APPENDIX N: NORTH TEXAS MUNICIPAL WATER DISTRICT WATER SUPPLY PLANNING PROCESS

References cited can be found in Chapter 6 of the EIS

CONTENTS

TABLES:

FIGURES:

1. Project Purpose and Need Background

As stated in Section 1.5 of Chapter 1 of the Revised DEIS, the purpose of and need for the proposal is to develop an additional supply of water to address the growing demand of the North Texas Municipal Water District's (NTMWD's) customers. The specific action proposed by NTMWD to meet this purpose and need is impounding up to 367,609 acre-feet (AF) of water from Bois d'Arc Creek and its tributaries in a new 16,641-acre water supply reservoir for NTMWD use only. This project would produce an estimated firm yield of 120,665 acre-feet per year (AFY). State population projections show the NTMWD service area population increasing from 1.6 million to 3.3 million by 2060. The proposed project would provide a new water supply to help meet demand from this increasing population. Even with aggressive efforts by NTMWD to promote water conservation, encourage efficiency, and develop water reuse projects (discussed further below), aggregate demand for new potable water supplies will grow substantially over the coming 50 years.

NTMWD provides wholesale treated water, wastewater treatment, and regional solid waste services to member cities and direct customers in a service area covering parts of nine counties in North Central Texas. This service area is one of the fastest growing areas in the state of Texas. McKinney and Frisco are among the fastest growing cities in the entire country. This growing population and the location of this growth are the impetus behind increased demands for water and the need to develop new sources of water supply. To meet these projected needs, NTMWD will have to construct the North water treatment plant (WTP) by 2020 to serve the fast-growing northern sectors of its service area. The Lower Bois d'Arc Creek Reservoir (LBCR) will provide new supply to the proposed North WTP to help meet this increasing demand (Freese and Nichols, 2008a).

The primary water supply sources now available to NTMWD include: 1) raw water from four reservoirs (Lakes Lavon, Chapman, Texoma, and Bonham); 2) wastewater reuse from the NTMWD's Wilson Creek Wastewater Treatment Plant and the East Fork Raw Water Supply Project; 3) interim purchases; and 4) direct reuse for irrigation use.

NTMWD's Current Supplies

- Lavon Lake
- Lake Chapman
- Lake Texoma
- Lake Bonham
- Wilson Creek Wastewater Treatment Plant reuse
- East Fork Raw Water Supply Project
- Supplies from Upper Sabine Basin (Lake Tawakoni)
  - Permanent contracted water
  - Interim contracted water
- Direct reuse for irrigation use

Near-Term Supplies Planned to be Implemented Prior to Proposed Project

- Main Stem Pump Station (MSPS)

Current Supplies that will be Unavailable in the Near Future

- Interim contract for Upper Sabine Water (2025)

To meet its immediate needs and to allow time for the development of new sources, the NTMWD has contracted with the Sabine River Authority for interim water supplies until 2025 when the contract expires. NTMWD also had an interim contract in place with Dallas Water Utilities to purchase up to 67,200 AFY (equivalent to 60 million gallons per day [mgd]) from April 2013 through April 2016. This contract was for three years; Dallas Water Utilities did not renew or extend the contract. Thus, these interim supplies from Dallas are no longer available, consistent with the *2016 Region C Water Plan*.

Including interim supplies from Lake Tawakoni in the Upper Sabine Basin, the total amount of water available to NTMWD from the above existing sources will be 360,831 AFY in 2020 and 390,738 AFY in 2060 (Table 1).

Table 1. Summary of Water Available (in AFY) from NTMWD's Existing Supplies

Current supply	2020	2030	2040	2050	2060
Lavon Lake[1]	94,459	93,635	92,699	91,762	90,826
Lake Texoma	70,623	70,623	70,623	70,623	70,623
Lake Chapman[1]	44,792	44,505	44,218	43,931	43,644
Wilson Creek reuse	47,418	56,386	63,785	71,882	71,882
Lake Bonham	2,511	3,195	3,195	3,195	3,195
East Fork reuse	47,802	62,977	75,524	87,291	97,655
Upper Sabine Basin	50,707	10,629	10,550	10,472	10,394
Direct reuse (irrigation)	2,519	2,519	2,519	2,519	2,519
Total supply	**360,831**	**344,468**	**363,113**	**381,675**	**390,738**

[1] Includes supply associated with the dredging projects listed in the *2016 Region C Water Plan*.
Source: Table 2 in Kiel and Gooch, 2015

With the overall population of the NTMWD service area projected to approximately double over the coming 40 years, the overall demand for water from existing and potential member cities and customers is likewise projected to increase substantially, from 430,193 AFY in 2020 to 665,375 AFY in 2060 (Kiel and Gooch, 2015). After customer conservation and NTMWD water loss reduction are taken into account, net demand is projected to increase from 419,998 AFY in 2020 to 626,436 AFY in 2060 (Table 1.5-1 in the Revised DEIS). To help meet these needs, the NTMWD is actively promoting conservation measures with its member cities and customers. NTMWD is also implementing the largest wastewater reuse program in Texas. However, even with advanced conservation measures and increases in wastewater reuse (see Section 6.D. of Appendix N for a description of NTMWD's wastewater reuse program), NTMWD's current water supplies will be unable to meet the projected, long-term growth in demand. By 2020, NTMWD will have a projected supply deficit of 6,031 AFY, increasing to 232,464 AFY by 2060 (Table 1.5.-1 of the Revised DEIS and Table 12 of Appendix N). Figure 1 depicts this emerging deficit graphically.

As listed in Table 1.5.-1 of the Revised DEIS and Table 12 of Appendix N, the MSPS refers to a new pump station that NTMWD is currently designing to deliver return flows from the main stem of the Trinity River to NTMWD's East Fork Raw Water Supply Project. The MSPS is expected to be online in 2018. Supplies from the MSPS will decline over time as more reuse water from the East Fork Trinity River is transferred to the East Fork Raw Water Supply Project.

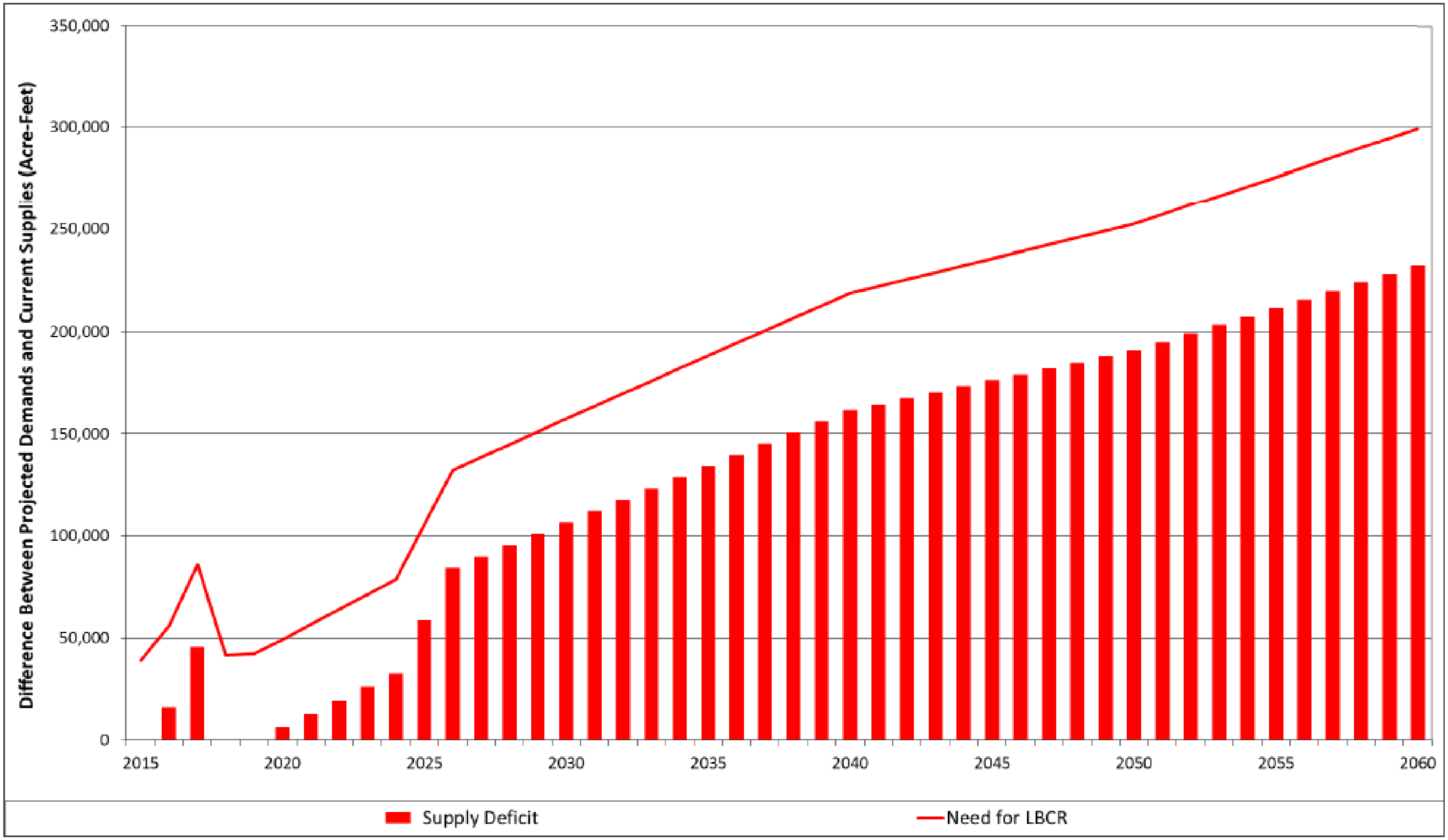

Figure 1. Water Supply Gap for NTMWD[1]

[1]Projected needs with conservation, reuse, and MSPS taken into account

Cautious water supply planning should acknowledge uncertainty with regard to the continued availability of particular water supplies in the future. As an approach to this uncertainty that the U.S. Army Corps of Engineers (USACE) considers prudent in light of recent experience, NTMWD also seeks to develop a reserve or contingency supply of water for emergency situations and for droughts worse than the drought of record. In recent years, NTMWD has experienced the urgent need for emergency supplies when USACE's Lake Texoma was forced offline due to the discovery of zebra mussels in the lake and the need to prevent their propagation to Lavon Lake and the Trinity River Basin. Lake Texoma, which provided about 28 percent of NTMWD's water supply at the time, was unavailable for five years. Fortunately, in response, NTMWD was able to implement interim contracts for water from other wholesale water providers and could accelerate other projects. NTMWD's water supplies were also adversely affected by a severe drought from 2010 to 2013; drought-imposed watering restrictions were not lifted until 2015 (Anon., 2015).

However, neither interim water supplies from third parties nor projects that can be accelerated will always be available. Therefore, relying on these does not represent prudent, cautious long-term water supply planning. Therefore, NTMWD looks to develop sufficient water supplies to provide for a critical reserve capacity of at least 10 percent of its demands. The proposed project would provide for the absolute deficit and the critical reserve supply. Figure 1 illustrates the supply gap, including direct demand and reserve supply, on an annual basis from 2015 through 2060. Table 12 shows a summary of the supply and demand comparison for NTMWD, including the need for the proposed project, from 2020 to 2060.

To address these shortages and provide a reasonable reserve for future growth and unforeseen conditions, the *2016 Region C Water Plan* and the *2017 Texas State Water Plan* (adopted by the Texas Water Development Board (TWDB) on May 19, 2016) recommend multiple water management strategies for NTMWD, including additional conservation and reuse, the connection of existing sources, and the development of new water supplies. The development of the LBCR is one of the strategies recommended in both plans.

As discussed in more detail below, where several alternative future demand projections for NTMWD are compared, the USACE Tulsa District considers the Capital Improvement Plan (CIP) demand projections to be the most reasonable and accurate at this point in time. These projections have been considered in crafting the purpose and need statement below. The CIP is developed specifically for NTMWD by its consultants and is updated every several years.

2. Meeting the Purpose and Need of the Applicant's Proposed Action

To meet the purpose and need of the proposed project or Applicant's Proposed Action an alternative must be capable of supplying at least 105,804 AFY of water by 2025. The amount of water required and the timeframe are illustrated in Figure 1 of Appendix N and in the third column, bottom row of Table 1.5-1 of the Revised DEIS. An alternative must be capable of supplying 105,804 AFY of water by 2025 to be considered "reasonable" and merit full consideration in this EIS. The NTMWD supply deficit is first projected to appear in 2020 as a deficit of 6,031 AFY, or 49,051 AFY with the recommended reserve supply included. By 2025, the deficit between supply and demand (i.e., need) will increase considerably, greatly decreasing NTMWD's ability to meet its growing needs through stopgap measures or interim strategies alone.

3. State and Regional Population Projections

In Texas as a whole, as well as in each water planning region, the five-year water planning cycle starts with projecting the state population over the coming 50 years and estimating the probable water demands of the populations over those 50 years. Developing population and water demand projections is a time-consuming process that is based on a consensus between state agencies, regional water planning groups, and local bodies. The TWDB, Texas Commission on Environmental Quality (TCEQ), Texas Parks and Wildlife Department (TPWD), Texas Department of Agriculture (TDA), representatives from the planning groups, and members of the public all help determine the final water demand projections for the Texas state water plan, using population projections developed initially by the Office of the State Demographer (OSD) and the Texas State Data Center (TWDB, 2016).

This section presents recent state and regional demographic projections. Much of the information has been updated since the LBCR DEIS was released in February 2015. Demographic data and projections from the *2017 State Water Plan* and the *2016 Region C Water Plan*, which have been released since the issuance of the DEIS, have been incorporated. Demographic factors – birth rates (fertility), death rates (mortality), in-migration (migration into Texas from other states or countries), and out-migration (emigration from Texas to other states or countries) – are constantly changing; thus, updated official population projections are required every few years. It is also important to note that demographers make projections, not predictions, about the future. Projections are based on credible assumptions and ranges of assumptions for the demographic factors listed above.

The population of Texas has grown very rapidly since World War II, and every indication is that it will continue to increase quite rapidly both in absolute and relative terms over the foreseeable future, although at a somewhat slower rate. It is expected to continue to grow at a faster annual and decadal rate (measured in percent change) than the U. S. as a whole. For the foreseeable future, the state population is expected to increase rather than to stabilize or decrease.

Texas is the second most populous state in the U.S., exceeded only by California. Since 2000, it has added more people than any other state, including California; since 2010, the Texas population has grown at twice the rate of the nation as a whole (Census, 2016). Overall, the population of Texas is anticipated to grow by over 70 percent between 2020 and 2070, from 29.5 million to 51 million. More than half of this population growth is expected to occur within Region C (where NTMWD and the proposed project are located) and Region H (TWDB, 2016).

A. State Population Projections

The population projections in the *2017 State Water Plan* were developed by the TWDB using standard demographic methodology known as the cohort-component model. The cohort-component procedure uses separate cohorts (combinations of age, sex, and racial-ethnic groups) and components of cohort change (birth, survival, and migration rates) to estimate future population size by county. The cohort-component model and demographic assumptions used as the basis for the regional population projections were prepared by the OSD at the Texas State Data Center. The OSD provided the TWDB with initial, 30-year projections for each county; these 30-year projections were then extended to the state water plan's 50-year planning horizon (TWDB, 2016).

Figure 2 depicts projected population growth for the entire state of Texas from 2020 to 2070. Although the state's population size will increase substantially, that growth will not be evenly distributed.

Of the three components of change in cohort size mentioned above – birth, survival, and migration rates – migration rate is the most critical. Migration rates refer to the number of people moving into and out of each county (in-migration and out-migration). Whereas birth and survival rates tend to follow predictable long-term trends, net migration rates are heavily influenced even in the short-term by the condition of the economy, which is inherently less predictable. Migration rates can also be affected by other unanticipated events, such as those associated with extreme weather (e.g., hurricanes, floods, droughts, wildfires).

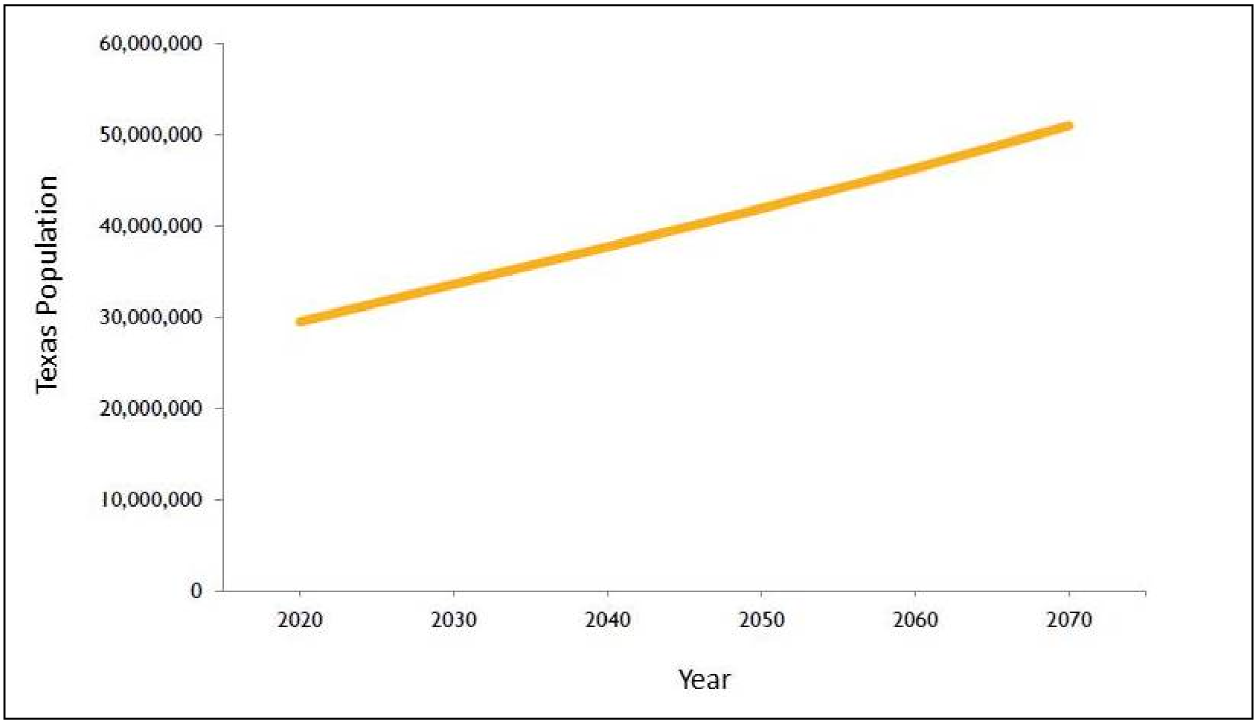

Figure 2. Projected Population Growth in Texas, 2020-2070

Source: TWDB, 2016; modified from Figure 5-1

In the most recent state water planning cycle (2012-2017), in order to determine the most appropriate migration projection for each region, the TWDB and the regional planning groups evaluated three sets of projections based on different migration patterns:

- Zero migration;
- One-half of the migration rates from 2000 to 2010; and
- 2000–2010 migration rates.

The TWDB used the one-half migration rate scenario for most of the counties, based on historical precedence and recommendations by the OSD for long-term projections. TWDB sent its draft population projections to the state water regions for review by planning groups and the public. At the request of planning groups, the TWDB then made more than 600 revisions to the population projections at the county and sub-county levels (TWDB, 2016).

As mentioned earlier, population growth in Texas is not expected to be evenly or proportionately distributed among regions. Region C, where most of NTMWD's service area and the proposed LBCR are located, is projected to incur nearly one-third (32 percent) of the population growth for the entire state of Texas, far more than any other single region (Figure 3). NTMWD also serves customers in Region D, but the current water demand for these customers is less than one percent of the total demand on NTMWD. By 2060, the customers in Region D will represent less than 1.5 percent of the total demand on NTMWD (Region C Water Planning Group, 2015). Thus the following discussions on regional water planning focus on the planning performed by Region C. Also, in accordance with TWDB guidelines, planning for wholesale water providers that serve customers in multiple regions is to be performed by the region in which the majority of the customers are located (TWDB, 2015). For NTMWD, regional water planning was conducted by Region C with coordination with Region D.

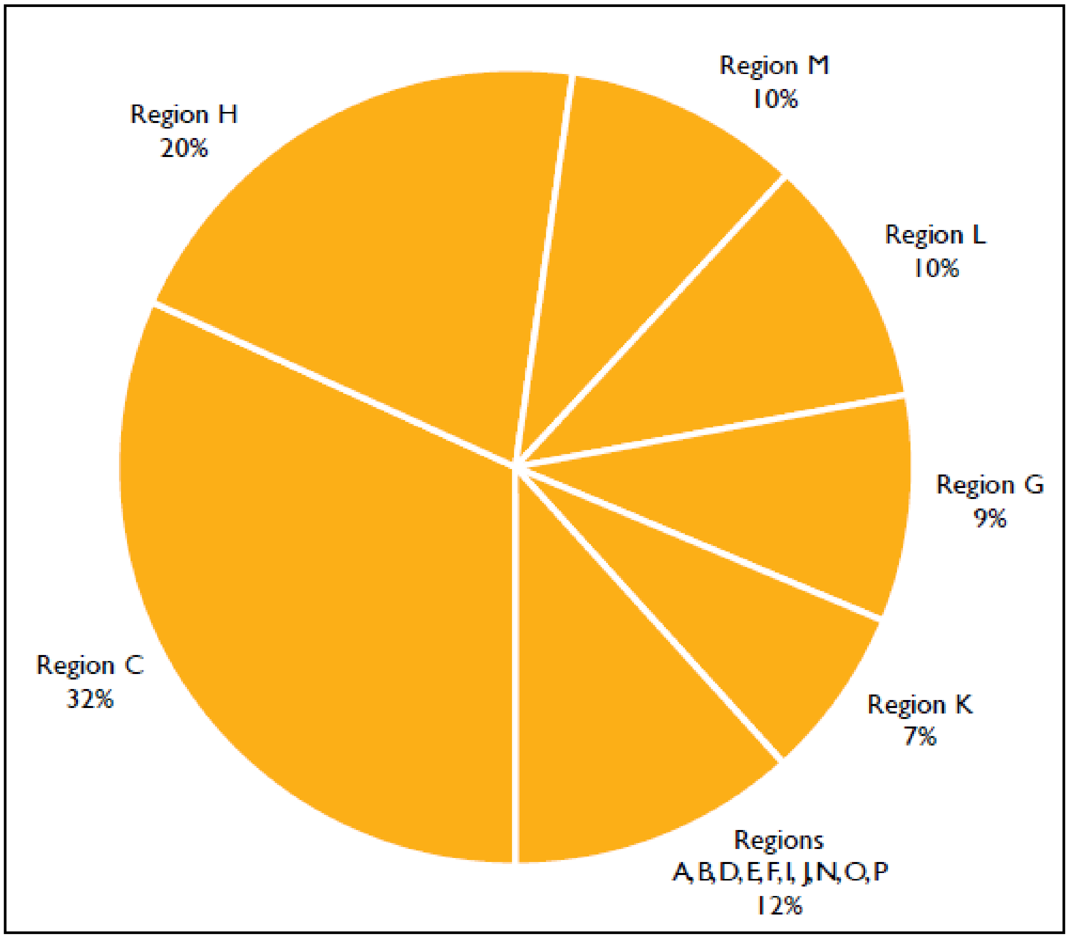

Figure 3. Projected Regional Shares of Statewide Population Growth from 2020 to 2070

Source: TWDB, 2016; Figure 5-3

B. Region C Population Projections

The current population projections for Region C are based on draft projections furnished by TWDB to the regional water planning group in March 2013. These draft projections were based on projections prepared by the OSD using data from the 2010 U.S. Census. The Region C Water Planning Group analyzed the draft projections provided by TWDB and modified them based on feedback received from water user groups (WUGs), wholesale water providers (WWPs), the North Central Texas Council of Governments, and other sources. TWDB allowed population adjustments to be made between WUGs and counties, but required that the aggregate regional population remain the same as the total of the draft projections supplied by TWDB (Region C Water Planning Group, 2015).

As mandated by TWDB regulations, Region C's population projections were posted for public review on the Region C website prior to the August 5, 2013 Region C Planning Group meeting at which they were considered and then approved. Subsequently, they were adopted by TWDB. Table 2 presents the TWDB-adopted population projections for the Region C counties. The projected 2020 population for Region C is 7,504,200. This is about six percent less than the projected 2020 population projection from the *2011 Region C Water Plan* of 7,971,728. The projected 2060 Region C population is 12,742,283; this is only about two percent less than the projected 2060 population of 13,045,592 in the *2011 Region C Water Plan* (Region C Water Planning Group, 2010 and 2015). Generally, the long-term population projections of the *2016 Region C Water Plan* are slightly lower but consistent with those of the 2011 plan. The projections presented in the 2016 plan reflect lower relative population growth in Dallas, Tarrant, and Collin Counties than in the *2011 Region C Water Plan*, but with relatively more growth occurring in the outlying, lower-population counties of the region.

The 16 counties that comprise Region C have been among the fastest growing in Texas and in the nation as a whole since the 1950s. The region's highest population density is concentrated in and near Dallas and Tarrant counties. For decades, the population growth in the region was centered on the cities of Dallas and Fort Worth. In the 1960s and 1970s, this growth enveloped the near suburbs in Dallas and Tarrant counties. Eventually, in the 1980s and even more so in the 1990s and 2000s, growth and development have spread to Collin, Denton, Rockwall, and Ellis counties (Region C Water Planning Group, 2015). Figure 4 shows the growth rates for Region C from 1960 to 2070 by decade.

TWDB and Region C water planners have developed both population and water demand projections out to 2070 for all towns and cities with a population over 500 and for any retail water supplier (such as a water supply corporation or a utility district) that provides an annual average of over 0.25 mgd of water supply. As mentioned above, this group of entities is collectively referred to as water user groups or WUGs. Any rural population not included in a specific water user group has been included in the "County Other" water user group for each county. Nineteen new WUGs were added for the 2016 update of the Region C Water Plan, either because their populations have recently reached at least 500 or because they have reached the 0.25 mgd supply threshold. Ten WUGs were removed for the 2016 update of the Region C Water Plan because they no longer met the population or water supply threshold. There are currently over 280 WUGs in Region C (Region C Water Planning Group, 2015).

As stated above, revisions to the initial draft population projections by TWDB were made based on input from WUGs and WWPs in Region C. Each WUG in Region C was queried about its population projections. In the survey, each WUG was provided a copy of their population projections from the *2011 Region C Water Plan* and TWDB's draft population projections for the *2016 Region C Water Plan*. Each WUG was then asked if they concurred with the projections. If the WUG was not in agreement with the projections it was asked to provide alternative projections. Many WUGs responded with suggestions for revisions to the population projections. Additionally, interviews were conducted with certain WUGs and WWPs to gather more detailed information. Phone and email correspondence were also used to gather additional information (Region C Water Planning Group, 2015).

Data obtained from surveys, interviews, and correspondence were compiled and used to develop a final set of recommended population projections that met the criteria established by the TWDB for revisions. Potential justifications for revisions included: 1) 2010 Census undercount with documentation; 2) documentation that the net migration rate is different from assumed; and 3) statistically different birth and death rates. All WUGs were notified as to which revisions were included in the recommended population projections. After posting for public review as required, the projections were approved on August 5, 2013 and formally adopted by TWDB (Region C Water Planning Group, 2015).

According to the projections shown in Table 2, during the 50 years from 2020 to 2070 the population of Region C will almost double, from 7,504,200 to 14,347,912. Dallas and Tarrant counties will remain the most populous in the region, with over three million residents each, but Collin and Denton counties are both anticipated to have more than two million residents; as recently as 1990, both of these counties were home to little more than 250,000 residents each.

Table 2. TWDB-Adopted Population Projections for Region C by County

County	Historical 1990	Historical 2000	Historical 2010	2020	2030	2040	2050	2060	2070
Collin	264,036	491,774	782,341	956,716	1,116,830	1,363,229	1,646,663	1,853,878	2,053,638
Cooke	30,777	36,363	38,437	42,033	45,121	48,079	53,532	64,047	96,463
Dallas	1,852,810	2,218,774	2,368,139	2,566,134	2,822,809	3,107,541	3,355,539	3,552,602	3,697,105
Denton	273,525	432,976	662,614	901,645	1,135,397	1,348,271	1,576,424	1,846,314	2,090,485
Ellis	85,167	111,360	149,610	183,814	224,000	276,931	362,668	488,768	683,974
Fannin	24,804	31,242	33,915	38,346	43,391	52,743	69,221	101,915	138,497
Freestone	15,818	17,867	19,816	20,437	21,077	22,947	31,142	44,475	73,287
Grayson	95,021	110,595	120,877	134,785	148,056	164,524	185,564	250,872	344,127
Henderson*	41,309	51,984	78,532	60,175	64,059	69,737	76,204	101,827	136,269
Jack	6,981	8,763	9,044	9,751	10,409	10,817	11,033	11,190	11,291
Kaufman	52,220	71,313	103,350	146,623	191,707	239,940	309,619	428,577	571,840
Navarro	39,926	45,124	47,735	52,544	57,032	61,667	71,452	86,952	107,814
Parker	64,785	88,495	116,927	199,955	255,133	291,007	366,596	480,530	629,277
Rockwall	25,604	43,080	78,337	104,887	137,304	160,918	198,279	249,594	301,970
Tarrant	1,170,103	1,446,219	1,809,034	2,006,473	2,281,666	2,579,553	2,797,060	2,991,972	3,184,348
Wise	34,679	48,793	59,127	79,882	94,734	110,668	149,261	188,770	227,527
Region C Total	**4,077,565**	**5,254,722**	**6,477,835**	**7,504,200**	**8,648,725**	**9,908,572**	**11,260,257**	**12,742,283**	**14,347,912**

*Projections for Henderson County only include the portion of Henderson County located within Region C.

Source: Table 2.1 in Region C Water Planning Group, 2015

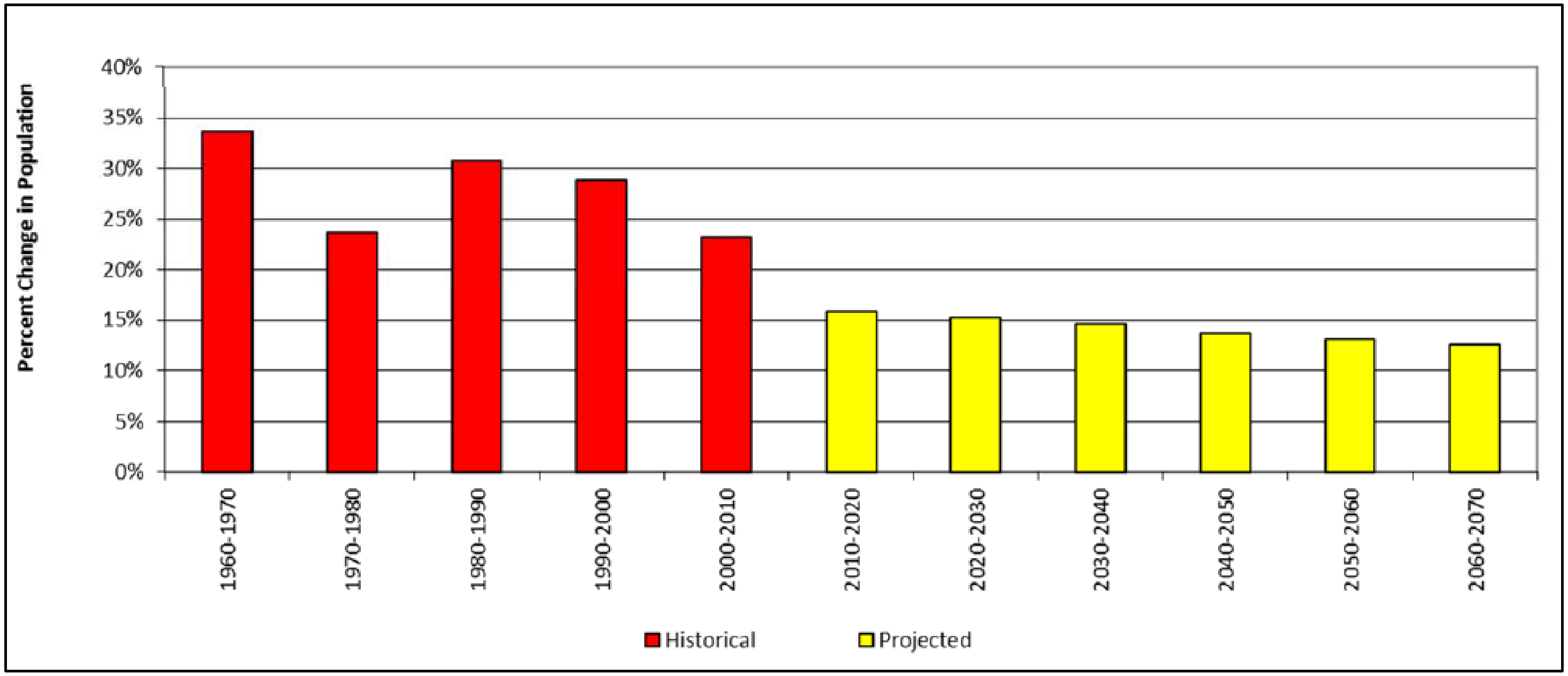

Figure 4. Historical and Projected Population Growth Rates by Decade in Region C, 1960-2070

Source: Figure 2.2 in Region C Water Planning Group, 2015

Figure 4 displays the historical and projected rate of population growth for Region C. This figure shows that the population projections for Region C represent a substantial reduction in the historical rate of increase. However, measuring rates of change only in relative terms (annual or decadal percentage change) can be misleading. It is also important to measure change in absolute numbers; in this case the change in the actual number of persons, each of whom will be a consumer of water, added to or subtracted from a population. As shown in Table 3, the population growth in Region C from decade to decade during the 80-year time period shown in Table 2 does not slow down; it increases. The last two decades shown, 2050-2060 and 2060-2070, have the greatest projected growth; 1.5 million and 1.6 million, respectively.

Table 3. Comparison of Region C Population Growth Increments from 1990 to 2070 by Decade

Decade	Population Growth
1990 to 2000	1,177,157
2000 to 2010	1,223,113
2010 to 2020	1,026,365
2020 to 2030	1,144,525
2030 to 2040	1,259,847
2040 to 2050	1,351,685
2050 to 2060	1,482,026
2060 to 2070	1,605,629

Source: Data from Table 2.1 in Region C Water Planning Group, 2015

Region C includes most of the Dallas and Fort Worth-Arlington metropolitan statistical areas (MSAs). The largest employment sector in the Dallas MSA is the service industry, followed by trade, manufacturing, and government. The Fort Worth-Arlington MSA's largest employment sectors are service, trade, and manufacturing. Both MSAs experienced strong economic growth in the 1990s and 2000s (Region C Water Planning Group, 2010). This growth continues today (Region C Water Planning Group, 2015).

NTMWD's service area is one of the fastest growing in the entire country at present. The area is attracting new businesses and associated population. Frisco and McKinney are two of the most rapidly growing cities in Texas, and the nation as a whole, with the 2014 growth rate at more than five percent. Frisco's population expanded by 24 percent and McKinney's by 20 percent from 2010 to 2014. Ranked by population added, five Texas cities – Houston, Austin, San Antonio, Dallas and Fort Worth – were among the top 10 fastest-growing cities in the U. S. between July 1, 2013 and July 1, 2014 (Young, 2015). Recent news of major new economic investments within NTMWD's service area that will have a bearing on near- to mid-term population growth and concomitant water demands include Toyota's announcement that it is moving its U.S. headquarters to Plano (Box, 2015) and Liberty Mutual Insurance's announcement that it is investing $325 million and bringing up to 5,000 jobs to a new campus and regional hub at Plano's $2 billion Legacy West development by 2017 (Carlisle, 2015).

4. Region C Water Demand Projections

Projections of municipal water demands in Texas are based on two key underlying variables: 1) historical per capita water use; and 2) projected population change. Reductions in water use associated with the 1991 State Water-Efficient Plumbing Act are taken into account separately by TWDB and provided to the regional planning groups, such as Region C. As in the case of population projections, the regional water planning groups can review the water demand projections at the water user level and recommend adjustments if needed and if supported by technical evidence. Demand projections for other water use categories in Texas are derived separately and are based on the best data available (Kiel, 2014a).

Per capita water use is the average amount of water used by each person, which is based on total water use divided by population size. Because of diverse climatic conditions, variable population and commercial business density, consumers' ability to pay for water as indicated by average incomes, effectiveness of local conservation programs, and availability of water across the state, Texas has a wide range of per capita water use.

The volume of water used for municipal purposes depends primarily on population size, climatic conditions, and water conservation practices. For the TWDB's planning purposes, municipal water use includes that consumed by residences (single and multifamily housing), commercial entities, and institutions. Commercial water use includes business establishments but excludes industrial water use. Residential, commercial, and institutional uses are grouped together because of the similarity of these uses; that is, they all use water primarily for drinking, cleaning, sanitation, air cooling, and outdoor use (e.g., landscaping, washing cars) (TWDB, 2005).

Municipal water use is reported to the TWDB on an annual basis by cities and water suppliers such as municipal utility districts like NTMWD. The types of information reported include groundwater and surface water use, source of the water (aquifer, river, reservoir, or stream), water sales to other municipalities and end users, water purchases, number of service connections, and estimated population served.

The weather influences the amount of water used annually. Rainfall frequency plays a large role in the volume of water used for municipal purposes, especially for outdoor uses. During below-normal rainfall periods, people tend to use more water than during normal weather conditions.

The state's methodology for water demand projections for the 2006 Regional Water Plans also served as the basis for the methodology for the 2011 Regional Water Plans, since the 2011 plans were an update of the 2006 plans. While there are some differences between the methodologies for the 2011 Regional Water Plans and the current 2016 Regional Water Plans, the concept and approaches are very similar.

The municipal water demand projections presented here are from the *2016 Region C Water Plan* (Region C Water Planning Group, 2015), and are based on per capita dry-year water use and the adopted population projections discussed in the previous section. In March 2013, TWDB furnished draft per-capita projections for each WUG based on each WUG's actual 2011 per capita use as determined by TWDB. These projections from 2020 through 2070 incorporated estimated water reductions due to savings from plumbing code requirements for low-flow fixtures. TWDB chose the year 2011 as the base year because it represented the most severe drought year in recent history for the majority of the state of Texas. However, 2011 was not the most severe recent drought year for much of Region C (Region C Water Planning Group, 2015).

Consultants for Region C met with TWDB staff and indicated that for many WUGs in Region C, 2006 and 2008 were more typical of dry-year, high-demand conditions than 2011. In parts of Region C, unlike most of the state, there were intermittent light rains during the summer of 2011 that suppressed water demand. The consultants suggested that the dry-year per capita demands should be based on the highest per capita use in recent years and then reduced over time to reflect savings from low-flow water fixtures. However, TWDB staff did not concur. Consequently, the projected dry-year demands for some WUGs in Region C likely underestimate actual dry-year demands.

TWDB did permit Region C to make changes to this 2011 base-year per capita water use in very restricted cases and required substantial justification supported by documentation in order to allow these changes. Overall, 73 percent of TWDB's recommended dry-year per capita values were retained. For the other WUGs, adjustments were made based on specific information obtained and submitted by Region C. Region C water planners prepared a detailed memorandum to outline the changes in select gallons per capita per day (GPCD) values and to document and justify those changes (Region C Water Planning Group, 2015).

As with the population projections, Region C water planners sent a survey to each WUG providing their demand projections from the *2011 Region C Water Plan* and TWDB's draft demand projections for the 2016 Region C Plan. If the WUG did not concur with the projections it was asked to provide alternative projections. Survey responses were used to identify instances where TWDB base-year 2011 per capita data may have contained an error. If a potential problem was identified, additional data were gathered and if necessary submitted to TWDB as justification for base per capita adjustment. As required by TWDB regulations, these projections were posted for public review on the Region C website before the Region C Planning Group meeting at which they were considered for approval. The municipal demand projections were approved by the Region C Water Planning Group at the same August 5, 2013 public meeting at which the population projections were approved (Region C Water Planning Group, 2015).

Table 4 presents the projected total dry-year water demand for the Region C counties, as adopted by TWDB. According to these projections, Dallas County will be the single largest user of water in 2020 and will remain so in 2070, followed by Tarrant and Collin counties, respectively. Overall demand is projected to increase by 71 percent in the half century between 2020 and 2070, which is substantially less than the rate of projected population increase over the same time period (91 percent), because of gradually declining per capita water demand.

Table 4. TWDB-Adopted Total Dry-Year Water Demand Projections for Region C by County

County	Projected dry-year water demand (AFY)					
	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Collin	224,022	256,375	305,795	354,437	384,105	412,735
Cooke	9,725	9,276	9,005	9,683	11,137	15,366
Dallas	577,785	618,807	674,672	720,897	757,834	782,053
Denton	185,710	226,706	265,820	306,284	353,071	392,342
Ellis	40,255	47,596	58,626	73,656	94,634	127,173
Fannin	21,517	27,201	28,967	31,697	36,106	41,013
Freestone	35,073	34,856	35,121	39,948	46,635	55,960
Grayson	40,623	49,497	52,616	56,853	68,207	85,117
Henderson	13,462	16,928	18,519	20,422	25,705	32,402
Jack	6,498	6,942	7,127	7,382	7,648	7,979
Kaufman	29,204	34,977	40,737	49,301	62,910	78,996
Navarro	20,683	27,025	28,015	29,746	32,110	35,114
Parker	36,785	46,580	51,788	62,476	77,868	98,251
Rockwall	20,419	27,595	31,483	36,966	44,600	53,074
Tarrant	431,918	481,457	536,594	580,170	620,092	659,399
Wise	29,646	33,173	38,063	45,919	54,174	62,906
Region C Total	**1,723,325**	**1,944,991**	**2,182,948**	**2,425,837**	**2,676,836**	**2,939,880**

Source: Table 2.2 in Region C Water Planning Group, 2015

Table 5 and Figure 5 show the projected dry-year water demand for the region by type of use. In 2020, municipal water use in Region C will account for about 86 percent of total water use.

Table 5. TWDB-Adopted Dry-Year Water Demand Projections for Region C by Type of Use

Water Use	Projected Dry-year Water Demand (AFY)					
	2020	**2030**	**2040**	**2050**	**2060**	**2070**
Municipal	1,481,530	1,675,385	1,894,722	2,119,813	2,352,818	2,594,833
Manufacturing	79,540	87,958	96,154	103,307	107,899	112,839
Steam electric power	71,452	94,176	106,033	113,641	124,001	135,443
Irrigation	33,167	33,383	33,599	33,815	34,032	34,248
Mining	38,858	35,311	33,662	36,483	39,308	43,739
Livestock	18,778	18,778	18,778	18,778	18,778	18,778
Region C total	**1,723,325**	**1,944,991**	**2,182,948**	**2,425,837**	**2,676,836**	**2,939,880**

Source: Table 2.3 in Region C Water Planning Group, 2015

5. NTMWD Water Demand Projections

USACE considered three different water demand projections for NTMWD in developing the purpose and need statement for the Proposed Action:

- *2011 Region C Water Plan* projections
- *2016 Region C Water Plan* projections
- 2013 NTMWD CIP demands

The original DEIS used projections from the *2011 Region C Water Plan* (Region C Water Planning Group, 2010), henceforth referred to as the 2011 Region C water demands. This set of demands include those of NTMWD's member cities and customers as of 2008, which were comprised of 75 municipal water user groups and multiple non-municipal users (e.g., electricity generating stations, manufacturing, and irrigation). The state of Texas' methodology to develop regional water planning demands was provided to the USACE Tulsa District on September 3, 2014 in a memorandum from Simone Kiel, dated August 8, 2014 (Kiel, 2014a). The 2011 Region C Water demands are based on dry year per capita water use that occurred prior to 2008. For many of NTMWD's member cities and customers, the dry year per capita water use for the 2011 projections was based on the year 2000 or 2006, which were both extremely dry years in the North Texas area.

For the *2016 Region C Water Plan*, the TWDB required the use of year 2011 as the dry year base per capita water use. In NTMWD's service area, 2011 was a dry year, but it was not the highest demand year in recent history for many of NTMWD's member cities and customers because there were several substantial rainfall events during the summer of 2011 that reduced municipal water use. Thus, the 2016 Plan's demands for NTMWD are lower than shown in the 2011 Plan.

Due to NTMWD's concern for its ability to meet the growing demands of its service area, NTMWD contracted with Freese and Nichols, Inc. (FNI) to develop demand projections for five-year intervals up through 2040. These demands are based on the 2016 Region C population projections and the highest per capita water use between 2006 and 2011. These demand projections were then extended to 2060 for the purpose and need evaluation in this Revised DEIS. They are referred to as the 2013 NTMWD CIP water demands (Kiel and Gooch, 2015).

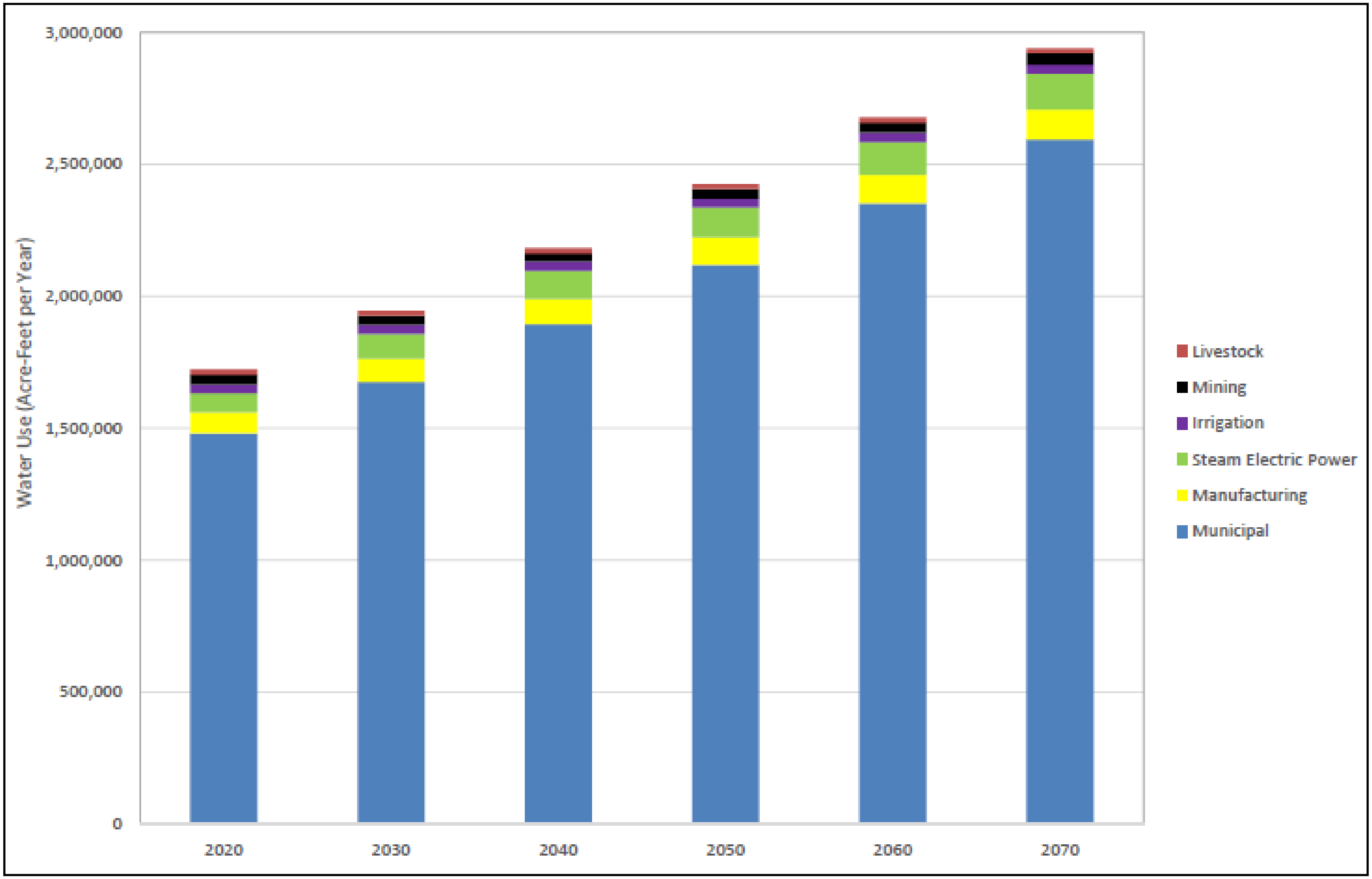

Figure 5. TWDB-adopted Projections for Dry Year Water Use by Category in Region C

Source: Figure 2.3 in Region C Water Planning Group, 2015

The 2011 Region C, 2016 Region C, and 2013 NTMWD CIP water demand projections are discussed in the sections below. Each of the three demand projections incorporate demand reductions associated with plumbing code requirements. Also, conservation measures already implemented are reflected in the per capita water use for the 2016 Region C water demands and the 2013 NTMWD CIP water demands. Additional conservation implemented over and above those already implemented by NTMWD's customers is shown as a demand reduction.

A. 2011 Region C Water Plan Demand Projections for NTWMD

The 2011 Region C water demands come from the *2011 Region C Water Plan* (Region C Water Planning Group, 2010) and were the basis for the purpose and need discussion in Chapter 1 of the DEIS. Taking into account both existing member cities and customers, as well as future customers, the total demand on NTMWD is expected to be 492,634 AFY by 2020, increasing to 789,676 AFY by 2060. These demand projections include a four percent loss in treatment and delivery for treated water supplies. No such loss is assumed for raw water customers. The projected demands, by customer, are shown in Table 6.

Table 6. 2011 Region C Water Demands for NTMWD (AFY)

Water User Group (WUG)	2020	2030	2040	2050	2060
Allen	24,699	27,663	27,694	27,694	27,694
Anna	2,736	4,187	5,653	7,329	12,356
Blackland WSC	699	842	999	1,197	1,433
Bonham	2,527	3,172	4,337	5,881	7,253
Caddo Basin SUD	1,501	1,893	2,423	3,382	4,787
Cash SUD	800	1,010	1,346	1,792	1,792
College Mound WSC	1,155	1,582	1,853	2,187	2,623
Collin Co. Other	371	338	306	277	252
Crandall	657	657	872	872	872
Culleoka WSC	1,350	1,625	1,883	2,185	2,506
Danville WSC	1,153	1,417	1,693	1,990	2,306
East Fork SUD	1,378	1,501	1,637	1,777	1,942
Fairview	3,992	5,012	6,593	6,593	6,593
Farmersville	1,176	1,680	2,520	3,696	5,041
Fate	3,968	4,943	5,842	6,496	6,945
Forney	4,033	4,973	5,763	6,422	7,048
Forney Lake WSC	1,694	2,096	2,592	3,222	4,028
Frisco	45,670	59,090	72,333	83,110	83,110
Garland	42,055	42,789	42,462	42,190	42,190
Gastonia-Scurry SUD	1,104	1,262	1,506	1,840	2,255
Hackberry	137	202	231	246	253
Heath	2,727	3,393	4,116	4,964	5,980
High Point WSC	517	616	728	865	1,044
Howe	473	720	968	1,120	1,248
Hunt County Other	128	157	203	313	485
Josephine	346	415	499	580	668

Water User Group (WUG)	2020	2030	2040	2050	2060
Kaufman	1,716	2,013	2,264	2,511	3,029
Kaufman County Other	1,446	1,436	1,425	1,414	1,414
Lavon WSC	1,746	2,414	2,997	3,796	5,015
Little Elm	5,365	6,652	7,625	7,625	7,625
Lowry Crossing	458	541	554	551	551
Lucas	1,533	1,828	2,344	3,327	4,537
McKinney	53,767	73,929	94,092	102,157	102,157
McLendon-Chisolm	296	320	347	396	467
Melissa	4,864	7,419	10,645	14,947	16,462
Mesquite	30,312	33,874	34,469	34,521	34,532
Milligan WSC	196	191	185	183	183
Mt. Zion WSC	436	430	425	421	421
Murphy	8,556	8,556	8,556	8,556	8,556
Nevada	528	631	1,254	2,090	5,226
North Collin WSC	1,116	1,321	1,525	1,757	2,005
New Hope	383	632	944	1,416	3,148
Oak Grove	148	172	201	236	283
Parker	4,078	5,950	9,669	14,132	19,338
Plano	76,828	77,318	77,570	77,818	78,097
Post Oak Bend City	138	226	369	602	982
Princeton	2,657	3,871	6,452	10,753	16,130
Prosper	3,239	5,669	7,829	12,688	13,498
RCH WSC	911	919	918	912	912
Richardson	36,123	35,993	35,602	35,343	35,343
Rockwall	17,597	21,596	25,162	25,826	25,826
Rockwall Co. Other	385	385	383	383	383
Rowlett	13,731	15,447	16,801	17,759	18,694
Royse City	4,422	5,959	7,789	9,561	11,521
Sachse	5,124	5,806	5,746	5,746	5,746
Saint Paul	468	930	1,479	1,756	1,848
Scurry	102	118	138	160	186
Sunnyvale	2,454	3,135	3,820	4,514	4,618
Talty WSC	1,717	2,337	3,024	3,878	4,948
Terrell	10,385	14,780	19,138	21,731	24,643
The Colony	778	861	881	901	909
Van Alstyne	961	2,060	2,692	2,969	3,099
Wylie	8,737	10,586	12,601	12,601	12,601
Non-municipal Customers					
Collin County manufacturing	3,810	4,327	4,843	5,306	5,788

Water User Group (WUG)	2020	2030	2040	2050	2060
Collin County irrigation (demand for reuse projects)	1,847	1,847	1,847	1,847	1,847
Collin County mining	146	146	146	146	146
Dallas County manufacturing	7,180	7,818	8,401	8,874	8,927
Dallas County steam electric	86	238	240	240	240
Denton County manufacturing	62	70	79	87	94
Fannin County manufacturing	82	90	98	105	114
Grayson County manufacturing	78	85	91	96	104
Kaufman County irrigation	1,805	1,805	1,805	1,805	1,805
Kaufman County manufacturing	813	869	928	993	1,061
Kaufman County steam electric	1,121	1,121	1,121	1,121	1,121
Rockwall County irrigation	848	848	848	848	848
Rockwall County manufacturing	23	26	29	32	35
Total	**468,648**	**548,830**	**625,443**	**685,657**	**729,767**
Potential Future Customers					
Ables Springs WSC	845	1,054	1,299	1,644	2,090
Blue Ridge	365	893	1,569	2,342	2,651
Celina	1,500	3,000	5,000	5,000	5,000
Ector	9	33	57	59	62
Fannin County Other	413	596	768	705	659
Honey Grove	96	268	460	564	671
Leonard	76	266	587	907	1,166
Savoy	13	35	57	59	61
South Grayson WSC	100	100	100	100	100
Southwest Fannin Co SUD	354	663	921	1,004	1,099
Trenton	131	368	694	1,077	1,464
Weston	451	1,316	4,124	7,300	12,592
Future customer total	**4,351**	**8,593**	**15,635**	**20,760**	**27,614**
Total future treated water demands	**472,999**	**557,423**	**641,078**	**706,417**	**757,381**
Losses in treatment and delivery	18,920	22,297	25,643	28,257	30,295
Collin Co. steam electric raw water	715	1,000	1,200	1,600	2,000
Total future demand	**492,634**	**580,720**	**667,921**	**736,274**	**789,676**

Source: Appendix H, *2011 Region C Water Plan* (Region C Water Planning Group, 2010)

B. 2016 Region C Water Plan Demand Projections for NTMWD

The 2016 Region C Water Demands are the most recent projections for the Texas regional water planning process (Region C Water Planning Group, 2015). As described above, these demands are based on the 2011 historical water use, which is not considered reflective of recent dry year usage for all NTMWD member cities and customers. Population projections are based on the 2010 Census and 50 percent of the 2000 to 2010 migration rate. Where appropriate, minor adjustments to population were made within the region to reflect build-out and changed conditions; however, the total population of Region C was held constant. The list of potential future customers did not change.

Taking into account both existing customers and future customers, the total demand on NTMWD is expected to be about 379,800 AFY in 2020, increasing to approximately 637,350 AFY by 2060. The projected demands by customer are shown in Table 7.

Table 7. 2016 Region C Water Demands for NTMWD (AFY)

Water User Group (WUG)	2020	2030	2040	2050	2060
Ables Springs WSC	383	494	630	796	1,006
Allen	20,533	20,336	20,215	20,139	20,108
Anna	976	1,268	2,666	3,904	8,245
Blackland WSC	678	712	754	800	857
Bonham	2,024	2,506	3,393	4,598	5,663
BHP WSC (Hunt Co portion)	342	371	429	454	438
Caddo Basin SUD	986	1,219	1,586	2,071	2,736
Cash SUD	2,466	2,466	2,466	2,466	2,466
College Mound WSC	790	989	1,218	1,481	2,017
Collin Co. Other	953	929	911	3,833	5,610
Copeville SUD[1]	319	376	452	596	1,037
Crandall	779	955	1,162	1,397	1,396
Culleoka WSC	328	370	605	740	807
Denton County Other	1,800	1,800	1,800	1,800	1,800
East Fork SUD	572	721	891	1,081	1,293
Fairview	4,644	5,329	7,094	7,087	7,084
Farmersville	958	2,310	2,299	2,293	2,291
Fate	1,731	2,457	3,291	4,135	5,079
Forney	3,191	3,707	4,803	5,817	8,428
Forney Lake WSC	896	1,108	1,355	1,639	2,694
Frisco	39,355	51,015	61,637	61,574	61,530
Garland	37,871	38,007	37,508	37,102	37,037
Gastonia-Scurry SUD	601	762	947	1,160	1,448
Hackberry	309	394	498	615	752
Heath	3,945	7,839	7,826	7,818	7,816
High Point WSC	477	569	681	817	1,298
Howe	5	36	70	108	150
Hunt County Other	274	371	514	726	1,052
Josephine	278	424	573	722	722
Kaufman	990	1,184	1,442	2,151	2,777
Kaufman County Other	362	408	991	2,127	4,452
Lavon[1]	559	711	1,081	1,392	3,125
Lavon WSC	590	711	881	1,152	2,007
Little Elm	4,108	4,600	4,586	4,574	4,564
Lowry Crossing	222	257	308	306	305
Lucas	2,132	2,406	3,165	3,528	3,896

Water User Group (WUG)	2020	2030	2040	2050	2060
McKinney	34,365	40,877	59,112	76,866	76,818
McLendon-Chisolm	330	406	495	587	691
Melissa	1,334	1,932	2,668	6,292	10,613
Mesquite	22,344	23,858	26,361	28,441	30,667
Milligan WSC	163	156	152	883	1,327
Mt. Zion WSC	395	485	589	698	822
Murphy	5,285	5,253	5,238	5,228	5,222
Nevada	96	112	133	528	1,316
North Collin WSC	782	871	987	1,117	1,279
New Hope	119	143	174	209	251
Oak Grove	75	88	103	157	212
Parker	2,561	6,772	8,454	8,450	8,449
Plano	69,020	70,608	73,054	73,153	73,059
Post Oak Bend City	93	113	134	205	276
Princeton	974	1,236	1,566	3,679	5,798
Prosper	5,322	8,355	11,405	14,457	17,511
RCH WSC	540	536	534	532	900
Richardson	26,328	26,676	27,364	28,016	27,979
Rockwall	8,914	11,049	13,526	16,057	18,911
Rockwall Co. Other	28	28	28	28	986
Rose Hill SUD[1]	456	546	656	789	1,033
Rowlett	9,870	10,484	10,348	10,270	10,249
Royse City	1,261	1,746	2,628	5,065	8,948
Sachse	5,179	5,124	5,091	5,071	5,064
Saint Paul	265	298	322	334	348
Scurry	59	71	85	129	182
Seis Lagos UD[1]	603	598	596	594	594
Sunnyvale	2,357	3,332	4,313	4,968	5,958
Talty	305	377	462	560	775
Talty WSC[1]	1,584	1,801	2,083	2,914	3,693
Terrell	4,035	7,143	8,638	10,670	12,372
The Colony	1,200	2,000	2,200	2,400	2,600
Van Alstyne	0	91	183	294	1,820
Wylie	7,308	8,052	8,552	8,954	9,230
Wylie Northeast SUD	257	319	396	785	1,305
Non-municipal Customers					
Collin County Manufacturing	3,283	3,694	4,103	4,471	4,854
Collin County Mining	0	0	0	0	0
Dallas County Manufacturing	3,779	4,115	4,421	4,670	4,698
Denton County Manufacturing	72	82	92	101	110
Fannin County Manufacturing	88	97	106	114	124
Grayson County Manufacturing	49	53	57	61	66
Kaufman County Manufacturing	813	869	928	993	1,061

Water User Group (WUG)	2020	2030	2040	2050	2060
Kaufman County Steam Electric	1,121	1,121	1,121	1,121	1,121
Rockwall County Irrigation	97	97	97	97	97
Rockwall County Manufacturing	35	40	45	50	55
Total	**360,571**	**411,821**	**470,328**	**524,057**	**573,430**
Potential Future Customers					
Blue Ridge	0	111	312	1,382	3,191
Celina	0	1,500	3,000	5,000	5,000
Ector	0	47	51	56	64
Fannin County Other	399	611	614	1,096	3,260
Honey Grove	0	188	244	241	241
Leonard	0	152	198	216	247
Savoy	0	32	44	48	56
South Grayson WSC	0	0	0	0	0
Southwest Fannin Co SUD	0	343	442	557	797
Trenton	0	93	523	955	1,301
Weston	0	839	4,648	11,658	18,613
Kaufman County mining	0	0	0	0	3
Fannin County mining	56	56	56	56	56
Future customer total	**455**	**3,972**	**10,132**	**21,265**	**32,829**
Total Future Treated Water Demands	**361,026**	**415,793**	**480,460**	**545,322**	**606,259**
Losses in treatment and delivery	18,051	20,790	24,023	27,266	30,313
Collin Co. steam elec. raw water	715	602	740	594	782
Total Future Demand	**379,792**	**437,185**	**505,223**	**573,182**	**637,354**

Source: Appendix H, Table H.23, *2016 Region C Water Plan* (Region C Water Planning Group, 2015)

C. 2013 CIP Water Demand Projections for NTWMD

FNI prepared these municipal water demand projections for NTMWD using the TWDB population projections developed for the proposed *2016 Region C Water Plan* as the initial population basis. These projections were reviewed with each customer and adjusted based on observed growth and build-out limits. In total, population projections were increased for 16 customers and decreased for three customers, resulting in a net increase of five to eight percent in the total population served from 2020 to 2040. Population for these customers beyond 2040 was projected at the same rate as the 2016 Region C projections or 50 percent of the growth rate from 2020 to 2040, depending upon expected future trends. For customers with no changes to populations, the 2016 Region C projections were used.

The water demands were calculated using the projected population and highest per capita water use recorded between 2006 and 2011. For two customers, baseline per capita water use was reduced based on customer input. Per capita water use was reduced over time to account for the implementation of water efficient plumbing fixtures. Water sales to other users, including other municipal customers and other industries, were estimated based on existing contracts and projected growth (Kiel and Gooch, 2015). The proposed final 2013 CIP demand projections include an eight percent loss in treatment and delivery for treated water supplies. This increase in loss from the *2011 Region C Water Plan* and the *2016 Region C Water Plan* (from four percent in the 2011 Plan and five percent in the 2016 Plan) is based on updated calculations of pumped water versus delivered water. As in the regional water plan demands, no loss is assumed for raw water customers.

Taking into account both existing member cities and customers, as well as future customers, the total demand for water on NTMWD is expected to be 430,200 AFY in 2020, increasing to 665,400 AFY by 2060. The projected demands by customer are shown in Table 8.

Table 8. 2013 CIP Water Demands for NTMWD (All Values in AFY)

Customer	2020	2030	2040	2050	2060
Allen	21,944	21,736	21,638	21,649	21,551
Anna	743	2,757	4,836	5,587	6,286
Blackland WSC	754	795	841	890	955
BHP WSC	511	508	506	504	500
Bonham	2,112	2,603	3,499	4,712	5,787
Caddo Basin SUD	985	1,218	1,586	2,071	2,736
Cash SUD	1,412	1,816	2,384	2,467	2,209
College Mound WSC	790	989	1,218	1,481	2,017
Collin Co. Other	County-other demands are included with the supplier				
Copeville WSC	319	376	452	596	1,037
Crandall	779	955	1,162	1,397	1,396
Culleoka WSC	650	750	850	900	950
East Fork SUD	987	1,158	1,335	1,511	1,688
Fairview	4,644	5,329	7,094	7,087	7,084
Farmersville	813	990	1,199	2,149	2,810
Fate	1,761	2,508	3,349	4,216	5,151
Forney	4,605	5,191	6,584	7,845	10,745
Forney Lake WSC	1,243	1,542	1,889	2,293	3,760
Frisco	40,194	48,620	61,732	61,755	61,778
Garland	44,462	45,493	45,059	45,266	45,310
Gastonia-Scurry SUD	799	1,001	1,232	1,498	2,520
Hackberry	309	394	498	615	752
Heath	4,353	8,656	8,629	8,629	8,601
High Point WSC	506	605	727	871	1,373
Howe	134	395	703	791	870
Hunt County Other	County-other demands are included with the supplier				
Josephine	278	424	571	719	717
Kaufman	1,527	1,870	2,480	3,492	4,377
Kaufman County Other	County-other demands are included with the supplier				
Lavon WSC	655	792	990	1,304	2,258
Little Elm	6,372	7,198	7,198	7,198	7,198
Lowry Crossing	249	290	349	349	346
Lucas	2,132	2,406	3,165	3,528	3,896

Customer	2020	2030	2040	2050	2060
McKinney	41,965	49,627	56,875	60,870	64,807
McLendon-Chisolm	423	524	641	763	896
Melissa	1,659	3,582	5,394	5,895	6,201
Mesquite	26,021	27,803	29,816	32,048	34,376
Milligan WSC	203	196	190	217	214
Mt. Zion WSC	398	489	597	711	834
Murphy	5,668	5,642	5,616	5,616	5,591
Nevada	96	113	135	538	1,344
North Collin WSC	858	961	1,085	1,240	1,412
New Hope	122	148	181	219	261
Oak Grove	75	88	103	157	212
Parker	2,561	6,772	8,454	8,450	8,449
Plano	75,590	77,155	77,164	77,067	76,442
Post Oak Bend City	93	113	134	205	276
Princeton	1,905	3,211	4,428	5,701	6,952
Prosper	7,174	14,125	21,299	24,494	27,433
RCH WSC	893	882	873	873	873
Richardson	35,095	37,909	39,641	40,315	40,995
Rockwall	9,952	14,697	14,614	14,619	14,668
Rockwall Co. Other	County-other demands are included with the supplier				
Rose Hill SUD	456	546	656	789	1,033
Rowlett	10,304	11,492	11,502	11,509	11,510
Royse City	1,916	2,925	4,764	5,717	6,746
Sachse	4,761	5,395	5,331	5,331	5,299
Saint Paul	387	440	475	496	514
Scurry	72	88	105	161	227
Seis Lagos UD	604	599	596	596	596
Sunnyvale	2,357	3,332	4,313	4,968	5,958
Talty WSC	1,584	1,801	2,083	2,914	3,693
Terrell	5,139	9,414	12,930	14,879	16,719
The Colony	1,200	2,000	2,200	2,300	2,300
Van Alstyne	287	885	1,545	1,750	1,936
Wylie	7,325	8,429	9,267	9,748	9,999
Wylie NE SUD	460	515	586	1,888	2,964
Non-municipal Customers					
Treated non-municipal demands are included with the municipal water provider					
Potential Future Customers					
Ables Springs WSC	419	542	692	874	1,104
Blue Ridge	0	546	753	3,533	6,012
Celina	0	1,500	3,000	3,000	3,000

Customer	2020	2030	2040	2050	2060
Ector	0	66	71	77	87
Fannin County Other	0	611	614	1,096	3,260
Honey Grove	0	188	244	241	241
Leonard	0	152	198	216	247
Savoy	0	32	44	48	56
South Grayson WSC	0	118	108	114	131
Southwest Fannin Co. SUD	0	407	504	552	594
Trenton	0	93	523	955	1,301
Weston	285	950	4,704	11,658	18,613
Total Treated Water Demands	**395,332**	**466,466**	**528,803**	**568,778**	**613,031**
Losses in treatment and delivery (8%)	31,627	37,317	42,304	45,502	49,043
Irrigation (Collin & Rockwall)	2,519	2,519	2,519	2,519	2,519
Collin Co. steam elec. raw water	715	602	740	594	782
Total Demand	**430,193**	**506,904**	**574,366**	**617,393**	**665,375**

Source: Table 6 in Kiel and Gooch, 2015

The three demand projections just discussed – *2011 Region C Water Plan*, *2016 Region C Water Plan*, and 2013 NTMWD CIP – are compared in Figure 6 and Table 9. These three curves show a range of anticipated water demand on NTMWD, with the 2011 Region C demand projections capturing the upper limits and the 2016 Region C demand projections capturing the lower limits. The 2013 CIP demand projections fall in between these two other projections, and in later decades converge with the 2016 Region C curve.

In Figure 6, there are four red circles in the lower left side of the figure, representing four years of historical demand for NTMWD. In these particular years, NTMWD imposed drought restrictions of water either because of extreme drought conditions (2006) or loss of Lake Texoma supplies due to the zebra mussel (2012-2014). If NTMWD had not imposed restrictions in these years, the demand would have been significantly higher. In Texas, drought restrictions that are included in drought contingency plans are only utilized under emergency conditions. Emergency conditions occur when supplies are insufficient to meet water supply demands either due to drought conditions or due to the unexpected loss of supplies, like the loss of Lake Texoma or the loss of a water supply due to contamination (30 Tex. Admin. Code Chapter 288, Subchapter B).

All three demand projections show significant increases in water demands on NTMWD over the coming decades through 2060. This is because, as stated earlier, NTMWD's service area is one of the fastest growing regions of the United States. With such a dynamic service area, it is crucial that NTMWD develop adequate water supplies to serve its customers and to provide a reserve both for unanticipated growth and unanticipated supply interruptions.

The USACE Tulsa District considers the 2013 NTMWD CIP projection to be the most realistic and reasonable at this point in time. The *2016 Region C Water Plan* does not accurately reflect current growth trends within NTMWD's service area; its demographic projections are below the population growth that is actually occurring. Moreover, the 2016 Plan does not appropriately reflect historic dry year per capita use for some WUGs and WWPs. Thus, the 2013 CIP demand projections are used as the basis for specifying the purpose and need for the Applicant's Proposed Action stated in Section 1.5.2 of the Revised DEIS.

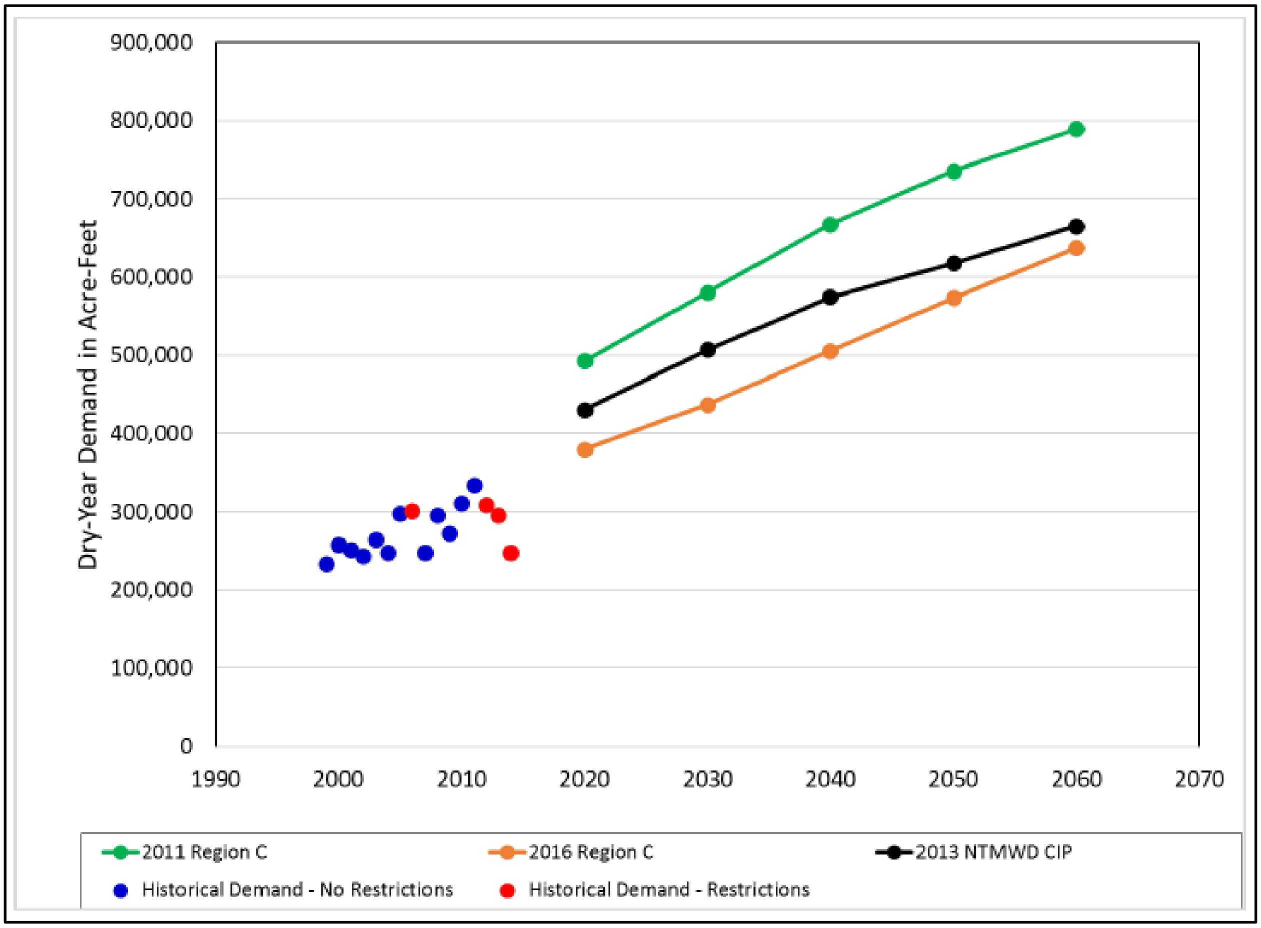

Figure 6. Alternative Water Demand Projections for NTMWD

Source: Figure 2 in Kiel and Gooch, 2015

Table 9. Comparison of Three Water Demand Projections for NTMWD to 2060

Total Demand	2020	2030	2040	2050	2060
2011 Region C Water Plan	492,634	580,720	667,921	736,274	789,676
2016 Region C Water Plan	393,142	452,177	522,156	592,061	658,061
2013 NTMWD CIP	430,193	506,904	574,366	617,393	665,375

The TWDB, which has authority over development of water demand projections for regional water planning in Texas, concurs with the use of the methodology used in the 2013 CIP demand projections. In a letter dated January 20, 2016, the executive administrator of the TWDB stated (Patteson, 2016):

> "Based on our review…and in the context of long-range planning with the attendant demand uncertainties, we consider the NTMWD projections, including the general methodology on which they are based, to be reasonable for use by a water provider that is responsible for ensuring adequate long-term supplies for its customers under all foreseeable conditions."

6. NTMWD's Existing Water Sources and Supplies

The primary water supply currently available to NTMWD includes raw water from three existing reservoirs (Lakes Lavon, Texoma, and Chapman), wastewater reuse from NTMWD's Wilson Creek Wastewater Treatment Plant, and the East Fork Raw Water Supply Project (Freese and Nichols, 2008a). To meet its immediate needs, NTMWD has also contracted with the Sabine River Authority for interim water supplies to 2025, when the contract terminates. Including these interim supplies, the total amount of water available to NTMWD is 413,966AFY in 2020 and 393,973 AFY in 2060.

A. Lavon Lake

Lavon Lake is NTMWD's primary water supply lake. It is owned and operated by the USACE. NTMWD has contracted with the USACE for all of the conservation storage capacity in Lavon Lake and has secured a Texas water right to divert and use the water supply yielded from this storage capacity. Supplies from several of NTMWD's other sources are transported via pipeline to Lavon Lake and subsequently diverted along with lake water to meet the needs of NTMWD's customers and member cities (Kiel and Gooch, 2015).

Lavon Lake Dam (Figure 7) is located at river mile 55.9 on the East Fork of the Trinity River, approximately three miles east of Wylie in Collin County, Texas. The lake is approximately 21,400 acres in area. It is part of the Trinity Project in the Fort Worth District of the USACE.

Figure 7. Lavon Lake Dam near Wylie, Texas

The Lavon Lake Project was authorized by Congress in 1945; construction began in 1948 and was completed six years later in 1954. The dam and lake have a drainage area (i.e., control runoff from an upstream watershed) of about 770 square miles, primarily located in Collin and Grayson counties, surrounding the headwaters of the East Fork Trinity River. Lavon Lake's authorized purposes are flood control, water supply, and recreation (USACE, 2008a).

Definition of terms for water supplies

Texas water right (Certificate of Adjudication or Permit) – Legal instrument issued by the State of Texas to divert, use and store waters of the state.

Permitted diversion – The amount of water that can be legally withdrawn from a water source in accordance with a Texas water right.

Firm Yield – The maximum amount of water that can be diverted from a reservoir on an annual basis during a repeat of the historical drought of record without shortage, assuming that all of the water in the reservoir is available for use.

Reliable Supply – Amount of water that is considered available 100 percent of the time during a repeat of the historical drought of record. This is commonly based on the firm yield of the water source and may differ from permitted diversions or contract amounts.

At Lavon Lake's normal conservation pool elevation of 492 ft. above sea level, it stores approximately 443,800 AF of water (162 billion gallons). Total lake storage, including flood storage, is 748,200 AF (245 billion gallons). NTMWD's water right in Lavon Lake is 118,680 AFY. NTMWD has the capability to divert and treat 770 million mgd from Lavon Lake at its local water treatment facility for wholesale distribution to its member cities and customers. However, NTMWD's ability to divert this quantity of water is affected by lake elevation. Some of this water is placed in Lavon Lake from other sources, which are discussed in subsequent sections.

The reliable water supply attributed to inflows to Lavon Lake is estimated to be about 87,000 AFY based on a minimum surface water elevation of 471 ft. MSL. This elevation is the lowest level at which NTMWD can use all three of its pump stations in Lavon Lake. Pumping capacity is limited when the lake elevation drops below 471 ft. MSL and pump stations go offline, which reduces the amount of water that can be withdrawn from Lavon on a reliable basis.

To improve NTMWD's ability to fully utilize this source, NTMWD dredged access channels to deeper water, completed in 2016. Dredging of Lavon Lake will allow for the use of all three pump stations down to an elevation of 467 ft. MSL (four feet below the current elevation) which provides an additional yield of approximately 8,000 AFY (Kiel and Gooch, 2015).

With the additional yield from this dredging, the reliable supply from Lavon Lake is estimated to be about 95,000 AFY. This potential supply is expected to decrease over time as sediment accumulates in the lake and reduces the storage in the reservoir. By 2040, the estimated supply from Lavon Lake is 93,000 AFY and by 2060, approximately 91,000 AFY.

Lavon Lake receives about 1.6 million visitors annually. The lake has numerous recreational facilities to accommodate these visitors, including 16 parks, 244 picnic sites, 19 four-lane boat ramps, five beaches, 71 tent camping sites with water, 167 camping sites with electric and water hook-ups, a handicapped park, and six group shelters for large group picnics. There are also two privately owned marinas and one fishing pier. The lake's fish population includes several species of sport fish, including crappie, white bass, black bass, channel catfish, striped bass and hybrid bass. Adjacent to the lake are 6,500 acres for wildlife and hunting. Game species include squirrel, cottontail rabbit, mourning dove, bobwhite quail, waterfowl, and feral hogs (USACE, 2008a).

B. Lake Chapman

Jim Chapman Lake (Figure 8) is another USACE reservoir, also known as Lake Chapman or Cooper Lake. It is a 19,305-acre impoundment with a drainage area upstream of the dam of 479 square miles. Cooper Lake provides water supply storage for NTMWD, the Sulphur River Municipal Water District, Upper Trinity Regional Water District and the city of Irving. NTMWD has a contract with the USACE for 36.86 percent of the conservation storage in the reservoir, and a Texas water right permit to divert up to 54,000 AFY from Lake Chapman (Kiel and Gooch, 2015).

Figure 8. Cooper Dam and Jim Chapman Lake, in Delta and Hopkins Counties, Texas

Water from Lake Chapman for NTMWD is transmitted by pipeline to Lavon Lake for diversion to NTMWD's Wylie WTP. According to the Region C Water Planning Group, the water supply available (firm yield) to NTMWD from Lake Chapman in 2010 was 47,132 AFY and the same amount will still be available in 2060. While NTMWD's water right to Lake Chapman is 54,000 AFY, another 3,214 AFY is available per a contract with the city of Cooper, for a total supply of 57,214 AFY. However, Lake Chapman is over-permitted, and 57,214 AFY would not be sustainable through a drought.

Recent yield studies indicate that Lake Chapman recently experienced a new drought of record (April 2003 to November 2006). Its previous drought of record was in the 1950s. Currently, NTMWD (and others) can only pump water when the lake is above an elevation of 420 ft.MSL because of sediment blocking the existing access channel to the pump station. NTMWD has begun dredging the channel to access water down to an elevation of 415.5 ft. MSL, which is the bottom of the conservation pool.

Based on the latest yield studies, the supply available to NTMWD from Lake Chapman (including the contracted supply with the city of Cooper) is estimated to be approximately 41,000 AFY. After dredging, the supply will increase to approximately 45,000 AFY. By 2040, supply available from Lake Chapman will decrease to approximately 44,000 AFY due to reduced storage from sedimentation. These values assume that periodic dredging of the access channel will be carried out to maintain access to the full conservation pool.

NTMWD is undertaking a project that would remove a silt barrier now found in Chapman Lake. This silt barrier limits the amount of water reaching the intake structure in the lake. The removal project will allow for use of Lake Chapman's full yield. This project is estimated to be finished before 2020 (Region C Water Planning Group, 2015). It is also included in the projections of water available from existing supplies in Tables 10 and 12.

The differences between these supply estimates for Lake Chapman and the *2011 Region C Water Plan* are the result of the new drought of record and the assumption that NTMWD cannot access its full storage capacity without the dredging project. The *2011 Region C Water Plan* supply values assume full access to an elevation of 415.5 ft. MSL (Kiel and Gooch, 2015).

Construction of Cooper Lake was authorized by Congress in 1955; construction started in 1986 and finished in 1991. The lake is located within the South Sulphur River watershed between Delta and Hopkins counties. The USACE built the lake both to control flooding on the Sulphur River and to serve as a water supply. The area provides recreational opportunities that include two state parks and a wildlife management area. USACE uses partnerships to manage more than 29,000 acres of public land at Jim Chapman Lake. Over 15,000 acres of land and water are leased to the TPWD for the management of fish and wildlife resources. TPWD also leases approximately 1,905 acres of land to provide recreational facilities in both Hopkins and Delta counties. NTMWD manages the water intake facility that provides the water supply to several communities (USACE, 2010c).

C. Lake Texoma

Impounded by the Denison Dam on the Red River in Bryan County, Oklahoma and Grayson County, Texas, Lake Texoma is the 12th-largest USACE reservoir in the country and the largest in the Tulsa District. The lake has a normal surface area of 86,910 acres (136 square miles), a volume of approximately 2,516,200 AF, and 580 miles of shoreline. The dam is 726 miles upstream from where the Red River discharges into the Atchafalaya and Mississippi rivers, and the drainage area above the dam is approximately 39,720 square miles. The reservoir is located at the confluence of the Red River and Washita River. The dam site is approximately five miles northwest of Denison, Texas, and 15 miles southwest of Durant, Oklahoma (USACE, no date-b).

Denison Dam and Lake Texoma were authorized for construction by Congress in 1938 for flood control and hydroelectric power generation. The dam, spillway, and outlet works were begun in 1939 and completed in 1944, at which point Denison Dam was America's largest rolled, earth-filled dam. The dam is now the 12th largest in volume in the United States.

Beginning in 1990, NTMWD began importing water from Lake Texoma to Lavon Lake. The water was discharged into a tributary of Lavon Lake (Sister Grove Creek), and blended in Lavon Lake to reduce salinity. Lake Texoma water is naturally high in total dissolved solids (TDS), and subsequently diverted for treatment at NTMWD's Wylie WTP. According to the Region C Water Planning Group, the water supply available to NTMWD from Lake Texoma in 2020 will be 70,623 AFY and the same amount will still be available in 2060. NTMWD's water right in Lake Texoma is 197,000 AFY, which includes:

- 84,000 AFY from the original permit which previously was conveyed by pipeline to Sister Grove Creek and hence to Lavon Lake. However, due to the presence of zebra mussels in Lake

Texoma, this water source can no longer be discharged to waters in the Trinity River Basin. Therefore, due to blending limitations at the Wylie WTP, the maximum amount of Lake Texoma water currently available to NTMWD is 70,623 AFY.

- 113,000 AFY that cannot be discharged into Lavon Lake, but must be taken directly to a water treatment plant. The high salinity of this water would require it to be blended with water from another lower salinity supply source or treated by advanced, and more expensive, water treatment methods. Facilities to transfer or treat this water have not been constructed.

As mentioned elsewhere in this chapter, Lake Texoma water was inaccessible to NTMWD for five years beginning in 2009 as a result of infestation by the invasive zebra mussel of the Texoma waters. This problem has now been resolved at great expense with the passage of federal legislation and the construction of a $300 million pipeline (Figure 9) to deliver the water directly from the Texas Balancing Reservoir near Howe, Texas to the Wylie WTP, bypassing discharge to Lavon Lake via Sister Grove Creek. In general, any future transfers of raw water between surface waters will raise potential invasive species issues and costs.

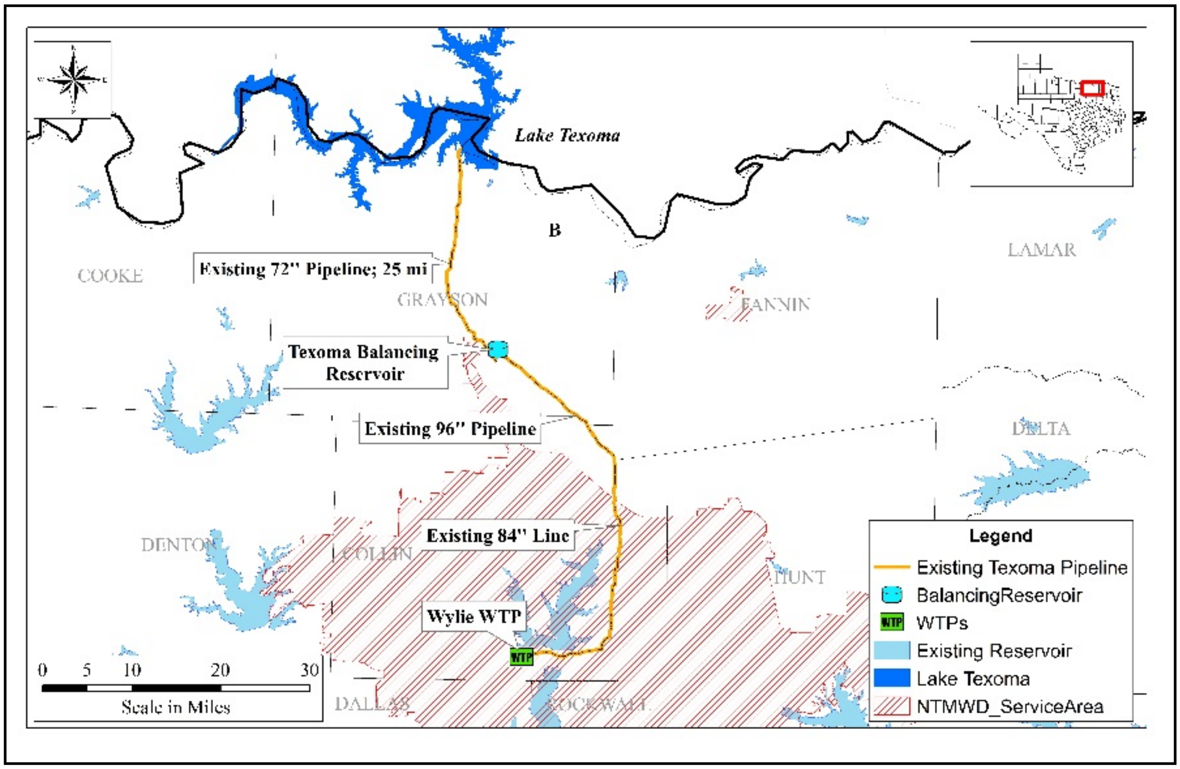

Figure 9. New Pipeline ("existing" line in yellow) from Lake Texoma to the Wylie WTP

The new pipeline does not restore access to all of the supplies NTMWD was previously diverting and using from Lake Texoma; however, it does provide access to about 70,000 to 80,000 AFY, depending upon the water quality in Lake Texoma and quantity of other NTMWD freshwater sources available for blending with Lake Texoma water. The transfer of water from Lake Texoma to Wylie is limited by: (a) the capacity of the 72-inch pipeline from the lake to the balancing reservoir; and (b) a 4:1 blend ratio (other supplies added to Lake Texoma supplies) that is needed to provide blended water with TDS levels less than 600 milligrams per liter (mg/L). Using the 4:1 blend ratio, the available supply from Lake Texoma is 70,600 AFY or 63 mgd (Kiel and Gooch, 2015).

The difference in the available supplies from Lake Texoma to those estimated for the *2011 Region C Water Plan* and the DEIS are the constraints associated with transporting all of the Lake Texoma water through the pipeline and the required blending ratio at the Wylie WTP. Previously, when Texoma water was blended in Lavon Lake, water could be moved continuously regardless of actual demand on the lake at any given moment; that is, more water could be moved during non-peak periods because the volume available for blending was large. However, blending at the Wylie WTP requires consideration of actual demand patterns to not exceed a 4:1 ratio at all times. As additional freshwater supplies are developed, it will be possible to use more water from Lake Texoma by blending it with the new freshwater supplies (Kiel and Gooch, 2015).

Lake Texoma is the most developed and popular lake within the USACE Tulsa District, attracting approximately six million visitors per year, many of them from the Dallas-Fort Worth Metroplex, about 50 miles south of the lake. Recreational activities available at the lake include fishing, boating, water-skiing, and other water-oriented activities. Popular sport fish include striped, largemouth, smallmouth, white, and hybrid striped bass, white and black crappie, and channel and blue catfish. The USACE alone has 10 different campgrounds (Figure 10) with more than 600 campsites around Lake Texoma. Forty miles of equestrian trails and the scenic, 14-mile Cross Timbers hiking trail wind above the lake on rocky ledges and through blackjack oak woodland. Also available adjacent to the lake are overnight accommodations, boat rental, slip rental, and supplies at many of the 22 commercial concessions (USACE, no date-b).

Figure 10. Campsite at Platter Flats Campground on Lake Texoma

Two national wildlife refuges on the lake – Hagerman and Tishomingo – occupy 30,000 acres both in Oklahoma and Texas. These refuges attract thousands of migratory Canada, snow, white-fronted, and Ross' geese, as well as various species of ducks, shorebirds, and bald eagles. Resident wildlife includes deer, wild turkey, bobcats, coyotes, fox squirrels, hawks, and songbirds (USACE, no date-b; USFWS, no date).

D. NTMWD Wastewater Reuse

Wilson Creek Wastewater Treatment Plant Reuse

The Wilson Creek Wastewater Treatment plant (WWTP) is one of NTMWD's largest facilities, and the effluent from this WWTP has been used to supplement NTMWD's water supplies since 1987. The Wilson Creek WWTP has a maximum permitted capacity of 64 mgd and currently returns an average of approximately 45,600 AFY of treated wastewater effluent to Lavon Lake. Treated wastewater effluent from the Wilson Creek Regional WWTP is discharged into Wilson Creek in the Lavon Lake watershed upstream of the lake itself. There, the treated effluent is mixed or blended with Lavon Lake waters and subjected to the same treatment methods used at the Wylie WTP facility to upgrade it to potable water quality (NTMWD, 2006).

The future quantity of this reuse supply available is dependent upon projected growth in return flows from the Wilson Creek WWTP. Available wastewater flows at the Wilson Creek WWTP are also subject to inflows and infiltration into the collection system. During dry periods, the wastewater flows available to the Wilson Creek WWTP are typically lower. Based on historical wastewater return flows and projected future wastewater return flows, the available reuse supply is estimated at 47,418 AFY in 2020, increasing to 71,882 AFY by 2050 (Kiel and Gooch, 2015).

The 2050 supply is the maximum annual return flow based on the permitted treatment capacity of the Wilson Creek WWTP and is consistent with both the *2011 Region C Water Plan* and proposed *2016 Region C Water Plan*. The 2020 through 2040 Wilson Creek Reuse supply in the *proposed 2016 Region C Water Plan* is less than the estimated return flows used for the *2011 Region C Water Plan* because of revised projections of future return flows. In recent years, a lower percentage of water used has returned to the Wilson Creek WWTP. This trend is in part due to recent developments such as: reductions in infiltration and inflows in the distribution system because of distribution system improvements and ongoing drought; and implementation of water conservation measures such as low-flow toilets and other water saving fixtures. This lower percentage of water used that shows up as return flows was incorporated in the new return flow projections (Kiel and Gooch, 2015).

East Fork Raw Water Supply Project

NTMWD constructed an artificial wetland called the East Fork Raw Water Supply Project (Figures 11, 12, and 13), which uses natural filtration to further cleanse raw water from the East Fork of the Trinity River and augment NTMWD's water supplies. In operation since 2009, this project is used to pretreat wastewater effluent return flows from five WWTPs owned by NTMWD (South Mesquite, Buffalo Creek, Muddy Creek, Squabble Creek, and Rowlett Creek) and two owned by the city of Garland (Duck Creek and Garland Rowlett Creek). All of these WWTPs discharge to the East Fork of the Trinity River watershed downstream of Lavon Lake and Lake Ray Hubbard (these WWTPs are collectively referred to as the "East Fork WWTPs"). These return flows are diverted from the East Fork of the Trinity River, conveyed through a series of wetland structures, and then pumped to Lavon Lake to augment NTMWD's water supplies (Kiel and Gooch, 2015).

Water is pumped from the East Fork of the Trinity near Crandall into the artificial wetland. As the water passes through 1,840 acres of wetland, aquatic plants "polish" it – a natural process that removes about 95 percent of sediments, 80 percent of nitrogen and 65 percent of phosphorus (NTMWD, no date-b). Cleansed water from the wetland is then pumped 43 miles to the north end of Lavon Lake and blended with raw water from NTMWD's other raw water sources that include Lavon Lake, Lake Chapman, and Lake Texoma, as well as with treated effluent from the Wilson Creek WWTP (Alan Plummer Associates, no date). In 2010, less than 50,000 AF of reuse water was available from the East Fork Raw Water Supply Project for transport to Lavon Lake.

Figure 11. Artificial Wetlands of East Fork Raw Water Supply Project with Downtown Dallas in the Background

Figure 12. Phase I Planting in 2004 at Area A, East Fork Reuse Project

Figure 13. Egrets Take Flight at East Fork Raw Water Supply Project Wetlands

The quantity of water available for diversion is limited by the actual discharge amount from the East Fork WWTPs and instream flow requirements associated with the Texas water right permit authorizing diversions of such return flows. The Wetland has a treatment capacity of 90 mgd (100,900 AFY) of finished water (i.e., water that is eventually conveyed to Lavon Lake). The current water supply resulting from this project is based on current return flows in the watershed and is slightly less than 50,000 AFY. This supply is expected to increase over time as population and water use increases, resulting in greater return flows discharged from the East Fork WWTPs. By 2060, the estimated supply from the East Fork Raw Water Supply Project will be approximately 97,700 AFY (Kiel and Gooch, 2015).

These supply estimates are slightly less than the estimates included in the *2011 Region C Water Plan* (102,000 AFY) because of an adjustment to the percentage of return flows to water used, as discussed in the section on the Wilson Creek WWTP, above. To expedite use of the entire capacity of the East Fork Raw Water Supply Project, NTMWD is contracting with the Trinity River Authority (TRA) to utilize some of TRA's return flows that discharge to the main stem of the Trinity River. Additional discussion of this is included below under the MSPS heading.

E. Sabine River Authority Contracted Upper Basin Supply

NTMWD has two contracts with the Sabine River Authority (SRA) for water supply from SRA's upper Sabine Basin reservoirs (Lakes Tawakoni and Fork) in eastern Texas, if SRA determines that amount of water is available. The water is withdrawn from Lake Tawakoni. In recent years, NTMWD has committed to supply treated water to the city of Terrell and Ables Springs Water Supply Corporation. As a result, NTMWD acquired a long-term water supply of 9.9 mgd (11,000 AFY) from Lake Tawakoni. In 2005, NTMWD entered into an interim 20-year contract for 40,000 AFY (35.7 mgd) of supplies from SRA, to be delivered from Lake Tawakoni and Lake Fork Reservoir. This interim contract will expire in

2025. Water from Lake Fork will be delivered to Lake Tawakoni by Dallas for use by NTMWD (Kiel and Gooch, 2015).

Lake Tawakoni is a major water supply source for the Dallas region. Currently, the lake's yield is over-contracted (i.e., there is no additional supply available for NTMWD). NTMWD's interim contract authorizes use of water that is already contracted to other long-term customers of the SRA in the Sabine River Basin, but which is not currently being diverted or used by these customers. Therefore, as existing SRA customers begin to use more of their contracted supplies in the future, the amount of water available to NTMWD will decrease.

Based on projected demands of SRA's customers, the full interim contracted supplies of 40,000 AFY are assumed to be an available water supply for NTMWD through the contract period (October 2025). This differs from the *2011 Region C Water Plan*, in which the supply amounts were assumed to decrease based on the contractual estimates. SRA has made no commitment to renew or extend the interim contract after 2025 because the supply is already committed to its other long-term customers in the Sabine River Basin. Therefore, beginning in November 2025, the available supply from SRA is limited to the long-term contract of 11,098 AFY. The values shown for NTMWD's Upper Sabine Supplies in the *2016 Region C Water Plan* show a slight decline in available supply over time due to reduced yields associated with sedimentation in Lake Fork and Lake Tawakoni (Kiel and Gooch, 2015).

Lake Tawakoni Reservoir is impounded by the Iron Bridge Dam, a 5.5-mile long, rolled-earth embankment across the Sabine River in Van Zandt and Rains counties. Construction on this dam began in 1958 and finished in 1960. The drainage area upstream of the reservoir is 752 square miles while the surface area of the reservoir at the spillway crest is about 36,700 acres.

Like most reservoirs, Lake Tawakoni has become an important outdoor recreation attraction (Figure 14). Its 200-mile shoreline furnishes extensive recreational opportunities; both private and public facilities have been developed around the lakeshore for swimming, boating, picnicking, fishing, duck hunting, and other uses (SRA, no date-a).

Figure 14. Children Splashing on a Beach at Lake Tawakoni

F. Lake Bonham

Lake Bonham is located three miles northeast of Bonham in Fannin County. Developed by the city of Bonham, it was impounded in 1969 and has a surface area of 1,020 acres. The lake supports native emergent vegetation, including cattail, pondweed, and American lotus, as well as native submerged vegetation such as bushy pondweed and coontail. It also supports a fishery, whose predominant fish species are largemouth bass, channel and blue catfish, sunfish, and crappie (TPWD, 2007b).

The Lake Bonham water right transferred to NTMWD in November 2010, and the lake is now utilized for water supply by NTMWD. Lake Bonham is used to meet the city of Bonham's demands, which were about 2,350 AFY in 2010. The reliable supply or firm yield for NTMWD from Lake Bonham is about 3,195 AFY.

This lake furnishes the raw water for NTMWD's supply of potable water to the city of Bonham, which used approximately 1,760 AFY in 2011, less than half the firm yield. However, this source is not connected to NTMWD's primary water supply system and can only be used to meet the city of Bonham's water demands and potential new local demands in Fannin County. Considering this constraint, the available supply from Lake Bonham is limited by the projected demand on this source. In 2020, Lake Bonham is expected to supply 2,511 AFY, increasing to 3,195 AFY by 2030. These supply estimates differ from those in the *2011 Region C Water Plan*, which show the full yield of Lake Bonham as available to meet NTMWD's water demands (Kiel and Gooch, 2015).

G. Direct Reuse

NTMWD provides a small amount of treated wastewater for irrigation in Collin and Rockwall counties. This supply is only available for these uses and cannot be used for other purposes. The quantity of water available is contingent upon the demand. The demand for direct reuse is about 2,500 AFY (Kiel and Gooch, 2015).

H. Summary of NTMWD's Available Long-term Water Supply Projections

A summary of the water supplies currently available to NTMWD and the projected volumes of water available from these supplies from the year 2020 to 2060 are shown in Table 10. These estimates and projections include water supplies expected to be online by January 2016 (e.g., both dredging projects at Lavon Lake and Lake Chapman), and are taken directly from the *2016 Region C Water Plan*.

Table 10. Summary of NTMWD's Currently Available Water Supplies (in AFY)

Current Supply	2020	2030	2040	2050	2060
Lavon Lake[1]	94,459	93,635	92,699	91,762	90,826
Lake Texoma	70,623	70,623	70,623	70,623	70,623
Lake Chapman[1]	44,792	44,505	44,218	43,931	43,644
Wilson Creek reuse	47,418	56,386	63,785	71,882	71,882
Lake Bonham	2,511	3,195	3,195	3,195	3,195
East Fork reuse	47,802	62,977	75,524	87,291	97,655
Upper Sabine Basin	50,707	10,629	10,550	10,472	10,394
Direct reuse (Irrigation)	2,519	2,519	2,519	2,519	2,519
Total Supply	**360,831**	**344,469**	**363,113**	**381,675**	**390,738**

Includes supply associated with the dredging projects in the *2016 Region C Water Plan*.

Source: Table 2 in Kiel and Gooch, 2015

7. NTMWD's Planned Near-Term Water Supplies

A. Main Stem Pump Station

As mentioned above, NTMWD is currently designing a new pump station to deliver return flows from the main stem of the Trinity River to NTMWD's East Fork Raw Water Supply Project. NTMWD has entered into an agreement with TRA to purchase up to 56,050 AFY (50 mgd) of return flows that are discharged from TRA wastewater treatment facilities to the main stem of the Trinity River. The East Fork Raw Water Supply Project has a total capacity of about 100,900 AFY.

Current available return flows from NTMWD's East Fork WWTP facilities can only deliver about half of that amount in 2020. TRA's return flows from the main stem of the Trinity River will supplement the NTMWD East Fork WWTP return flows currently being diverted from the East Fork, allowing the East Fork Raw Water Supply Project to operate at full capacity once the MSPS is built.

Over time, the available return flows from East Fork WWTPs discharging into the East Fork of the Trinity River will increase as water use and therefore wastewater return flow increases. The return flows from the East Fork WWTPs will be sufficient to supply the East Fork Raw Water Supply Project at near capacity by 2060. The supply available from the MSPS is the difference in the East Fork Raw Water Supply Project capacity and the NTMWD return flows available from the East Fork WWTPs. As such, the supplies from the MSPS decline over time, as shown in Table 11 (Kiel and Gooch, 2015).

Table 11. Water Supplies from the MSPS (in AFY)

Supply	2020	2030	2040	2050	2060
MSPS (additional East Fork wetlands - TRA)	53,135	37,913	25,366	13,599	3,235

Source: Kiel and Gooch (2015)

In addition, Dallas Water Utilities and NTMWD have an agreement which would permit NTMWD to exchange return flows from its WWTPs discharging into Lake Ray Hubbard for Dallas return flows discharged to the main stem of the Trinity River by Dallas. Under this agreement, Dallas will obtain the right to divert NTMWD return flows from Lake Ray Hubbard and will discharge an equal amount of flow for NTMWD's diversion through the MSPS to the wetland for use by NTMWD. Furthermore, once water rights for NTMWD's future Elm Fork return flows (from NTMWD WWTPs discharging to the Lake Lewisville watershed) have been secured by NTMWD (NTMWD is in the process of obtaining a water right permit for these return flows), it will support Dallas Water Utilities' efforts to secure bed and banks transport and storage and diversion rights for the future Elm Fork return flows. In exchange, Dallas will discharge a quantity equal to NTMWD's discharge of its future Elm Fork return flows to the Wetland via the MSPS for use by (Region C Water Planning Group, 2010).

8. NTMWD's Projected Long-Term Water Needs

Projected water need is the difference between aggregate water demand from NTMWD's member cities and customers, including reserve supply, and currently available water supplies. If the aggregate demand exceeds the combined sources of supply, then there is a supply deficit and a projected need for additional water. As shown in Table 12, NTMWD's currently available supplies range from approximately 361,000 to 391,000 AFY over the next 45 years (to 2060). If the MSPS is successfully implemented as intended, NTMWD supplies would increase during the earlier decades. Since the MSPS is proceeding and anticipated to be completed prior to the development of the LBCR, the supplies associated with the MSPS are considered in the determination of the water need for the proposed LBCR project discussed in the Revised DEIS.

The projected demand for water constitutes one half of the water need calculation. In October 2015, at the request of the USACE Tulsa District and NTMWD, water planners at FNI with extensive experience in the Texas water planning process developed and compared three different demand scenarios based on different input and assumptions related to population growth and the selection of a baseline dry year. These three scenarios were presented in the Revised DEIS. USACE has decided to use NTMWD's 2013 CIP water demand projections as the basis of the need determination. These demands best express GPCD during dry year conditions and conservation efforts that have already been implemented.

Water conservation and water reuse are integral facets of NTMWD's long-range water supply plan. Conservation in particular is sometimes expressed as a future supply in and of itself, but in reality, it constitutes demand reduction and is represented as such in this document. NTMWD has achieved considerable conservation savings since it initiated its program in 2004 with its member cities and customers, and further savings are anticipated in the future. NTMWD is actively working to lower its system losses, such as from leakage, thereby providing additional water savings. These added water savings are incorporated into the needs calculation as a demand reduction. Therefore, the supply deficit for NTMWD is calculated as the difference between the current supplies (including the MSPS) and the 2013 NTMWD CIP water demands and future water conservation savings.

In addition to responding to this looming water deficit, the USACE concurs that NTMWD must develop a reserve supply. Development of additional supplies takes years to plan, study, permit, build, and implement. Without such a reserve supply there is no redundancy in NTMWD's raw water system, and thus, no water resources to respond to unanticipated growth, emergency situations, and droughts worse than the drought of record. As mentioned earlier in this chapter, NTMWD has recently experienced the need for emergency supplies, when water imports from USACE's Lake Texoma were abruptly halted due to the discovery of zebra mussels in the lake, and the need to prevent their spread to Lavon Lake and the Trinity River Basin.

The Lake Texoma water source, which accounted for 28 percent of NTMWD's water in 2011, was made unavailable for five years. Consequently, NTMWD had to overdraft the other sources in its water supply system, increasing their vulnerability to drought. When the 2010 drought hit the North Texas region, NTMWD had little reserve supplies, which resulted in NTMWD triggering a modified Stage 3 of its drought contingency plan. This contingency plan limited NTMWD member cities and customers to twice a month watering during the hottest and driest periods of the year. The only way NTMWD was able to continue to serve its customers was through the execution of an emergency three-year interim contract with the city of Dallas (cited earlier).

Suddenly adding NTMWD as a customer resulted in Dallas entering new drought stages that may have been avoided if NTMWD had reserve supplies available. The failure to have water supplies in reserve leads to drought restrictions that harm the viability of existing communities and businesses as well as threatening future economic growth and prosperity. NTMWD is no longer able to rely on emergency purchases of water, especially because there may be none available. Therefore, the USACE Tulsa District concurs that NTMWD has an obligation to its existing member cities and customers – currently 1.6 million people – as well as to its future customers, to plan proactively for circumstances that could result in the loss of a large water supply and needs to develop reserve supplies. The purpose of the proposed LBCR project is to serve NTMWD's existing and future member cities and customers by meeting the need comprised of both the calculated supply deficit and the recommended reserve supplies.

The projected water needs for NTMWD are summarized in Tables 12, 13, and 14. Due to the termination of the interim supplies in mid-decade, the needs calculation is presented on a decadal basis from 2020 to 2060 in Tables 12 and 13 and on an annual basis from 2020 to 2030 in Table 14. Figure 15 shows the comparison of the current and near-term water supplies to NTMWD's projected water demands on an annual basis through 2040.

Based on the comparison of supply and demand, NTMWD has a supply deficit that began in 2016. With the development of the MSPS, assumed to be online sometime in 2018, as well as the expected additional advanced conservation efforts of its member cities and customers, NTMWD will need to have additional water online by 2020 just to meet the supply deficit. By 2025, the supply deficit is anticipated to be 59,000 AFY, increasing to over 84,000 AFY by 2026. These increases in supply deficit correspond to the expiration of the interim SRA contract in October 2025 (Kiel and Gooch, 2015).

In order to provide the recommended reserve supplies, NTMWD needs to develop additional water supplies. Over the planning horizon, that is, to 2060, the need for additional supplies is more than twice the reliable supply from LBCR. Thus, NTMWD will need to develop additional water sources beyond LBCR; however, LBCR would account for a significant portion of the long-term supply needed.

Figure 1 depicts the projected water needs for NTMWD and the LBCR project through 2060. Table 14 and Figure 15 show projected supplies, demands, and the widening supply deficit through 2030 and 2060, respectively. Table 13 summarizes NTMWD's projected need for water out to the year 2060.

Table 12. Projected Decadal Needs for NTMWD after Conservation and Implementation of MSPS (in AFY)

	2020	2030	2040	2050	2060
Current supplies	360,831	344,468	363,113	381,675	390,738
MSPS	53,135	37,913	25,366	13,599	3,235
Total Supplies	**413,966**	**382,381**	**388,479**	**395,274**	**393,973**
Demands (2013 CIP)	430,193	506,904	574,366	617,393	665,375
Customer conservation	8,044	12,805	15,816	18,955	22,305
NTMWD water loss reduction	2,151	5,069	8,615	12,348	16,634
Net Demand	**419,998**	**489,030**	**549,935**	**586,090**	**626,436**
Supply deficit	6,031	106,649	161,456	190,815	232,464
Recommended reserve supply	43,020	50,690	57,440	61,740	66,540
Need	**49,051**	**157,339**	**218,896**	**252,555**	**299,004**

Source: Table 7 in Kiel and Gooch, 2015

Table 13. Summary of Projected Needs for Proposed Action (in AFY)

	2020	2025	2030	2035	2040	2050	2060
Supply deficit	6,031	58,694	106,649	134,240	161,456	190,815	232,464
Recommended reserve supply	43,020	47,110	50,690	54,080	57,440	61,740	66,540
Water Need	**49,051**	**105,804**	**157,339**	**188,320**	**218,896**	**252,555**	**299,004**

Table 14. Projected Annual Needs for NTMWD after Conservation and Implementation of MSPS Through 2030 (in AFY)

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Current supplies	360,831	363,152	365,482	367,812	370,142	352,872	335,202	337,532	339,862	342,192	344,468
MSPS	53,135	51,570	50,050	48,530	47,010	45,490	43,970	42,450	40,930	39,410	37,913
Total Supplies	**413,966**	**414,722**	**415,532**	**416,342**	**417,152**	**398,362**	**379,172**	**379,982**	**380,792**	**381,602**	**382,381**
Demands (2013 CIP)	430,193	438,375	446,558	454,741	462,924	471,107	478,266	485,425	492,584	499,743	506,904
Customer conservation	8,044	8,520	9,000	9,480	9,960	10,440	10,920	11,400	11,880	12,360	12,805
NTMWD water loss reduction	2,151	2,443	2,735	3,027	3,319	3,611	3,903	4,195	4,487	4,779	5,069
Net Demand	**419,998**	**427,412**	**434,823**	**442,234**	**449,645**	**457,056**	**463,443**	**469,830**	**476,217**	**482,604**	**489,030**
Supply deficit	6,031	12,690	19,291	25,892	32,493	58,694	84,271	89,848	95,425	101,002	106,649
Recommended reserve supply	43,020	43,840	44,660	45,470	46,290	47,110	47,830	48,540	49,260	49,970	50,690
Need for LBCR	**49,051**	**56,530**	**63,951**	**71,362**	**78,783**	**105,804**	**132,101**	**138,388**	**144,685**	**150,972**	**157,339**

Source: Table 8 in Kiel and Gooch, 2015

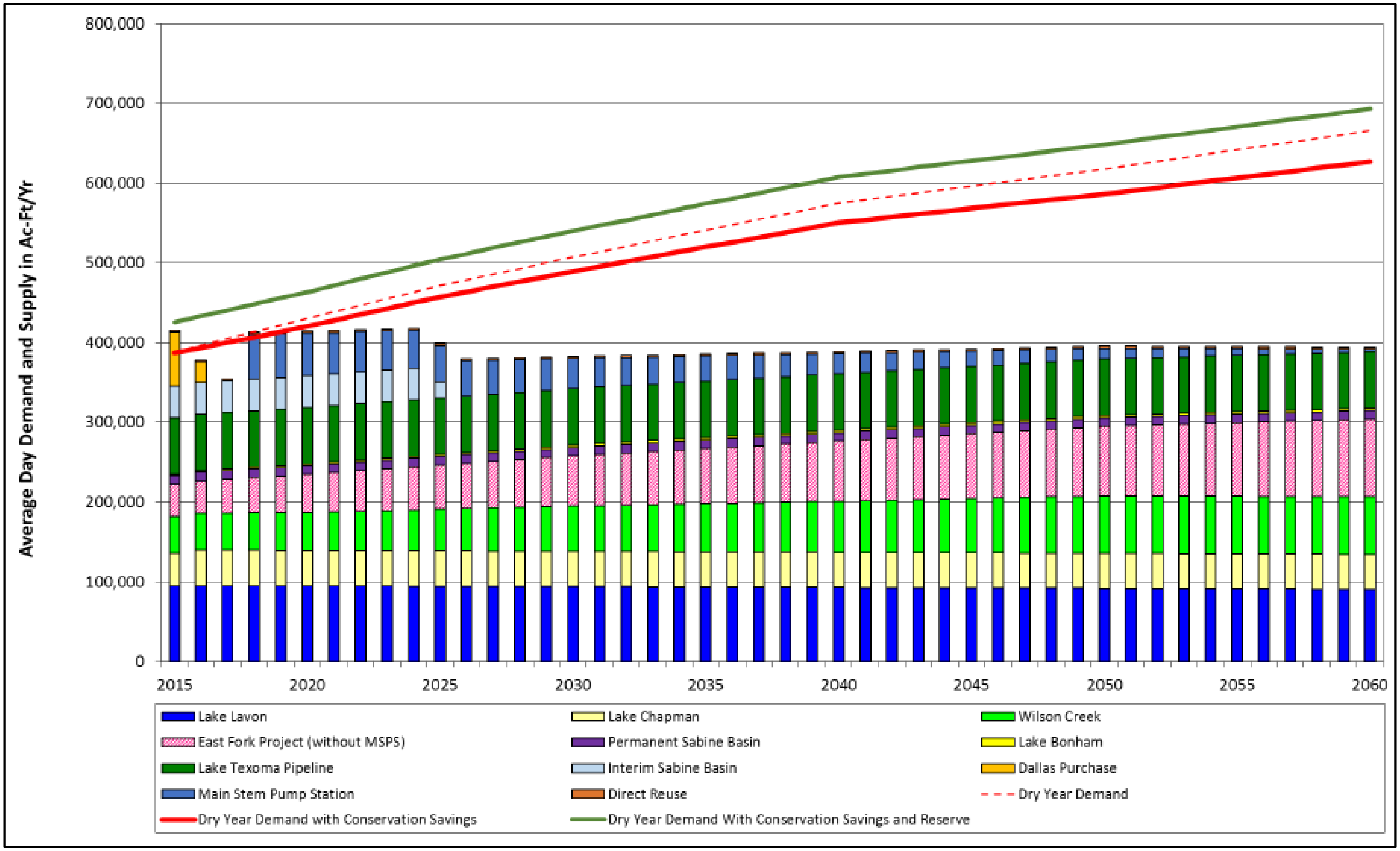

Figure 15. Comparison of Supply and Demand for NTMWD through 2060

Source: Modified from Figure 3 in Kiel and Gooch, 2015

9. Texas State Water Planning Process

As previously discussed, the state of Texas has been publishing state water plans every five years since the 1990s, with previous state water plans dating back to 1938. The regional water planning process, which was developed by the state in the late 1990s, provides the framework for purpose and need development and identification of alternatives that are required as part of the NEPA process. This planning process does not supplant the NEPA process but rather complements it. As such, a description of the Texas state water planning process is provided below.

Subsequent to the passage of Senate Bill 1 (SB 1) by the 75th Legislature in 1997, TWDB began the regional water planning process in Texas by developing and publishing draft rules for regional and state water planning. After extensive consultation with other state agencies, stakeholders, and the public, TWDB adopted its final rules in February 1998. These rules outlined the required elements in the regional and state water plans, the composition of planning groups, and guidelines for financial assistance from the TWDB (TWDB, 2012).

SB 1 directed TWDB to designate regional water planning areas, considering such factors as river basin and aquifer delineations, water utility development patterns, socioeconomic characteristics, existing regional water planning areas, political subdivision boundaries, public comment, and other relevant factors. Regional water planning area boundaries were delineated and adjusted accordingly. This process eventually resulted in 16 regional water planning areas (Figure 1.2-1 in the Revised DEIS). TWDB is required to review, update, and if indicated, adjust these boundaries at least once every five years. The planning area boundaries in the 2017 State Water Plan are identical to those in the 2012, 2007, and 2002 State Water Plans (TWDB, 2007; TWDB, 2012; TWDB, 2016).

Each regional water planning area has its own planning group. Members of this group represent the interests of its planning area and are responsible for developing a regional water plan every five years. As required by SB 1, TWDB selected the initial members of the planning groups. These members, known as initial coordinating bodies, were selected from 11 interests identified in SB 1 and other relevant interests in the regional water planning areas. SB 1 required that interests including but not limited to the general public, counties, municipalities, industries, agriculture, environment, small businesses, electric-generating utilities, river authorities, water districts, and water utilities be represented. The initial coordinating bodies then added other members as appropriate, as they transitioned into planning groups. To replace members who leave the planning groups, the groups themselves vote to approve new members. Each planning group approved its own bylaws to govern its methods of conducting business and each designated a political subdivision, such as a river authority, groundwater conservation district, or council of governments, to administer the planning process and manage any contracts related to developing regional water plans TWDB, 2007; TWDB, 2012; TWDB, 2016).

Ongoing work of the regional water planning process consists of seven major tasks:

- Describing the regional water planning area;
- Quantifying current and projected population growth/decline and water demand;
- Evaluating and quantifying current water supplies;
- Identifying surpluses and needs;
- Evaluating water management strategies and preparing plans to meet the needs;
- Recommending regulatory, administrative, and legislative changes; and
- Adopting the plan, including the required level of public participation.

In developing a regional water plan, planning groups first describe their areas. These descriptions include information on major water providers, current water use, groundwater and surface water sources, agricultural and natural resources, the regional economy, local water plan summaries, and any other information considered relevant by the planning groups (TWDB, 2007; TWDB, 2012; TWDB, 2016).

Next, population growth/change and water demand projections are reviewed. Planning groups review the demographic and water demand projections provided by TWDB and propose revisions based on either new conditions or new information. In the most recent planning round (2016 regional water plans), most of the 16 planning groups in the state requested revisions to population and water demand projections for some of the water users in their regions. TWDB, after consulting with other state agencies, namely the TDA, TCEQ, and TPWD, formally approved requests for revisions that met established criteria.

The third task is to determine the water supplies that would be physically and legally available from existing sources during a repeat of the drought of record. Planning for a drought of record is required by SB 1 and is important in helping prepare for future droughts. To estimate existing water supplies, planning groups use surface water and groundwater availability models. If such models are unavailable, the groups use other available information (TWDB, 2007; TWDB, 2012; TWDB, 2016).

Next, existing water supplies are compared with current and projected water demands to identify whether additional water supplies are needed for each identified WUG and WWP.

SB 1 mandated planning groups to address the needs of all water users. If existing supplies do not meet projected future demand, the planning groups need to recommend specific water management strategies to meet water supply needs. Examples of recommended water management strategies include advanced conservation of existing water supplies, new surface water and groundwater development, conveyance facilities like pipelines to move available or newly developed water supplies to areas of need, water reuse, water rights subordination agreements, and others. The Texas Legislature also required that each planning group assess the financing needed to implement the water management strategies and projects in their water plans (TWDB, 2007; TWDB, 2012; TWDB, 2016).

To assess financing, the planning groups must: 1) survey local governments, regional authorities, and other political subdivisions on how they propose to pay for water infrastructure projects in the plan; and 2) identify the appropriate role of the state in financing these projects. Assisted by TWDB, the planning groups also assess the social and economic impact of not meeting projected water needs. If it is not feasible to meet a need, the planning groups identify and explain the conditions that led to their inability to plan for fully meeting the need.

The regional plans include regulatory, administrative, and legislative recommendations as well as recommendations for designating unique reservoir sites and stream segments of unique ecological value; they also consider water conservation strategies and evaluate the impacts to the state's water, agriculture and natural resources. In the 2007, 2012, and 2017 plans, planning groups recommended significant amounts of water conservation and reuse compared to the 2002 plan (TWDB, 2007; TWDB, 2012; TWDB, 2016).

All regional planning group meetings and functions are open to the public and participation is welcomed. The planning groups conduct special public meetings when they prepare scopes of work and hold hearings before adopting their regional water plans. This kind of public involvement helps the planning groups determine which water management strategies to recommend. Building consensus within the planning groups is crucial to ensure sufficient support for adopting the plan. Planning group members adopt plans by vote at open meetings in accordance with each group's respective bylaws.

Some joint meetings between adjacent planning groups are held to coordinate water management strategies and to help circumvent later conflicts over the use of shared resources. In addition, planning groups also send non-voting representatives to adjacent planning groups.

In 2001 and 2007, the Texas Legislature passed SB 2 and SB 3. These bills included the funding mechanisms to continue updating the regional water plans every five years. SB 2 provided the funding for the first update to the regional water plans which produced the 2006 Region C Water Plan, while SB 3 funded the 2011 update to the regional water plans (Region C Water Planning Group, 2010).

The latest round of regional water planning in Texas has now culminated in the approval of all 16 regional water plans, including that of Region C, which was finalized in November 2015. During 2015, TWDB compiled and summarized all 16 regional water plans into the 2017 Texas State Water Plan, which provides overall guidance for the coming five-year period.

Region C, which is the primary region for NTMWD, covers all or part of 16 counties in North Central Texas. As shown in Figure 16, Region C includes all of Cooke, Grayson, Fannin, Jack, Wise, Denton, Collin, Parker, Tarrant, Dallas, Rockwall, Kaufman, Ellis, Navarro, and Freestone counties and the portion of Henderson County that is in the Trinity Basin. Like other water planning regions, the Region C planning group includes representatives from 11 designated interest groups. There are actually 22 members of the Region C water planning group because some of the interest groups have more than one representative (Table 15). The Region C Water Planning Group hired a team of consultants to conduct technical analyses and prepare the regional water plan under the supervision of the planning group (Region C Water Planning Group, 2015).

Table 15. Number of Representatives on Region C Planning Group from Interest Groups

Interest group	Number of representatives	Interest group	Number of representatives
Municipalities	4	Industry	1
Water districts	3	Small business	1
Groundwater management areas	3	Counties	1
Environmental interests	2	Electric generating utilities	1
Public	2	River authorities	1
Water utilities	2	Agricultural interests	1

Source: Region C Water Planning Group, 2015

Sections 16.051(e) and 16.053(e)(6) of the Texas Water Code (the Code) stipulate that the state and regional water plans should identify prospective sites of unique value for constructing reservoirs. Section 16.051(g) of the Code provides for legislative designation of sites of unique value for the construction of a reservoir. This means that a state agency or political subdivision of the state may not obtain a fee title or an easement to a designated site that would impede the construction of a reservoir there. Designation by the Texas Legislature thus provides a limited but important means of reserving proposed reservoir sites for future development. The LBCR was one of 19 potential reservoir sites in the state recommended in the *2007 State Water Plan* for such a designation (TWDB, 2007). SB 3, in the 2007 legislative session, designated all of these recommended sites.

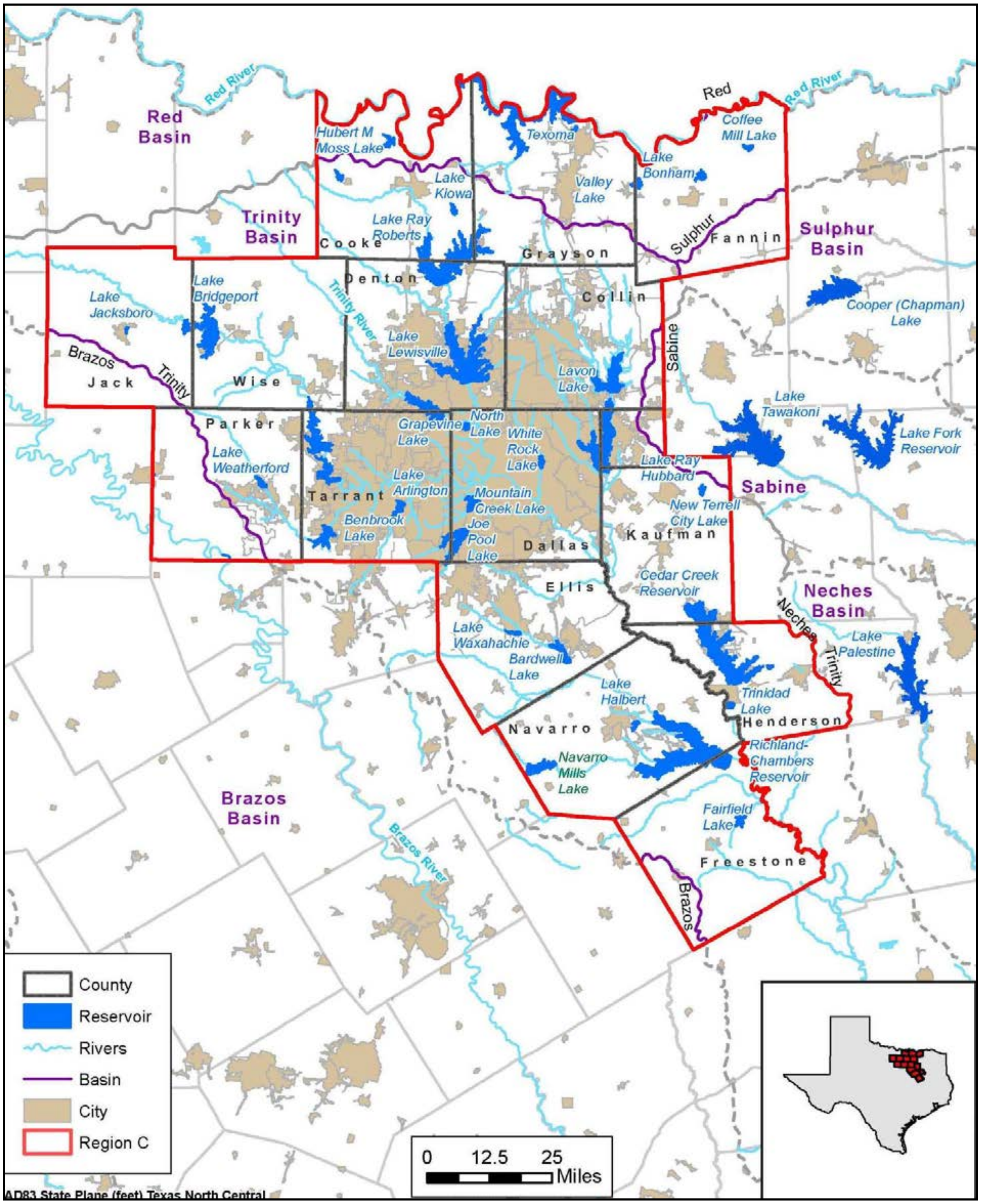

Figure 16. Region C and Outside Water Supplies Designated as Special Water Resources for Use in Region C

Source: Region C Water Planning Group, 2015

10. Water Conservation and Reuse

A. Water Conservation in Texas and Region C

In passing SB 2 in 2001, the 77th Texas Legislature emphasized the importance of water conservation as a water management strategy. SB 2 requires that regional planning groups consider water conservation practices for each need identified for a WUG (TWDB, 2007; TWDB, 2012; TWDB, 2016).

The Texas Water Code §11.002(8) defines conservation as: "the development of water resources; and those practices, techniques, and technologies that will reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling and reuse of water so that a water supply is made available for future or alternative uses" (TWC, no date).

Water conservation measures and drought/emergency water management measures both aim to save water. However, water conservation measures are fundamentally different from drought or emergency management measures in that they are designed to be long-term or permanent, whereas drought/ emergency management measures are temporary. The latter are implemented when certain criteria are met and are stopped when these criteria are no longer met (Region C Water Planning Group, 2015).

Comparing the *2007 State Water Plan* to the *2002 State Water Plan* demonstrates the growing priority accorded to water conservation in Texas in the new century. For example, recommended water management strategies for conservation in the *2002 State Water Plan* generated 14 percent of the water needed to meet the state's needs in 2050, or a total of about 990,000 AFY. By way of contrast, in the *2007 State Water Plan*, conservation accounts for nearly 23 percent of required water in 2060, or a total of about two million AFY. These figures represent "active conservation," that is, those measures usually initiated by water utilities, individual businesses, residential water consumers, and agricultural water users to reduce water consumption. In the 2006 Regional Water Plans, 14 of the 16 planning groups included some water conservation strategies to meet needs, and 13 of the 16 planning groups included policy recommendations concerning water conservation (TWDB, 2007).

According to the *2017 State Water Plan*, by 2070, 30 percent of recommended water management strategies will be demand management (which includes conservation), with an additional 14 percent consisting of reuse (Figure 17).

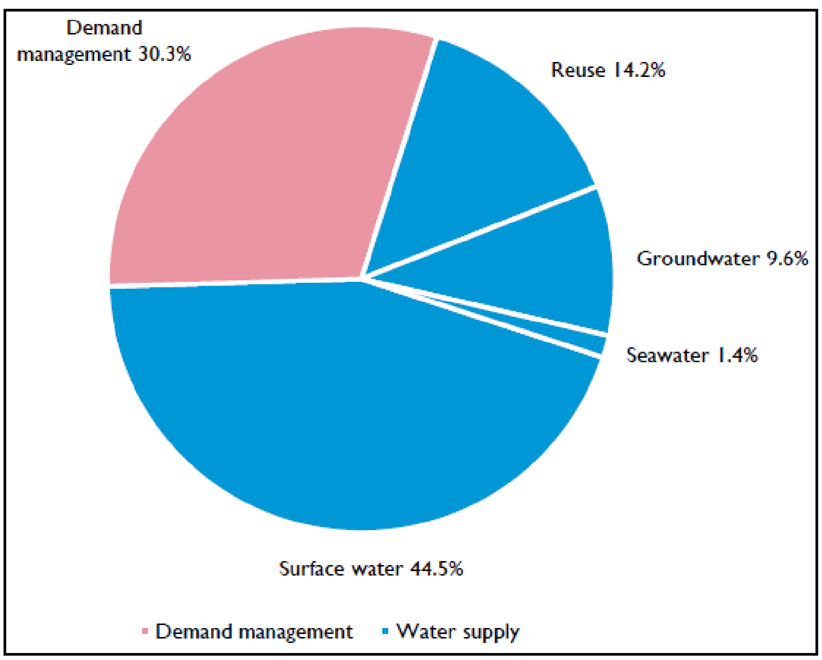

Figure 17. Share of Recommended Water Management Strategies by Water Resource in 2070

Source: Figure ES.6 in TWDB, 2016

In 2003, the 78th Texas Legislature passed SB 1094, which considered a broad spectrum of issues related to water conservation and established the Water Conservation Implementation Task Force. This task force began to review, evaluate, and recommend optimum levels of water use efficiency and conservation for the state. It also developed a Best Management Practices (BMPs) Guide consisting of 21 municipal, 14 industrial, and 20 agricultural water conservation BMPs (TWDB, 2004a). The practices included in the BMPs Guide are voluntary efficiency measures that save a quantifiable amount of water, either directly or indirectly, and can be implemented within a specified timeframe.

The task force's municipal BMPs enable utilities to both improve water use efficiency of their own operations and for programs to improve the efficiency of their customers. The municipal BMPs are listed in Table 16.

Municipal water conservation strategies in the 2006 Regional Water Plans relied heavily on the Water Conservation Implementation Task Force's BMPs Guide and included such measures as aggressive plumbing fixture replacement programs, water-efficient landscaping codes, water loss and leak detection programs, education and public awareness programs, rainwater harvesting, and changes in water rate structures. Fourteen of the 16 planning groups recommended municipal water conservation as a potential way to meet future municipal water needs. In total, municipal water conservation strategies constituted nearly 617,000 AFY (7 percent) of water generated by all recommend strategies by 2060 (TWDB, 2007).

Table 16. BMPs for Municipal Water Users

Water Conservation Implementation Task Force's BMPs for Municipal Water Users	
System water audit and water loss	Water conservation pricing
Prohibition on wasting water	Shower head, aerator, and toilet flapper retrofit
Residential toilet replacement programs	Residential clothes washer incentive program
School education	Landscape irrigation conservation and incentives
Water survey for single-family and multi-family customers	Metering of all new connections and retrofit of existing connections
Water wise landscape design and conversion programs	Conservation programs for industrial, commercial, and institutional accounts
Athletic field conservation	Golf course conservation
Wholesale agency assistance programs	Conservation coordinator
Water reuse	Public information
Rainwater harvesting and condensate reuse	New construction graywater
Park conservation	

Source: TWDB, 2004a

In addition to developing the BMPs that could be adopted as strategies, the task force made 25 recommendations related to water conservation. One of these was to create and fund a statewide water conservation public awareness campaign. The task force recognized the need to promote public awareness of water conservation issues and recommended implementing a program that focuses on delivering a simple, enduring, universal water use awareness message. The thrust of the program is increasing the relevance of water conservation to all Texans and raising awareness that natural water resources are limited, that individual water consumption habits have consequences, and that changes in individual behavior can make a difference.

In 2004, TWDB contracted with consultants to conduct research to develop a market strategy and brand for a possible statewide water conservation public awareness program. The project was funded by a voluntary coalition of 36 water utilities, municipalities, businesses, and conservation groups.

Data from the 2004 research showed that only 28 percent of Texans "definitely" knew the natural source of their drinking water at that time. The research also showed a strong correlation between knowledge of water sources and willingness to conserve water. As part of the study, 11 logo and tagline variations were tested in focus groups in five cities around the state. "Water IQ: Know Your Water" was considered the most effective brand because it can be tailored with local information and informative tips. It was translated for Spanish-speaking Texans with the tagline "*Conozca Tu Agua*" (TWDB, 2007).

Because of local drought impacts, four major regional water providers and one groundwater conservation district have embraced the "Water IQ" campaign concept. Their efforts will contribute print ads, public service announcements, and television spots that can be used in developing a statewide program. To date, NTMWD and four other major water providers around the state have begun implementing their Water IQ campaigns (Figure 18).

Over the past decade, Region C water providers and water users have made noteworthy and growing efforts to conserve water. For several years, NTMWD has partnered with Dallas Water Utilities and Tarrant Regional Water District to jointly sponsor the North Texas Regional Water Conservation Symposium. Outdoor water conservation practices like time-of-day watering restrictions have become part of local ordinances in Dallas, Fort Worth, and most of the larger cities in the area. Cities and water utilities have started allocating conservation staff and budgeting dollars as part of their full time water management strategies. These endeavors exemplify the ongoing, coordinated Region C effort to promote conservation as a permanent, valuable water management strategy (Region C Water Planning Group, 2010).

Figure 18. NTMWD's Sport Utility Vehicle Displaying the Water IQ message

In 2007, the 80th Texas Legislature, in passing SB 3 and House Bill 4, directed TWDB to appoint 23 members, who represent a cross-section of water-related interests, to the newly created Water

Conservation Advisory Council (WCAC). The WCAC replaced the Water Conservation Implementation Task Force mentioned above. Duties of the WCAC include:

- Monitoring trends in water conservation implementation and new technologies for possible inclusion as BMPs;
- Monitoring the effectiveness of the statewide water conservation public awareness program;
- Developing and implementing a state water management resource library;
- Developing and implementing a public recognition program for water conservation;
- Monitoring the implementation of water conservation strategies by water users included in regional water plans;
- Monitoring target and goal guidelines for water conservation to be considered by the TWDB and TCEQ; and
- Conducting a study to evaluate the desirability of requiring the TWDB to designate entities and programs that provide assistance to retail public utilities in developing water conservation plans as certified water conservation training facilities, and to give preference to certified water conservation training facilities in making loans or grants for water conservation training and education activities.

In December 2008, WCAC published the first of its biannual reports, *A Report on Progress of Water Conservation in Texas*, which included a number of detailed and technical recommendations regarding water conservation and regional water planning. The report also recognized that conservation is one of the most cost-effective tools in meeting the growing demand for water in Texas. Furthermore, it reiterated that according to the *2007 State Water Plan*, conservation would account for nearly 23 percent of the projected additional water supply needed in 2060 – a total of about two million AFY, or enough to supply half of the current annual municipal use in Texas (WCAC, 2008).

Region C is placing more emphasis on water conservation than the state as a whole. In 2010, TWDB projected that by 2060, based on the strategies included in the 2006 regional water plans, Region C alone would account for 277,000 AF of water savings annually, or 47 percent of all municipal conservation in Texas (Figure 19). In other words, Region C would conserve almost as much water as the rest of the state combined. By 2030, Region C expects to meet one-third of its municipal demand through a combination of conservation and reuse (Hardin, 2010).

In 2000, of the 16 water planning regions in the state, Region C ranked third-highest in municipal water consumption per capita, as measured by GPCD. As a measure of municipal water use, GPCD is defined as the average daily total of residential plus commercial plus institutional water use, divided by the resident population of the city or region in question. It measures water used at home as well as water used at work. As such, GPCD tends to inflate Region C's apparent residential per capita water consumption because of the number of commuters who are residents of other regions but work in Region C (principally the Dallas-Fort Worth Metroplex). For example, in 2007, the total GPCD of Dallas was 240 and that of San Antonio 150, seemingly indicating that Dallas uses more water per capita than San Antonio. However, a more meaningful comparison of residential GPCD's of the two cities shows a much smaller difference – 92 (Dallas) and 86 (San Antonio) (Hardin, 2010).

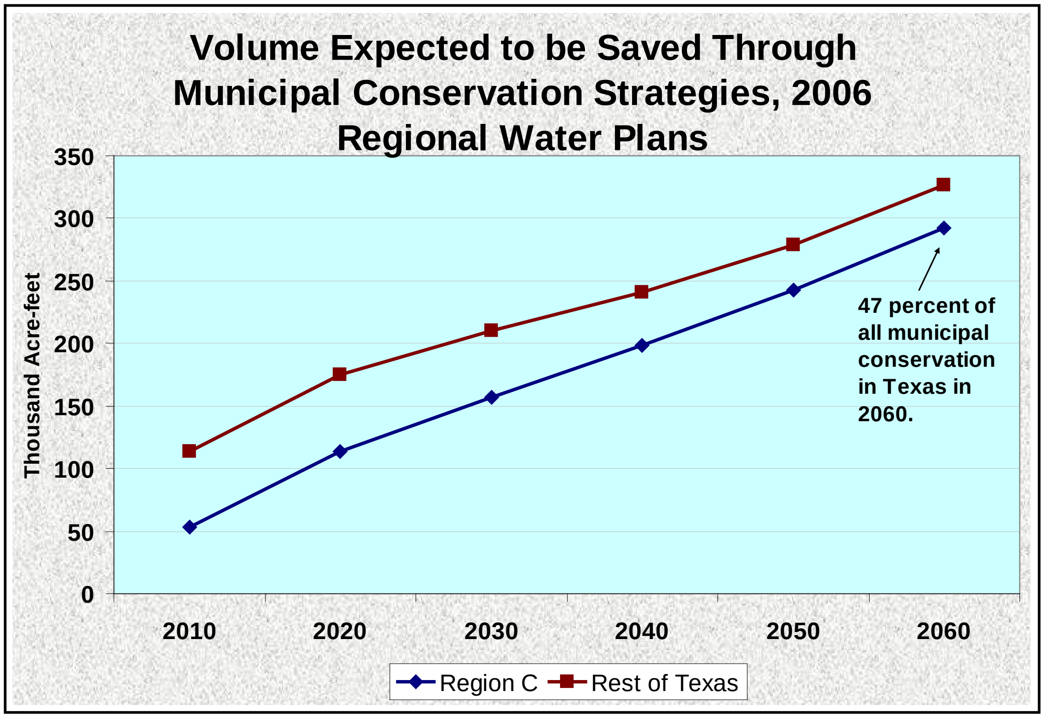

Figure 19. Expected Water Savings in Region C Compared with State of Texas

Source: Hardin (2010)

All other things being equal, the GPCD is higher in those cities or regions wherein the daytime population is augmented by commuters who reside in a different city or region. Dallas adds 290,000 net commuters on a daily basis (23 percent of its residential population), while San Antonio adds less than 50,000 (3.8 percent of its residential population). This accounts for almost all of the apparent discrepancy between the municipal GPCD's of the two cities. Similarly, on a daily basis (2006 data), Region C's water users are augmented by 22 percent of the total workforce in the western counties of Region D (Delta, Hopkins, Hunt, Lamar, Rains, Van Zandt, and Wood) (Hardin, 2010).

The *2016 Region C Water Plan* recommends water conservation and reuse programs and projects that would attain the following:

- Including the 246,869 AFY of conservation built into the demand projections (for low-flow plumbing fixtures, efficient residential clothes washer standards, and efficient residential dishwasher standards), a total conservation and reuse supply of over 1.16 million AFY by 2070, or 41 percent of the region's demand without conservation.
- A dry-year per capita municipal use for the region (after crediting for conservation and reuse) ranging from 119 GPCD in 2020 to 105 GPCD by 2070, a decline of 12 percent (Region C Water Planning Group, 2015).

In the *2016 Region C Water Plan*, conservation is a recommended water management strategy for the NTMWD. The *2016 Region C Water Plan* reaffirms the region's commitment to conservation and reuse. TWDB now mandates that each regional water planning group evaluate all water management strategies that it determines to be potentially feasible, including water conservation practices, reuse of treated wastewater effluent, and drought management measures. In response, the Region C Water Planning Group decided to incorporate water management strategies involving both water conservation and reuse of treated wastewater effluent as major components of the long-term water supply for Region C, to encourage planning and implementation of water conservation and reuse projects, and to monitor legislation and regulatory actions related to water conservation and reuse.

Table 17 summarizes the effect of recommended conservation and reuse measures on municipal water use in Region C from 2020 to 2060.

Table 17. Projected Municipal Per Capita Water Use in Region C

Basic Data	Projections				
	2020	2030	2040	2050	2060
Population	7,504,200	8,648,725	9,908,572	11,260,257	12,742,283
Municipal demand without additional low-flow fixtures (AFY)	1,555,200	1,792,515	2,051,621	2,310,412	2,571,986
Municipal demand with additional low-flow fixtures (AFY)	1,481,530	1,675,385	1,894,722	2,119,813	2,352,818
Recommended municipal water conservation (AFY)	48,021	78,768	87,673	102,646	116,598
Current municipal reuse (AFY)	283,893	316,972	343,226	380,051	408,880
Recommended municipal reuse (AFY)	239,062	245,927	258,963	343,681	356,065
Municipal Per Capita Use (GPCD)					
No conservation or reuse	185	185	185	183	180
With full implementation of low-flow fixtures	176	173	171	168	165
With low-flow fixtures and recommended conservation	171	165	163	160	157
With recommended conservation and reuse	108	107	109	103	103
Normal-year use (assumed dry-year use 12 percent higher)	97	95	97	92	92

Source: Modified from Table 5E.10; Region C Water Planning Group, 2015

The gradually increasing emphasis on conservation and reuse in Region C is illustrated by comparing the municipal GPCD values in the year 2060 from the 2011 plan and the 2016 plan. The 2060 values from the 2011 plan are shown in Table 2-3 on p. 2-28 of the original DEIS (final column on the right), in the bottom five rows. The 2060 values from the 2016 plan are shown in the next-to-last column on the right in Table 18. These two sets of values are also compared in Table 18.

In the *2016 Region C Water Plan*, the Region C Water Planning Group analyzed a range of conservation measures which were considered appropriate for water users within the region. These measures are shown in Table 19 and detailed in Appendix K of the *2016 Region C Water Plan*. The *2011 Region C Water Plan* considered similar measures; however, the new residential dishwasher standards were not in effect at the time and were not considered.

The low-flow plumbing fixtures rule requires installation of new plumbing fixtures to meet specific water use targets. This regulation was first implemented in 1991 and expected future water savings are incorporated into the demands developed for the *2011 Region C Water Plan* and the *2016 Region C*

Water Plan. They were also incorporated into the 2013 CIP Demands analysis developed by NTMWD. Therefore, the water savings due to the installation of low-flow plumbing fixtures are included in the base demands and are not shown as conservation savings in water demand projections for NTMWD.

Table 18. Comparison of Municipal Per Capita Water Use Between 2011 and 2016 Region C Plans

Municipal Per Capita Use (GPCD)	2060 as Projected in 2011 Plan	2060 as Projected in 2016 Plan
No conservation or reuse	212	180
With full implementation of low-flow fixtures	198	165
With low-flow fixtures and recommended conservation	178	157
With recommended conservation and reuse	135	103
Normal-year use (assumed dry-year use 12 percent higher)	120	92

Other conservation measures in the 2016 Plan include public and school education programs, price elasticity/rate structure, water loss control programs, water waste prohibition, and time of day irrigation restrictions (Table 19). These measures were specifically considered in developing the water savings by customer. These considerations are detailed in Appendix K of the *2016 Region C Water Plan* (Region C Water Planning Group, 2015).

Table 19. Water Conservation Measures in the *2016 Region C Water Plan*

Recommended sSrategies	Water Conservation Measures
Municipal water conservation package	• Low-flow plumbing fixture rules[1] • Efficient new residential clothes washer standards[2] • Efficient new residential dishwasher standards[2] • Enhanced public and school education • Price elasticity/rate structure impacts • Enhanced water loss control program • Water waste prohibition • Time-of-day irrigation restrictions

[1] Incorporated into water demands for all demand methodologies

[2] Incorporated into demands for *2016 Region C Water Plan* and 2013 CIP Demands analysis

In general, education programs and the effects of increasing rates were evaluated for all water users. The other measures were evaluated for water users that did not already have such a program in place or that did not meet their water loss goals. For NTMWD customers, many of these measures are already in place today, as mandated by NTMWD's Water Conservation Plan (WCP) (discussed below).

B. Water Conservation in the North Texas Municipal Water District

Overview

TCEQ requires water conservation plans for all large municipal, industrial, and mining water users in the state. NTMWD prepared its first WCP in 1997, and the current WCP is dated April 2014 (NTMWD, 2014a). As emphasized in this plan, "as a wholesale water supplier, NTMWD does not control the water use of its Member Cities and Customers and does not have a direct relationship with the retail customers who are the ultimate consumers of the water." Thus, to some extent, thorough and diligent implementation of conservation measures by, for example, residential water consumers, is beyond NTMWD's direct influence. However, NTMWD does control the operation of its water supply, treatment, and delivery system and can thus take direct action to maximize its efficiency and minimize system waste and losses.

In areas under its direct control, NTMWD has adopted the following goals for water conservation and efficiency:

- Keep the level of unaccounted water in the system below five percent.
- Maintain universal metering of customers, meter calibration, and meter replacement and repair.
- Maintain a program of leak detection and repair.
- Continue to utilize wastewater reuse as a major source of water supply. Seek TCEQ authorization for additional reuse to increase the efficiency of the NTMWD water supply system.
- Continue to recycle wash water from NTMWD water treatment plants.
- Continue to implement other in-house water conservation efforts.
- Raise public awareness of water conservation and encourage responsible public behavior by a public education program (NTMWD, 2014a).

Like every regional wholesale water provider, NTMWD experiences losses in its raw water transmission system, at the WTP during the treatment process, and in its treated water transmission system delivery to customer meters (Figure 20). NTMWD includes these losses in its demand and needs estimates and projections since customer demand is determined at the delivery point. In its 2014 WCP, NTMWD has a goal of keeping overall losses below five percent in its portion of the system (NTMWD, 2014a). This goal is also reflected in the water loss reduction estimates in the needs analysis and projections (Rice, 2016).

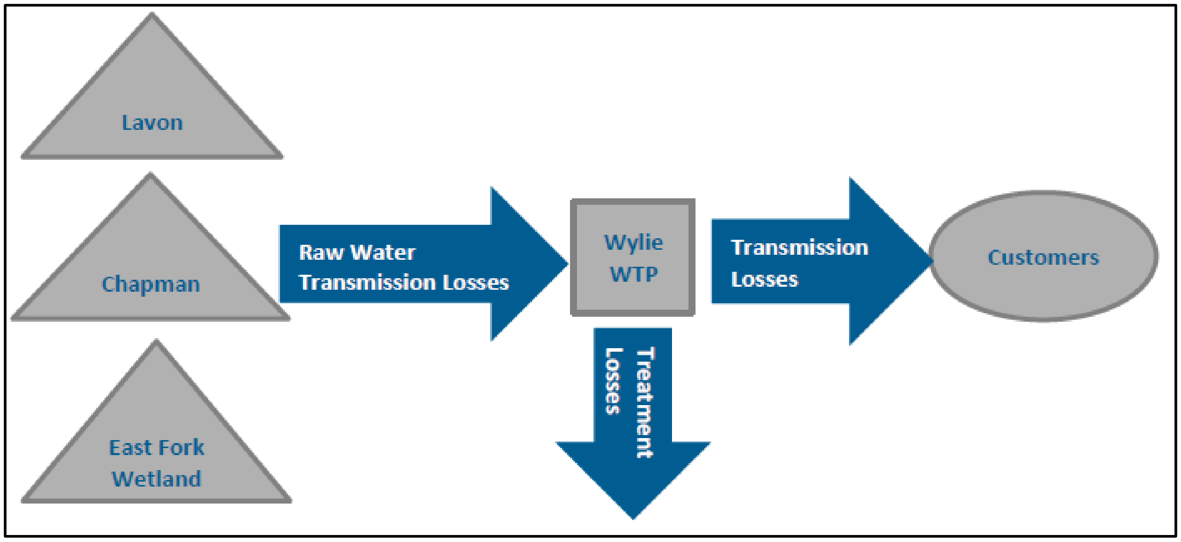

Figure 20. Treatment and Delivery Losses in NTMWD's Water System

For planning purposes, losses within NTMWD's customer's water distribution systems are included in customer demands and are not included as NTMWD losses. Individual customers have goals in their own WCPs to maintain or reduce water loss below a certain percentage. NTMWD's model plan for its customers suggests that each keep its distribution system losses below 12 percent (NTMWD, 2014a).

Since 2006, NTMWD has invested $11.2 million in the development and implementation of the aforementioned Water IQ campaign, more than any other water provider in the North Texas region. The Water IQ campaign has had a demonstrably positive effect on water conservation among NTMWD's member cities and customers. This campaign continues to be an integral part of NTMWD's overall efforts to foster a water conservation ethic among its customers and all Texans. NTMWD has made the Water IQ campaign materials available at essentially no cost to all water suppliers throughout the state (Rice, 2014).

NTMWD promotes water conservation in North Texas and across the state. It participates in Water Smart Innovations, the Texas A&M Agrilife Extension Service's Texas Water Star conferences and presentations, and Water Educators of North Texas. NTMWD staff attends and has presented at the Gulf Coast Water Conservation Symposium, the Central Texas Water Conservation Symposium, and the Water Smart Innovations national water efficiency conference. NTMWD collaborates with stakeholders such as landscapers, irrigators, nursery growers, homebuilders, and homeowners associations for presentations at various local, regional, and state meetings and conferences. NTMWD also makes presentations to civic/community organizations, schools, and local/state government agencies.

Since 2007, NTMWD has co-sponsored the annual North Texas Regional Water Conservation Symposium with Dallas Water Utilities (DWU) and Tarrant Regional Water District (TRWD). Approximately 200 regional stakeholders from the Dallas-Ft. Worth Metroplex attend this symposium, which has presenters from across the United States with substantial expertise and experience in water conservation. These speakers inform the attendees of BMPs for achieving water conservation, as well as programs designed for reducing water use. NTMWD, DWU, and TRWD collaborate to obtain sponsorship funding for the symposium, so as to allow attendees free admittance each year.

As noted, NTMWD adopted an updated WCP in 2014. The WCP meets all of the requirements for submission to the TCEQ and TWDB. One part of the WCP is a Model WCP, which provides minimum guidelines for NTMWD's member cities and customers to use in the adoption of their plans. To date, all of the member cities have adopted the Model WCP. In adopting the Model WCP, these member cities have adopted the following additional water conservation measures:

- Conservation oriented rates;
- Reuse and recycling of wastewater;
- Lawn watering restricted to 2 days per week year-round;
- Prohibition on lawn irrigation between 10 am-6 pm from April to October;
- Prohibit watering impervious surfaces;
- Prohibit watering during rain or freeze events;
- Prohibit use of poorly maintained systems;
- Prohibit runoff and waste;
- Require rain/freeze sensors and/or evapotranspiration controllers;
- Prohibit overseeding cool season grass;
- Irrigation inspection at backflow inspection;
- New irrigation systems meet state requirements;
- Irrigation evaluations on periodic basis;
- Prohibit filling of pond (>500 ft.^{2});
- Hose end nozzle requirement;
- Hotel/motel linen replacement program;
- Restaurant water on request;
- Existing systems be retrofitted;

- New athletic fields separate irrigation system;
- Other measures to encourage off-peak use;
- Landscape ordinance;
- Water audits; and
- Rebates for low-flow toilets, showerheads, etc.

NTMWD compiles and reviews water use data from its member cities and customers; these data are then used to assist with regional water conservation efforts. NTMWD has partnered with Texas Agrilife Extension Service (a statewide network of agricultural extension offices and professional educators) in implementing a regional network of weather stations to collect rainfall, humidity, wind, evaporation, and evapotranspiration data. These data are used to develop site-specific, precise turf irrigation needs and publicly report them in real time. Meteorologically-based lawn irrigation guidelines are used by residences and businesses throughout NTMWD's service area to help minimize water use for irrigation by calculating the maximum amount of water required at a user's specific location to nourish and maintain healthy turf (Rice, 2014).

Over the past decade, NTMWD's conservation efforts have resulted in a substantial and sustained reduction in per capita water use, which started years before the onset of the current drought. In 2000, NTMWD's member cities and customers averaged 224 GPCD. By 2013, this figure had decreased to 162 GPCD, a decline of 28 percent. Even as NTMWD continues pushing for further reductions in residential GPCD, it pursues programs to assist in reducing water use for its industrial, commercial, and institutional customers.

Since 2006, NTMWD's water use tracking reveals water savings of about 12 percent have been achieved on an annualized basis. During peak summer months, this results in conservation of about 250 mgd. These water savings correlate to GPCD reductions throughout NTMWD's service area (Rice, 2014).

According to the *2016 Region C Water Plan* (Table ES.2), conservation and reuse will account for 20.6 percent of NTMWD's total water supply in the year 2070 (Region C Water Planning Group, 2015). Conservation achieved through 2011 is reflected in the base water demands.

NTMWD Water Conservation Details

The February 2015 DEIS discussion on water conservation in Chapter 2 (Section 2.3.3.1 starting on p. 2-25) contained several pages of background information on water conservation in the state and Region C. That information, derived mostly from the *2011 Region C Water Plan* and earlier ones, is incorporated by reference. In the meantime, the *2016 Region C Water Plan* was developed and finalized later in November 2015, after the publication of the original DEIS. This section contains newer information from the *2016 Region C Water Plan* and other sources.

During and after the preparation and publication of the DEIS in 2015, three different demand methodologies were developed: 2011 Region C Water Demands, 2016 Region C Water Demands, and the 2013 CIP Demands. These are described above. The savings in water conservation used in the calculation of the need for the proposed LBCR project were developed at the time each of the demand projections were developed. As a result, there are differences in the conservation savings between the *2011 Region C Water Plan* (used in the DEIS) and the subsequent *2016 Region C Water Plan* and 2013 CIP Demands (Kiel, 2015b).

There are two main reasons for these differences:

1. Water savings as the result of state and federal mandates on low-flow plumbing fixtures and appliances are incorporated into the NTMWD projected water demands. Federal laws for energy-

efficient appliances were not in effect when the demands for the *2011 Region C Plan* were developed. Therefore, only projected savings from low-flow plumbing fixtures were incorporated into the 2011 Region C demands, while actual savings from water efficient appliances were incorporated into the 2016 Region C Demands and the 2013 CIP Demands analysis. Therefore, any savings from water efficient appliances for the 2011 analyses were shown as additional water conservation savings (strategy).

2. Conservation savings that have been implemented since the early 2000s (which is the base year water use for the 2011 Region C Water Demands) are reflected in the base per capita water use for the more recent demand projections. Therefore, some of the conservation savings identified in the 2011 Demands analysis have already been realized and the opportunity for additional conservation would be less.

Calculating Water Conservation Savings for NTMWD

Water conservation savings for NTMWD are first estimated on an individual customer basis. Using industry-established adoption rates for each water conservation measure, these per capita savings are then multiplied by the number of customers to obtain a total estimate of reduced demands on NTMWD. With those customers for whom NTMWD provides only a portion of their water supply, the conservation savings are assigned proportionally.

Water savings from the implementation of conservation measures to date are reflected in the base per capita water use for the *2016 Region C Water Plan* and the 2013 CIP Demands analysis and are not highlighted as additional conservation. As previously discussed, these savings would have been shown as additional conservation in the *2011 Region C Water Plan*, making it appear as if the 2011 plan is more conservation–conscious, which is not the case.

A comparison of the NTMWD municipal per capita water use projections in the *2011 Region C Water Plan* to projections in the *2016 Region C Water Plan* and 2013 CIP Demands analysis shows considerable reductions in per capita water use (measured in GPCD) between the two later projections (2013 and 2016) and the earlier one (2011) (Table 20). These reductions are due in part to the conservation measures that have been implemented and in part to the methodology of incorporating the water savings associated with new efficient clothes washers and dishwashers into the demands.

Table 20. Comparison of Per Capita Water Consumption in NTMWD's Current Municipal Customers in GPCD

NTMWD Current Municipal Customers	2020	2030	2040	2050	2060
2011 Region C Water Plan	213	213	212	212	210
2016 Region C Water Plan	179	176	174	170	165
2013 CIP estimates	186	183	181	176	171

Source: Adapted from Table 2 in Kiel, 2015b

Table 21 presents a summary of projected water conservation savings by NTMWD customers as determined by the Region C Water Planning Group (2015).

Table 21. Summary of Projected Water Savings by NTMWD Customers

NTMWD Current Municipal Customers	Conservation (AFY)				
	2020	2030	2040	2050	2060
Ables Springs WSC	3	4	5	8	12
Allen	763	953	1,002	1,047	1,113
Anna	79	211	36	64	153
BHP WSC	1	1	1	1	2
Blackland WSC	12	19	22	26	31
Bonham	35	27	34	61	94
Caddo Basin Special Utility District (SUD)	2	4	4	7	10
Cash SUD	1	1	2	2	3
Celina	0	37	91	168	184
College Mound WSC	7	11	12	20	34
Collin County-Other	7	10	9	51	92
Copeville SUD	3	4	5	8	17
Crandall	14	25	35	47	51
Culleoka WSC	3	4	6	10	13
Denton County-Other	8	12	8	9	9
East Fork SUD	5	8	9	14	22
Fairview	91	145	219	243	266
Farmersville	8	20	23	31	38
Fate	32	62	99	138	186
Forney	27	41	48	78	140
Forney Lake WSC	16	28	41	55	99
Frisco	1,730	2,645	3,572	3,793	4,015
Garland	694	1,013	375	495	617
Gastonia-Scurry SUD	5	9	10	15	24
Hackberry	6	10	15	21	28
Heath	78	217	262	288	314
High Point WSC	4	6	7	11	22
Hunt County-Other	2	4	4	5	7
Josephine	2	4	5	9	11
Kaufman	8	13	14	29	46
Kaufman County-Other	3	5	10	29	74
Lavon	10	18	32	19	52
Lavon WSC	5	8	9	15	33
Little Elm	34	51	46	61	76
Lowry Crossing	2	3	3	4	5
Lucas	82	204	281	325	373
McKinney	755	1,470	2,364	3,327	3,581
McLendon-Chisholm	6	10	15	20	25
Melissa	47	81	122	298	532
Mesquite	186	271	264	379	511
Milligan WSC	3	4	3	14	25
Mt Zion WSC	7	12	18	23	30
Murphy	124	194	210	227	245

NTMWD Current Municipal Customers	Conservation (AFY)				
	2020	2030	2040	2050	2060
Nevada	1	1	1	7	22
North Collin WSC	7	10	10	15	21
New Hope	1	2	2	3	4
Oak Grove	1	1	1	2	4
Parker	47	160	254	282	310
Plano	1,460	2,135	2,640	2,458	2,698
Post Oak Bend City	1	1	1	3	5
Princeton	8	13	16	49	97
Prosper	198	365	557	754	972
Richardson	604	830	941	1,054	1,146
Rockwall	329	490	658	834	1,045
Rockwall County-Other	0	0	0	0	15
R-C-H WSC	5	7	6	7	15
Rose Hill SUD	4	6	7	11	17
Rowlett	82	119	103	137	171
Royse City	10	17	26	66	147
Sachse	95	137	153	169	186
St. Paul	2	3	3	4	6
Scurry	0	1	1	2	3
Seis Lagos UD	34	39	41	42	44
Sunnyvale	43	84	129	166	218
Talty	3	4	5	7	13
Talty WSC	29	47	62	97	135
Terrell	74	175	259	356	454
The Colony	12	26	26	37	50
Van Alstyne	4	7	7	11	39
Wylie	61	90	86	119	154
Wylie Northeast SUD	2	3	4	10	22
Collin County irrigation	5	83	159	199	237
Collin County manufacturing	0	8	86	126	138
Dallas Co. manufacturing (10%)	0	8	92	132	137
Denton County manufacturing	0	0	2	3	3
Grayson County manufacturing	0	0	1	2	2
Kaufman Co. manufacturing (100%)	0	2	20	28	30
Rockwall County irrigation	0	3	6	8	9
Rockwall County manufacturing (100%)	0	0	1	1	2
Potential Customers					
Blue Ridge	0	2	4	19	54
Ector	0	1	1	1	2
Fannin County-Other	12	17	14	25	67
Honey Grove	0	3	3	4	5
Leonard	0	4	4	5	7
Savoy	0	1	1	1	2
Southwest Fannin County SUD	0	7	8	12	19

NTMWD Current Municipal Customers	Conservation (AFY)				
	2020	**2030**	**2040**	**2050**	**2060**
Trenton	0	4	15	35	51
Weston	0	10	48	157	312
Total conservation savings: current and potential customers	**8,044**	**12,805**	**15,816**	**18,955**	**22,305**

In general, water conservation measures can be divided into those that are passive and those that are active. The former yield water savings associated with the plumbing code and the adoption of more water-efficient appliances. The latter yield savings associated with BMPs implemented by the member cities and customers of NTMWD.

Table 22 lists water savings due to passive measures (plumbing code and water efficient appliances) and active measures (conservation BMPs). Savings from active measures include those realized from BMPs implemented since 2004 and those anticipated to occur after 2010. To showcase these savings, the NTMWD GPCD use in 2000 (218) was selected as the baseline for a typical dry year prior to the implementation of water conservation programs.

Table 22. Estimated and Projected NTMWD Water Conservation Savings Since 2000

	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Population	1,575,639	1,994,056	2,394,007	2,784,051	3,155,447	3,515,291
NTMWD 2000 GPCD	218	218	218	218	218	218
2013 CIP GPCD	188	186	183	181	176	171
GCPD reduction from 2000	30	32	35	37	42	47
Additional savings - BMPs	--	4	5	5	5	6
Plumbing code/efficient appliances	--	2	5	7	12	17
Total per capita savings	--	36	40	42	47	53
% from plumbing code/ efficient appliances	--	6%	13%	17%	26%	32%
% from BMPs implemented prior to 2010	--	83%	75%	71%	64%	57%
% from BMPs implemented after 2010	--	11%	13%	12%	11%	11%
	NTMWD Total Conservation in AFY					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Savings from demand reductions since 2000	52,948	71,476	93,857	115,386	148,451	185,069
Additional municipal conservation	--	8,044	12,805	15,816	18,955	22,305
NTMWD total projected water savings compared to 2000 demands	52,948	79,520	106,662	131,202	167,406	207,374

The 2013 CIP demands for 2020 indicate a reduction to 186 GPCD. The 2013 CIP per capita estimates are then decreased over time by additional savings from the increasing penetration of more water-efficient appliances in homes, institutions, and businesses. Table 22 shows that, by 2030, NTMWD will have reduced its overall GPCD demand by 40. By 2060, active conservation programs in place since the mid-2000s, additional active conservation programs, and savings from water efficient fixtures will have reduced the GPCD by 53. In this analysis, savings from water efficient-appliances in the *2016 Region C Water Plan* account for 13 percent of the total GPCD demand reduction in 2030. This percentage increases over time, up to 32 percent in 2060, as new, more water-efficient development becomes a larger percentage of NTMWD's total customer base and older residences convert to more water-efficient fixtures (Rice, 2016).

NTMWD's additional water conservation measures shown in Table 22 include (Rice, 2016):

- No more than twice per week watering (April 1-October 31);
- No more than once per week watering (November 1-March 1);
- Direct reuse programs for non-potable use;
- Interactive weather station program (accessed at www.watermyyard.org);
- Irrigation audits/inspections for regulated irrigation properties;
- Rebate programs;
- Hotel and motel linen program; and
- Prohibition on cool season grasses.

Overall, the following NTMWD water conservation efforts have been recognized at the state and national levels:

- The 2010 ADDY Award, in recognition of the 2011 "Water IQ" media campaign on water conservation;
- Texas Water Conservation Advisory Council Large Supplier Water Conservation and Stewardship Award in 2011, in recognition of outstanding and innovative commitment to the conservation of Texas' water resources;
- TCEQ's 2011 Environmental Excellence Award;
- Texas American Water Works Association Watermark Award in 2012, in recognition of the 2010 "Water IQ" media campaign on water conservation; and
- Texas Water Conservation Advisory Council 2015 Blue Legacy Award, in recognition of the "Water My Yard" program to install weather stations throughout NTMWD's service area for providing up-to-date information on lawn watering needs in NTMWD's service area.

C. Water Reuse in Region C

Reuse is emerging as an increasingly important source of water in Region C and throughout Texas. There are already a number of water reuse projects in operation in Region C, and many others are currently in the planning and permitting process. Direct reuse and indirect reuse have significantly different permitting requirements and potential applications. Direct reuse occurs when reclaimed water is delivered directly from a wastewater treatment plant to a water user, with no intervening discharge to waters of the state. Direct reuse requires a notification to TCEQ, which is routinely accepted as long as requirements to protect public health are met. The most common application of direct reuse is supplying water for landscape irrigation, particularly golf courses, and industrial uses, especially cooling for steam electric power plants (Region C Water Planning Group, 2010; Region C Water Planning Group, 2016).

Indirect reuse is when treated effluent (wastewater) is discharged to a stream, reservoir, or aquifer and subsequently retrieved for reuse by being diverted downstream or pumped from the reservoir or aquifer. The discharged effluent mixes with ambient water in the stream or reservoir as it travels to the point of diversion. Many of the water supplies within Region C have historically included return flows from treated wastewater as well as from natural runoff. These return flows supplement supply and can be used as long as the return flows continue. An entity can ensure the ability to use its return flows through a water right permit from TCEQ. A wastewater discharge permit from TCEQ may also be required if the discharge location were to be changed as part of the reuse project (Region C Water Planning Group, 2010).

In general, reuse strategies require the use of multiple barriers (such as advanced wastewater treatment, blending, residence time, and/or advanced water treatment) to mitigate potential negative impacts to the aquatic environment and agricultural resources. Sources of wastewater effluent needed for new reuse projects are generally restricted to owners and operators of large wastewater treatment plants. In Region C, these include the Trinity River Authority, which operates several wastewater treatment plants in the region, NTMWD, the cities of Fort Worth and Dallas, and several smaller cities.

The potential for additional reuse projects in Region C is dependent upon the amount of wastewater generated and the ability of prospective users to utilize treated effluent. Approximately 93 percent of the 1.76 million AF of water used in the Trinity River Basin in Region C in 2010 could be attributed to municipal and manufacturing use. Municipal and manufacturing use in Region C is expected to increase to 3.2 million AFY by 2060. Of the total amount of water projected for use in Region C, a considerable amount is expected to be returned to the Trinity River Basin through return flows (Freese and Nichols, et al., 2010).

Potential applications for water reuse in Region C include:

- Landscape irrigation (parks, school grounds, freeway medians, golf courses, cemeteries, and residential areas);
- Agricultural irrigation (crops and commercial nurseries);
- Industrial and power generation reuse (cooling, boiler feed, process water, heavy construction, and mining);
- Recreational/environmental uses (lakes and ponds, wetlands, and stream flow augmentation); and
- Supplementing potable water supplies.

In 2006 it was estimated that Region C reuse strategies would comprise 86 percent of all municipal reuse in Texas by 2030 (Hardin, 2010) (Figure 21) with the NTMWD's reuse program accounting for much of the reuse in Region C and Texas.

Return Flows

"Return flow" is the term used to describe water that has been beneficially used and then is discharged to a receiving water body. Existing streams and reservoirs have historically relied on these return flows for water supplies and instream uses.

The Region C plan proposes to reuse over 270,000 AF of additional return flows in 2020 through both direct and indirect reuse projects, with most of this additional reuse occurring in the Trinity River Basin. By 2060, the total reuse from proposed and existing projects will be nearly 623,000 AFY (Freese and Nichols, et al., 2010).

By implementing both water conservation and reuse strategies between 2010 and 2060, in keeping with the emphasis of the *2017 State Water Plan*, Region C will close the gap between its per capita municipal water use and that of the rest of the state, on average (Figure 22). As noted earlier, part of the reason for this apparent gap in per capita consumption rates is commuting patterns, under which residents of other regions who work in Region C boost its municipal per capita water use while simultaneously reducing the water use in their home regions. Other contributing factors to differences in GPCD include climate, economic activity, and urban densities. By 2030, after savings from water conservation and reuse strategies have been accounted for, Region C will have reduced its municipal GPCD from third-highest to sixth-lowest of the 16 regions in the state.

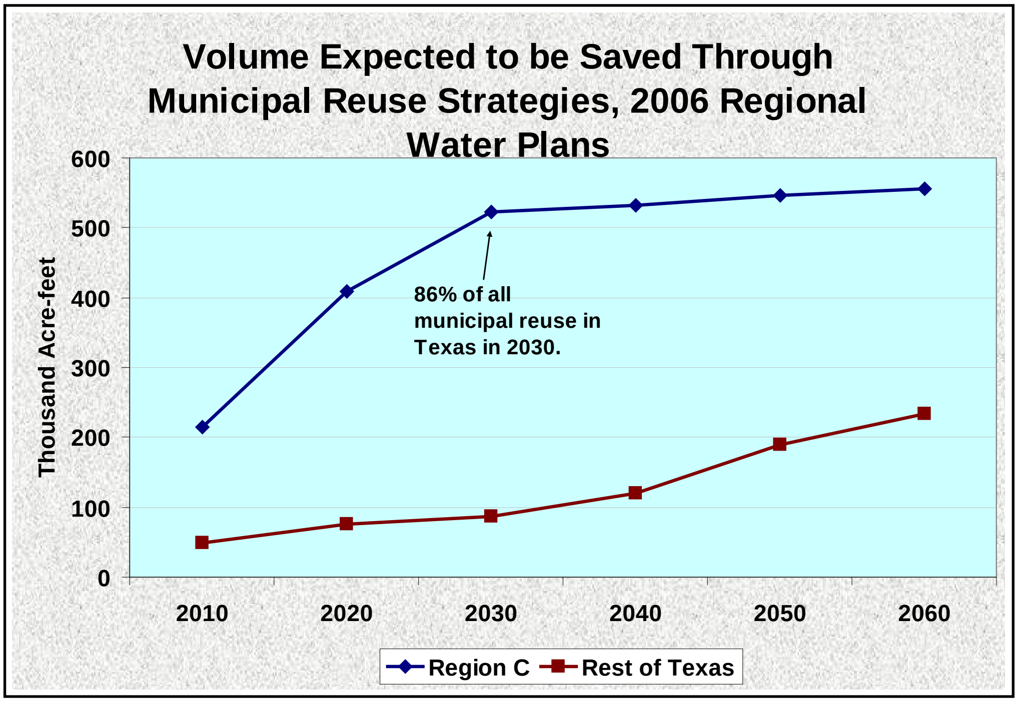

Figure 21. Water Savings from Municipal Reuse Strategies, Region C vs. Rest of Texas

Source: Hardin, 2010

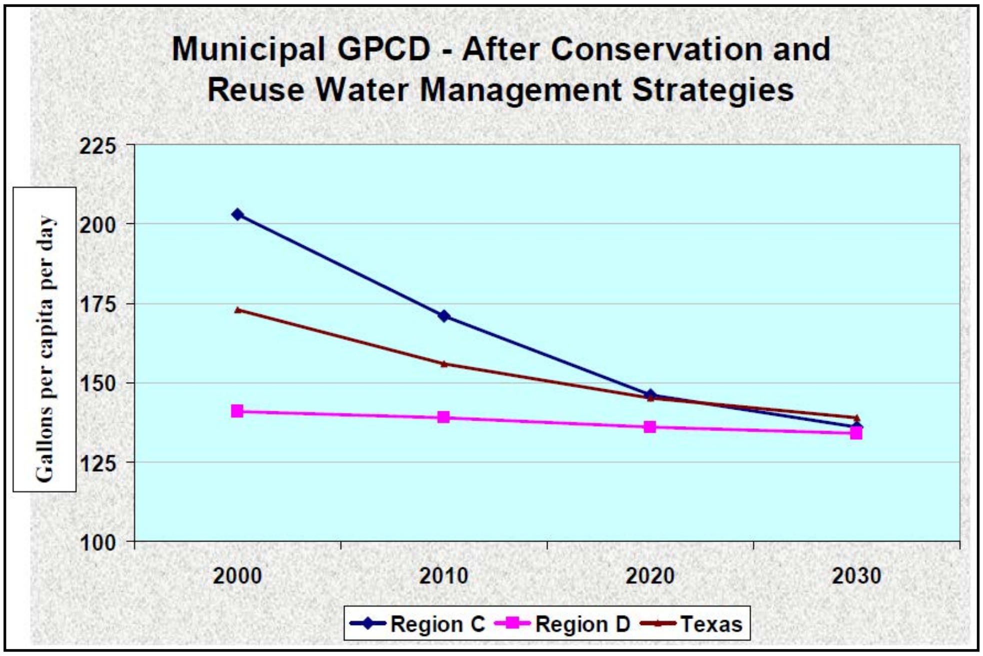

Figure 22. Converging Municipal GPCD's after Implementing Conservation and Reuse

Source: Hardin, 2010

D. Water Reuse in NTMWD

NTMWD is also implementing water reuse strategies to help meet its water needs; its reuse program is the largest of any wholesale water provider in Texas. Effluent from the Wilson Creek WWTP has been used to supplement NTMWD's water supplies since 1987. NTMWD's East Fork Raw Water Supply Project, described earlier, began operation in 2009, diverting return flows to Lake Lavon for subsequent reuse. This project diverts return flows from the East Fork of the Trinity River to a constructed wetland for polishing treatment and ultimately returns this water to Lake Lavon. The water right for the project authorizes diversions up to 157,393 AFY, as return flows increase and become available. NTMWD is planning on using 102,000 AFY by 2060 based on available wastewater flows (Freese and Nichols, et al., 2010).

Overall, by 2060, NTMWD is projected to have added approximately 172,000 AFY to its supplies from implementing its own reuse projects (Wilson Creek and East Fork). NTMWD is also implementing a direct reuse project for irrigation in Collin and Rockwall Counties for approximately 2,500 AFY.

Expanded conservation and reuse are already integral strategies in NTMWD's ability to meet future water demands. However, intensified conservation and reuse are insufficient to provide enough water to meet the projected demand from the more than doubling in population size to 3.7 million that NTMWD's service area is expected to undergo by 2060. The expected supply that will be available from implementation of these strategies is accounted for in NTMWD's projections. Figure 1 and Table 12 show the remaining supply deficit (need), which continues to widen each year. In fact, according to these projections, even before 2030, LBCR alone would not be enough to meet NTMWD's growing water needs.

According to the 2013 CIP, the projected remaining net need is 6,031 AFY in 2020 (49,051 AFY with the recommended reserve supply), growing to 232,464 AFY by 2060 (299,004 AFY with the recommended reserve supply). Conservation and reuse do not obviate the need for the Proposed Action, but help to reduce NTMWD's short and long-term supply deficit. Conservation and reuse strategies and the Proposed Action are all part of the portfolio of recommended strategies to meet the rapidly rising demand for municipal water supplies in the NTMWD service area as its population, economic activity, and area of developed land all continue to increase, and as outlying rural areas are gradually converted to more water-intensive urban and suburban land uses.

In summary, conservation is projected to supply 151,132 AFY in 2060 (Kiel, 2015b) (the sum of the second and fourth rows for 2060 in Table 23). Combined conservation and reuse total approximately 217,000 AFY in 2020 and are projected to reach about 343,000 AFY in 2060. This will constitute a substantial share of NTMWD's aggregate water supply portfolio. Table 23 summarizes projected conservation and reuse water savings within NTMWD through 2060.

Table 23. Summary of Conservation and Reuse Savings for NTMWD (AFY)

Conservation and Reuse	2020	2030	2040	2050	2060
Existing conservation[1]	55,852	73,787	86,625	108,978	128,827
Existing reuse	97,739	121,882	141,828	161,692	172,056
Planned conservation [2]	8,044	12,805	15,816	18,955	22,305
Water loss reduction	2,151	5,069	8,615	12,348	16,634
Planned reuse	53,135	37,913	25,366	13,599	3,235
Total	**216,921**	**251,456**	**278,250**	**315,572**	**343,057**

1. This represents the conservation savings realized by NTMWD through the projected demands and are not included as additional savings against the supply deficit.
2. This represents additional conservation savings through the implementation of the additional conservation measures listed in Table 22.