATER AUTHORITY	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ 94,758,058	782.33
61	COUNTY LINE WSC	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ -	782.33
62	CRYSTAL CLEAR WSC	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ -	782.33
63	EAST CENTRAL WSC	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ -	782.33
64	GOFORTH WSC	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ 15,139,490	782.33
65	GREEN VALLEY SUD	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ -	782.33
66	LA VERNIA	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ -	782.33
67	MARION	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ -	782.33
68	SANTA CLARA	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ -	782.33
69	SS WSC	Hays/Caldwell Public Utility Authority Project (including Gonzales County)	$ -	782.33
70	MANUFACTURING, CALHOUN	Construction of Lavaca River off-channel reservoir diversion project (Region L component)	$ 85,429,083	780.67
71	GUADALUPE BLANCO RIVER AUTHORITY	GBRA mid basin (surface water)	$ 546,941,000	778.33
72	MUSTANG RIDGE	Municipal water conservation	$ -	775.24
73	BEXAR MET WATER DISTRICT	Medina Lake firm-up (aquifer storage and recovery)	$ 146,237,000	774.33
74	BULVERDE CITY	TWA Regional Carrizo (including Gonzales County)	$ -	774.33
75	CANYON LAKE WSC	TWA Regional Carrizo (including Gonzales County)	$ -	774.33
76	CIBOLO	Medina Lake firm-up (aquifer storage and recovery)	$ -	774.33
77	COUNTY-OTHER, COMAL	TWA Regional Carrizo (including Gonzales County)	$ -	774.33
78	GUADALUPE BLANCO RIVER AUTHORITY	Wimberley and Woodcreek water supply project	$ 33,771,000	774.33
79	SHAVANO PARK	Edwards transfers	$ -	774.33
80	SPRINGS HILL WSC	TWA Regional Carrizo (including Gonzales County)	$ -	774.33
81	WATER SERVICES INC	TWA Regional Carrizo (including Gonzales County)	$ -	774.33
82	NEW BRAUNFELS	GBRA Simsboro project (overdraft)	$ -	774.00
83	MINING, COMAL	Industrial, steam-electric power generation, and mining water conservation	$ -	772.67
84	MINING, HAYS	Industrial, steam-electric power generation, and mining water conservation	$ -	772.67
85	JOURDANTON	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 2,441,000	772.33
86	MCCOY WSC	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 5,803,000	772.33
87	CANYON REGIONAL WATER AUTHORITY	GBRA mid basin (surface water)	$ -	770.33
88	CIBOLO	GBRA mid basin (surface water)	$ -	770.33
89	CREEDMOOR-MAHA WSC	GBRA mid basin (surface water)	$ -	770.33
90	CRYSTAL CLEAR WSC	GBRA mid basin (surface water)	$ -	770.33
91	GOFORTH WSC	GBRA mid basin (surface water)	$ -	770.33

*Prioritizations are based on Uniform Standards developed and adopted by the HB4 Stakeholder Committee.
**Projects are ordered from highest to lowest score.

Final Prioritizations of Recommended Water Management Strategies in the 2011 Regional Water Plans
REGION L

Unique ID #	Sponsor	Recommended Water Management Strategy (WMS) Name	Capital Cost ($)	Final Prioritization Score (max = 1,000)
92	GREEN VALLEY SUD	GBRA mid basin (surface water)	$ -	770.33
93	LOCKHART	GBRA mid basin (surface water)	$ -	770.33
94	LULING	GBRA mid basin (surface water)	$ -	770.33
95	MARION	GBRA mid basin (surface water)	$ -	770.33
96	MUSTANG RIDGE	GBRA mid basin (surface water)	$ -	770.33
97	NIEDERWALD	GBRA mid basin (surface water)	$ -	770.33
98	SANTA CLARA	GBRA mid basin (surface water)	$ -	770.33
99	BOERNE	Municipal water conservation	$ -	769.33
100	FLORESVILLE	Municipal water conservation	$ -	769.33
101	KENEDY	Municipal water conservation	$ -	769.33
102	SELMA	Municipal water conservation	$ -	769.33
103	UVALDE	Municipal water conservation	$ -	767.42
104	HONDO	Municipal water conservation	$ -	761.25
105	KARNES CITY	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 3,430,000	752.33
106	COUNTY-OTHER, BEXAR	Municipal water conservation	$ -	750.25
107	STEAM ELECTRIC POWER, VICTORIA	Purchase from wholesale water provider (GBRA)	$ -	749.33
108	WATER SERVICES INC	Edwards transfers	$ -	745.78
109	BEXAR MET WATER DISTRICT	Edwards transfers	$ -	744.91
110	CASTROVILLE	Municipal water conservation	$ -	744.79
111	SAN ANTONIO WATER SYSTEM	Edwards transfers	$ -	743.85
112	GUADALUPE BLANCO RIVER AUTHORITY	Storage above Canyon Reservoir (aquifer storage and recovery)	$ 37,326,000	742.33
113	GUADALUPE BLANCO RIVER AUTHORITY	GBRA lower basin storage	$ 33,800,000	741.54
114	MANUFACTURING, VICTORIA	GBRA lower basin storage	$ -	741.54
115	STEAM ELECTRIC POWER, VICTORIA	GBRA lower basin storage	$ -	741.54
116	MANUFACTURING, BEXAR	Recycled water programs	$ -	741.01
117	HOLLYWOOD PARK	Municipal water conservation	$ -	737.32
118	HILL COUNTRY VILLAGE	Municipal water conservation	$ -	737.15
119	YANCEY WSC	Municipal water conservation	$ -	736.49
120	GARDEN RIDGE	Municipal water conservation	$ -	736.06
121	POINT COMFORT	Municipal water conservation	$ -	735.31
122	NEW BRAUNFELS	Municipal water conservation	$ -	734.80
123	CONVERSE	Local groundwater (Trinity Aquifer)	$ -	734.33
124	COUNTY LINE WSC	Local groundwater (Trinity Aquifer)	$ 20,562,000	732.67
125	BULVERDE CITY	GBRA Simsboro project (overdraft)	$ -	732.33
126	CANYON LAKE WSC	GBRA Simsboro project (overdraft)	$ -	732.33
127	COUNTY-OTHER, COMAL	GBRA Simsboro project (overdraft)	$ -	732.33
128	GUADALUPE BLANCO RIVER AUTHORITY	GBRA Simsboro project (overdraft)	$ 330,782,000	732.33
129	MANUFACTURING, COMAL	GBRA Simsboro project (overdraft)	$ -	732.33
130	SS WSC	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 29,537,000	730.67
131	IRRIGATION, ZAVALA	Irrigation water conservation	$ -	730.56
132	SUNKO WSC	Municipal water conservation	$ -	729.33
133	SCHERTZ	Municipal water conservation	$ -	723.22
134	WOODCREEK UTILITIES INC	Municipal water conservation	$ -	721.16
135	LULING	Municipal water conservation	$ -	717.62
136	BEXAR MET WATER DISTRICT	Local groundwater (Trinity Aquifer)	$ 9,662,000	712.47
137	NATALIA	Municipal water conservation	$ -	712.19
138	COUNTY-OTHER, VICTORIA	GBRA new appropriation (lower basin)	$ -	712.00
139	MANUFACTURING, VICTORIA	Purchase from wholesale water provider (GBRA)	$ -	709.33
140	SAN MARCOS	Municipal water conservation	$ -	705.44
141	GUADALUPE BLANCO RIVER AUTHORITY	GBRA Integrated Water-Power Project	$ 1,181,020,000	704.67
142	LOCKHART	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 24,246,000	702.67
143	LULING	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 5,906,000	702.67
144	COUNTY LINE WSC	Municipal water conservation	$ -	702.52
145	SAN ANTONIO	Municipal water conservation	$ -	702.34
146	COUNTY-OTHER, KENDALL	Storage above Canyon Reservoir (aquifer storage and recovery)	$ -	700.67
147	CANYON REGIONAL WATER AUTHORITY	CRWA Siesta project	$ 53,481,000	694.33
148	CIBOLO	CRWA Siesta project	$ -	694.33

*Prioritizations are based on Uniform Standards developed and adopted by the HB4 Stakeholder Committee.
**Projects are ordered from highest to lowest score.

Final Prioritizations of Recommended Water Management Strategies in the 2011 Regional Water Plans
REGION L

Unique ID #	Sponsor	Recommended Water Management Strategy (WMS) Name	Capital Cost ($)	Final Prioritization Score (max = 1,000)
149	GREEN VALLEY SUD	CRWA Siesta project	$ -	694.33
150	MARION	CRWA Siesta project	$ -	694.33
151	BENTON CITY WSC	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 4,372,000	692.33
152	SAN ANTONIO WATER SYSTEM	Recycled water programs	$ 168,655,703	691.32
153	BULVERDE CITY	Purchase from wholesale water provider (GBRA)	$ -	689.33
154	COUNTY-OTHER, KENDALL	Purchase from wholesale water provider (GBRA)	$ -	689.33
155	LIVESTOCK, GOLIAD	Livestock water conservation	$ -	689.33
156	MANUFACTURING, COMAL	Purchase from wholesale water provider (GBRA)	$ -	689.33
157	MUSTANG RIDGE	Purchase from wholesale water provider (GBRA)	$ -	689.33
158	NIEDERWALD	Purchase from wholesale water provider (GBRA)	$ -	689.33
159	WATER SERVICES INC	Purchase from wholesale water provider (SSLGC)/redistribution of supplies	$ -	689.02
160	ASHERTON	Municipal water conservation	$ -	686.00
161	BALCONES HEIGHTS	Municipal water conservation	$ -	686.00
162	CARRIZO SPRINGS	Municipal water conservation	$ -	686.00
163	CHINA GROVE	Municipal water conservation	$ -	686.00
164	CIBOLO	Municipal water conservation	$ -	686.00
165	COTULLA	Municipal water conservation	$ -	686.00
166	COUNTY-OTHER, GUADALUPE	Municipal water conservation	$ -	686.00
167	CRYSTAL CITY	Municipal water conservation	$ -	686.00
168	CUERO	Municipal water conservation	$ -	686.00
169	DEVINE	Municipal water conservation	$ -	686.00
170	DILLEY	Municipal water conservation	$ -	686.00
171	EL OSO WSC	Municipal water conservation	$ -	686.00
172	FAIROAKS RANCH	Municipal water conservation	$ -	686.00
173	FALLS CITY	Municipal water conservation	$ -	686.00
174	GONZALES	Municipal water conservation	$ -	686.00
175	GONZALES COUNTY WSC	Municipal water conservation	$ -	686.00
176	HELOTES	Municipal water conservation	$ -	686.00
177	LA VERNIA	Municipal water conservation	$ -	686.00
178	LACKLAND AFB	Municipal water conservation	$ -	686.00
179	NIXON	Municipal water conservation	$ -	686.00
180	OLMOS PARK	Municipal water conservation	$ -	686.00
181	PEARSALL	Municipal water conservation	$ -	686.00
182	PLEASANTON	Municipal water conservation	$ -	686.00
183	POTEET	Municipal water conservation	$ -	686.00
184	REFUGIO	Municipal water conservation	$ -	686.00
185	SEADRIFT	Municipal water conservation	$ -	686.00
186	SEGUIN	Municipal water conservation	$ -	686.00
187	SOMERSET	Municipal water conservation	$ -	686.00
188	SPRINGS HILL WSC	Municipal water conservation	$ -	686.00
189	STOCKDALE	Municipal water conservation	$ -	686.00
190	TERRELL HILLS	Municipal water conservation	$ -	686.00
191	VICTORIA	Municipal water conservation	$ -	686.00
192	GREEN VALLEY SUD	Purchase from New Braunfels Utilities/redistribution of supplies	$ -	677.88
193	LYTLE	Municipal water conservation	$ -	676.33
194	CANYON REGIONAL WATER AUTHORITY	Brackish groundwater desalination (Wilcox Aquifer) (RWA)	$ 97,347,786	674.33
195	CRYSTAL CLEAR WSC	Brackish groundwater desalination (Wilcox Aquifer) (RWA)	$ -	674.33
196	GREEN VALLEY SUD	Brackish groundwater desalination (Wilcox Aquifer) (RWA)	$ -	674.33
197	SCHERTZ-SEGUIN LOCAL GOVERNMENT CORPORATION	Brackish groundwater desalination (Wilcox Aquifer) (RWA)	$ 17,374,408	674.33
198	SPRINGS HILL WSC	Brackish groundwater desalination (Wilcox Aquifer) (RWA)	$ 13,030,806	674.33
199	KYLE	Municipal water conservation	$ -	672.89
200	GUADALUPE BLANCO RIVER AUTHORITY	GBRA Exelon project	$ 280,598,000	671.67
201	SAN ANTONIO WATER SYSTEM	Drought management	$ -	670.26
202	SAN ANTONIO WATER SYSTEM	Regional Carrizo for SAWS (including Gonzalas County)	$ 136,550,000	666.20
203	CHARLOTTE	Municipal water conservation	$ -	666.00
204	COUNTY-OTHER, KARNES	Municipal water conservation	$ -	666.00
205	COUNTY-OTHER, ZAVALA	Municipal water conservation	$ -	666.00
206	GOLIAD	Municipal water conservation	$ -	666.00
207	YOAKUM	Municipal water conservation	$ -	666.00

*Prioritizations are based on Uniform Standards developed and adopted by the HB4 Stakeholder Committee.
**Projects are ordered from highest to lowest score.

Final Prioritizations of Recommended Water Management Strategies in the 2011 Regional Water Plans
REGION L

Unique ID #	Sponsor	Recommended Water Management Strategy (WMS) Name	Capital Cost ($)	Final Prioritization Score (max = 1,000)
208	MOUNTAIN CITY	Municipal water conservation	$ -	661.09
209	SAN ANTONIO WATER SYSTEM	Brackish groundwater desalination (Wilcox Aquifer) (SAWS)	$ 236,220,000	656.80
210	BOERNE	Western Canyon water treatment plant expansion	$ -	656.00
211	MINING, BEXAR	Industrial, steam-electric power generation, and mining water conservation	$ -	652.67
212	EAST CENTRAL WSC	Edwards transfers	$ -	649.33
213	COUNTY-OTHER, MEDINA	Municipal water conservation	$ -	648.75
214	COUNTY-OTHER, COMAL	Purchase from New Braunfels Utilities/redistribution of supplies	$ -	647.67
215	COUNTY-OTHER, COMAL	Purchase from wholesale water provider (GBRA)	$ -	647.67
216	SAN ANTONIO WATER SYSTEM	Aquifer storage and recovery project and phased expansion	$ -	646.87
217	BIG WELLS	Municipal water conservation	$ -	646.00
218	COUNTY-OTHER, ATASCOSA	Municipal water conservation	$ -	646.00
219	COUNTY-OTHER, CALDWELL	Municipal water conservation	$ -	646.00
220	COUNTY-OTHER, GONZALES	Municipal water conservation	$ -	646.00
221	COUNTY-OTHER, LA SALLE	Municipal water conservation	$ -	646.00
222	ENCINAL	Municipal water conservation	$ -	646.00
223	POTH	Municipal water conservation	$ -	646.00
224	RUNGE	Municipal water conservation	$ -	646.00
225	WOODSBORO	Municipal water conservation	$ -	646.00
226	UNIVERSAL CITY	Drought management	$ -	629.33
227	SAN ANTONIO WATER SYSTEM	Edwards Aquifer recharge - Type 2 projects	$ 527,643,000	627.90
228	POINT COMFORT	Drought management	$ -	625.93
229	EAST CENTRAL WSC	Local groundwater (Trinity Aquifer)	$ -	623.69
230	SHAVANO PARK	Drought management	$ -	616.68
231	NIEDERWALD	Municipal water conservation	$ -	615.99
232	COUNTY-OTHER, KENDALL	Western Canyon water treatment plant expansion	$ -	614.33
233	GUADALUPE BLANCO RIVER AUTHORITY	Western Canyon water treatment plant expansion	$ 11,727,436	614.33
234	UVALDE	Drought management	$ -	613.99
235	CANYON LAKE WSC	Municipal water conservation	$ -	613.41
236	MANUFACTURING, BEXAR	Edwards transfers	$ -	611.36
237	HOLLYWOOD PARK	Drought management	$ -	610.91
238	HILL COUNTRY VILLAGE	Drought management	$ -	610.79
239	SAN ANTONIO WATER SYSTEM	Firm-up- run-of-river with off-channel reservoir - LCRA/SAWS project (Region L component)	$ 1,986,684,000	609.01
240	COUNTY LINE WSC	Drought management	$ -	606.00
241	CREEDMOOR-MAHA WSC	Purchase from wholesale water provider (GBRA)	$ -	606.00
242	NEW BRAUNFELS	Drought management	$ -	606.00
243	YORKTOWN	Municipal water conservation	$ -	606.00
244	LYTLE	Drought management	$ -	600.18
245	KIRBY	Drought management	$ -	598.44
246	GARDEN RIDGE	Drought management	$ -	595.08
247	LACOSTE	Drought management	$ -	595.06
248	COUNTY-OTHER, BEXAR	Edwards transfers	$ -	594.33
249	CRYSTAL CLEAR WSC	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 33,754,000	590.67
250	ATASCOSA RURAL WSC	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ -	590.53
251	WATER SERVICES INC	Drought management	$ -	590.39
252	WOODCREEK	Drought management	$ -	589.48
253	GUADALUPE BLANCO RIVER AUTHORITY	GBRA new appropriation (lower basin)	$ 246,849,000	587.00
254	LULING	Drought management	$ -	586.00
255	MARTINDALE	Drought management	$ -	586.00
256	LOCKHART	Municipal water conservation	$ -	579.77
257	BULVERDE CITY	Municipal water conservation	$ -	575.29
258	SS WSC	Drought management	$ -	575.15
259	KENEDY	Local groundwater (Gulf Coast Aquifer)	$ 2,194,000	574.33
260	COUNTY-OTHER, WILSON	Municipal water conservation	$ -	569.33
261	MARTINDALE WSC	Drought management	$ -	563.86
262	SABINAL	Drought management	$ -	559.12
263	WOODCREEK	Municipal water conservation	$ -	555.00
264	FLORESVILLE	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 2,344,000	544.33

*Prioritizations are based on Uniform Standards developed and adopted by the HB4 Stakeholder Committee.
**Projects are ordered from highest to lowest score.

Final Prioritizations of Recommended Water Management Strategies in the 2011 Regional Water Plans
REGION L

Unique ID #	Sponsor	Recommended Water Management Strategy (WMS) Name	Capital Cost ($)	Final Prioritization Score (max = 1,000)
265	CASTLE HILLS	Drought management	$ -	541.59
266	SANTA CLARA	Municipal water conservation	$ -	536.52
267	JOURDANTON	Drought management	$ -	535.76
268	MUSTANG RIDGE	Drought management	$ -	532.32
269	HONDO	Drought management	$ -	529.25
270	AQUA WSC	Drought management	$ -	528.11
271	COUNTY-OTHER, HAYS	Municipal water conservation	$ -	526.00
272	EAST MEDINA SUD	Drought management	$ -	526.00
273	KYLE	Drought management	$ -	526.00
274	OAK HILLS WSC	Municipal water conservation	$ -	524.03
275	WIMBERLEY WSC	Drought management	$ -	520.84
276	ALAMO HEIGHTS	Drought management	$ -	520.64
277	SANTA CLARA	Drought management	$ -	518.06
278	NIEDERWALD	Drought management	$ -	516.06
279	CASTROVILLE	Drought management	$ -	515.64
280	NATALIA	Drought management	$ -	513.30
281	ATASCOSA RURAL WSC	Drought management	$ -	513.17
282	BULVERDE CITY	Drought management	$ -	512.76
283	SAN ANTONIO	Drought management	$ -	507.32
284	CHARLOTTE	Drought management	$ -	506.00
285	LOCKHART	Drought management	$ -	506.00
286	POLONIA WSC	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 2,087,000	504.33
287	WATER SERVICES INC	Municipal water conservation	$ -	491.27
288	SS WSC	Brackish groundwater desalination (Wilcox Aquifer) (SS WSC)	$ 14,357,000	475.12
289	COUNTY-OTHER, UVALDE	Municipal water conservation	$ -	466.00
290	WAELDER	Municipal water conservation	$ -	446.00
291	UNIVERSAL CITY	Municipal water conservation	$ -	433.09
292	CHARLOTTE	Facilities expansion	$ 38,356,000	427.67
293	COUNTY-OTHER, CALDWELL	Facilities expansion	$ 17,584,000	427.67
294	HELOTES	Facilities expansion	$ 2,863,000	427.67
295	BENTON CITY WSC	Municipal water conservation	$ -	424.79
296	OAK HILLS WSC	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 259,000	424.33
297	SUNKO WSC	Local groundwater Carrizo-Wilcox Aquifer (includes overdrafts)	$ 1,375,000	424.33
298	MCCOY WSC	Municipal water conservation	$ -	421.72
299	CONVERSE	Municipal water conservation	$ -	417.90
300	COUNTY-OTHER, KENDALL	Municipal water conservation	$ -	414.49
301	CRYSTAL CLEAR WSC	Municipal water conservation	$ -	413.42
302	SS WSC	Municipal water conservation	$ -	413.37
303	WIMBERLEY WSC	Municipal water conservation	$ -	411.48
304	ELMENDORF	Municipal water conservation	$ -	406.00
305	PORT LAVACA	Municipal water conservation	$ -	406.00
306	PORT O'CONNOR MUD	Municipal water conservation	$ -	406.00
307	EAST MEDINA SUD	Municipal water conservation	$ -	399.15
308	EAST CENTRAL WSC	Municipal water conservation	$ -	398.92
309	AQUA WSC	Municipal water conservation	$ -	392.04
310	ATASCOSA RURAL WSC	Facilities expansion	$ 72,433,000	386.00
311	CASTROVILLE	Facilities expansion	$ 11,046,000	386.00
312	SPRINGS HILL WSC	Facilities expansion	$ 2,277,000	386.00
313	MARION	Municipal water conservation	$ -	381.83
314	PLUM CREEK WATER COMPANY	Municipal water conservation	$ -	375.05
315	MAXWELL WSC	Municipal water conservation	$ -	374.58
316	LACOSTE	Municipal water conservation	$ -	373.65
317	GOFORTH WSC	Municipal water conservation	$ -	372.06
318	SAN ANTONIO WATER SYSTEM	Seawater desalination	$ 1,293,827,000	360.12
319	COUNTY-OTHER, VICTORIA	Municipal water conservation	$ -	343.20
320	BEXAR MET WATER DISTRICT	Municipal water conservation	$ -	332.94
321	COUNTY-OTHER, COMAL	Municipal water conservation	$ -	330.79
322	COUNTY-OTHER, FRIO	Municipal water conservation	$ -	326.00
323	LEON VALLEY	Municipal water conservation	$ -	326.00

*Prioritizations are based on Uniform Standards developed and adopted by the HB4 Stakeholder Committee.
**Projects are ordered from highest to lowest score.

Final Prioritizations of Recommended Water Management Strategies in the 2011 Regional Water Plans
REGION L

Unique ID #	Sponsor	Recommended Water Management Strategy (WMS) Name	Capital Cost ($)	Final Prioritization Score (max = 1,000)
324	ST. HEDWIG	Municipal water conservation	$ -	326.00
325	KARNES CITY	Municipal water conservation	$ -	313.00
326	ATASCOSA RURAL WSC	Municipal water conservation	$ -	309.01
327	GREEN VALLEY SUD	Municipal water conservation	$ -	291.21
328	COUNTY-OTHER, DEWITT	Municipal water conservation	$ -	286.00
329	COUNTY-OTHER, GOLIAD	Municipal water conservation	$ -	286.00
330	CREEDMOOR-MAHA WSC	Municipal water conservation	$ -	286.00

*Prioritizations are based on Uniform Standards developed and adopted by the HB4 Stakeholder Committee.
**Projects are ordered from highest to lowest score.