5D MAJOR WATER PROVIDER WATER MANAGEMENT STRATEGIES

Region F has five major water providers. Among these providers, four are shown to have water supply shortages (see Chapter 4). To better understand the quantity of water that will need to be developed through infrastructure strategies, the needs presented for the major water providers consider supply reductions from municipal conservation and supplies made available through subordination. Both of these strategies are developed and discussed in Chapters 5B and 5C, respectively, and are presented in this chapter for completeness in identifying recommended water management strategies. Discussion of the water needs and recommended water management strategies for each of the major water providers is presented in the following sections. Full strategy evaluations are included in Appendix C.

Region F Major Water Providers

- Brown County Water Improvement District No. 1 (BCWID No. 1)
- Colorado River Municipal Water District (CRMWD)
- Midland
- Odessa
- San Angelo

5D.1 Brown County Water Improvement District No. 1

The Brown County Water Improvement District (BCWID) #1 supplies water to members in Brown, Coleman, Mills and Runnels counties. Major customers include Bangs, Brookesmith SUD, Brownwood, Early, Zephyr WSC, and manufacturers and irrigators in Brown County. The BCWID currently receives all of its supply from Lake Brownwood. Lake Brownwood has sufficient yield to meet BCWID's needs even without subordination. With subordination and conservation, BCWID shows a supply surplus of nearly 7,000 acre-feet in 2020. The surplus declines slightly over time to around 6,400 acre-feet in 2070 due to sedimentation in the reservoir. BCWID has investigated groundwater development as a way to ensure a reliable water supplies during times of extreme drought. However, test wells found that the water quality was poor and would be very costly to treat. BCWID does not intend to develop a groundwater source at this time but would consider pursuit of this source if needed under extreme drought conditions. Table 5D- 1 shows the comparison of supply and demand for BCWID with subordination and conservation supplies.

Potentially feasible water management strategies for Brown County WID #1 include:

- Municipal Conservation
- Subordination
- Brush Control
- Develop Groundwater Supplies

Full strategy evaluations are included in Appendix C. The following strategies were recommended for BCWID #1. Both conservation and subordination are discussed in detail in previous chapters, but they are also discussed below as a recommended strategy for completeness.

Table 5D-1
Comparison of Supply and Demand for BCWID

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Lake Brownwood Safe Supply (with subordination)	24,340	24,226	24,112	23,998	23,884	23,770
Customer Conservation	254	285	282	281	281	281
Total Availability	**24,594**	**24,511**	**24,394**	**24,279**	**24,165**	**24,051**
Treated Water Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
City of Bangs	310	305	296	291	290	290
Brookesmith SUD	1,212	1,208	1,183	1,169	1,167	1,167
Coleman County SUD	229	227	222	219	218	218
City of Santa Anna	156	154	149	149	148	148
Brownwood	3,717	3,713	3,640	3,600	3,593	3,593
County-Other, Brown	129	129	129	129	129	129
Early	292	287	277	271	270	270
Zephyr WSC	346	342	333	328	327	328
Manufacturing, Brown	548	651	651	651	651	651
Total Treated Water Demand [a]	**6,939**	**7,016**	**6,880**	**6,807**	**6,793**	**6,794**
Irrigation, Brown	5,000	5,000	5,000	5,000	5,000	5,000
Total Raw Water Demand	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**	**5,000**
Total Demand	**11,939**	**12,016**	**11,880**	**11,807**	**11,793**	**11,794**
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage)	***12,655***	***12,495***	***12,514***	***12,472***	***12,372***	***12,257***

a. Existing treatment capacity limits treated water supply to 11,050 acre-feet per year.

5D.1.1 BCWID No. 1 Recommended Water Management Strategies

Municipal Conservation

This strategy pro-actively reduces municipal retail water demands through public education and outreach, an inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. As a wholesale water provider, BCWID #1 cannot carry out this strategy. This strategy will be implemented by each individual member and customer city. These combined efforts are expected to reduce BCWID's demands by about 2 percent throughout the planning horizon. The costs for this strategy are associated with each retail water provider.

Subordination

The subordination strategy increases the supply to Lake Brownwood by changing the strict priority modeling assumptions utilized in WAM Run 3. Under the subordination strategy, Lake Brownwood's supplies increase to over 24,300 acre-feet in 2020. The supplies decrease to nearly 23,700 acre-feet by 2070 due to sedimentation in the reservoir. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C. Region F recognizes that a subordination agreement is not within the authority of the RWPG. Such an agreement must be developed by the water rights holders themselves, including BCWID.

Brush Control

Certain species of brush can drastically reduce the water yield in a watershed. By replacing water intensive brush species with less water

intensive native plants, increased runoff to the reservoirs is possible. Funding for this type of project is typically available through the Water Supply Enhancement Program of the Texas State Soil and Water Conservation Board (TSSWCB), though there was no funding statewide in 2019. The TSSWCB has already completed feasibility studies for the Lake Brownwood watershed. Some of this land has already been treated for brush. However, in order to continue to realize these water savings, brush must be continually retreated. The reservoir yields shown under subordination include hydrology through the end of 2016. Therefore, all savings gained by previous treatment of brush are shown in the modeled yield of these reservoirs. However, any future brush treatments could yield small amounts of additional savings. According to the TSSWCB annual reports, on average, about 1,000 acres of brush per year are treated in this area. Based on this level of brush treatment, around 400 acre-feet of increased supply is estimated.

5D.1.2 BCWID No. 1 Water Management Plan Summary

BCWID No. 1 Recommended Water Management Strategies

- Municipal Conservation
- Subordination
- Brush Control

Table 5D- 2 shows a comparison of supply and demand after recommended strategies are implemented for BCWID No. 1. Subordination and conservation are shown in this table as strategies for completeness. Table 5D- 3 shows the capital and annual costs for the recommended plan for BCWID #1.

Figure 5-1 illustrates the recommended water management plan for BCWID. BCWID currently has a surplus of water available. The only recommended strategy is brush control.

Table 5D-2
Recommended Water Management Strategies for BCWID #1
-Values are in Acre-Feet per Year-

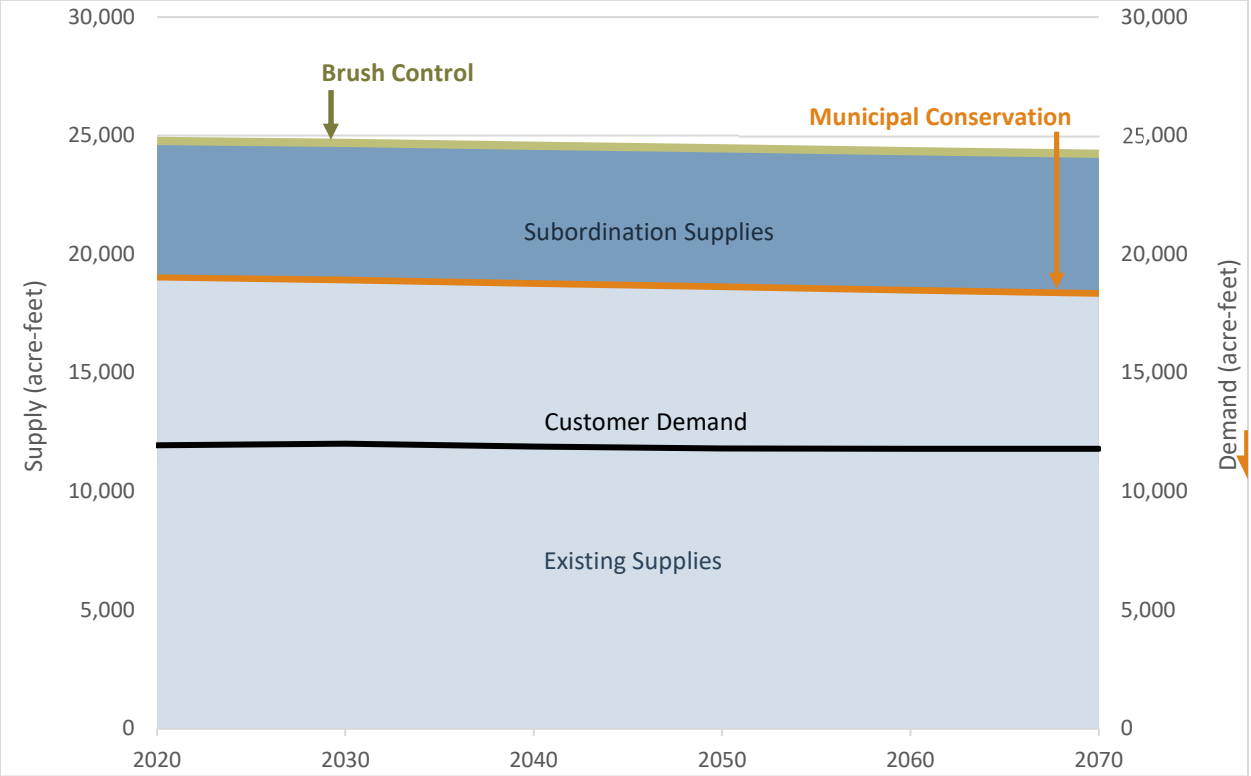
	2020	2030	2040	2050	2060	2070
Surplus (Shortage) before Recommended Strategies	**12,401**	**12,210**	**12,232**	**12,191**	**12,091**	**11,976**
Recommended Strategies (acre-feet per year)	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Subordination	*5,440*	*5,466*	*5,492*	*5,518*	*5,544*	*5,570*
Customer Conservation	*254*	*285*	*282*	*281*	*281*	*281*
Brush Control	400	400	400	400	400	400
Surplus (Shortage) after Recommended Strategies	***13,055***	***12,895***	***12,914***	***12,872***	***12,772***	***12,657***
Management Supply Factor	*2.1*	*2.1*	*2.1*	*2.1*	*2.1*	*2.1*

Strategies in grey italics were included in the previous calculation of surplus (shortages). They are included in this table for completeness but are not included in the total to avoid double counting.

Table 5D-3
Cost for Strategies for BCWID #1

Strategy	Capital Cost (Thousand $)	Unit Cost ($/1,000 gal)	
		With Debt Service	After Debt Service
Municipal Conservation of Customers	---	NA	NA
Subordination	---	$0	$0
Brush Control	---	NA	$1.20

Figure 5D-1
BCWID No. 1 Water Management Plan



BCWID No. 1 Alternative Water Management Strategies

BCWID No. 1 investigated groundwater development to bolster the security of their water supplies and to serve as a potential backup supply to Lake Brownwood. Based on analysis from their test wells, wells in Brown County can yield supply from deep formations, however, water quality is poor and contains high total dissolved solids (TDS), requiring advanced treatment. Due to the high cost and currently adequate supplies from Lake Brownwood, BCWID does not intend to pursue a groundwater strategy at this time. However, it is included as an alternative water management strategy should conditions change. Additional information on this strategy is included in Appendix C.

5D.2 Colorado River Municipal Water District (CRMWD)

The Colorado River Municipal Water District (CRMWD), the largest water supplier in Region F, provides raw water from both groundwater and surface water sources to its member cities and customers. CRMWD owns and operates three major reservoirs, Lake J.B. Thomas, E.V. Spence Reservoir, and O.H. Ivie Reservoir, as well as several chloride control reservoirs (diverted water system) for water quality control. Groundwater sources include well fields in Ward and Martin Counties. CRMWD member cities include Big Spring, Odessa and Snyder. CRMWD also supplies water to Midland, San Angelo and Abilene, as well as several smaller water utilities and cities that serve customers in Concho, Howard, Martin, Runnels, and Ward counties.

CRMWD can be thought of as two systems: customers who have contracts only from Lake Ivie (Lake Ivie-non system) and CRMWD member cities and system customers which are supplied from the remaining yield in Ivie, as well as all of CRMWD's other sources of supply. Because the nature of these contractual relationships are different, the needs of each system are evaluated separately. Table 5D- 1 summarizes the supplies and demands for CRMWD's system, which includes subordinated supplies from Lake O.H. Ivie, E.V. Spence Reservoir, Lake J.B. Thomas, potable reuse water from Big Spring, and groundwater. Potential future customers include demands that CRMWD's member cities intend to serve. Table 5D- 2 summarizes the supplies and demands for CRMWD's Lake Ivie non-system portion. Supply from the diverted water system is brackish and cannot be used for municipal purposes in its typical state. Currently, there are no potable or non-potable demands on this water source.

Following the most recent significant drought years (2011-2015), the demands on CRMWD decreased significantly. This was partly due to drought restrictions and partly due to the development of additional supplies by several of CRMWD's customers (Midland and San Angelo). The water demands adopted by Region F and the TWDB are based on dry year use in 2011, prior to this observed decline. To better understand CRMWD's needs analysis with the reduced demands, a secondary demand scenario was developed. (More detail on the secondary demand scenario is in Chapter 2.) These demands are between 60 and 70 percent of the TWDB-adopted demands, and are shown on Table 5-1, beneath the TWDB-adopted demands. There is no secondary demand analysis developed for the Lake Ivie non-system demands because the demands are contractual.

Table 5D-4
Comparison of Supply and Demand for CRMWD System
-Values are in Acre-Feet per Year-

CRMWD System Supplies	Supply 2020	Supply 2030	Supply 2040	Supply 2050	Supply 2060	Supply 2070
Lake Ivie (with subordination)	15,193	14,769	14,342	13,918	13,491	13,067
Spence Reservoir (with subordination)	21,575	21,531	21,487	21,443	21,399	21,355
Thomas Reservoir (with subordination)	3,725	3,702	3,679	3,656	3,633	3,610
Big Spring Potable Reuse	1,855	1,855	1,855	1,855	1,855	1,855
Ward County Well Field	39,044	38,176	36,441	32,970	31,235	29,500
Martin County Well Field	1,035	1,035	1,035	1,035	1,035	1,035
Customer Conservation	899	1,050	1,137	1,249	1,341	1,474
Total Supply Availability	**83,326**	**82,118**	**79,976**	**76,126**	**73,989**	**71,896**

CRMWD System Current Demands	Demand 2020	Demand 2030	Demand 2040	Demand 2050	Demand 2060	Demand 2070
Odessa and Customers	31,632	35,267	38,319	41,604	45,051	48,842
Odessa	25,004	28,329	31,091	34,071	37,202	40,669
Ector County UD	2,385	2,645	2,935	3,240	3,556	3,880
Manufacturing, Ector County	1,902	1,952	1,952	1,952	1,952	1,952
Irrigation, Ector County	1,197	1,194	1,192	1,191	1,190	1,189
Irrigation, Midland County	23	26	28	29	30	31
SEP, Ector County	1,121	1,121	1,121	1,121	1,121	1,121
Big Spring and Customers	8,462	8,611	8,625	8,573	8,561	8,561
Big Spring	6,227	6,368	6,379	6,327	6,316	6,316
Coahoma	526	534	537	537	536	536
Manufacturing, Howard Co.	1,500	1,500	1,500	1,500	1,500	1,500
SEP, Howard Co.	209	209	209	209	209	209
Snyder and Customers	2,458	2,671	2,785	2,963	3,149	3,345
Snyder	1,980	2,201	2,320	2,499	2,686	2,882
Scurry County-Other	300	300	300	300	300	300
Rotan	178	170	165	164	163	163
Other Customers	19,753	861	865	869	720	720
Midland [a]	18,798	0	0	0	0	0
Stanton	320	320	320	320	320	320
Irrigation	400	400	400	400	400	400
Ward County Other	100	-	-	-	-	-
Grandfalls	135	141	145	-	-	-
Total Current 2021 RWP Demands	***62,305***	***47,410***	***50,594***	***53,860***	***57,481***	***61,468***
Total Current Secondary Scenario Demands	***44,124***	***30,199***	***32,373***	***34,710***	***37,091***	***39,682***
CRMWD System Potential Future Customer Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Additional Supply for Odessa Advanced Treatment Losses	3,930	3,930	3,930	3,930	3,930	3,930
Howard County Manufacturing (Sales from Big Spring)		500	500	500	500	500
Greater Gardendale WSC (Sales from Odessa)		375	445	445	445	445
Ector County - Other (ECUD Expanded Service Area, Sales from Odessa)		1,200	2,500	2,500	2,500	2,500
Scurry County-Other (Sales from Snyder)	373	414	447	491	547	607
Total Future Customer Demand	**4,303**	**6,419**	**7,822**	**7,866**	**7,922**	**7,982**
CRMWD System Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage) with 2021 RWP Demands	***16,738***	***28,312***	***21,585***	***14,426***	***8,613***	***2,474***
Surplus (Shortage) with Secondary Scenario Demands	***34,919***	***45,523***	***39,806***	***33,576***	***29,004***	***24,260***

[a] Midland 1966 Contract expires in 2029.

Table 5D-5
Comparison of Supply and Demand for Lake Ivie Non-System

Lake Ivie Non-System Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Lake Ivie (with subordination)	17,147	16,727	16,310	15,890	15,473	15,053
Total Availability	**17,147**	**16,727**	**16,310**	**15,890**	**15,473**	**15,053**
Lake Ivie Non-System Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Abilene [a]	5,349	5,209	5,070	4,930	4,791	4,651
Midland [a]	5,349	5,209	5,070	4,930	4,791	4,651
San Angelo [a]	5,349	5,209	5,070	4,930	4,791	4,651
Millersview-Doole WSC	600	600	600	600	600	600
Ballinger	500	500	500	500	500	500
Total Current Demand	**17,147**	**16,727**	**16,310**	**15,890**	**15,473**	**15,053**
Lake Ivie Non-System Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Available Surplus Supply	***0***	***0***	***0***	***0***	***0***	***0***

[a] Contract is for 16.54% of the safe yield of Ivie. So this demand changes with the implementation of the subordination strategy.

With subordinated supplies, CRMWD can fully meet its current customer demands without developing additional supplies. After the expiration of its contract with Midland in 2029, CRMWD is shown to have a surplus of over 32,000 acre-feet in 2030. CRMWD has a reserve of water for their existing customers and has the potential to serve additional future customers beyond those shown in this plan, if they choose. When the lower secondary demand scenario is considered, the surplus of water in 2030 increases to over 49,000 acre-feet year.

While CRMWD is shown to have sufficient water supplies, there is some uncertainty associated with the reliability of surface water supplies in the Upper Colorado Basin. CRMWD lakes are still in drought of record conditions and on-going drought will likely continue to decrease the reliable supply from these sources. It is important for CRMWD to develop and maintain their portfolio of water supplies that can be used during drought to increase the reliability of the CRMWD system. Also, as the region continues to respond to the increased oil and gas activities, the demands on CRMWD may increase as new customers request water. Given these unknowns, CRMWD is pursuing water management strategies to meet these future demands and bolster the reliability of their water supply.

The following strategies were identified as potentially feasible for CRMWD:

- Conservation of Wholesale Customers
- Subordination of Senior Downstream Water Rights
- Ward County Well Field Well Replacement
- Ward County Well Field Expansion and the Development of Winkler County Well Field
- Develop Additional Groundwater Supplies in Pecos, Reeves, Ward and Winkler Counties

Full strategy evaluations are included in Appendix C. The following strategies were recommended for CRMWD. Both conservation and subordination are discussed in detail in previous chapters, but they are also discussed below as a recommended strategy for completeness.

5D.2.1 CRMWD Recommended Water Management Strategies

Municipal Conservation

This strategy pro-actively reduces municipal retail water demands through public education and outreach, an inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. As a wholesale water provider, CRMWD cannot carry out this strategy. This strategy will be carried out by each individual member and customer city. These combined efforts are expected to reduce CRMWD customer demands by about 2 to 4 percent throughout the planning horizon. The costs for this strategy are associated with each retail water provider. CRMWD fully supports the efforts of the cities to implement water education and conservation measures.

Subordination

The subordination strategy increases the supply to CRMWD's reservoirs by changing the strict priority modeling assumptions utilized in WAM Run 3 such that downstream senior water right holders do not make priority calls on upstream users in Region F. Under the subordination strategy, the District's surface water system's supplies increase from about 30,000 acre-feet to over 57,600 acre-feet in 2020. By 2070, the subordination supplies decrease to about 53,000 acre-feet due to sedimentation in the reservoirs. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C. Region F recognizes that a subordination agreement is not within the authority of the RWPG. Such an agreement must be developed by the water rights holders themselves, including CRMWD. CRMWD already has agreements in place with LCRA for Lake Ivie and other surface water sources.

Ward County Well Replacement

CRMWD currently owns and operates a well field in Ward County that produces water from the Pecos Valley aquifer. The integrity of the wells and pipelines that comprise this well field are expected to deteriorate over time, reducing the available supply of the well field. As a result, CRMWD plans to actively rehabilitate and/or replace out-of-service wells to restore the yield of the well field throughout the planning horizon (2020 – 2070). In this strategy, it was assumed that new water wells and well field piping would be constructed to replace old infrastructure, which would enable CRMWD to withdraw additional groundwater from their Ward County well field that would otherwise be inaccessible. All other infrastructure is in place to transmit and treat the supply from this well field.

Ward County Well Field Expansion and Development of Winkler County Well Field

CRMWD owns and operates a well field in Ward County and owns the rights to an undeveloped well field in southern Winkler County. Both areas produce water from the Pecos Valley aquifer. This strategy involves the development of the Winkler County rights as well as an expansion of their existing Ward County well field. A newly developed pipeline and pump station will deliver supply from the Winkler County well field to the existing Ward County well field. From there, supply from both sources will be transferred to CRMWD's service area using existing transmission lines, as well as new and/or upgraded pump stations along the route. The capacity of the existing transmission system will be upgraded from 46 MGD to 65 MGD to accommodate the additional 20 MGD peak supply estimated from this project. This project is expected to come online in 2050.

5D.2.2 CRMWD Water Management Plan Summary

CRMWD Recommended Water Management Strategies

- Municipal Conservation
- Subordination
- Ward County Well Field Well Replacement
- Ward County Well Field Expansion and the Development of Winkler County Well Field

Figure 5D-2 illustrates the recommended water management plan for CRMWD. Major recommended strategies include expansion of the Ward County Well Field and development of the Winkler County Well field, in addition to well replacement at the Winkler County Well Field. CRMWD has no identified water needs and the development of the recommended strategies will increase their reserve supplies. The surplus of supply for CRMWD after the implementation of recommended strategies are shown in Table 5D- 3.

The costs for these strategies are summarized in Table 5D-4. The recommended water plan for CRMWD will provide water to meet all current and future customer demands with a reserve.

Figure 5D-2
CRMWD Water Management Plan

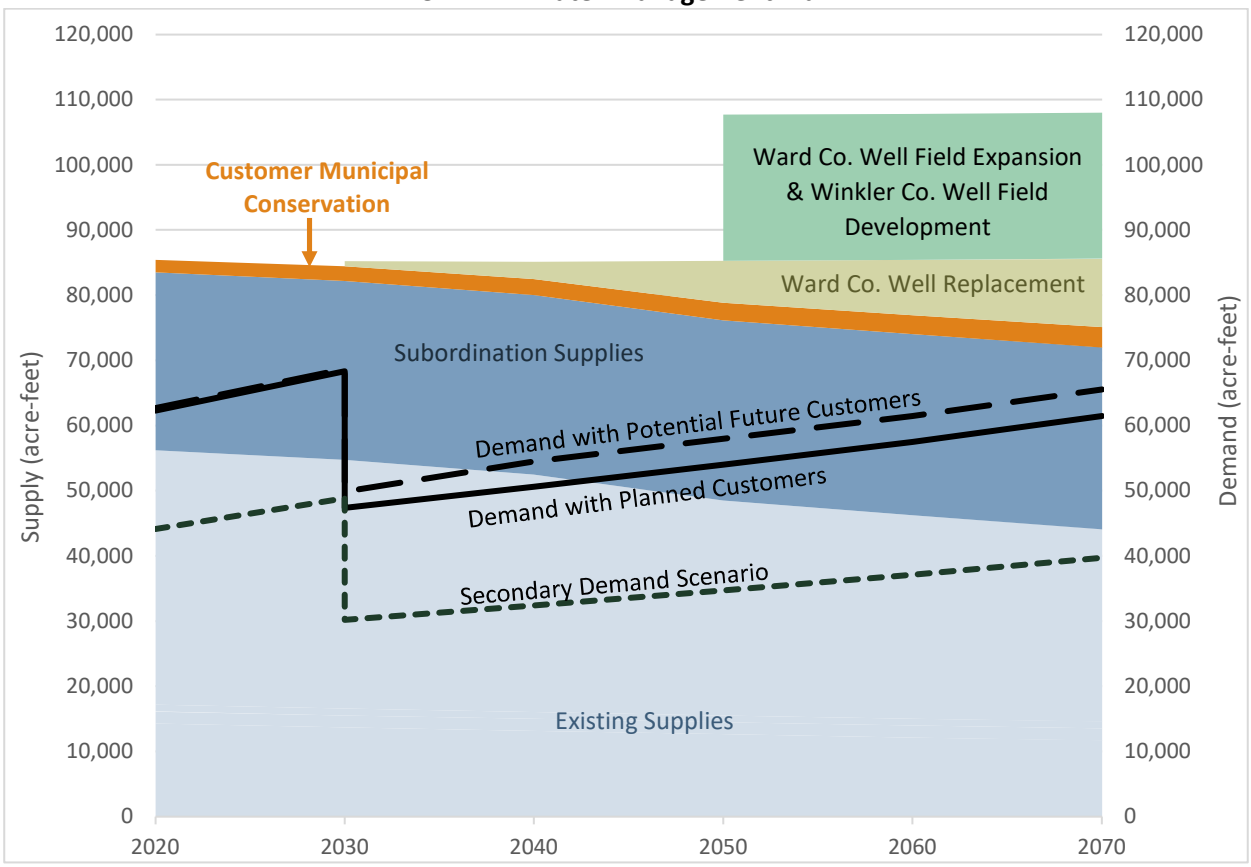


Table 5D-6
Recommended Water Management Strategies for CRMWD
Values are in Acre-Feet per Year-

CRMWD Strategies Summary						
	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Surplus (Shortage) with 2021 RWP Demands before Recommended Water Management Strategies	***16,738***	***28,312***	***21,585***	***14,426***	***8,613***	***2,474***
Surplus (Shortage) with Secondary Scenario Demands before Recommended Water Management Strategies	***34,919***	***45,523***	***39,806***	***33,576***	***29,004***	***24,260***
Recommended Strategies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Subordination	*27,290*	*27,409*	*27,528*	*27,647*	*27,766*	*27,885*
Customer Conservation	*899*	*1,050*	*1,137*	*1,249*	*1,341*	*1,474*
Ward County Well Replacement	0	755	2,650	6,450	8,516	10,498
Ward and Winkler County Well Field Expansion				22,400	22,400	22,400
Total Strategy Supply (Excluding Conservation and Subordination)	**0**	**755**	**2,650**	**28,850**	**30,916**	**32,898**
Surplus (Shortage) after Recommended Strategies	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Surplus (Shortage) Supply with 2021 RWP Demands	*16,718*	*29,044*	*24,210*	*43,250*	*39,502*	*35,344*
Surplus (Shortage) Supply with Secondary Scenario Demands	*34,899*	*46,255*	*42,431*	*62,400*	*59,892*	*57,130*
Management Supply Factor	*1.3*	*1.5*	*1.4*	*1.7*	*1.6*	*1.5*

Strategies in grey italics were included in the previous calculation of surplus (shortages). They are included in this table for completeness but are not included in the total to avoid double counting.

Table 5D-7
Cost of Recommended Water Management Strategies for CRMWD

Strategy	Capital Cost (Million $)	Unit Cost ($/1,000 gal)	
		With Debt Service	After Debt Service
Subordination	$0	$0	$0
Customer Conservation	NA	NA	NA
Ward County Well Replacement	$10.4	$0.31	$0.23
Ward and Winkler County Well Field Expansion	$168.3	$2.61	$0.99

CRMWD Alternative Water Management Strategies

Alternative water management strategies are identified and may be implemented if a recommended strategy is no longer viable or if there is a new need that cannot be met by the recommended water management plan. CRMWD has identified one alternate water management strategy to develop additional groundwater supplies from Pecos, Reeves, Ward and/or Winkler Counties. This strategy is for new groundwater supplies and does not include water rights currently held by CRMWD. Some of these groundwater supplies may require advanced treatment, such as desalination but the development of the treatment facilities would not occur until after 2070. Therefore, costs for advanced treatment were not included. This strategy is described in full and evaluated in Appendix C.

5D.3 Midland

The City of Midland, located in Midland County, is the largest city in Region F and serves as a prominent center for economic, trade, and cultural activities. The City of Midland has experienced rapid population growth in recent years, primarily due to increased oil and gas exploration in the underlying Permian Basin. Over the planning horizon (2020 – 2070), this rapid growth is expected to continue as the City's population is projected to grow by nearly 60 percent and its municipal demands are projected to increase by over 50 percent. In addition to the increase in the number of residents in Midland, many workers commute from other areas of the State during the work week. These working commuters are officially counted as residents elsewhere, so they are not considered in the population and water demands in this Plan; however, they still contribute to the water demand the City must provide.

The City of Midland draws its supply from four main sources: sales from CRMWD, the Airport well field in Midland County, the Paul Davis well field in Andrews and Martin Counties, and the T-Bar Ranch and Clearwater Well Fields in Winkler and Loving Counties. The City provides water to their municipal customers as well as manufacturing demand within the City. Based on these projections, the City begins to experience shortages in 2030 after the expiration of one its contracts with CRMWD in 2030. The Airport well field is expected to be depleted by 2035 and the Paul Davis well field is limited by the MAG from 2040 onward, deepening the shortage after 2040. Table 5D- 8 shows the City's supplies and demands.

Table 5D-8
City of Midland Water Supplies and Demands

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
CRMWD Contracts with Midland (w/ Subordination)	24,147	5,209	5,070	4,930	4,791	4,651
CRMWD (Ivie)	5,020	4,850	4,679	4,509	4,338	4,168
CRMWD (1966 Contract)	16,954	0	0	0	0	0
CRMWD Subordination	2,173	359	391	421	453	483
T-Bar Ranch/Clearwater Well Field	16,815	16,815	16,815	16,815	16,815	16,815
Paul Davis Well Field (Ogallala Aquifer)	4,652	3,807	3,334	3,065	2,887	2,764
Airport Well Field	560	560	0	0	0	0
Municipal Conservation	631	755	816	882	944	1,012
Total Availability	**46,805**	**27,261**	**26,035**	**25,692**	**25,437**	**25,242**
Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
City of Midland	27,972	31,803	34,256	36,811	39,405	42,232
Manufacturing, Midland County	147	177	177	177	177	177
Total Raw Water Demands	**28,119**	**31,980**	**34,433**	**36,988**	**39,582**	**42,409**
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage)	**18,686**	**(4,719)**	**(8,398)**	**(11,296)**	**(14,145)**	**(17,167)**

The City of Midland also has a contract to sell their treated wastewater effluent for mining use. No potable water supplies are used to meet this demand. The treated wastewater is expected to be primarily used for mining in Midland, Martin, Reagan, and Upton Counties. The contract is for up to 15 MGD (16,800 acre-feet per year) but will be limited by actual wastewater flow. Current flows are around 10 MGD (11,200 acre-feet per year). Improvements are currently being designed to the wastewater plant to make this volume feasible, with improvements expected to be completed by 2020. As shown in Table 5D- 9, there are no shortages to meet the demand for wastewater for the mining industry over the planning horizon and thus, no strategies were considered for this purpose.

Table 5D-9
City of Midland Wastewater Supplies and Demands

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Direct Reuse (WW Effluent Sales to Mining)	11,210	11,210	11,210	11,210	11,210	11,210
Total Availability	**11,210**	**11,210**	**11,210**	**11,210**	**11,210**	**11,210**
Wastewater Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Mining, Pioneer Resources Contract	11,210	11,210	11,210	11,210	11,210	11,210
Mining, Midland County	2,803	2,803	2,803	2,803	2,803	2,803
Mining, Martin County	2,803	2,803	2,803	2,803	2,803	2,803
Mining, Reagan County	2,803	2,803	2,803	2,803	2,803	2,803
Mining, Upton County	2,801	2,801	2,801	2,801	2,801	2,801
Total Demand	**11,210**	**11,210**	**11,210**	**11,210**	**11,210**	**11,210**
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage)	0	0	0	0	0	0

However, several water management strategies were considered for Midland to meet the municipal needs of their retail customers.

Potentially Feasible Water Management Strategies Considered for Midland:

- Municipal Conservation
- Subordination
- West Texas Water Partnership
- Advanced Water Treatment and Expanded Use of the Paul Davis Well Field
- Purchase from CRMWD

Full strategy evaluations are included in Appendix C. Both conservation and subordination are discussed in detail in previous sections, but they are also discussed below as a recommended strategy for completeness.

5D.3.1 Midland Recommended Water Management Strategies

Municipal Conservation

Municipal conservation pro-actively reduces municipal water demands through public education and outreach, an inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. These efforts are projected to reduce the City of Midland's demands by about 631 – 1,012 acre-feet per year throughout the planning horizon (2020 – 2070).

Subordination

The subordination strategy increases the supply to CRMWD's reservoirs by changing the strict priority modeling assumptions utilized in WAM Run 3 such that downstream senior water right holders do not make priority calls on upstream users in Region F. Some of the subordinated supply goes to supply Midland as a customer city to meet the city's demands on CRMWD. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C.

Advanced (RO) Water Treatment and Expanded Use of Paul Davis Well Field

Groundwater from the Paul Davis Well Field typically contains high TDS levels. Consequently, the City is interested in pursuing the development of an advanced treatment (RO) facility to treat this groundwater to a higher quality. For planning purposes, it was assumed that the project would generally operate at around 7.5 MGD on an average annual basis to bring the total supply from the Paul Davis Well Field to 10 MGD. Current transmission infrastructure is in place to transport this water to the City for treatment and distribution. Treatment losses were estimated at 25 percent. It was assumed that the reject stream from this facility would be treated at the City's wastewater treatment plant (WWTP). The treated water from this facility water would be blended with the rest of their supplies to improve overall drinking water quality. Overall, this project is estimated to require a capital investment of $56 million and is projected to come online by 2040.

West Texas Water Partnership

The Cities of Midland, San Angelo, and Abilene have formed the West Texas Water Partnership (the Partnership) to evaluate long-term water supplies the Partnership could develop jointly. The Partnership is conducting a separate study to determine the most feasible water management strategies for these cities, but the results were not available at the writing of this Initially Prepared Plan. Additional information is anticipated before the publication of the Final Region F Water Plan.

5D.3.2 Midland Water Management Plan Summary

Midland Recommended Water Management Strategies

- Municipal Conservation
- Subordination
- West Texas Water Partnership
- Advanced Treatment (RO) of Paul Davis Well Field Supplies

Figure 5-3 depicts the recommended water management plan for Midland. Main strategies include the West Texas Water Partnership and Advanced Treatment of Paul Davis Well Field Supplies.

The needs for the City of Midland after the implementation of recommended strategies are shown in Table 5-3. Table 5D-4 shows the capital and annual costs for these strategies. With the recommended water plan, Midland shows no water supply shortages throughout the planning horizon.

Figure 5D-3
Midland Water Management Plan

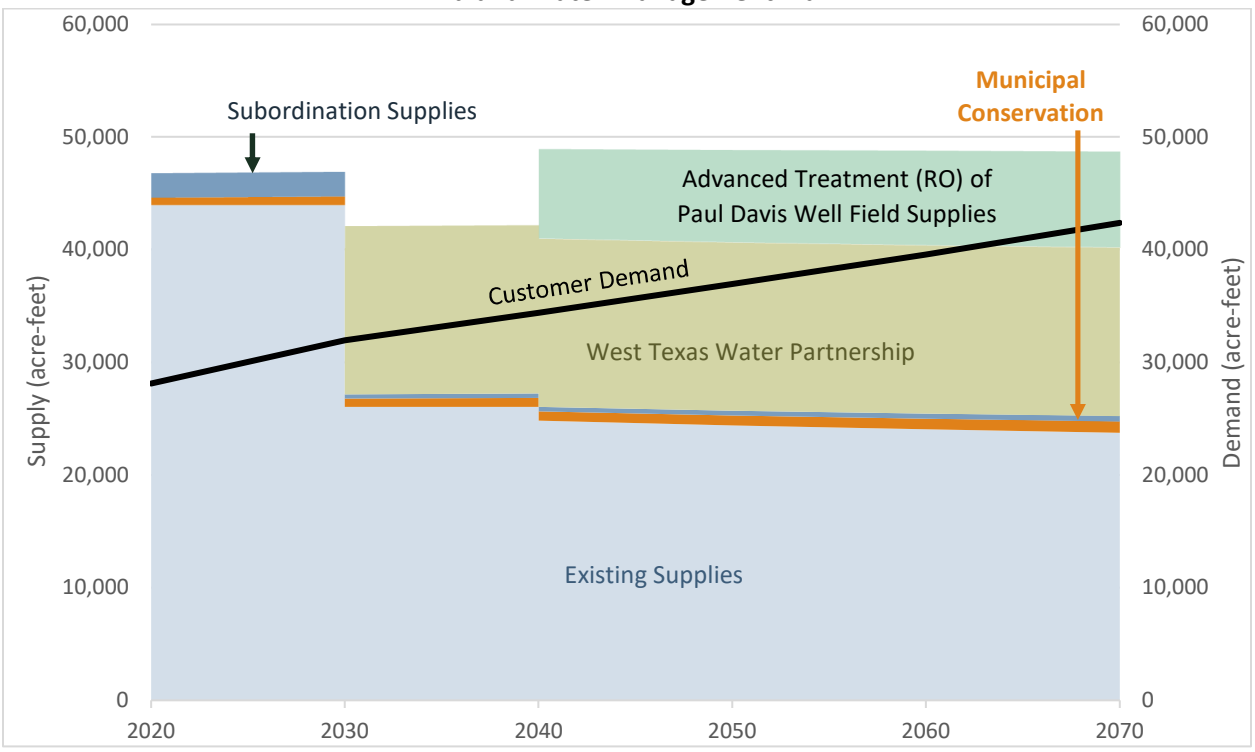


Table 5D-10
Recommended Water Strategies for Midland

Summary before Recommended Strategies	2020	2030	2040	2050	2060	2070
Supplies	46,805	27,261	26,035	25,692	25,437	25,242
Demand	28,119	31,980	34,433	36,988	39,582	42,409
Surplus (Shortage) with Conservation and Subordination	**18,686**	**(4,719)**	**(8,398)**	**(11,296)**	**(14,145)**	**(17,167)**
Recommended Strategies (acre-feet per year)	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Subordination	*2,173*	*359*	*391*	*421*	*453*	*483*
Municipal Conservation	*631*	*755*	*816*	*882*	*944*	*1,012*
West Texas Water Partnership		15,000	15,000	15,000	15,000	15,000
Additional Paul Davis Groundwater w/ Treatment			7,866	8,135	8,313	8,436
Total Supply from Recommended Strategies	**0**	**15,000**	**22,866**	**23,135**	**23,313**	**23,436**
Surplus (Shortage) after Recommended Strategies	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Surplus (Shortage)	**18,686**	**10,281**	**14,468**	**11,839**	**9,168**	**6,269**
Management Supply Factor	*1.7*	*1.3*	*1.4*	*1.3*	*1.2*	*1.1*

Strategies in grey italics were included in the previous calculation of surplus (shortages). They are included in this table for completeness but are not included in the total to avoid double counting.

Table 5D-11
Recommended Water Strategies for Midland

Strategy	Capital Cost (Million $)	Unit Cost ($/1,000 gal)	
		With Debt Service	After Debt Service
Municipal Conservation	---	NA	NA
Subordination	---	NA	NA
West Texas Water Partnership	TBD	TBD	TBD
Advanced Treatment Facility	$55.8	$3.71	$2.30

Midland Alternative Water Management Strategies

Alternative strategies are included in the plan as additional options that the City may pursue. One alternative strategy has been identified for the City of Midland to purchase supplies from CRMWD. The City of Midland currently receives water from CRMWD through two separate contracts: the Ivie Contract and the 1966 Contract. The 1966 Contract provides around 18,000 acre-feet of supply from any of CRMWDs sources to Midland. This contract will expire by 2029. An alternative strategy involves the City of Midland entering into a new contract agreement with CRMWD to replace the 1966 Contract. Contract negotiations are beyond the scope of regional water planning and are dependent upon the two parties reaching mutually agreeable terms that may differ from what is outlined in this plan.

5D.4 Odessa

The City of Odessa is located in Ector County. As one of the largest cities in Region F, it is a major center of employment, trade and cultural activities. The City of Odessa is a member city of CRMWD and receives all of its supply from CRMWD. The City currently sells treated supplies to Ector County Utility District, and some manufacturing operations. The City's raw water is currently contracted for use by manufacturing and irrigation users. Additionally, Odessa produces about 8.5 MGD of wastewater; 2.5 MGD is diverted to the Gulf Coast Authority (GCA), while the other 6 MGD is sold to Pioneer for mining use.

Table 5D- 12 shows a comparison of the Region F supply and demand for the City of Odessa, considering subordination of CRMWD's surface water sources. Under these assumptions, the City of Odessa does not show a shortage over the planning horizon for current users. However, the City is planning to develop advanced treatment which will increase losses and effectively increase the City's demand. This additional demand will be met by additional supplies from CRMWD.

Table 5D-12
Comparison of Supply and Demand for Treated and Water for Odessa
-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
CRMWD System Total (without subordination)	28,531	35,267	38,319	37,343	36,255	35,041
Subordination of CRMWD Supplies	3,101	0	0	4,261	8,796	13,801
Total Availability	**31,632**	**35,267**	**38,319**	**41,604**	**45,051**	**48,842**
Current Potable Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
City of Odessa	25,004	28,329	31,091	34,071	37,202	40,669
Ector County UD	2,385	2,645	2,935	3,240	3,556	3,880
Manufacturing, Ector County	450	500	500	500	500	500
Quail Run Power Generation Facility	1,121	1,121	1,121	1,121	1,121	1,121
Total Current Potable Demand	**28,960**	**32,595**	**35,647**	**38,932**	**42,379**	**46,170**
Potential Future Potable Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Greater Gardendale WSC	0	375	445	445	445	445
Ector County - Other (ECUD Expanded Service Area)	0	1,200	2,500	2,500	2,500	2,500
Total Future Potable Demand	**0**	**1,575**	**2,945**	**2,945**	**2,945**	**2,945**
Raw Water Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Irrigation, Ector County	1,197	1,194	1,192	1,191	1,190	1,189
Irrigation, Midland County	23	26	28	29	30	31
Manufacturing, Ector County (Rextac)	1,452	1,452	1,452	1,452	1,452	1,452
Total Current Demand	**2,672**	**2,672**	**2,672**	**2,672**	**2,672**	**2,672**
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Current Surplus (Shortage)	**0**	**0**	**0**	**0**	**0**	**0**
Future Surplus (Shortage)	**0**	**(1,575)**	**(2,945)**	**(2,945)**	**(2,945)**	**(2,945)**

Table 5D-13
Comparison of Supply and Demand for Reuse Water for Odessa
-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Direct Reuse - Ector County	9,530	9,530	9,530	9,530	9,530	9,530
Total Availability	**9,530**	**9,530**	**9,530**	**9,530**	**9,530**	**9,530**
Reuse Water Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
Mining, Ector (Pioneer)	6,727	6,727	6,727	6,727	6,727	6,727
Mining, Ector (GCA)	2,803	2,803	2,803	2,803	2,803	2,803
Total Demand	**9,530**	**9,530**	**9,530**	**9,530**	**9,530**	**9,530**
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage)	**0**	**0**	**0**	**0**	**0**	**0**

As a member city of CRMWD, CRMWD plans to provide all of Odessa's water needs through development of additional strategies. CRMWD has sufficient water to meet Odessa's current and future demands. However, should the City of Odessa pursue the development of supplies independently of CRMWD, the following strategies were identified as potentially feasible for the City of Odessa:

- Municipal Conservation
- Subordination (associated with CRMWD sources)
- Additional Supplies from CRMWD
- New Reverse Osmosis Treatment Facility
- Development of Brackish Groundwater in Ward County
- Development of Groundwater near Fort Stockton

Full strategy evaluations are included in Appendix C. Both conservation and subordination are discussed in detail in previous sections, but they are also discussed below as a recommended strategy for completeness.

5D.4.1 Odessa Recommended Water Management Strategies

Municipal Conservation

This strategy pro-actively reduces municipal water demands through public education and outreach, an inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. These efforts are expected to reduce the City of Odessa's demands by about 1.5 to 2 percent throughout the planning horizon.

Subordination

The subordination strategy increases the supply to CRMWD's reservoirs by changing the strict priority modeling assumptions utilized in WAM Run 3 such that downstream senior water right holders do not make priority calls on upstream users in Region F. Some of the subordinated supply goes to supply Odessa as a member city to meet the City's demands. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C. Region F recognizes that a subordination agreement is not within the authority of the RWPG. Such an agreement must be developed by the water rights holders themselves, including CRMWD. CRMWD already has such an agreement in place with LCRA for Lake Ivie and other surface water sources.

Additional Supplies from CRMWD

To meet the additional demands of the City, Ector County UD, manufacturing, irrigation users, or other future customers, Odessa would obtain additional supplies from CRMWD. These supplies would likely come from one or more of the multiple strategies that CRMWD is developing for its member cities and customers. With the development of these strategies, CRMWD is planning to take the new supplies to the Odessa Terminal Storage Reservoir, where Odessa would transport the water to its treatment facilities. It is assumed that all improvements and costs for these additional supplies are included with the development of the CRMWD strategies. Therefore, the capital cost of this water is shown on CRMWD.

Advanced Treatment (RO) Facility

To address water quality concerns associated with existing high TDS levels in CRMWD's surface water system, the City of Odessa is planning to pursue the development of an advanced treatment (RO) facility. For planning purposes, it was assumed that this project would have a peak capacity 20 MGD but would generally operate at around 14 MGD on an average annual basis. This facility is estimated to produce 15,700 acre-feet of finished water per year, based on estimated treatment losses of 20 percent. Finished water would be blended with the rest of the City's supplies to improve the overall drinking water quality. This project is estimated to require a capital investment of $83.1 million.

5D.4.2 Odessa Water Management Plan Summary

Odessa Recommended Water Management Strategies

- Municipal Conservation
- Subordination
- Additional Supplies from CRMWD
- New Reverse Osmosis Treatment Facility

The needs for Odessa after the implementation of recommended strategies are shown in Table 5D- 3. Table 5D- 4 shows the capital and annual costs for these strategies.

Figure 5D-4 demonstrates the recommended water management plan for the City of Odessa. The primary recommended strategy for the City is to improve the water quality of the subordinated surface water supplies with the addition of advanced treatment. This plan indicates the recommended strategies are sufficient to meet Odessa's projected needs.

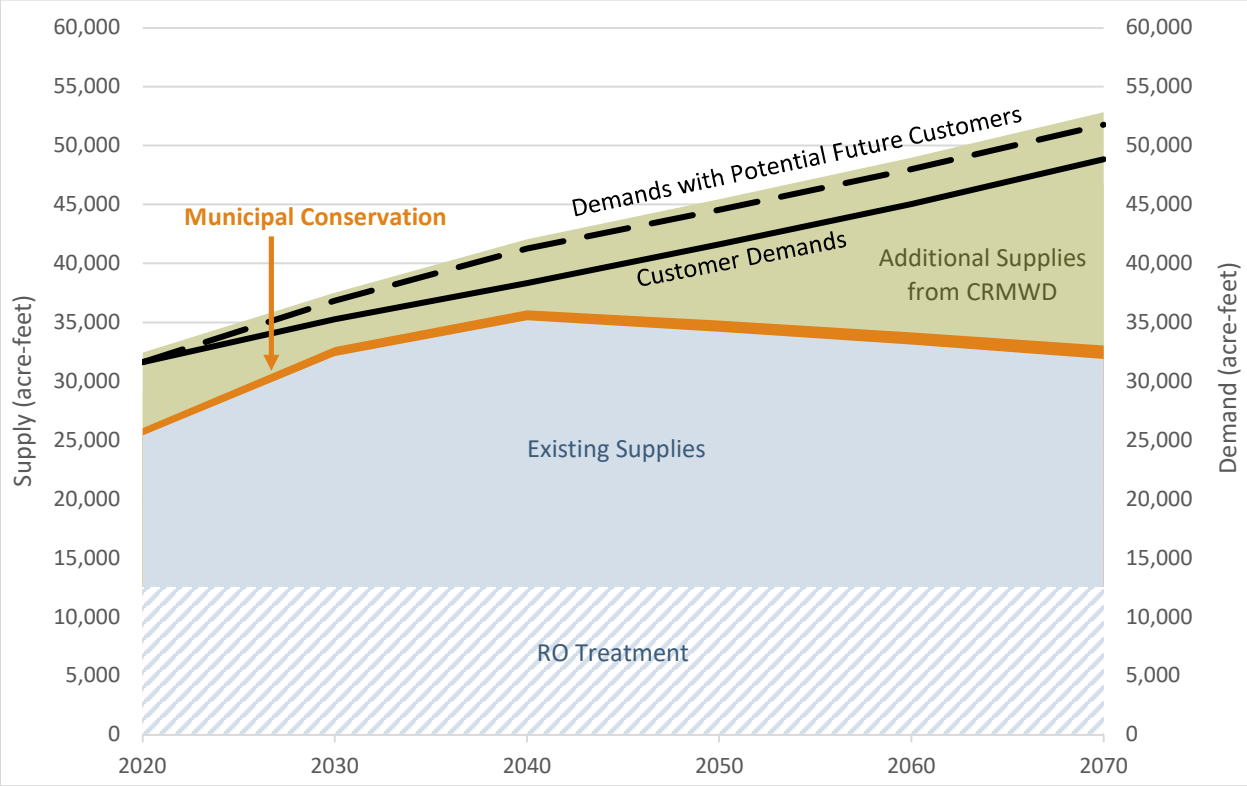
Table 5D-14
Recommended Strategies for the City of Odessa
-Values are in Acre-Feet per Year-

Summary before Recommended Strategies	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Current Surplus (Shortage) with Subordination	**0**	**0**	**0**	**0**	**0**	**0**
Future Surplus (Shortage)	**0**	**(1,575)**	**(2,945)**	**(2,945)**	**(2,945)**	**(2,945)**
Recommended Strategies (acre-feet per year)	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Subordination of CRMWD Supplies	*3,101*	*0*	*0*	*4,261*	*8,796*	*13,801*
Municipal Conservation	628	764	846	954	1,042	1,139
RO Treatment	*15,700*	*15,700*	*15,700*	*15,700*	*15,700*	*15,700*
Treatment Losses	-3,930	-3,930	-3,930	-3,930	-3,930	-3,930
Additional Supply from CRMWD	3,930	5,505	6,875	6,875	6,875	6,875
Surplus (Shortage) after Recommended Strategies	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Current Surplus (Shortage)	***628***	***764***	***846***	***954***	***1,042***	***1,139***
Future Surplus (Shortage)	***0***	***0***	***0***	***0***	***0***	***0***
Management Supply Factor	***1***	***1***	***1***	***1***	***1***	***1***

Table 5D-15
Costs for the Recommended Strategies for the City of Odessa

Strategy	Capital Cost (Thousand $)	Unit Cost ($/1,000 gal)	
		With Debt Service	After Debt Service
Municipal Conservation	---	NA	NA
Subordination	---	NA	NA
Advanced Treatment (RO) Facility	$83,072	$3.41	$2.27

Figure 5D-4
Odessa Water Management Plan



Odessa Alternative Water Management Strategies

Odessa has identified two alternative strategies, which may be implemented if additional supplies are needed or one of the City's strategies cannot be implemented. The Alternate Water Management Strategies for Odessa include:

- Development of Brackish Groundwater in Ward County
- Development of Groundwater near Fort Stockton

Both of these strategies are described in full and evaluated in Appendix C.

5D.5 City of San Angelo

The City of San Angelo is located in Tom Green County near the center of Region F. As one of the largest cities in the region, it is a major center of employment, trade and cultural activities in the region. The City currently receives water from six sources: Lake Nasworthy, Twin Buttes Reservoir, the Concho River, O.C. Fisher Reservoir, Ivie Reservoir and a well field in McCulloch County (Hickory aquifer). The city also has a contract with CRMWD for water from the Spence Reservoir, but the pipeline needs rehabilitation and is not currently being used. Tom Green County WCID #1 currently utilizes the City of San Angelo's effluent water prior to taking their water supplies (when available) in Twin Buttes. The City plans to convert this to municipal supply as part of the Concho River Water Project. San Angelo will continue to provide wastewater to the irrigators when it is not needed as municipal supply.

Table 5D- 1 is a comparison of the Region F supply and water demand for the City of San Angelo and its customers. San Angelo supplies all the treated water to Goodfellow Air Force Base and about half of the manufacturing demand in Tom Green County. The City also has a contract with the Upper Colorado River Authority (UCRA) to supply up to 1,000 acre-feet per year.

There is a small reliable supply from three of the City's run-of- river permits but under strict priority analysis there is no reliable supply from the San Angelo Reservoir system. However, these reservoirs are used by the City during most years but may not be reliable during extreme drought years. As such only, a portion of the supply theoretically available from the subordination model is shown as available to City of San Angelo. This supply is expected to decrease over time due to reduction in yield from sedimentation. The City of San Angelo is actively pursuing other strategies to replace supplies from their surface water system. The contracts between the City and CRMWD specify that San Angelo is entitled to 6 percent of the safe yield of Spence Reservoir and 16.54 percent of the safe yield of Ivie. Since the City cannot physically take water from Spence due to the poor condition of the pipeline, San Angelo has no current supply from this source. Due to cost, quality, and reliability concerns, the City of San Angelo does not plan to rehabilitate the Spence Pipeline at this time.

The City of San Angelo is currently authorized to divert 2,750 plus any banked water from their Hickory well field which increases their supply to 12,000 acre-feet per year over time. Currently, the City can treat up to 8 MGD (8,960 AFY) of this supply. Increases in well field and treatment capacity are considered in this plan as a strategy.

Table 5D-16
Comparison of Supply and Demand for the City of San Angelo
-Values are in Acre-Feet per Year-

Supplies	**Supply 2020**	**Supply 2030**	**Supply 2040**	**Supply 2050**	**Supply 2060**	**Supply 2070**
Concho River	214	214	214	214	214	214
San Angelo System (with subordination) [a]	1,670	1,575	1,480	1,385	1,290	1,195
Ivie Reservoir (with subordination) [b]	5,349	5,209	5,070	4,930	4,791	4,651
McCulloch County Well Field (Hickory Aquifer)	8,960	8,960	8,960	8,960	8,960	8,960
Municipal Conservation	467	541	567	602	639	679
Total Availability	**16,660**	**16,499**	**16,291**	**16,091**	**15,894**	**15,699**
Demands	**Demand 2020**	**Demand 2030**	**Demand 2040**	**Demand 2050**	**Demand 2060**	**Demand 2070**
City of San Angelo	17,924	19,657	20,494	21,556	22,847	24,250
UCRA	1,000	1,000	1,000	1,000	1,000	1,000
Goodfellow Air Force Base	513	568	596	629	666	707
Manufacturing, Tom Green County	425	481	481	481	481	481
Total Demand	**19,862**	**21,706**	**22,571**	**23,666**	**24,994**	**26,438**
Surplus (Shortage)	**Surplus (Shortage) 2020**	**Surplus (Shortage) 2030**	**Surplus (Shortage) 2040**	**Surplus (Shortage) 2050**	**Surplus (Shortage) 2060**	**Surplus (Shortage) 2070**
Surplus (Shortage)	**(3,202)**	**(5,207)**	**(6,280)**	**(7,575)**	**(9,100)**	**(10,739)**

[a] Includes Twin Buttes, Lake Nasworthy, and O.C. Fisher; includes contracted portion to UCRA and future contractual increases. Shown as less than what is theoretically available from the WMS.
[b] 16.54% of the safe yield of Ivie with subordination

Through the standard procedure and discussions with the City of San Angelo, potentially feasible water management strategies were developed for further evaluation. A few strategies were discussed but not considered feasible at this time. These include system optimization and voluntary redistribution through lease or purchase of existing water rights. The system optimization strategy looks at the potential benefit from operating the Twin Buttes, Nasworthy, and O.C. Fisher's reservoirs as a system. The City of San Angelo currently operates its reservoir in this fashion and likely experiences a small benefit. However, since the yield of the reservoirs under the extended Colorado WAM is negligible, this strategy was not further evaluated. It is recommended however that San Angelo continue to operate their reservoirs as a system to obtain optimal supply. Voluntary redistribution of existing water rights is a strategy where the City would enter into purchase or lease agreements for existing water rights currently held by other users. The City of San Angelo has purchased existing water rights in the past and may continue to purchase other water rights on a willing-buyer willing-seller basis if the cost is not prohibitive. Diversions for these rights could be moved to one of San Angelo's existing diversion points, or the rights could simply not be exercised, eliminating the possibility of a priority call. The City has been approached by individuals wishing to sell their water rights, but the high costs have made this option unfeasible. If there was a cost-effective opportunity to purchase or lease water rights in the future, the City of San Angelo may want to move forward with this strategy. Region F has not identified any specific rights for purchase at this time, so no quantity, costs or impacts can be developed at this time.

The following strategies were identified as potentially feasible for the City of San Angelo:

- Municipal Conservation
- Subordination
- Brush Control
- Indirect reuse for municipal use (Concho River Water Project)
- Hickory Well Field Expansion in McCulloch County
- Development of Pecos Valley Edwards-Trinity aquifer supplies in Southwest Pecos County
- Development of Edwards-Trinity aquifer supplies in Schleicher County
- Desalination of Additional Groundwater Supplies
- West Texas Water Partnership

Full strategy evaluations are included in Appendix C.

5D.5.1 San Angelo Recommended Water Management Strategies

Municipal Conservation

This strategy pro-actively reduces municipal water demands through public education and outreach, inclining rate structure to discourage high water use, a water waste ordinance, a landscape ordinance for new construction, and time of day outdoor watering limits. These efforts are expected to reduce the City of San Angelo's demands by about 2 percent throughout the planning horizon.

Brush Control

Certain species of brush can drastically reduce the water yield in a watershed. By replacing water intensive brush species with less water intensive native plants, increased runoff to the reservoirs is possible during normal and wet periods. Funding for this type of project may be available through the Water Supply Enhancement Program of the Texas State Soil and Water Conservation Board (TSSWCB), though none was allocated in 2019. The TSSWCB has already completed feasibility studies for the O.C. Fisher, Twin Buttes and Lake Nasworthy watersheds. To date, nearly half of this land has already been treated for brush. However, in order to continue to realize these water savings, brush must be continually retreated. The reservoir yields shown under subordination include hydrology through the end of 2016. Therefore, all savings gained by previous treatment of brush are shown in the modeled yield of these reservoirs under subordination. However, any future brush treatments could yield small amounts of additional savings. According to the TSSWCB annual reports, on average, about 500 to 3,000 acres of brush per year are treated in this area.

Subordination

The subordination strategy increases the supply to San Angelo's reservoirs by changing the strict priority modeling assumptions utilized in WAM Run 3 such that downstream senior water right holders do not make priority calls on upstream users in Region F. As discussed previously, supplies from the subordination strategy will be available in most years but may not be reliable in extreme drought years. Because of this, the supplies from this strategy were limited from what is theoretically available from the subordination model for San Angelo. For the purposes of this plan, the subordination strategy for San Angelo increases the City's surface water system (Twin Buttes, Lake Nasworthy, and O.C. Fisher Reservoirs) supplies increase from 0 acre-feet to 1,670 acre-feet in 2020 and decrease to about 1,200 acre-feet by 2070 due to sedimentation in the reservoirs. The subordination strategy is discussed in detail in Chapter 5C and in Appendix C. Region F recognizes that a subordination agreement is not within the authority of the Regional Water Planning Group. Such an agreement must be developed by the water rights holders themselves, including the City of San Angelo.

Concho River Water Project

The City of San Angelo recently completed a long-range water supply study which identified the Concho River Water Project as the next major water supply for the City. The project is an indirect reuse project that will provide approximately 8,400 acre-feet of water as municipal supply. The project will release highly treated wastewater into the Concho River where it will be diverted approximately 8 miles downstream and treated for municipal use. The project includes permitting, and water and wastewater treatment plant upgrades. The capital costs associated with these upgrades are estimate at nearly $117 million.

Hickory Aquifer Well Field Expansion in McCulloch County

The City of San Angelo operates a well field project in McCulloch County that pumps groundwater from the Hickory Aquifer. This project consists of 15 wells and a transmission system that transports water to the City. This system has the capability to pump about 12,000 acre-feet per year (10.8 MGD) and has infrastructure in place to treat 8,960 acre-feet per year (8 MGD). Based on the current treatment capacity, this project can provide up to 8,960 acre-feet per year according to their agreement with the Hickory Underground Water District and utilizing banked water. Starting in 2026, the City's permitted supply increases to an annual amount of 10,000 acre-feet. The project's permitted supply will reach its ultimate capacity of 12,000 acre-feet by 2036. In order to reach this full capacity, the City will need to add additional wells, increase their radium treatment capacity, and upgrade some pump stations along the pipeline route. No additional pipelines or increases in pipeline capacity are required. The capital costs associated with these upgrades are estimated at $66 million.

5D.5.2 San Angelo Water Management Plan Summary

San Angelo Recommended Water Management Strategies

- Municipal Conservation
- Subordination
- Brush Control
- Concho River Water Project (Indirect Reuse)
- Hickory Well Field Expansion in McCulloch County

Table 5D- 17 shows the supply amounts from each strategy and the needs after implementation of the recommended strategies for San Angelo. The costs for each recommended strategy are summarized in Table 5D- 18.

Primary strategies for San Angelo include the Concho River Water Project and expansion of the City's Hickory Well Field. Figure 5D-5 illustrates the recommended water management plan for San Angelo. This plan indicates that the recommended strategies will be able to meet all of San Angelo's projected needs throughout the planning horizon.

Table 5D-17
Recommended Water Management Strategies for the City of San Angelo

-Values are in Acre-Feet per Year-

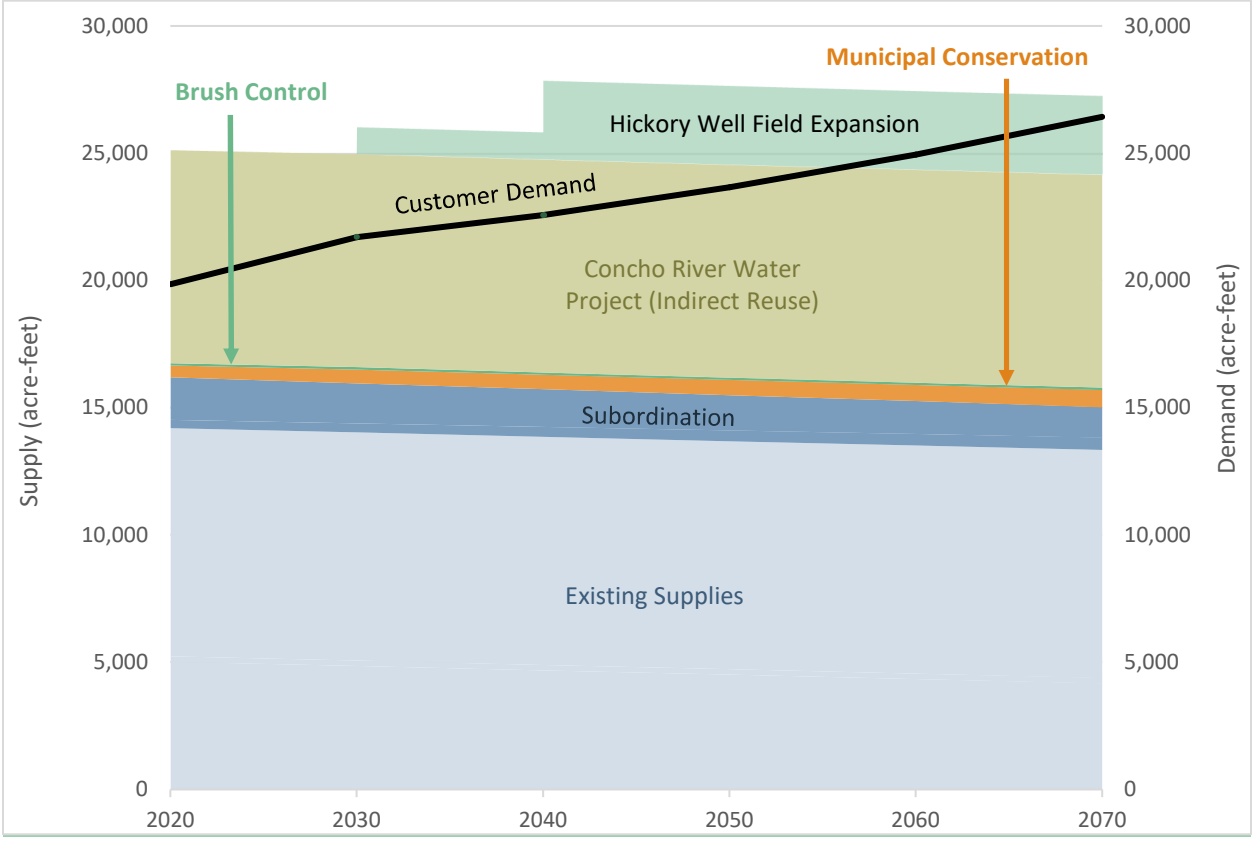
	2020	2030	2040	2050	2060	2070
Surplus (Shortage) before Recommend Strategies	**(3,202)**	**(5,207)**	**(6,280)**	**(7,575)**	**(9,100)**	**(10,739)**
Recommended Strategies	**2020**	**2030**	**2040**	**2050**	**2060**	**2070**
Subordination - Ivie Contract	*329*	*359*	*391*	*421*	*453*	*483*
Subordination - San Angelo System	*1,670*	*1,575*	*1,480*	*1,385*	*1,290*	*1,195*
Municipal Conservation	*467*	*541*	*567*	*602*	*639*	*679*
Brush Control	90	90	90	90	90	90
Concho River Project (Indirect Reuse)	8,400	8,400	8,400	8,400	8,400	8,400
Hickory Well Field Expansion	0	1,040	3,040	3,040	3,040	3,040
Total Supply from Recommended Strategies	**8,490**	**9,530**	**11,530**	**11,530**	**11,530**	**11,530**
	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Surplus (Shortage) after Recommended Strategies	**3,028**	**4,323**	**5,250**	**3,955**	**2,430**	**791**
Management Supply Factor	*1.3*	*1.2*	*1.2*	*1.2*	*1.1*	*1*

Strategies in grey italics were included in the previous calculation of surplus (shortages). They are included in this table for completeness but are not included in the total to avoid double counting.

Table 5D-18
Costs for the Recommended Strategies for the City of San Angelo

Strategy	Capital Cost (Million $)	Unit Cost ($/1,000 gal)	
		With Debt Service	After Debt Service
Municipal Conservation	---	NA	NA
Subordination	---	NA	NA
Brush Control	---	NA	$1.50
Concho River Water Project	$117	$3.84	$0.83
Hickory Well Field Expansion	$66	$7.12	$3.18

Figure 5D-5
San Angelo Water Management Plan



San Angelo Alternative Water Management Strategies

The City of San Angelo is considering additional strategies which may be implemented if additional supplies are needed or if one or more of the recommended strategies is determined to be no longer feasible. Alternate water management strategies for San Angelo include:

- Development of Edwards-Trinity aquifer supplies in Schleicher County
- Development of Pecos Valley-Edwards-Trinity aquifer supplies in Southwest Pecos County
- Desalination of Additional Groundwater Supplies