7 DROUGHT RESPONSE INFORMATION, ACTIVITIES, AND RECOMMENDATIONS

During the past century, recurring drought has been a natural part of Texas' varying climate, especially in the arid and semi-arid regions of the state. An old saying about droughts in west Texas is that "droughts are continual with short intermittent periods of rainfall." Droughts, due to their complex nature, are difficult to define and understand, especially in a context that is useful for communities that must plan and prepare for drought. Drought directly impacts the availability of ground and surface water supplies for agricultural, industrial, municipal, recreational, and designated aquatic life uses. The location, duration, and severity of drought determine the extent to which the natural environment, human activities, and economic factors are impacted.

Geography, geology, and climate vary significantly from east to west in Region F. Ecoregions within Region F vary from the Edwards Plateau to the east, Central Great and Western High Plains in the central and northern portions of the region, and Chihuahuan Deserts to the west. Annual rainfall in Region F ranges from an average of more than 30 inches in the east to slightly more than 11 inches in the west. Likewise, the annual gross reservoir evaporation rate ranges from 60 inches in the east to approximately 75 inches in the western portion of the region.

Numerous definitions of drought have been developed to describe drought conditions based on various factors and potential consequences. In the simplest of terms, drought can be defined as "a prolonged period of below-normal rainfall." However, the State Drought Preparedness Plan provides more specific and detailed definitions shown in the box at right.

These definitions are not mutually exclusive, and provide valuable insight into the complexity of droughts and their impacts. They also help to identify factors to be considered in the development of appropriate and effective drought preparation and contingency measures.

Types of Drought

- **Meteorological Drought.** A period of substantially diminished precipitation duration and/or intensity that persists long enough to produce a significant hydrologic imbalance.
- **Agricultural Drought.** Inadequate precipitation and/or soil moisture to sustain crop or forage production systems. The water deficit results in serious damage and economic loss to plant and animal agriculture. Agricultural drought usually begins after meteorological drought but before hydrological drought and can also affect livestock and other agricultural operations.
- **Hydrological Drought.** Refers to deficiencies in surface and subsurface water supplies. It is measured as streamflow, and as lake, reservoir, and groundwater levels. There is usually a lack of rain or snow and less measurable water in streams, lakes, and reservoirs, making hydrological measurements not the earliest indicators of drought.
- **Socioeconomic Drought.** Occurs when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought starts to affect the supply and demand of an economic product.

Droughts have often been described as "insidious by nature." This is mainly due to several factors:

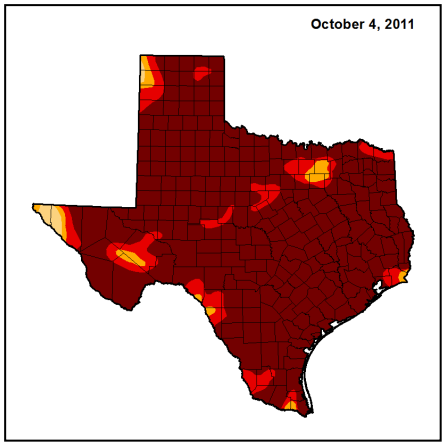
- Droughts cannot be accurately characterized by well-defined beginning or end points.
- Severity of drought-related impacts is dependent on antecedent conditions, as well as ambient conditions such as temperature, wind, and cloud cover.

- Droughts, depending on their severity, may have significant impacts on human activities; and human activities during periods of drought may exacerbate the drought conditions through increased water usage and demand.

Furthermore, the impact of a drought may extend well past the time when normal or above-normal precipitation returns.

7.1 Drought of Record in the Regional Water Planning Area (RWPA)

Various indices have been developed in an attempt to quantify drought severity for assessment and comparative purposes. One numerical measure of drought severity that is frequently used by many federal and state government agencies is the Palmer Drought Severity Index (PDSI). It is an estimate of soil moisture that is calculated based on precipitation and temperature. Another measure is the Drought Monitor that incorporates measurement of climate, hydrologic and soils conditions as well as site specific observations and reports. The Drought Monitor is distributed weekly and is often the tool used to convey drought conditions to the public and water users. In 2011, all counties of Region F experienced at least some periods of severe or extreme drought. Conditions have improved since 2011 but the Region is still experiencing ongoing drought conditions



Drought Monitor, October 2011

7.1.1 Drought of Record in Region F

The drought of record is commonly defined as the worst drought to occur in a region during the entire period of meteorological record keeping. For most of Texas, the drought of record occurred from 1950 to 1957. During the 1950's drought, many wells, springs, streams, and rivers went dry and some cities had to rely on water trucked in from other areas to meet drinking water demands. By the end of 1956, 244 of the 254 Texas counties were classified as disaster areas due to the drought, including all of the counties in Region F.

During the past decade, most regions of Texas have experienced droughts resulting in diminished water supplies for agricultural and municipal use, decreased flows in streams and reservoirs, and significant economic loss. Droughts of severe to extreme conditions occurred in the 1950s, 1990s, 2000s, and 2010s in Region F. The worst year during the recent drought was 2011, when most Region F counties experienced extreme drought. Despite some improvements from the worst part of 2011, drought conditions continue to persist throughout the region today.

For reservoirs, the drought of record is defined as the period of record that includes the minimum content of the reservoir. The period is recorded from the last time the reservoir spills before reaching its minimum content to the next time the reservoir spills. If a reservoir has reached its minimum content but has not yet filled enough to spill, then it is considered to be still in drought of record conditions. Based on the water availability modeling, most of the reservoirs in Region F are currently experiencing a new drought of record. The minimum content of many reservoirs in the Colorado River Basin occurs at or near the end of the modeling simulation for TCEQ WAM Run 3 in December 2013. If the drought continues, the minimum content of the reservoir could continue to decrease, reducing the firm yield of

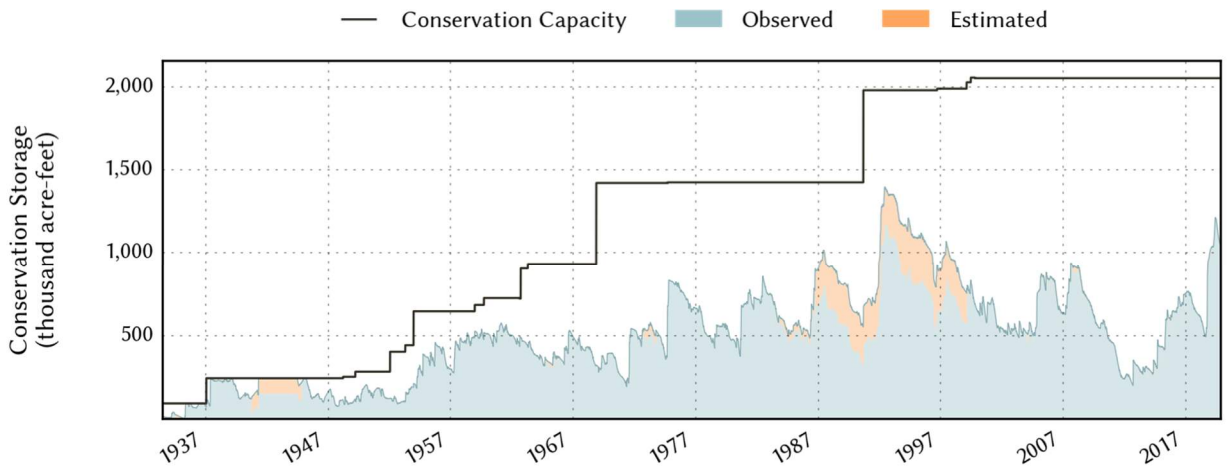
the reservoirs. The modeled drought of records for the reservoirs in Region F are shown below in Table 7-1. Figure 7-1 is another perspective of reservoir storage in the region during the most recent drought which is generated by TWDB[1].

Table 7-1
Modeled Droughts of Record in Region F

Reservoir	Date last full in WAM	Date of minimum content in WAM	Drought of Record based on the WAM
Ballinger/Moonen	March 2008	August 2012	2008 – Current
Balmorhea	February 1997	September 2000	1997 – 2000
Brady Creek	March 1998	June 2013	1998 – Current
Brownwood	July 2007	September 2013	2007 – Current
Champion Creek	May 1987	August 2012	1987 – Current
Coleman	August 2007	December 2013[b]	2007 – Current
Colorado City	May 1994	May 2003	1994 – Current
Hords Creek	July 2007	December 2013[b]	2007 – Current
Lake Clyde	August 2007	December 2013[b]	2007 – Current
Mountain Creek	May 2008	August 2012	2008 – Current
Nasworthy	April 2008	October 2013	2008 – Current
Oak Creek	June 1997	August 2012	1997 – Current
O.C. Fisher	June 1987	September 2013	1987 – Current
O.H. Ivie	June 1997	December 2013[b]	1997 – Current
Red Bluff	March 1943	September 2000[b,c]	1943 – 2000
Spence	June 1992[a]	August 2012	1992 – Current
Thomas	September 1962	December 2013[b]	1962 – Current
Twin Buttes	March 1993	December 2013[b]	1993 – Current
Winters	June 1997	August 2012	1997 – Current

(1) This reservoir has never filled. The Date Last Full is based on the firm yield analyses. (Note: Firm yield analyses assume the reservoir is full at the beginning of the simulation.)
(2) Date of the end of the simulation.
(3) Hydrology for WAM simulations for the Rio Grande River Basin end in 2000. It was not extended.

Figure 7-1
TWDB Region-F Planning Region Reservoirs



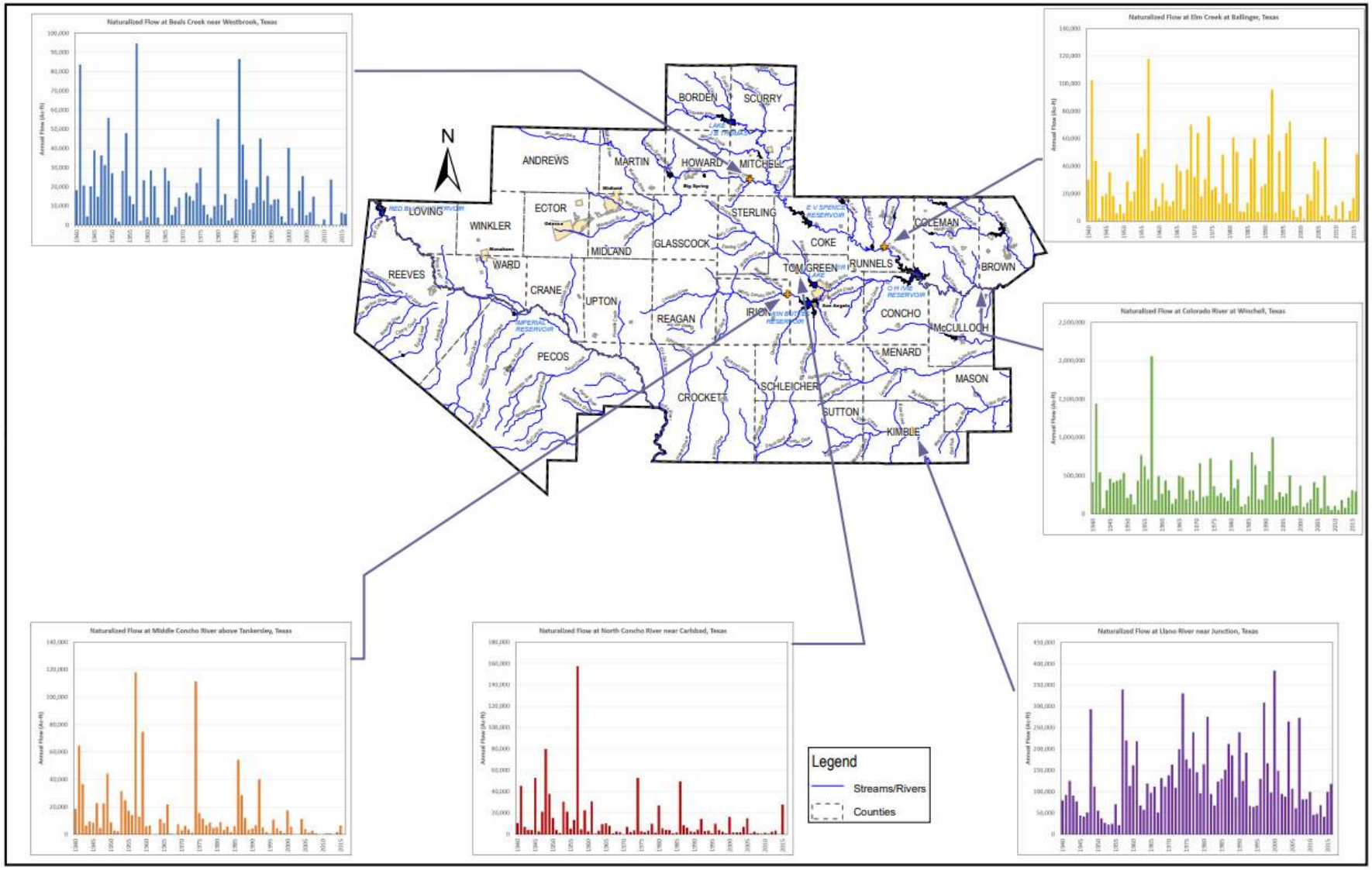
Drought of record conditions for run of the river supplies are typically evaluated based on minimum annual stream flows. Figure 7-2 shows the variations in naturalized flows from the WAM for seven U.S. Geological Survey (USGS) streamflow gages in Region F.[2] The five gages on tributaries have watersheds with limited development and show the natural variation in streamflows in this region. The Colorado gage near Winchell is the most downstream gage on the main stem of the Colorado River in Region F. Flows at the Pecos River gage near Girvin are largely controlled by releases from Red Bluff Reservoir. Based on the naturalized flows at these locations, the 2011 drought is the drought of record for the run-of-river supplies in the Colorado Basin with the exception of the Llano River where the drought of record is still in the 1950s. The drought of 2011 is also the drought of record for the Rio Grande River Basin in Region F.

For groundwater, meteorological and agricultural conditions were considered for defining the drought of record in Region F. The National Atmospheric and Oceanic Administration (NOAA) maintains data on the historical meteorological conditions and drought indices across the country. Figure 7-3 shows the historical precipitation for Midland, Texas. As is typical in Texas, the average annual precipitation in Region F increases from west to east. Midland is further west, and averages about 14.6 inches a year over the period shown. The years with the lowest historical precipitation occurred in 1951, 1998, and 2011. In 1951, 4.60 inches were recorded and 5.16 inches were recorded in 1998. In 2011, 5.47 inches were recorded. For both the 1950's drought and the recent drought, annual rainfall is significantly below average for an extended number of years. The current drought rivals the 1950's drought. Seven of the last fifteen years show rainfall less than the historic average. This is similar to the drought of the 1950s.

Drought Record in Region F:

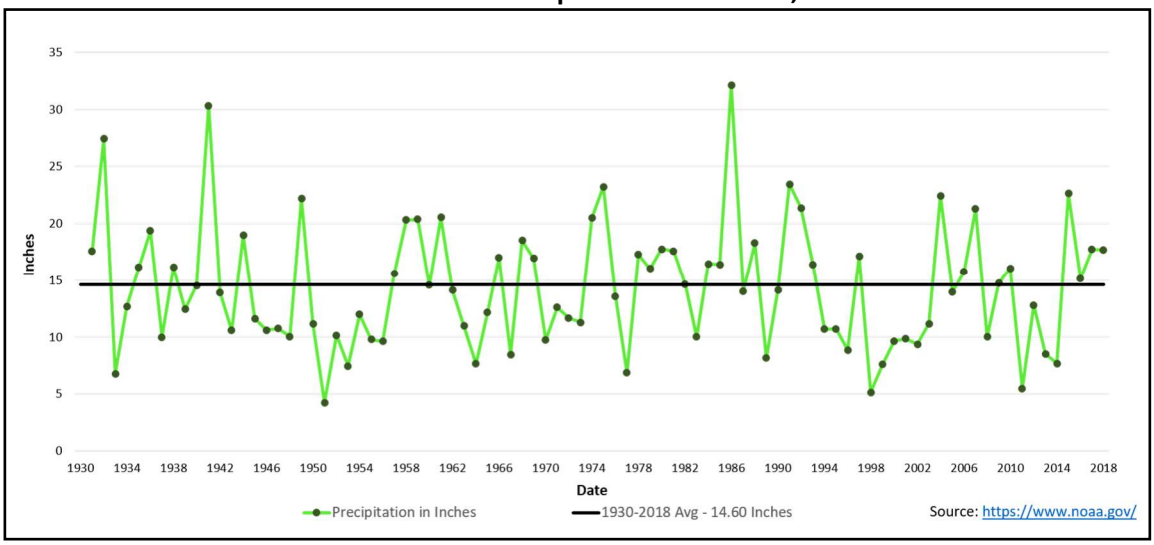
- The drought of record is worst drought in recorded history.
- For reservoirs, the drought of record is measured from the last time the reservoir was full before reaching its minimum content until the next time the reservoir fills and spill.
- For most of the region, the most recent drought in the 1990s, 2000s, and 2010s is the drought of record.
- This is different than most of the state where the drought of the 1950s is still the drought of record.
- In some cases, reservoirs in Region F still have not fully filled, indicating the drought of record is still on-going even though conditions have significantly improved over the past few years.
- 2011 was the worst single year of drought in Region F.

Figure 7-2
Region F Annual Streamflow



* Natural Dam Lake, which is above the Beals Creek gage, spilled intermittantly during 1986 and 1987. Natural Dam has subsequently been improved so that spills from the lake will not reoccur.

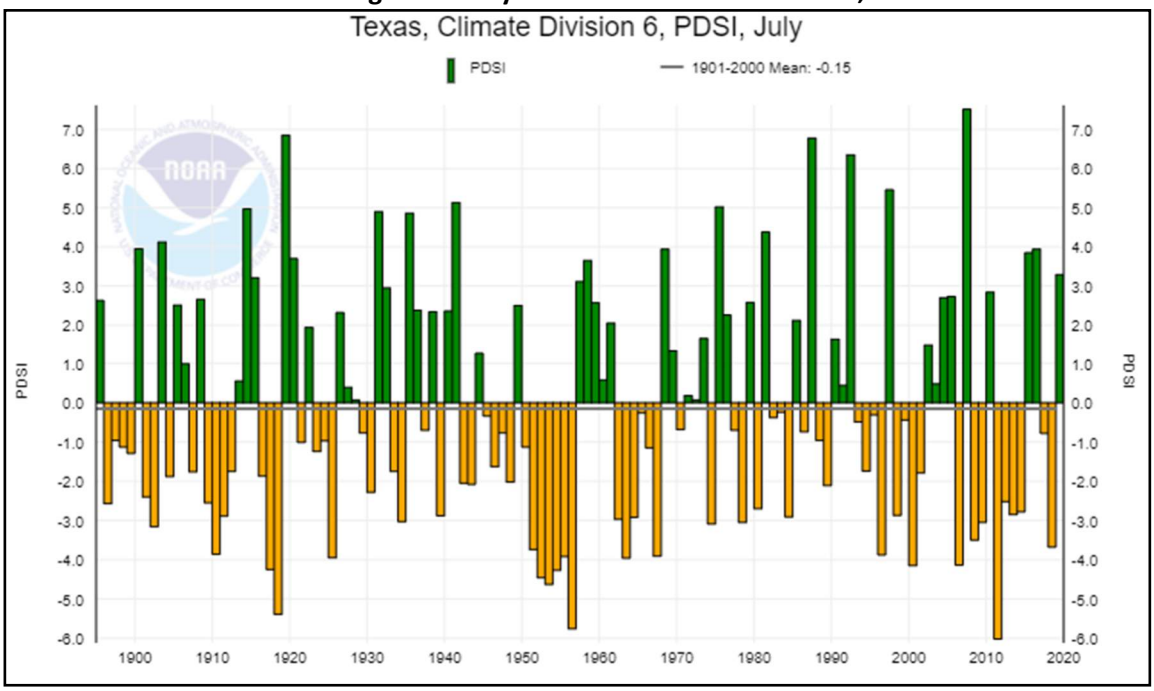
Figure 7-3
Historical Annual Precipitation in Midland, Texas



Looking at the Palmer Drought Severity Indices over the same time period for Climate Region 6 (where most of Region F is located), Figure 7-4 clearly shows the drought impacts during the 1950s and again since 2011. The Palmer Drought Severity Indices (PDSI) provide a measurement of long-term drought based on the intensity of drought during the current month plus the cumulative patterns of previous months. It considers antecedent soil moisture and precipitation. For Region F, these considerations are important in assessing the potential impacts to groundwater sources during drought from increases in water demands and agricultural water needs.

Considering both the annual precipitation and PDSI in the region, the drought of record for groundwater and run of the river sources is still the drought of the 1950s, although the current drought that began in 2011 is nearly as severe.

Figure 7-4
Palmer Drought Severity Indices for Edwards Plateau, Texas



7.1.2 Impacts of Drought on Water Supplies

Drought is a major threat to surface water supplies in Region F. For surface water, hydrological drought is significant because it impacts the yield of water sources. Typically, multi-year droughts have the greatest impact on a reservoir yield. Impacts of the new drought on reservoir yields in Region F using WAM Run 3 (no subordination) are negligible in most cases where the yields were already at or near zero. Impacts are more readily seen with the subordination strategy, which is discussed in Chapter 5C. With subordination, the analysis showed that most of the Colorado Basin reservoirs in Region F are currently experiencing new ongoing drought-of-record conditions. As a result of this current drought, many reservoirs have shown reductions in yield and may continue to decline if the drought persists.

Drought can also be a major threat to groundwater supplies that rely heavily on recharge. While some aquifers are less impacted by reduced recharge, others may be heavily impacted by the ongoing agricultural drought which can increase the demands on these sources. Furthermore, the reduced reliability of surface water sources in the region from the drought has caused many to shift to groundwater sources to secure a more drought-tolerant source of water supply. Over time the increased demands can impact the amount of storage in the aquifers for future use.

7.2 Current Drought Preparations and Response

In 1997, the Texas Legislature directed the TCEQ to adopt rules establishing common drought plan requirements for water suppliers in response to drought conditions throughout the State. Since 1997, the TCEQ has required all wholesale public water suppliers, retail public water suppliers serving 3,300 connections or more, and irrigation districts to develop, implement, and submit Drought Contingency Plans (DCPs) every five years. The most recent updates were to be submitted to the TCEQ by May 1, 2019. Retail public water suppliers serving less than 3,300 connections must prepare and adopt a DCP but are not required to submit plans to TCEQ. All DCPs should be made available for inspection by TCEQ. DCPs typically identify different stages of drought (e.g., mild, moderate, severe) and specific triggers and responses for each stage. In addition, DCPs specify quantifiable targets for water use reductions for each stage, and a means and method for enforcement.

Most wholesale water providers and municipalities in Region F have taken steps to prepare for and respond to drought through efforts, including the preparation of individual DCPs and readiness to implement them as necessary. Region F DCPs include specific water savings goals and drought contingency measures associated with multiple drought stages. In addition to these Plans, many water providers have a Management Supply Factor (or safety factor) greater than 1.0 for demands that are essential to public health and safety.

7.2.1 Drought Preparedness

Frequent recurring drought is a fact of life in Region F. Droughts have occurred in almost every decade since the 1940s. Recent experience with critical drought conditions attests to the effectiveness of drought management in the region. These reductions are at least partially due to the implementation of drought response activities included in the municipality's drought plan. However, according to city officials, the most significant factor in reducing water consumption is public awareness of drought conditions and voluntary reductions in water use. Some cities are pursuing aggressive water conservation programs that include using xeriscaping and efficient irrigation practices

for public properties such as parks and buildings, and reuse of treated effluent for municipal and manufacturing supplies.

In general, water suppliers in Region F identify the onset of drought (set drought triggers) based on either their current level of supply or their current level of demand. Often the triggers for surface water reservoirs are based on the current capacity of the reservoir as a percentage of the total reservoir capacity. In Region F, the reservoir operators use a combination of reservoir storage (elevation triggers) and/or demand levels. Triggers for groundwater supplies are commonly determined by demand as a percentage of total supply or total delivery capacity. Suppliers set these triggers as needed based on the individual parameters of their system. Customers of a wholesale water provider (WWP) are subject to the triggers and measures of the WWPs' Drought Plans.

Fourteen updated Drought Contingency Plans were either submitted to Region F or adopted by an entity during this round of planning. The majority of these DCPs use trigger conditions that are supply-based, while the rest either use triggers that are based on the demands placed on the water system, or are a combination of multiple conditions. Table 7-2 summarizes the basis of the drought triggers by provider. Appendix G, Table G-1 summarizes the triggers and actions by water provider for initiation and response to drought.

Table 7-2
Type of Trigger Condition for Entities with Drought Contingency Plans Submitted to the Region F Planning Group

Entity	Type Trigger Conditions	
	Demand	Supply
Brookesmith SUD	X	
Brownwood	X	X
Brown County WID		X
CRMWD		X
Ector County UD		X
Eden		X
Fort Stockton	X	
Grandfalls	X	
Midland	X	
Red Bluff Power Control District		X
San Angelo		X
Snyder	X	X
Sonora	X	X
UCRA		X

Challenges to the drought preparedness in Region F include the resources available to smaller cities to adequately prepare for drought and respond in a timely manner. Also, for many cities the drought of 2011 truly tested the entity's drought plan and triggers. Some water providers found that the triggers were not set at the appropriate level to initiate different stages of the drought plan. The 2011 drought came quickly and was very intense. This increased demands on local resources and for many groundwater users increased competition for the water. Some systems had difficulty meeting demands and little time to make adjustments.

Many water providers of surface water sources have proactively developed supplemental groundwater sources, providing additional protections during drought. Many of the groundwater users have expanded groundwater production or are planning to develop additional groundwater in response to the current drought. Groundwater in Region F provides a more drought-resilient water source, but it needs to be managed to assure future supplies.

7.3 Existing and Potential Emergency Interconnects

According to Texas Statute §357.42(d),(e) regional water planning groups are to collect information on existing major water infrastructure facilities that may be used in the event of an emergency shortage of water. Pertinent information includes identifying the potential user(s) of the interconnect, the potential supplier(s), the estimated potential volume of supply that could be provided, and a general description of the facility. Texas Water Code §16.053(c) requires information regarding facility locations to remain confidential. This section provides general information regarding existing and potential emergency interconnects among water user groups within Region F.

7.3.1 Existing Emergency Interconnects

Major water infrastructure facilities within Region F were identified through a survey process to better evaluate existing and potentially feasible emergency interconnects. Pecos County WCID and the City of Fort Stockton were described in the survey to have reverse capabilities of who could provide and who could receive. In addition, two of the four systems within Concho Rural Water North Concho Lake Estates system are linked. Table 7-3 presents the survey results for the existing emergency interconnects among water users and neighboring systems.

Table 7-3
Existing Emergency Interconnects to Major Water Facilities in Region F

Entity *Providing* Supply	Entity *Receiving* Supply
CRMWD	Monahans
Millersview-Doole WSC	City of Paint Rock
City of San Angelo	Millersview-Doole WSC
City of Fort Stockton	Pecos Co. Water District
Pecos Co. WCID #1	City of Fort Stockton
Concho Rural Water N. Concho Lake Estates	CRWC Grape Creek
Zephyr WSC	City of Blanket
City of Odessa	Steam Electric Power, Ector County

7.3.2 Potential Emergency Interconnects

Responses to survey questions helped identify other potential emergency interconnects for various WUGs in Region F. Table 7-4 presents a list of cities for those receiving and those supplying the potential emergency interconnects.

Table 7-4
Potential Emergency Interconnects to Major Water Facilities in Region F

Entity *Providing* Supply	Entity *Receiving* Supply
CRMWD (O.H. Ivie Lake)	Ballinger
Midland County FWSD#1	Greater Gardendale WSC
City of Ballinger	North Runnels WSC
Texland Great Plains WSC	City of Andrews
Millersview-Doole WSC	City of Miles
CRMWD	Wickett

Emergency interconnects were found to be not practical for many of the entities that were evaluated for potential emergency water supplies. The type of infrastructure required between entities to provide or receive water during an emergency shortage was deemed impractical due to long transmission distances. Furthermore, it was deemed impractical during an emergency situation, to complete the required construction in a reasonable timeframe.

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

Texas Statute §357.42(g) requires regional water planning groups to evaluate potential temporary emergency water supplies for all County-Other WUGs and municipalities with 2010 populations less than 7,500 that rely on a sole source of water. The purpose of this evaluation is to identify potential alternative water sources that may be considered for temporary emergency use in the event that the existing water supply sources become temporarily unavailable due to extreme hydrologic conditions such as emergency water right curtailment, unanticipated loss of reservoir conservation storage, or other localized drought impacts.

This section provides potential solutions that should act as a guide for municipal water users that are most vulnerable in the event of a loss of supply. This review was limited and did not require technical analyses or evaluations in accordance with 31 TAC §357.34.

7.4.1 Emergency Responses to Local Drought Conditions

A survey was conducted to identify and evaluate the municipal water users that are most vulnerable in the event of an emergency water shortage. The analysis included all County-Other WUGs and rural cities with a population less than 7,500 and on a sole source of water. A sole source is defined here as a single well field or single surface water source. If an entity receives water from a single wholesale provider with only one source, they were considered as part of this analysis. If an entity receives water from a single wholesale provider who has multiple sources, they were not considered to have a sole source and were not included in this analysis.

Table 7-5 presents potential temporary responses that may or may not require permanent infrastructure. It was assumed in the analysis that the entities listed would have approximately 180 days or less of remaining water supply.

Releases from Upstream Reservoirs and Curtailment of Rights

Releases from upstream reservoirs and curtailment of water rights was considered as a temporary measure that may help increase water supplies during an emergency water shortage. This response was only considered for those entities who receive surface water and may not be viable for all water right holders. Surface water in Texas is operated on a priority system and the water right holder may have no legal authority on which to request a release from an upstream reservoir or the curtailment of other water rights if their rights are junior. Even if the water user has a senior water right, in some cases, these strategies may result in what is known as a futile call. This occurs if shutting down a junior water right will not actually result in water being delivered to the senior right. In which case, the call will not be enforced.

Brackish Groundwater

Brackish groundwater was evaluated as a temporary source during an emergency water shortage. Some brackish groundwater is found in certain places in the Ogallala, but other brackish groundwater supplies can be obtained from the Dockum, Hickory, Ellenburger-San Saba, Lipan, Capitan Reef, Pecos Valley Alluvium and other formations which underlie the shallow aquifers found in Region F.

Required infrastructure would include additional groundwater wells, potential treatment facilities and conveyance facilities. Brackish groundwater at lower TDS concentrations may require only limited treatment. Twelve of the entities listed in Table 7-5 may not be able to potentially use brackish groundwater as a feasible solution to an emergency local drought condition.

Drill Additional Local Groundwater Wells and Trucking in Water

In the event that the existing water supply sources become temporarily unavailable, possible solutions include drilling additional groundwater wells or trucking in water. Table 7-5 presents this option as viable for all entities listed.

Table 7-5
Emergency Responses to Local Drought Conditions in Region F

Entity				Implementation Requirements									
Water User Group	County	2020 Population	2020 Demand (AF/YR)	Release from upstream reservoir	Curtailment of water rights	Local groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Trucked - in water	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Bangs	Brown	2,506	310			▪	▪		▪	▪			
Barstow	Ward	375	119			▪				▪			
Big Lake	Reagan	3,357	730			▪	▪	▪		▪			
Colorado City	Mitchell	5,149	1,308			▪	▪			▪			
Crockett Co. WCID1	Crockett	3,885	1,153			▪	▪			▪			
DADS Supported Living Center	Tom Green	253	109			▪				▪			
Early	Brown	2,907	292			▪	▪		▪	▪	Pipeline	Brownwood	
Eldorado	Schleicher	2,104	662			▪				▪			
Grandfalls	Ward	427	135			▪				▪			
Greater Gardendale WSC	Ector	2,547	211			▪	▪	▪		▪			
	Midland	1,299	108			▪	▪	▪		▪			
Greenwood Water	Midland	993	310			▪	▪			▪			
Iraan	Pecos	1,347	458			▪	▪	▪	▪	▪	Pipeline; PS; Treatment	Pecos Co. Precinct #3	
Junction	Kimble	2,632	626			▪	▪	▪		▪			
Kermit	Winkler	5,917	1,811			▪	▪	▪	▪	▪	Pipeline; PS; Treatment	Midland Freshwater District/ WRTA	

Entity				Implementation Requirements										
Water User Group	County	2020 Population	2020 Demand (AF/YR)	Release from upstream reservoir	Curtailment of water rights	Local groundwater wells	Brackish groundwater limited treatment	Brackish groundwater desalination	Emergency interconnect	Trucked - in water	Type of infrastructure required	Entity providing supply	Emergency agreements already in place
Loraine	Mitchell	656	76			▪				▪			
Madera Valley WSC	Reeves	1,541	446			▪	▪	▪		▪			
Mason	Mason	2,134	700			▪				▪			
McCamey	Upton	2,215	827			▪	▪	▪		▪			
Menard	Menard	1,492	350			▪	▪			▪			
Mertzon	Irion	823	101			▪	▪			▪			
Mitchell Co. Utility	Mitchell	1,596	210			▪	▪			▪			
Pecos Co. Fresh Water	Pecos	748	201			▪				▪			
Pecos Co. WCID 1	Pecos	3,019	384			▪	▪	▪	▪	▪	Pipeline	Fort Stockton	▪
Rankin	Upton	856	276			▪				▪			
Santa Anna	Coleman	1,121	156			▪	▪			▪			
Sonora	Sutton	2,800	1,045			▪				▪			
Southwest Sandhills WSC	Ward	1,937	185			▪	▪			▪			
Sterling City	Sterling	944	276			▪	▪	▪		▪			
Tom Green Co. FWSD 3	Tom Green	1,132	131			▪				▪			
Wickett	Ward	512	208			▪				▪			
Wink	Winkler	1,059	358			▪	▪	▪		▪			
Winters	Runnels	2,763	226			▪		▪	▪	▪	Pipeline	Abilene (Ivie Pipeline)	
Zephyr WSC	Brown	4,173	343			▪	▪			▪			▪

7.5 Region Specific Drought Response Recommendations and Model Drought Contingency Plans

As required by the TWDB, the RWPG (Regional Water Planning Group) shall develop drought recommendations regarding the management of existing groundwater and surface water sources. These recommendations must include factors specific to each source as to when to initiate drought response and actions to be taken as part of the drought response. These actions should be specified for the manager of a water source and entities relying on the water source. The RWPG has defined the manager of water sources as the entity that controls the water production and distribution of the water supply from the source. For purposes of this assessment, a manager must also meet the TCEQ requirements for development of a Drought Contingency Plan. Entities that rely on the water sources include customers of the water source manager and direct users of the water sources, such as irrigators.

A list of each surface water and groundwater source in Region F and the associated managers and users of the source is included in Table G-2 in Appendix G.

In addition, the RWPG must identify unnecessary or counterproductive variations in specific drought response strategies, including outdoor watering restrictions, among user groups in the regional water planning area that may confuse the public or otherwise impede drought response efforts. The Region F RWPG recognizes the benefit of additional coordination between drought responses within more urban planning areas where people living in very close proximity to one another may have different outdoor water restrictions. However, this situation does not occur in Region F. Region F maintains that DCPs developed by the local, individual water providers are the best available tool for drought management. Region F fully supports the use and implementation of individual DCPs during times of drought and did not find the differences in local response to be unnecessary or counterproductive.

7.5.1 Drought Trigger Conditions for Surface Water Supply

Drought trigger conditions for surface water supply are customarily related to reservoir levels. Region F acknowledges that the Drought Contingency Plans for the suppliers who have surface water supplies are the best management tool for these water supplies. The RWPG recommends that the drought triggers and associated actions developed by the regional operator of the reservoirs are the Region F regional triggers for these sources. A summary of these triggers and actions for major Region F reservoirs follows as defined by each source manager. Triggers and actions for other reservoirs are included in Table G-3 in Appendix G. The region also recognizes any modification to these drought triggers that are adopted by the regional operator.

Lake Brownwood (Brown County WCID #1)

BCWID #1 adopted their current Drought Contingency Plan in March of 2019. The triggers and actions are related to the elevation of Lake Brownwood and are summarized below in Table 7-6.

Table 7-6
Lake Brownwood Triggers and Actions

Drought Stage	Trigger	Action
Mild	Elevation below 1,420 ft. (76% capacity)	Advise customer of early conditions. Initiate Stage I of DCPs. Increase public education. Request voluntary conservation measures.
Moderate	Elevation below 1,417 ft. (64% capacity)	Request decrease in water usage. Implement watering restrictions. Request monitoring of irrigation facilities. District may reduce water delivery in accordance with pro rate curtailment.
Severe	Elevation below 1,414 ft. (53% capacity)	Request to severely reduce water usage. Watering restrictions. May conduct site visits to irrigation facilities. District may reduce water delivery in accordance with pro rata curtailment. May utilize alternate water sources, with TCEQ approval.
Exceptional	Elevation below 1,411 ft. (43% capacity)	District may call an emergency meeting with customers. Completely restrict watering. District may evaluate the need to discontinue delivery of water for second crops and non-essential uses. May reduce water delivery in accordance with pro rata curtailment. May utilize alternate water sources, with TCEQ approval.
Emergency	Elevation below 1408 ft. (34% capacity)	Same as the Exceptional drought stage. Any other necessary actions.

O.H. Ivie Reservoir (CRMWD)

The Board of Directors of CRMWD adopted their current Drought Contingency Plan in May 2019. In CRMWD's DCP, drought contingency triggers and actions are separated into two categories: the non-system portion of the O.H. Ivie Reservoir (Ivie) and the remaining CRMWD System. Triggers for these two categories are associated with their respective storage capacities. The triggers and actions related to the capacities of the O.H. Ivie Reservoir are outlined below in Table 7-7.

Lake Spence during 2010s Region F Drought

Table 7-7
O.H. Ivie Reservoir Drought Triggers and Actions

Drought Stage	Trigger	Action[a]
Mild	Capacity below 138,028 ac-ft.	Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on Ivie water to implement Stage 1 of their DCP.
Moderate	Capacity below 107,060 ac-ft.	Continue or initiate actions under Stage 1. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 2 of their DCP.
Severe	Capacity below 76,092 ac-ft.	Continue or initiate actions under Stage 1 and 2. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 3 of their DCP.
Critical	Pipeline break, equipment failure, or source contamination that severely limits distribution capacity.	Assess the severity of the problem and identify actions and time need to resolve it. Inform responsible officials for each wholesale water customer and suggest actions to alleviate problems. If appropriate, notify city, county, and/or state emergency response officials. Undertake necessary actions. Prepare a post-event assessment report.

a. During each stage, the following actions may be implemented by the District:
(1) Contact wholesale water customers monthly to discuss water supply and/or demand actions.
(2) Requesting wholesale water customers to reduce non-essential water use.
(3) Discussing the possibility of pro rate curtailment of water diversions and/or deliveries.
(4) Preparing a monthly water usage allocation baseline for each wholesale customer.

CRMWD System (CRMWD)

The CRMWD System includes supplies from Lake J.B. Thomas, E.V. Spence Reservoir, O.H. Ivie Reservoir, North Ward County Well Field, and the Big Spring Raw Water Production Facility. The triggers and actions related to the capacity of the CRMWD System are outlined below in Table 7-8.

Table 7-8
CRMWD System Drought Triggers and Actions

Drought Stage	Trigger	Action[a]
Mild	Capacity below 77,998 ac-ft.	Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on Ivie water to implement Stage 1 of their DCP.
Moderate	Capacity below 58,499 ac-ft.	Continue or initiate actions under Stage 1. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 2 of their DCP.
Severe	Capacity below 38,999 ac-ft.	Continue or initiate actions under Stage 1 and 2. Initiate studies to evaluate alternative actions if conditions worsen. Request any WUG solely dependent on this source to implement Stage 3 of their DCP.
Critical	Pipeline break, equipment failure, or source contamination that severely limits distribution capacity.	Assess the severity of the problem and identify actions and time need to resolve it. Inform responsible officials for each wholesale water customer and suggest actions to alleviate problems. If appropriate, notify city, county, and/or state emergency response officials. Undertake necessary actions. Prepare a post-event assessment report.

a. During each stage, the following actions may be implemented by the District:
(1) Contact wholesale water customers monthly to discuss water supply and/or demand actions.
(2) Requesting wholesale water customers to reduce non-essential water use.
(3) Discussing the possibility of pro rate curtailment of water diversions and/or deliveries.
(4) Preparing a monthly water usage allocation baseline for each wholesale customer.

O.C. Fisher, Twin Buttes, Nasworthy (San Angelo)

O.C. Fisher, Twin Buttes, and Nasworthy are all operated by the City of San Angelo. The City of San Angelo adopted their most recent Drought Contingency Plan in September of 2019. The triggers and actions in the City's DCP are based on combined storage and supply from all of the City's sources, which includes these reservoirs, as well as groundwater. These are outlined in Table 7-9 below.

Table 7-9
O.C Fisher, Twin Buttes and Nasworthy Drought Triggers and Actions

Drought Stage	Trigger	Action
Mild	Less than 24 months supply	Outdoor watering restrictions, watering schedule, water usage fees.
Moderate	Less than 18 months supply	Same as Stage 1 ("Mild" drought stage).
Critical/Emergency	Less than 12 months supply	Outdoor watering, filling of fountains or swimming pools, and/or washing of vehicles are all prohibited, water usage fees.

7.5.2 Drought Trigger Conditions for Run-of-River and Groundwater Supply

Both run-of-river and ground water supplies are more regional than reservoirs and typically there are many users of these sources. As noted in Section 7.2, some water providers will have developed Drought Contingency Plans that are specific to their water supplies. Other water users, such as agricultural or industrial users, may not have Drought Contingency Plans. To convey drought conditions to all users of these resources in Region F, the RWPG proposes to use the Drought Monitor. This information is easily accessible and updated regularly. It does not require a specific entity to monitor well water levels or stream gages. It is also geographically specific so that drought triggers can be identified on a sub-county level that is consistent with the location of use. Region F has adopted the same nomenclature as the Drought Monitor for corresponding Region F drought triggers. Table 7-10 shows the categories adopted by the U.S. Drought Monitor and the associated Palmer Drought Index.

Table 7-10
Drought Severity Classification

Category	Description	Possible Impacts	Palmer Drought Severity Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered	-1.0 to -1.9
D1	Moderate Drought	Some damage to crops, pastures; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested	-2.0 to -2.9
D2	Severe Drought	Crop or pasture losses likely; water shortages common; water restrictions imposed	-3.0 to -3.9
D3	Extreme Drought	Major crop/pasture losses; widespread water shortages or restrictions	-4.0 to -4.9
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; shortages of water in reservoirs, streams, and wells creating water emergencies	-5.0 or less

U.S. Drought Monitor: https://droughtmonitor.unl.edu/AboutUSDM/AbouttheData/DroughtClassification.aspx

For groundwater and run-of-river supplies, Region F recognizes that the initiation of drought response is the decision of the manager of the source and/or user of the source. Region F recommends the following actions based on each of the drought classifications listed above:

- Abnormally Dry – Entities should begin to review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage is necessary.
- Moderate Drought – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage is necessary.
- Severe Drought – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point if the review indicates current supplies may not be sufficient to meet reduced demands the entity should begin considering alternative supplies.
- Extreme Drought – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point if the review indicates current supplies may not be sufficient to meet reduced demands the entity should consider alternative supplies.
- Exceptional Drought – Entities should review their DCP, status of current supplies and current demands to determine if implementation of a DCP stage or changing to a more stringent stage is necessary. At this point if the review indicates current supplies are not sufficient to meet reduced demands the entity should implement alternative supplies

7.5.3 Model Drought Contingency Plans

Model Drought Contingency Plans (DCPs) were developed for Region F and can be accessed online at www.regionfwater.org. Each plan identifies four drought stages: mild, moderate, severe and emergency. The recommended responses range from notification of drought conditions and voluntary reductions in the "mild" stage to mandatory restrictions during an "emergency" stage. Entities using the model plan can select the trigger conditions for the different stages and appropriate responses for each stage.

In 2019, the Drought Preparedness Council recommended that a model DCP be in place for any water user group that exceeds ten percent of the Region's water demands. For Region F, these user groups include irrigation, municipal, and mining. Region F developed Model DCPs for municipal, irrigation, and industrial users, which can be accessed at http://regionfwater.org/index.aspx?id=Documents. The TCEQ does not require a DCP for mining users since mining is a private industry and is not subject to TCEQ enforcement. Thus, no model DCP was developed for mining.

7.6 Drought Management Water Management Strategies

Drought management is a temporary strategy to conserve available water supplies during times of drought or emergencies. This strategy is not recommended to meet long-term growth in demands, but rather acts as a means to minimize the potential for adverse impacts or water supply shortages during drought. The TCEQ requires Drought Contingency Plans (DCPs) for wholesale and retail public water suppliers and irrigation districts. A DCP may also be required for entities seeking state funding for water projects. Region F does not recommend specific drought management strategies. Region F recommends the implementation of DCPs by suppliers when appropriate to reduce demand during drought and prolong current supplies.

7.7 Other Drought-Related Considerations and Recommendations

7.7.1 Texas Drought Preparedness Council and Drought Preparedness Plan

In accordance with TWDB rules, all relevant recommendations from the Drought Preparedness Council were considered in the writing of this Chapter. The Texas Drought Preparedness Council is composed of representatives from multiple State agencies and plays an important role in monitoring drought conditions, advising the governor and other groups on significant drought conditions, and facilitating coordination among local, State, and federal agencies in drought-response planning. The Council meets regularly to discuss drought indicators and conditions across the State and releases Situation Reports summarizing their findings. Additionally, the Council has developed the State Drought Preparedness Plan, which sets forth a framework for approaching drought to minimize impacts to people and resources. Region F supports the efforts of the Texas Drought Preparedness Council and recommends that water providers regularly review the Situation Reports as part of their drought monitoring.

The Council provided two new recommendations in 2019 to all RWPGs which are addressed in this chapter:

- Follow the outline template for Chapter 7 provided to the regions by Texas Water Development Board staff in April of 2019, making an effort to fully address the assessment of current drought preparations and planned responses, as well as planned responses to local drought conditions or loss of municipal supply.
- Develop region-specific model drought contingency plans for all water use categories in the region that account for more than 10 percent of water demands in any decade over the 50-year planning horizon.To meet these recommendations, Region F has developed this Chapter to correspond with the sections of the outline template. Region F also prepared Model DCPs for municipal, irrigation, and industrial users. Region F did not prepare a Model DCP for mining despite it accounting for greater than 10 percent of the Region's water demands in some decades. The primary drivers for mining water use are economic, not drought conditions. Thus, the Region F RWPG did not feel it was appropriate a Model DCP for mining. Further discussion of these Model DCPs are discussed in Section 7.5.3.

7.7.2 Other Drought Recommendations

Region F recognizes that while drought preparedness, including DCPs, are an important tool, in some instances drought cannot be prepared for, it must be responded to. Region F recognizes the Drought Preparedness Council's ability to assist with drought response when needed. Region F, however, maintains that DCPs developed by the local, individual water providers are the best available tool for drought management. Region F fully supports the use and implementation of individual DCPs during times of drought.

To better prepare for future droughts, Region F makes the following recommendations:

- That the Regional Water Plans remain a separate process for developing long-term water supply solutions for increased growth. The Regional Water Plans should not be the resource for times of emergency drought.
- The Drought Preparedness Council should increase coordination with local providers regarding drought conditions and potential implementation of drought stages, particularly during times of limited precipitation.

LIST OF REFERENCES

[1] Texas Water Development Board “Water Data for Texas” <https://www.waterdatafortexas.org/reservoirs/region/region-f>

[2] U.S. Geological Survey. "Streamflow Gage Records." <http://waterdata.usgs.gov/tx/nwis.>.