

Appendix E

Water Supply Available

Appendix E Water Supply Available to Region C

Table E.1 shows the overall water supply available to Region C. **Table E.2** shows the overall water supply available to Region C that was reported in the *2016 Region C Water Plan* ⁽¹⁾. The rest of this appendix explains the sources of the data in **Table E.1**. The table represents the water supply that might be available to the region, whether it is currently connected to a water user group or not.

Section Outline

Section E.1 – Methodology for Determining Surface Water Availability

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Section E.5 – Irrigation Local Supply and Other Local Supply

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Table E.1 Overall Water Supply Availability in Region C

Source	Values in Acre-Feet per Year					
	2020	2030	2040	2050	2060	2070
Reservoirs in Region C	1,269,040	1,249,558	1,229,730	1,209,600	1,189,327	1,169,027
Run-of-River Irrigation	8,735	8,735	8,735	8,735	8,735	8,735
Livestock and Other Local Supply	21,248	21,248	21,248	21,248	21,248	21,248
Surface and Groundwater Imports	570,746	520,778	510,783	500,854	491,718	481,582
Groundwater	161,948	161,800	162,386	162,100	162,548	162,150
Reuse	337,067	361,209	378,854	391,173	403,239	411,487
REGION C TOTAL	2,368,784	2,323,328	2,311,736	2,293,710	2,276,815	2,254,229

Table E.2 2016 Plan - Overall Water Supply Availability in Region C

Source	Values in Acre-Feet per Year					
	2020	2030	2040	2050	2060	2070
Reservoirs in Region C	1,275,970	1,256,257	1,236,417	1,216,578	1,196,738	1,177,262
Run-of-River Irrigation	8,734	8,734	8,734	8,734	8,734	8,734
Livestock and Other Local Supply	19,931	19,931	19,931	19,931	19,931	19,931
Surface and Groundwater Imports	581,567	531,265	520,931	510,717	501,415	491,109
Groundwater	146,178	146,190	146,188	146,135	146,132	146,096
Reuse	283,893	316,972	343,226	380,051	408,880	427,011
REGION C TOTAL	2,316,273	2,279,349	2,275,427	2,282,147	2,281,830	2,270,143

E.1 Methodology for Determining Surface Water Availability

Table E.3 presents the water availability for reservoir systems and reservoirs in Region C. The table also shows the water availability that was presented in the *2016 Region C Water Plan* ⁽¹⁾. In accordance with the Texas Water Development Board's (TWDB) established procedures ⁽²⁾, these surface water supplies are determined using the TCEQ-approved Water Availability Models (WAM). WAMs have been completed for each of the major river basins in Texas. The WAM models were developed for the purpose of reviewing and granting new surface water rights permits. The assumptions in the WAM models are based on the legal interpretation of water rights, and in some cases do not accurately reflect current operations. Availabilities for each water right are analyzed in priority date order, with water rights with the earliest permit date diverting first. WAM Run 3, which is the version used for planning, assumes full permitted diversions by all water rights and no return flows unless return flows are specifically required in the water right. Run 3 also does not include agreements or operations that are not reflected in the water right permits and does not account for reductions in reservoir capacities due to sediment accumulation. For planning purposes, adjustments were made to the WAMs to better reflect current and future surface water conditions in the region. Generally, changes to the WAMs included:

- Assessment of reservoir sedimentation rates and calculation of area-capacity conditions for current conditions (the most recent volumetric survey) and 2070 conditions. If only the original survey was available, then estimated year

2020 sediment conditions were used for current conditions. This WAM change results in reservoir yields that usually decrease over time due to the assumed accumulation of sediment.

- Inclusion of subordination agreements not already included in the TCEQ WAM
- Inclusion of system operation where appropriate
- Other corrections

The reliable supply from run-of-the-river diversions was calculated as the minimum monthly diversion for the permitted water rights located on the main stem and tributaries of the river and are based on the TCEQ WAM Run 3.

Specific adjustments to the WAMs to more accurately reflect the water rights and agreements for water supply sources in Region C are:

Trinity River Basin WAM

- Modeling of Lake Jacksboro and Lost Creek Reservoir as a system. System modeling includes subordination of Lake Bridgeport.
- Modeling of Tarrant Regional Water District's West Fork reservoirs (Bridgeport, Eagle Mountain, and Worth) as a system.
- Inclusion of a minimum elevation for Lake Fairfield (305.0 ft. msl). This is the minimum operating elevation for the intake to the power plant according to the *1999 Volumetric Survey of Fairfield Lake* prepared by the Texas Water Development Board.
- Modeling of Dallas' water rights in the Elm Fork of the Trinity River as a system with Lake Lewisville and Ray Roberts.
- Added new water right that had been

granted but was not in the WAM (119,000 acre-feet per year of additional diversion from Lake Ray Hubbard for the City of Dallas).

- Revised modeling for overdrafting Lake Lavon according to recent amendment and application for North Texas Municipal Water District. Before the August 2017 amendment (08-2410-J), the trigger for overdrafting Lake Lavon was Lake Hubbard being full and spilling. The amendment moves this trigger to Lake Lavon being in the flood pool. NTMWD currently has an application for amending the water right to include overdrafting Lake Lavon in lieu of additional sources of imported water.
- Use of full storage for Forest Grove Reservoir with an annual depletion limit of 16,348 acre-feet per year. The TCEQ WAM incorrectly uses the 16,348 acre-feet as the storage of the reservoir rather than the authorized storage of 20,038 acre-feet.
- Modeling of Corsicana’s rights from Richland-Chambers Reservoir as a system with Lake Halbert, reflecting how the rights are actually used.
- Modeling of Lake Benbrook as one pool instead of multiple pools to facilitate the calculation of yields. The current modeling incorrectly assigns evaporation to the dead pool of the reservoir which does not refill because it is modeled as non-priority. In actual operation, TRWD cannot use water from the reservoir unless the dead storage is full. This modeling respects the USACE minimum elevation for water supply.

Red River Basin WAM

- Changes to Lake Modeling of Lake Randell and Valley Lake as stand-alone reservoirs without Lake

Texoma backups for the firm yield calculation of these two reservoirs. Backup supply for these reservoirs from Lake Texoma is included in the supplies from Lake Texoma. This prevents double counting of the makeup water from Lake Texoma. For firm yield calculations for reservoirs other than Lake Randell, Valley Lake and Lake Texoma, the backups for Lake Randell and Valley Lake were retained.

- Lake Texoma is located on the Texas-Oklahoma border, and in accordance with the Red River Compact, water in Lake Texoma is equally shared by Texas and Oklahoma. There are three distinct water storage pools in Lake Texoma: 1) water supply, 2) hydropower, and 3) sediment storage (dead pool). Use of water from Lake Texoma is authorized by multiple Texas water rights and Oklahoma water rights, as well as authorizations by the US Congress and contracts with the Corps. To assess the firm yield of the reservoir for Region C, the total firm yield for both the water supply and hydropower pools was modeled. This total yield was equally split between Texas and Oklahoma. The reliable supplies from the lake are limited to the Texas water rights and associated storage contracts with the Corps.
- Removal of diversion backups of individual Texas water rights in Lake Texoma from the hydropower pool. All Texas water rights are 100% reliable in the WAM, so these backups are not invoked in the WAM. The code was removed because it made the modeling unnecessarily complicated.

Unless there were changed conditions (new water rights, WAM modifications, new area/capacity relationships, other), the firm yields from the *2016 Region C Water Plan* ⁽¹⁾

were used. The Region C reservoirs for which new firm yields were calculated include the Elm Fork of the Trinity River System, Lake Lavon, Richland-Chambers Reservoir, the West Fork of the Trinity River System, Cedar Creek Reservoir, Benbrook Lake, Lake Ray Hubbard, White Rock Lake, and Chapman Lake. The Elm Fork System was updated using a refined methodology to better reflect actual conditions and to include Lake Grapevine as part of Dallas' system operations. Lake Grapevine was also updated to model the Park Cities MUD and City of Grapevine rights in Lake Grapevine separately, rather than as part of the Dallas System Operations. Cedar Creek and Lake Ray Hubbard yields were updated to reflect new area/capacity relationships. White Rock Lake was updated assuming Dallas will continue to dredge the lake and keep it at its current capacity. The minimum storage was changed for the modeling of Lake Benbrook. Lakes Lavon and Richland-Chambers were updated using a refined methodology to better reflect actual operations.

TRWD has elected to show the currently available supplies for the reservoirs they obtain water from as safe yields, rather than firm yields, based on the operation of these reservoirs. DWU has also elected to do this for their Elm Fork Reservoir System. Both the firm yield and safe yield are reported for these reservoirs. However, the safe yield is

E.2 Water Supply Systems in Region C

The water availability for water supply systems in Region C is shown in **Table E.3**. The systems listed are operated as physical systems – the water they provide cannot easily be separated by individual source. The supply available is based on the calculation of the Water Availability Models (WAMs), as described above. More detailed

what is used to determine the overall water supply availability in Region C.

At the end of this appendix, **Table E.10** summarizes the WAM models used for the 2021 Region C Plan.

Imports to Region C

Supplies from Lake Chapman were determined using the Sulphur River Basin WAM with extended hydrology to include the new drought of record for the reservoir (2010-2015).

The yields for Lake Fork and Lake Tawakoni were those used in the *2016 Region C Water Plan* ⁽¹⁾. The yields were provided to Region D for inclusion in the 2021 Region D Water Plan. It should be noted that the recent drought (2010-2015) did not represent a new drought of record for Lake Fork or Lake Tawakoni.

Region C has very few water supplies in the Brazos River Basin. Thus, the water availability information as determined by the Brazos G Regional Water Planning Group was adopted.

For Lake Palestine and Lake Athens, both in the Neches River Basin, the water availability information as determined by the Region I Water Planning Group was adopted. For Lake Livingston, the water availability information as determined by the Region H Water Planning Group was adopted.

discussions on water supply available for each system are given below.

Lost Creek/Jacksboro System (Jacksboro)

Lake Jacksboro is a 2,129 acre-foot reservoir located just outside of the City of Jacksboro in the Trinity River Basin in Jack County, and Lost Creek Reservoir is an

11,961 acre-foot reservoir located 1.5 miles downstream of the Lake Jacksboro dam. The City of Jacksboro holds a water right for the combined use of both reservoirs for municipal water supply and the right to divert 1,397 acre-feet per year. The water right authorizes the reservoirs to be operated as a system, so the WAM was modified to include system operation and the subordination agreement with TRWD. According to the WAM, the firm yield from this system exceeds the permit amount. The available supply from this system is limited to 1,597 acre-feet per year, which is the permitted amount of 1,397 acre-feet per year plus 200 acre-feet per year of return flows that Jacksboro is authorized to reuse.

West Fork Including Bridgeport Local System (Tarrant Regional Water District)

Tarrant Regional Water District's West Fork Reservoir system is comprised of Lake Bridgeport, Lake Worth, and Eagle Mountain Lake. The WAM was modified to include the system operation of these three reservoirs. The water right for Lake Bridgeport allows for between 15,000 acre-feet per year and 27,000 acre-feet per year to be diverted for local use at Lake Bridgeport. Based on planned TRWD operations, the modified WAM model assumes 27,000 acre-feet per year is used locally at Lake Bridgeport (previous plans assumed 15,000 acre-feet per year of local use). The resulting combined system firm yield was 115,908 acre-feet per year in 2020 and 102,825 acre-feet per year in 2070. The decreased firm yield is due to the changed assumption in local Lake Bridgeport use.

Under current conditions, this system provides somewhat less supply than shown. With existing facilities, it is not possible to divert water from Lake Worth when the lake is drawn down more than four feet, which makes some of the water stored in Lake Worth unavailable. In addition, the Tarrant

Regional Water District operates its water supplies on a safe yield basis, which provides a smaller supply than the firm yield numbers shown. (In safe yield operation, the user takes less than the firm yield in order to leave a reserve supply in the reservoir in case a drought worse than any historical drought occurs). The safe yield for the West Fork System, which includes Eagle Mountain Lake, Lake Worth, and Lake Bridgeport, is 94,192 acre-feet per year in 2020 and 85,525 acre-feet per year in 2070.

Elm Fork/Lake Lewisville/Ray Roberts System (Dallas)

This system, owned by Dallas, is comprised of Lake Lewisville, Lake Ray Roberts, and run-of-the-river rights from the Elm Fork of the Trinity River. The WAM was modified to include the system operation of these supplies. The resulting combined system firm yield was 192,596 acre-feet per year in 2020 and 185,378 acre-feet per year in 2070. The firm yield is higher than what was shown in the *2016 Region C Water Plan* ⁽¹⁾ due to changes made in the WAM with respect to the methodology used to reflect actual conditions. The safe yield of the reservoir system in 2020 is 172,975 acre-feet per year and in 2070 is 136,001 acre-feet per year.

Lake Grapevine (Dallas)

Dallas includes its portion of supply from Lake Grapevine in its system operation with Elm Fork/Lewisville/Ray Roberts. The WAM was modified to include this system operation. The resulting yield for Dallas' portion of Lake Grapevine was 7,367 acre-feet per year in 2020 and 6,650 acre-feet per year in 2070. The increase from the available supply shown in the 2016 Region C Water Plan is due to using a slightly lower sedimentation rate, which was calculated using the 2011 volumetric survey of Lake Grapevine.

Table E.3 Supply Available from Water Supply Systems and Reservoirs in Region C (Not Considering Transmission Constraints)

Water Right No.(s)	Basin	Surface Water Availability in 2021 Plan							Surface Water Availability in 2016 Plan					
		2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070	
WATER SUPPLY SYSTEMS														
Lost Creek/Jacksboro	Trinity	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597
West Fork (includes Bridgeport Local) ^(a)	Trinity	94,192	92,458	90,725	88,992	87,258	85,525	96,458	95,625	94,792	93,958	93,125	92,292	
Elm Fork/Lewisville/Ray Roberts (Dallas) ^(a)	Trinity	172,975	165,580	158,185	150,791	143,396	136,001	172,975	165,580	158,185	150,791	143,396	136,001	
Grapevine - Dallas	Trinity	7,367	7,367	7,367	7,142	6,896	6,650	7,367	7,150	6,933	6,717	6,500	6,283	
Subtotal Systems		276,131	267,002	257,874	248,522	239,147	229,773	278,397	269,952	261,507	253,063	244,618	236,173	
RESERVOIRS IN REGION C														
Cedar Creek ^(a)	4976C	Trinity	158,891	157,192	155,494	153,796	152,098	150,400	158,891	157,850	156,333	154,817	153,300	151,783
Richland-Chambers (TRWD) ^(a)	5030, 5035C	Trinity	185,230	180,984	176,738	172,492	168,246	164,000	185,230	182,700	178,800	174,900	171,000	167,100
Richland-Chambers (Corsicana) and Lake Halbert	5030, 5035C	Trinity	13,863	13,855	13,847	13,838	13,830	13,822	13,863	13,855	13,847	13,838	13,830	13,822
Moss	4881	Red	7,410	7,410	7,410	7,410	7,410	7,410	7,410	7,410	7,410	7,410	7,410	7,410
Lake Texoma (Texas' Share - NTMWD)	5003	Red	197,000	197,000	197,000	197,000	197,000	197,000	197,000	197,000	197,000	197,000	197,000	197,000
Lake Texoma (Texas' Share - GTUA)	4301B, 4301C	Red	83,200	83,200	83,200	83,200	83,200	83,200	83,200	83,200	83,200	83,200	83,200	83,200
Lake Texoma (Texas' Share - Denison)	4901	Red	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400

Water Right No.(s)	Basin	Surface Water Availability in 2021 Plan							Surface Water Availability in 2016 Plan					
		2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070	
Lake Texoma (Texas' Share – Luminant)	4900	Red	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400	16,400
Lake Texoma (Texas' Share – RRA)	4898, 4899	Red	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250	2,250
Randell	4901	Red	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400	1,400
Valley	4900	Red	0	0	0	0	0	0	0	0	0	0	0	0
Bonham	4925	Red	5,340	5,340	5,340	5,340	5,340	5,340	5,340	5,340	5,340	5,340	5,340	5,340
Ray Roberts (Denton)	2335A, 2455B	Trinity	18,902	18,853	18,676	18,500	18,324	18,148	18,902	18,733	18,564	18,395	18,226	18,057
Lewisville (Denton)	2348, 2456	Trinity	7,817	7,817	7,817	7,817	7,698	7,550	7,817	7,715	7,613	7,512	7,410	7,308
Benbrook ^(a)	5157A	Trinity	5,391	5,387	5,383	5,378	5,374	5,370	5,417	5,400	5,383	5,367	5,350	5,333
Weatherford	3356	Trinity	2,923	2,880	2,837	2,793	2,750	2,707	2,923	2,880	2,837	2,793	2,750	2,707
Grapevine (PCMUD)	2362A, 2363A, 2458C	Trinity	16,900	16,900	16,808	16,639	16,469	16,300	16,900	16,750	16,600	16,450	16,300	16,150
Grapevine (Grapevine)	2362A, 2363A, 2458C	Trinity	1,919	1,886	1,852	1,818	1,784	1,750	1,983	1,950	1,917	1,883	1,850	1,817
Arlington ^(a)	3391	Trinity	7,640	7,530	7,420	7,310	7,200	7,090	7,667	7,550	7,433	7,317	7,200	7,083
Joe Pool	3404C	Trinity	14,883	14,575	14,267	13,958	13,650	13,342	14,883	14,575	14,267	13,958	13,650	13,342
Mountain Creek	3408	Trinity	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400	6,400
North		Trinity	0	0	0	0	0	0	0	0	0	0	0	0
Lake Ray Hubbard (Dallas)	2462H	Trinity	55,730	54,828	53,926	53,024	52,122	51,220	56,113	54,800	53,487	52,173	50,860	49,547
White Rock	2461B	Trinity	3,200	3,200	3,200	3,200	3,200	3,200	3,200	2,900	2,600	2,300	2,000	1,700
Terrell	4972	Trinity	2,267	2,250	2,233	2,217	2,200	2,183	2,267	2,250	2,233	2,217	2,200	2,183
Clark	5019	Trinity	210	210	210	210	210	210	210	210	210	210	210	210
Bardwell	5021A	Trinity	9,600	9,295	8,863	8,432	8,000	7,568	9,600	9,295	8,863	8,432	8,000	7,931
Waxahachie	5018	Trinity	2,800	2,695	2,590	2,485	2,380	2,275	2,800	2,695	2,590	2,485	2,380	2,275

	Water Right No.(s)	Basin	Surface Water Availability in 2021 Plan						Surface Water Availability in 2016 Plan					
			2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
Forest Grove	4983	Trinity	8,653	8,590	8,527	8,463	8,400	8,337	8,653	8,590	8,527	8,463	8,400	8,337
Trinidad City Lake	5291	Trinity	450	450	450	450	450	450	450	450	450	450	450	450
Trinidad	4970	Trinity	3,050	3,050	3,050	3,050	3,050	3,050	3,050	3,050	3,050	3,050	3,050	3,050
Navarro Mills	4992	Trinity	18,333	17,325	16,317	15,308	14,300	13,292	18,333	17,325	16,317	15,308	14,300	13,292
Halbert		Trinity	0	0	0	0	0	0						
Fairfield	5040	Trinity	870	870	870	870	870	870	870	870	870	870	870	870
Bryson		Brazos	0	0	0	0	0	0	0	0	0	0	0	0
Mineral Wells	4039	Brazos	2,495	2,483	2,470	2,458	2,445	2,433	2,495	2,483	2,470	2,458	2,445	2,433
Teague City Lake	5291	Brazos	189	189	189	189	189	189	189	189	189	189	189	189
Lavon	2410G	Trinity	106,603	105,163	103,722	102,281	100,841	99,400	108,920	107,140	105,360	103,580	101,800	100,020
Muenster	2323	Trinity	300	300	300	300	300	300	300	300	300	300	300	300
Subtotal Reservoirs			992,909	982,556	971,856	961,078	950,180	939,254	997,573	986,305	974,910	963,515	952,120	941,088
TOTAL			1,269,040	1,249,558	1,229,730	1,209,600	1,189,327	1,169,027	1,275,970	1,256,257	1,236,417	1,216,578	1,196,738	1,177,261

a. Amounts reported are safe yields.

E.3 Reservoirs in Region C

All major reservoirs in Region C as well as some smaller reservoirs used for municipal supply are listed in **Table E.3**. The supply available is based on the calculation of the Water Availability Models (WAMs), which limits the supply to the lesser of the firm yield or the permit amount. In some cases, the safe yield is used as the supply available based on the operational policies of the reservoir owner.

Cedar Creek

Cedar Creek Reservoir is located on Cedar Creek in the Trinity River Basin in Henderson and Kaufman Counties. The reservoir has a permitted conservation storage of 678,900 acre-feet. Tarrant Regional Water District holds a water right for diversion of 175,000 acre-feet per year. According to the WAM, the firm yield (not limited to the water right) is 204,587 acre-feet per year in 2020 decreasing to 202,700 acre-feet per year by 2070. The firm yield is lower than what was shown in the 2016 Region C Water Plan ⁽¹⁾ due to changes made in the WAM with respect to the area/capacity relationships. The decrease from the available supply shown in the *2016 Region C Water Plan* ⁽¹⁾ is due to using a higher sedimentation rate, which was calculated using the 2017 volumetric survey. The available supply from Cedar Creek is limited to the permit amount of 175,000 acre-feet per year. The safe yield, on which TRWD bases its supplies, is 158,891 acre-feet per year in 2020 decreasing to 150,400 acre-feet per year in 2070.

Richland-Chambers (and Lake Halbert)

Richland-Chambers Reservoir is located on Richland Creek in the Trinity River Basin in Freestone and Navarro Counties. The reservoir has a permitted conservation storage of 1,135,000 acre-feet. Tarrant

Regional Water District and City of Corsicana hold water rights in the reservoir (210,000 acre-feet per year for TRWD and 13,650 acre-feet per year for Corsicana). According to the WAM, the firm yield of the TRWD water right is 221,565 acre-feet per year in 2020, decreasing to 207,201 acre-feet per year by 2070. The firm yield from Richland-Chambers is limited to the permitted amount of 210,000 acre-feet per year. The safe yield is 185,230 acre-feet per year in 2020 decreasing to 164,000 acre-feet per year in 2070. The firm yield is lower than what was shown in the 2016 Region C Water Plan (1) due to refinement of the methodology to better reflect actual conditions.

Corsicana's water right in Lake Halbert is backed up by the city's water right in Richland-Chambers. Lake Halbert is located on Elm Creek in the Trinity River Basin in Navarro County. The reservoir has permitted conservation storage of 7,357 acre-feet. The City of Corsicana holds a water right in Lake Halbert for 4,003 acre-feet per year. According to the WAM, the available supply from Richland-Chambers Reservoir and Lake Halbert to Corsicana is 13,863 acre-feet per year in 2020 and decreasing slightly to 13,822 acre-feet per year in 2070.

Moss

Moss Lake is located on Fish Creek in the Red River Basin in Cooke County. The reservoir has permitted conservation storage of 23,210 acre-feet. The City of Gainesville holds water rights in the reservoir for 7,740 acre-feet per year. According to the WAM, the available supply from Moss Lake in 2070 is 7,410 acre-feet per year.

Texoma (Texas' share)

Lake Texoma is located along the Texas and Oklahoma border in the Red River Basin in Grayson and Cooke Counties. The permitted conservation storage for water supply in Texas is 300,000 acre-feet. Red River Authority, Greater Texoma Utility Authority, Denison, North Texas Municipal Water District, and Luminant all hold water rights in the reservoir. The total Texoma supply available to Region C as of 2070 is limited to the total water rights of 323,250 acre-feet per year [2,250 acre-feet per year for Red River Authority; 83,200 acre-feet per year for Greater Texoma Utility Authority; 24,400 acre-feet per year for Denison; 197,000 acre-feet per year for NTMWD; and 16,400 acre-feet per year for Luminant]. The firm yield of Texas' share of Lake Texoma is greater than the total of the Texas water rights and is 642,608 acre-feet per year in 2020, decreasing to 640,067 acre-feet per year by 2070.

Randell

Randell Reservoir is located on an unnamed tributary of Shawnee Creek in the Red River Basin in Grayson County. The reservoir has permitted conservation storage of 5,400 acre-feet. The City of Denison holds a water right in the reservoir for 5,280 acre-feet per year. The supply from Lake Randell is backed up by up to 24,400 acre-feet per year of diversions from Lake Texoma, which are fully reliable. The available supply from Randell Reservoir as of 2070 is 1,400 acre-feet per year without a backup from Lake Texoma.

Valley

Valley Lake is located on Sand Creek in the Red River Basin in Fannin and Grayson Counties. The reservoir has a permitted conservation storage of 15,000 acre-feet. This reservoir is operated by Luminant for steam electric power cooling in conjunction with their water right in Lake Texoma. The total amount of water that can be diverted

from either Texoma or Valley Lake is 16,400 acre-feet per year. During drought, it is assumed that the full permitted diversion would be taken from Lake Texoma (see Lake Texoma discussion). Therefore, the available supply from Valley Lake is 0 acre-feet per year.

Bonham

Lake Bonham is located on Timber Creek in the Red River Basin in Fannin County. The reservoir has permitted conservation storage of 13,000 acre-feet. The City of Bonham holds a water right in the reservoir for 5,340 acre-feet per year. The NTMWD has an agreement with the City of Bonham to operate the lake and water treatment plant. According to the WAM, the firm yield of Lake Bonham is 6,267 acre-feet per year in 2020, decreasing to 5,683 acre-feet per year by 2070. The available supply from Lake Bonham is limited to the permitted amount of 5,340 acre-feet per year.

Ray Roberts (Denton)

Lake Ray Roberts and Lake Lewisville were modeled as part of the Elm Fork System to find the firm yields of Denton's water rights. Lake Ray Roberts is located on the Elm Fork of the Trinity River in Denton, Cooke, and Grayson Counties. The reservoir has a permitted conservation storage of 799,600 acre-feet. The City of Dallas and the City of Denton hold combined water rights in the reservoir totaling 799,600 acre-feet per year, which is much greater than the actual yield of the reservoir. Dallas' share of Lake Ray Roberts was discussed above under Water Supply Systems. According to the WAM, Denton's available supply from Ray Roberts as of 2020 was 18,902 acre-feet per year and as of 2070 is 18,148 acre-feet per year. The slight increase from the available supply shown in the 2016 Region C Water Plan is due to refinement of the methodology to better reflect actual operations.

Lewisville (Denton)

Lake Lewisville is located on the Elm Fork of the Trinity River in Denton County. The reservoir has a permitted conservation storage of 618,400 acre-feet. The City of Dallas and the City of Denton hold combined water rights in the reservoir totaling 598,900 acre-feet per year, which is much greater than the actual yield of the reservoir. Dallas' share of Lake Lewisville was discussed above under Water Supply Systems. According to the WAM, Denton's available supply from Lewisville as of 2020 is 7,817 acre-feet per year and as of 2070 is 7,550 acre-feet per year. The slight increase in available supply from the 2016 Region C Water Plan is due to refinement of the methodology to better reflect actual operations.

Benbrook

Lake Benbrook is located on the Clear Fork of the Trinity River in Tarrant County. Certificate of Adjudication 08-5157 authorizes the impoundment of 72,500 acre-feet of water in Benbrook Reservoir between the elevations of 665 feet and 694 feet. The authorized diversions from Lake Benbrook are 72,500 acre-feet per year, of which only 6,833 acre-feet per year are on a priority basis. Tarrant Regional Water District holds the water right, which specifies use amounts for Benbrook Water and Sewer Authority, City of Fort Worth, and City of Weatherford. According to the WAM, the firm yield of Lake Benbrook is 6,740 acre-feet per year in 2020, decreasing to 6,671 acre-feet per year by 2070. The safe yield is 5,391 acre-feet per year in 2020 and 5,370 acre-feet per year in 2070. Lake Benbrook is used as terminal storage for water pumped from Cedar Creek and Richland-Chambers Reservoirs. The available supply does not include water from these sources. According to the 1998 TWDB volumetric survey of Benbrook

Reservoir, the storage capacity at elevation 665.0 feet is 14,307 acre-feet and the capacity at 694.0 feet is 89,402 acre-feet. This results in a usable conservation storage of 71,341 acre-feet, which is less than the authorized amount. The estimated yields decreased slightly relative to the 2016 Plan yields because the 2016 Plan modeling allowed access to the full 72,500 acre-feet of permitted storage, which is inconsistent with the language in the water right that limits the useable storage to between 665 feet and 694 feet. TCEQ also revised the WAM to change the hydrology and channel losses in the model.

Weatherford

Lake Weatherford is located on the Clear Fork of the Trinity River in Parker County. The reservoir has permitted conservation storage of 19,470 acre-feet. The City of Weatherford holds a water right for consumptive use of 5,220 acre-feet per year. (The permit also authorizes 59,400 acre-feet per year of non-consumptive industrial use.) According to the WAM, the available supply from Lake Weatherford is 2,923 acre-feet per year in 2020, decreasing to 2,707 acre-feet per year in 2070.

Grapevine

Lake Grapevine is located on Denton Creek in the Trinity River Basin in Tarrant and Denton Counties. The reservoir has a permitted conservation storage of 161,250 acre-feet. City of Dallas, City of Grapevine, and Dallas County Park Cities MUD hold combined water rights in the reservoir for a total diversion of 161,250 acre-feet per year, which is much greater than the actual yield of the reservoir. Dallas' share of Lake Grapevine was discussed above under Water Supply Systems. According to the WAM, Dallas County PCMUD's available supply from Lake Grapevine as of 2070 is 16,900 acre-feet per year in 2020, decreasing to 16,300 acre-feet per year. The

City of Grapevine’s available supply from Lake Grapevine is 1,919 acre-feet per year in 2020, decreasing to 1,750 acre-feet per year in 2070. The change from the available supply shown in the 2016 Region C Water Plan is because Lake Grapevine is modeled as an independent, stand-alone, reservoir to determine the yields for PCMUD and the City of Grapevine as opposed to being operated as a system with other reservoirs. (Note, however, that Dallas’ share of Lake Grapevine is based on operating the lake as a system with Lakes Lewisville and Ray Roberts.) The yields from independent reservoir operations are less than the yield from system operations with other Elm Fork reservoirs.

Arlington

Lake Arlington is located on Village Creek in the Trinity River Basin in Tarrant County. The reservoir has a permitted conservation storage of 45,710 acre-feet. The City of Arlington and Luminant jointly hold a water right for 23,120 acre-feet per year (13,000 acre-feet per year for Arlington and 10,120 acre-feet per year for Luminant). By contract, City of Arlington has dedicated its Lake Arlington water rights to the TRWD System. According to the WAM, available supply from Lake Arlington as of 2070 is 8,950 acre-feet per year. The safe yield is 7,640 acre-feet per year in 2020 and 7,090 acre-feet per year in 2070. Like Lake Benbrook, Lake Arlington serves as terminal storage for water pumped from Richland-Chambers and Cedar Creek Reservoirs. The available supply from Lake Arlington does not include water from these sources.

Joe Pool

Joe Pool Lake is located on Mountain Creek in the Trinity River Basin in Dallas and Tarrant Counties. The reservoir has a permitted conservation storage of 176,900 acre-feet. The Trinity River Authority holds a water right for 17,000 acre-feet per year.

According to the WAM, available supply from Joe Pool Lake is 14,882 acre-feet per year in 2020, decreasing to 13,342 acre-feet per year in 2070.

Mountain Creek

Mountain Creek Lake is located on Mountain Creek in the Trinity River Basin in Dallas County. The reservoir has a permitted conservation storage of 22,840 acre-feet. Luminant holds a water right for 6,400 acre-feet per year. According to the WAM, the firm yield of Mountain Creek Lake is 12,767 acre-feet per year in 2020, decreasing to 11,433 acre-feet per year by 2070. The available supply from Mountain Creek Lake is limited to the permitted amount of 6,400 acre-feet per year.

North

North Lake is an off-channel reservoir located on the South Fork of Grapevine Creek in the Trinity River Basin in Dallas County. The reservoir has a permitted conservation storage of 17,100 acre-feet. Luminant holds a water right for 1,000 acre-feet per year. According to the WAM, available supply from North Lake as of 2070 is 0 acre-feet per year without backup from the Elm Fork.

Ray Hubbard

Lake Ray Hubbard is located on the Elm Fork of the Trinity River in Dallas, Kaufman, and Rockwall Counties. The reservoir has a permitted conservation storage of 490,000 acre-feet. The City of Dallas holds a water right for 89,700 acre-feet per year. According to the WAM, the firm yield of Ray Hubbard as of 2020 is 55,730 acre-feet per year, decreasing to 51,220 acre-feet per year by 2070. The change from the available supply shown in the *2016 Region C Water Plan* ⁽¹⁾ is due to using a lower sedimentation rate, which was calculated using the 2015 volumetric survey for Lake

Ray Hubbard and the inclusion of an additional 119,000 acre-feet per year authorized for diversion.

White Rock Lake

White Rock Lake is located on White Rock Creek in the Trinity River Basin in Dallas County. The reservoir has a permitted conservation storage of 21,345 acre-feet. The City of Dallas holds a water right for 8,703 acre-feet per year. According to the WAM, available supply from White Rock Lake as of 2070 is 3,200 acre-feet per year. The modeling on this lake assumes Dallas will continue to dredge the lake to maintain its current capacity.

Terrell

Lake Terrell is located on Muddy Cedar Creek in the Trinity River Basin in Kaufman County. The reservoir has a permitted conservation storage of 8,712 acre-feet. The City of Terrell holds a water right for 6,000 acre-feet per year. According to the WAM, available supply from Terrell is 2,267 acre-feet per year in 2020, decreasing slightly to 2,183 acre-feet per year in 2070. The City of Terrell no longer uses water from Lake Terrell.

Clark

Lake Clark is located on Little Mustang Creek in the Trinity River Basin in Ellis County. The reservoir has a permitted conservation storage of 1,549 acre-feet. The City of Ennis holds a water right for 450 acre-feet per year. According to the WAM, available supply from Lake Clark is 210 acre-feet per year. The City of Ennis no longer uses water from Lake Clark.

Bardwell

Lake Bardwell is located on Waxahachie Creek in the Trinity River Basin in Ellis County. The reservoir has a permitted conservation storage of 54,900 acre-feet.

The Trinity River Authority holds a water right for 18,424.5 acre-feet per year (which includes reuse of up to 5,129 acre-feet per year of return flows). According to the WAM, the firm yield of Lake Bardwell is 9,727 acre-feet per year in 2020, decreasing to 7,568 acre-feet per year by 2070. In 2020, the available supply from Lake Bardwell (shown in **Table E.3**) is the smaller of the firm yield or the permitted amount of 9,600 acre-feet per year without return flows.

Waxahachie

Lake Waxahachie is located on Waxahachie Creek in the Trinity River Basin in Ellis County. The reservoir has a permitted conservation storage of 13,500 acre-feet. Ellis County Water Control and Improvement District #1 (an entity of the City of Waxahachie) holds a water right for 3,570 acre-feet per year. According to the WAM, available supply from Lake Waxahachie is 2,800 acre-feet, decreasing slightly to 2,275 acre-feet per year in 2070.

Forest Grove

Forest Grove Reservoir is located on Caney Creek in the Trinity River Basin in Henderson County. The reservoir has a permitted conservation storage of 20,038 acre-feet. Luminant holds a water right for 9,500 acre-feet per year (not including non-consumptive use). Presently, the dam for Forest Grove Reservoir is built, but the lake has not begun to store water. According to the WAM, available supply from Forest Grove is 8,653 acre-feet per year in 2020, decreasing to 8,337 acre-feet per year in 2070.

Trinidad City Lake

Trinidad City Lake is located on Cedar Creek in the Trinity River Basin in Henderson County. The reservoir has a permitted conservation storage of 498 acre-feet. The City of Trinidad holds a water right for 1,000

acre-feet per year. According to the WAM, available supply from Trinidad City Lake is 450 acre-feet per year.

Trinidad

Lake Trinidad is an off-channel reservoir located just off the Trinity River in Henderson County, with permitted diversions from the Trinity River. The reservoir has a permitted conservation storage of 6,200 acre-feet. Luminant holds a water right for 4,000 acre-feet per year. According to the WAM, available supply from Lake Trinidad with the diversions from the Trinity is 3,050 acre-feet per year. However, return flows in the Trinity River watershed make the Lake Trinidad permitted supply fully reliable.

Navarro Mills

Lake Navarro Mills is located on Richland Creek in the Trinity River Basin in Navarro County. The reservoir has a permitted conservation storage of 63,300 acre-feet. The Trinity River Authority holds a water right to divert 19,400 acre-feet per year. According to the WAM, available supply from Navarro Mills is 18,333 in 2020, decreasing to 13,292 acre-feet per year in 2070.

Fairfield

Lake Fairfield is located on Big Brown Creek in the Trinity River Basin in Freestone County. The reservoir has a permitted conservation storage of 50,600 acre-feet. Luminant holds a water right for 14,150 acre-feet per year. According to the WAM, available supply from Lake Fairfield is 870 acre-feet per year with a minimum operating level of 305.0 feet msl and without backup from the Trinity River.

Bryson

Lake Bryson is located on East Rock Creek in the Brazos River Basin in Jack County.

The reservoir has a permitted conservation storage of 950 acre-feet. The City of Bryson holds a water right for 90 acre-feet per year. According to the WAM, available supply from Bryson as of 2070 is 0 acre-feet per year.

Mineral Wells

Lake Mineral Wells is located on Rock Creek in the Brazos River Basin in Parker County. The reservoir has a permitted conservation storage of 7,065 acre-feet. The City of Mineral Wells holds a water right for 2,520 acre-feet per year. According to the WAM, available supply from Mineral Wells is 2,495 acre-feet per year in 2020, decreasing slightly to 2,433 in 2070. The City of Mineral Wells is not currently using water from Lake Mineral Wells.

Teague City Lake

Teague City Lake is located on Holman Creek in the Brazos River Basin in Freestone County. The reservoir has permitted conservation storage of 1,160 acre-feet. The City of Teague holds a water right for 605 acre-feet per year. According to the WAM, available supply from Teague City Lake is 189 acre-feet per year. The City of Teague no longer uses Teague City Lake for water supply.

Lavon

Lake Lavon is located on the East Fork of the Trinity River in Collin County. The reservoir has permitted conservation storage of 443,800 acre-feet. North Texas Municipal Water District holds water rights for 118,670 acre-feet per year. According to the WAM, the available supply from Lake Lavon is 106,603 acre-feet per year in 2020, decreasing to 99,400 acre-feet per year by 2070. This yield does not include return flows or imported water. The decrease from the available supply shown in the *2016 Region C Water Plan* ⁽¹⁾ is due to refined

methodology to better reflect actual operations, including recent amendment applications submitted to TCEQ. TCEQ also changed the hydrology and channel losses in the model.

Muenster

Lake Muenster is a 4,700 acre-foot lake located in the Trinity River Basin in Cooke County. Muenster Water Districts holds a water right to divert 500 acre-feet per year. According to the WAM, the available supply from Lake Muenster is 300 acre-feet per year.

E.4 Unpermitted Yields in Region C Reservoirs

According to the WAMs, there are six reservoirs and one reservoir system in Region C with firm yields that exceed the currently permitted diversion amounts. These reservoirs with their unpermitted yields are listed in **Table E.4**. Note that the Oklahoma share of Lake Texoma yield is not included in the table. The Oklahoma yield in Lake Texoma would be about 640,000 acre-feet per year in 2070.

Table E.4 Unpermitted Yields in Region C Reservoirs

Source	Basin	Values in Acre-Feet per Year					
		2020	2030	2040	2050	2060	2070
Lost Creek/Jacksboro System	Trinity	1,086	1,073	1,060	1,046	1,033	1,020
Cedar Creek	Trinity	29,587	29,209	28,832	28,455	28,077	27,700
Richland Chambers	Trinity	11,565	8,692	5,820	2,947	74	0
Lake Texoma (Texas' Share)	Red	319,358	318,850	318,342	317,833	317,325	316,817
Bonham	Red	927	810	693	577	460	343
Mountain Creek	Trinity	6,367	6,100	5,833	5,567	5,300	5,033
Bardwell	Trinity	127	0	0	0	0	0

E.5 Imports

The total supply available (not limited to infrastructure constraints) from imports is based upon the Water Availability Models (WAMs) from the TCEQ and the current contracts with the owners of the water sources. **Table E.5** shows those imports. Below is a discussion of each of the imported water sources.

Chapman

North Texas Municipal Water District, the City of Irving, and the Sulphur River Water District hold water rights in Lake Chapman totaling 146,520 acre-feet per year. Of this total, 127,320 acre-feet per year can be exported for use in Region C – 57,214 acre-feet per year for North Texas Municipal Water District, 54,000 acre-feet per year for Irving, and 16,106 acre-feet per year for the Upper Trinity Regional Water District (purchased from the Sulphur River Water District through the City of Commerce). Yields for Lake Chapman were updated because of a new critical period. The critical period for the 2016 Plan was from April 2003 to November 2006. The new critical period is from April 2010 to December 2014. Flows from 1940 to 1996 are based on WAM inflows. The hydrology was extended through December 2017 using mass balance.

Accounting for the new critical period, the year 2020 firm yield of Lake Chapman is about 109,520 acre-feet per year, decreasing to 106,410 acre-feet per year by 2070.

The values in **Table E.5** show Lake Chapman’s computed firm yield divided proportionally among the Region C water suppliers with a share of the water. It should be noted that UTRWD’s contract with the City of Commerce, which was originally signed in 1991, renews every 25 years unless UTRWD provides five years notice prior to termination. The contract was renewed in 2016 with no changes. According to the terms of the contract, after 2066, the City of Commerce can reduce the quantity of water supplied with each subsequent renewal, and in 2141 they have the right to cancel the contract if they wish. For the purpose of this plan, the full contract amount was assumed through 2070. It should also be noted that the actual availability for UTRWD is limited by the yield rather than the contract amount.

Table E.5 Total Available Surface Water Supplies from Imports

Source	Basin of Origin	Values in Acre-Feet per Year						2070 from 2016 Plan
		2020	2030	2040	2050	2060	2070	
Chapman (NTMWD) ^a	Sulphur	42,768	42,525	42,282	42,039	41,796	41,553	43,357
Chapman (Irving)	Sulphur	40,369	40,140	39,911	39,681	39,452	39,223	40,926
Chapman (Upper Trinity MWD)	Sulphur	12,036	11,968	11,900	11,831	11,763	11,694	12,202
Tawakoni (Dallas)	Sabine	174,080	169,120	164,160	159,200	154,240	149,280	149,280
Fork (Dallas) ^b	Sabine	119,699	116,180	112,332	108,484	104,636	100,788	100,788
Upper Sabine Basin (NTMWD) ^c	Sabine	51,201	10,655	10,565	10,475	10,395	10,293	10,315
Palestine (Dallas) ^d	Neches	106,230	105,370	104,564	103,704	102,791	101,555	106,239
Livingston ^e	Trinity	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Lake Athens ^f	Neches	1,192	1,570	1,798	2,132	3,366	3,930	4,759
Possum Kingdom ^g	Brazos	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Lake Aquilla	Brazos	380	459	508	572	629	655	523
Lake Granbury	Brazos	576	577	576	576	576	576	444
Lake Palo Pinto	Brazos	796	783	772	762	754	746	1,276
TOTAL		570,327	520,347	510,368	500,456	491,398	481,293	491,109

- The supplies from Lake Chapman for NTMWD include NTMWD’s share of Lake Chapman and sales from the City of Cooper.
- The import of water from Lake Fork to the Trinity Basin is limited to 224,200 acre-feet per year. The first phase of infrastructure to transport this water to DWU is completed. The second phase is scheduled to be completed in the next five years.
- NTMWD has acquired Terrell’s and Ables Springs WSC’s supply in Lake Tawakoni. NTMWD also has a contract for 40,000 acre-feet per year of temporary supply from the Upper Sabine Basin for 2020 (contract expires in 2025).
- There is no current infrastructure to transport the water from Lake Palestine to DWU.
- Water supply contract from Lake Livingston is for 20,000 acre-feet per year in any one year with no more than 48,000 acre-feet per year over a three year period.
- The amount of water from Lake Athens is the amount that is imported to Region C. It increases as demand increases.
- The supply from Possum Kingdom Lake is for Vulcan Materials (Parker County Mining).

Tawakoni

Lake Tawakoni is located in the Sabine River Basin. The Sabine River Authority (SRA) holds water rights for 238,100 acre-feet per year. The City of Dallas has a contract with SRA for 190,480 acre-feet per year. The North Texas Municipal Water District has water rights for 11,098 acre-feet per year that were transferred from the City of Terrell and Ables Springs WSC. NTMWD also has a temporary contract with SRA for up to 40,000 acre-feet from Lake Tawakoni and Lake Fork. Generally, about half (20,000 acre-feet) is supplied from Lake Tawakoni, though the split between Tawakoni and Lake Fork may vary from year to year. Using the Sabine River WAM, the firm yield of Lake Tawakoni is 229,710 in year 2020, reducing to 221,310 acre-feet per year by 2070 due to sedimentation. The supplies available to the cities of Dallas and NTMWD are based on the proportion of the contracted amount to the firm yield. Adjustments were made to ensure that supplies to each customer of the Sabine River Authority were reduced proportionally. NTMWD's share of the Lake Tawakoni supply is included in the Upper Sabine Basin Supply in **Table E.5**.

Lake Fork (Dallas)

Lake Fork is located in the Sabine River Basin. The Sabine River Authority holds water rights for 188,660 acre-feet per year. The City of Dallas has a contract for 131,860 acre-feet per year. Of this amount, 120,000 acre-feet per year can be exported to the Trinity Basin in Region C. The remainder can only be used in the Sabine River Basin. The firm yield of Lake Fork was calculated as 171,260 acre-feet per year in year 2020, reducing due to sedimentation to 161,360 acre-feet per year in 2070. The supply to Dallas is based on the proportion of the contracted amount to the firm yield. The total amount exported to Region C was limited to the 120,000 acre-feet per year

specified in the trans-basin diversion permit.

Upper Sabine Basin Supply (NTMWD). In addition to the 11,098 acre-feet per year of contracts for water from Lake Tawakoni transferred to NTMWD by Terrell and Ables Springs WSC, NTMWD has a temporary contract with Sabine River Authority for 40,000 acre-feet per year additional supply from the Upper Sabine Basin (Lake Fork and Lake Tawakoni). This contract expires in 2025. Generally, about half (20,000 acre-feet) is supplied from each reservoir, though the split between the two lakes may vary from year to year. The available supply to NTMWD from the Upper Sabine Basin that is shown in **Table E.5** includes the temporary supply (2020 only) and the firm yield of the Lake Tawakoni contracts that were transferred from Terrell and Ables Springs WSC to NTMWD.

Palestine (Dallas)

Lake Palestine is located on the Neches River in the Neches River Basin. The lake is owned and operated by the Upper Neches River Municipal Water Authority (UNRMWA) in conjunction with a downstream diversion point (Rocky Point). The UNRMWA holds water rights totaling 238,110 acre-feet per year from the Lake Palestine system. The firm yield of the Palestine system using the numbers provided by Region I is estimated at 197,710 acre-feet per year in year 2020, reducing to 189,010 acre-feet per year by 2070. The decreased firm yield compared to the 2016 regional plan is due to a new sedimentation rate from the volumetric survey performed in 2012 and published in 2014. The City of Dallas has a contract with the UNRMWA for 114,337 acre-feet per year. The supply to Dallas was reduced due to the reduced yield. Presently there is no infrastructure to transport this water from Lake Palestine to Dallas. This will be

considered as a water management strategy.

Athens (Athens)

Lake Athens is located in Henderson County in the Neches River Basin. The Athens Municipal Water Authority holds water rights in Lake Athens totaling 8,500 acre-feet per year. Of this amount 3,023 acre-feet per year is designated for industrial use for the Athens Fish Hatchery, which is located at the lake. The yield of Lake Athens was determined by Region I using the Neches Basin Water Availability Model and is estimated at 5,950 acre-feet per year in 2020. The amount that is exported to Region C for use by the Region C portion of City of Athens is 2,063 acre-feet per year, increasing to 4,046 acre-feet per year in 2070.

Possum Kingdom Lake (Vulcan Materials)

Vulcan Materials has a contract to purchase 1,000 acre-feet per year of water originating in Possum Kingdom Lake from the Brazos River Authority for mining use. Possum Kingdom Lake is in the Brazos River Basin in Region G.

Lake Aquilla

Lake Aquilla is located in the Brazos River Basin in Region G. The Aquilla Water Supply Corporation provides water to entities in Ellis and Navarro Counties in Region C. The total estimated supply provided to Region C from Lake Aquilla is 380 acre-feet per year in 2020, increasing to 655 acre-feet per year by 2070.

Lake Granbury

Lake Granbury is located in the Brazos River Basin in Region G. The Brazos River Authority (BRA) owns and operates the lake as part of the Authority's water system. Currently, the Authority sells water from Lake Granbury to Johnson County Special

Utility District (SUD) and Parker County SUD. The amount of existing supplies imported to Region C is estimated at 576 acre-feet per year in 2020 through 2070. Parker County SUD's contract with the BRA allows for additional supply, but Parker County SUD will need a water management strategy of expanding water treatment to utilize the additional supply.

Lake Palo Pinto

Lake Palo Pinto is located in Palo Pinto County in the Brazos River Basin in Region G. A portion of Mineral Wells is in Parker County in Region C. All of Mineral Wells' water supply currently comes from Lake Palo Pinto. (Mineral Wells has a water right in Lake Mineral Wells in Parker County but has no plans to use that source for water supply.) The supply from Lake Palo Pinto to Region C also supplies Mineral Wells' customers located in Region C, which include portions of Parker County Other, Parker County Manufacturing, and Santo SUD. The amount of existing supplies imported to Region C from Lake Palo Pinto is estimated at 796 acre-feet per year in 2020 decreasing slightly (due to sedimentation) to 746 acre-feet per year in 2070.

E.6 Irrigation Local Supply and Other Local Supply

The local irrigation availability is based on existing run-of-the-river surface water rights for irrigation not associated with major reservoirs. The reliable supply from run-of-the-river diversions was calculated using the WAM run 3 as the minimum monthly diversion for the permitted water rights located on the main stem and tributaries of the river. In Region C Water Plans prior to the 2016 *Region C Water Plan* the reliable supply from run-of-the-river diversions was assumed equal to the permitted diversion

for water rights located on the main stem of the river and 75 percent of the permitted diversion for water rights located on tributaries. This revision decreased the local irrigation availability in the Red River Basin.

Other local supply includes non-irrigation run-of-the-river supplies and mining and livestock local supplies that do not have a water right. Most surface water used for

livestock is taken from unpermitted stock ponds or directly from streams. These supplies are based on historical use. For livestock and mining local supplies, some of the available supply volumes were revised considering the historical use over the past ten years ⁽³⁾ and the projected demands.

Table E.6 shows the available supply for irrigation and other local supplies.

Table E.6 Summary of Local Surface Water Supplies for Region C

Use	County	Basin	Values in Acre-Feet per Year					
			2020	2030	2040	2050	2060	2070
IRRIGATION RUN-OF-RIVER SUPPLIES								
Irrigation	Fannin	Red	4,613	4,613	4,613	4,613	4,613	4,613
Irrigation	Grayson	Red	1,091	1,091	1,091	1,091	1,091	1,091
Irrigation	Collin	Trinity	408	408	408	408	408	408
Irrigation	Dallas	Trinity	791	791	791	791	791	791
Irrigation	Ellis	Trinity	3	3	3	3	3	3
Irrigation	Freestone	Trinity	87	87	87	87	87	87
Irrigation	Henderson	Trinity	415	415	415	415	415	415
Irrigation	Jack	Trinity	110	110	110	110	110	110
Irrigation	Kaufman	Trinity	64	64	64	64	64	64
Irrigation	Navarro	Trinity	226	226	226	226	226	226
Irrigation	Parker	Trinity	122	122	122	122	122	122
Irrigation	Tarrant	Trinity	549	549	549	549	549	549
Irrigation	Wise	Trinity	139	139	139	139	139	139
Irrigation	Parker	Brazos	117	117	117	117	117	117
SUBTOTAL			8,735	8,735	8,735	8,735	8,735	8,735
NON-IRRIGATION RUN-OF-RIVER SUPPLIES								
Municipal	Fannin	Sulphur	49	49	49	49	49	49
Municipal	Freestone	Trinity	41	41	41	41	41	41
Municipal	Navarro	Trinity	252	252	252	252	252	252
Manufacturing	Grayson	Red	30	30	30	30	30	30
Steam Electric Power	Dallas	Trinity	368	368	368	368	368	368
Steam Electric Power	Tarrant	Trinity	959	959	959	959	959	959
LIVESTOCK AND MINING LOCAL SUPPLIES								
Livestock	Collin	Sabine	31	31	31	31	31	31
Livestock	Collin	Trinity	971	971	971	971	971	971
Livestock	Cooke	Red	380	380	380	380	380	380
Livestock	Cooke	Trinity	807	807	807	807	807	807
Livestock	Dallas	Trinity	198	198	198	198	198	198
Livestock	Denton	Trinity	622	622	622	622	622	622
Livestock	Ellis	Trinity	1,112	1,112	1,112	1,112	1,112	1,112
Livestock	Fannin	Red	973	973	973	973	973	973
Livestock	Fannin	Sulphur	272	272	272	272	272	272
Livestock	Fannin	Trinity	61	61	61	61	61	61
Livestock	Freestone	Brazos	83	83	83	83	83	83
Livestock	Freestone	Trinity	960	960	960	960	960	960

Use	County	Basin	Values in Acre-Feet per Year					
			2020	2030	2040	2050	2060	2070
Livestock	Grayson	Red	688	688	688	688	688	688
Livestock	Grayson	Trinity	387	387	387	387	387	387
Livestock	Henderson	Trinity	345	345	345	345	345	345
Livestock	Jack	Brazos	231	231	231	231	231	231
Livestock	Jack	Trinity	571	571	571	571	571	571
Livestock	Kaufman	Sabine	98	98	98	98	98	98
Livestock	Kaufman	Trinity	1,524	1,524	1,524	1,524	1,524	1,524
Livestock	Navarro	Trinity	1,603	1,603	1,603	1,603	1,603	1,603
Livestock	Parker	Brazos	903	903	903	903	903	903
Livestock	Parker	Trinity	1,019	1,019	1,019	1,019	1,019	1,019
Livestock	Rockwall	Sabine	58	58	58	58	58	58
Livestock	Rockwall	Trinity	59	59	59	59	59	59
Livestock	Tarrant	Trinity	442	442	442	442	442	442
Livestock	Wise	Trinity	1,117	1,117	1,117	1,117	1,117	1,117
Mining	Dallas	Trinity	1,525	1,525	1,525	1,525	1,525	1,525
Mining	Denton	Trinity	1,366	1,366	1,366	1,366	1,366	1,366
Mining	Fannin	Red	72	72	72	72	72	72
Mining	Freestone	Trinity	120	120	120	120	120	120
Mining	Jack	Trinity	370	370	370	370	370	370
Mining	Kaufman	Trinity	86	86	86	86	86	86
Mining	Parker	Brazos	14	14	14	14	14	14
Mining	Parker	Trinity	6	6	6	6	6	6
Mining	Tarrant	Trinity	342	342	342	342	342	342
Mining	Wise	Trinity	133	133	133	133	133	133
SUBTOTAL NON-IRRIGATION SUPPLIES			21,248	21,248	21,248	21,248	21,248	21,248
TOTAL RUN-OF-RIVER AND LOCAL SUPPLIES			29,983	29,983	29,983	29,983	29,983	29,983

E.7 Reuse

The reuse quantities listed in **Table E.1** are limited to currently permitted and operating indirect reuse projects and existing direct reuse for irrigation or industrial purposes.

Table E.7 shows new and amended reuse water rights and permits since the 2016 *Region C Plan*. **Table E.8** shows the individual reuse projects that make up the total overall (not limited to infrastructure constraints) reuse amount in **Table E.1**. The recommended regional reuse plan is outlined in **Chapter 5B** of the Region C plan.

Water Right Amendments Involving Reuse since the 2016 Region C Water Plan

The Texas Commission on Environmental Quality (TCEQ) has granted reuse-based amendments to water right certificates of adjudication held by several entities in Region C. These recent amendments are discussed below and summarized in

Table E.7.

On April 18, 2017, the City of Weatherford received an amendment to its water right in Lake Weatherford. The amended certificate allows the city to divert discharges from their wastewater treatment plant to Lake Weatherford and reuse the water.

On June 9, 2017, NTMWD received a water right allowing for the diversion of return

flows from the Elm Fork Trinity River. The diversion of discharges from the Stewart Creek West, Panther Creek, and Cottonwood Creek Wastewater Treatment Plants (WWTPs) is allowed for up to 28,340 acre-feet per year. The Cottonwood Creek WWTP has since been decommissioned and all of its flow redirected to Stewart Creek West for treatment and discharge. Dallas and NTMWD are currently negotiating an agreement by which Dallas can divert the

discharges from the previously mentioned WWTPs out of Lake Lewisville. Even though the permit has been obtained, neither NTMWD or Dallas Water Utilities are currently using this reuse source.

The two remaining reuse permits (TRA and Irving) do not provide any additional supply volume. They merely change locations of diversion and/or use.

Table E.7 Water Right Amendments and Permit Applications Involving Reuse

Entity	Description	Certification of Adjudication/ Permit Number	Status	Date of Permit	Additional Annual Diversion for Water Supply (ac-ft/yr)
Weatherford	Return flow diversions from Lake Weatherford	08-3356B	Amended	04/18/17	6,166
North Texas Municipal Water District	District return flows discharged into the Elm Fork Trinity River and its tributaries from various WWTPs.	12472	New Permit	06/9/17	28,340
Trinity River Authority	Allows for return flow diversions at the NTMWD Main Stem Pump Station	08-4248E	Amended	10/19/16	0
Irving	Return flow diversions of Chapman-based water for the Twin Wells golf course	03-4799D	Amended	10/30/13	0

Table E.8 Summary of Supplies Available from Reuse

Provider	Project Name	Description	Type	County	2020	2030	2040	2050	2060	2070
Annetta	Annetta Direct Reuse	Golf Course	direct	Parker	126	145	167	183	202	222
Azle	Azle Direct Reuse	Cross Timbers Golf Course	direct	Tarrant	300	300	300	300	300	300
Bryson	Jack County Direct Reuse	Clayton Ranch Irrigation	direct	Jack	27	26	26	25	25	24
Crandall	Crandall Direct Reuse	Creekview Golf Club	direct	Kaufman	446	541	645	666	666	666
Dallas	Cedar Crest Golf Course Reuse	Cedar Crest & Steven Creek Golf Courses	direct	Dallas	1,121	1,121	1,121	1,121	1,121	1,121
Dallas	Dallas Indirect Reuse	Dallas	indirect	Denton	43,451	49,167	52,547	57,540	69,313	77,705
Denton	Denton Power Plant Direct Reuse	City of Garland Steam Electric Power Plant, Denton Regional Medical Office Building, Caruthers Oil Co. Inc., Robert Donnelly, Day Surgery Center DRMC, Denton Landfill, Denton State School, Oakmont Country Club	direct	Denton	173	173	173	173	173	173
Denton	Denton County Indirect Reuse	Indirect reuse	indirect	Denton	5,740	7,291	9,063	12,515	12,818	12,683
Denton	Denton County Direct Reuse	Direct Reuse	direct	Denton	265	265	265	265	265	265
Ennis	Ennis Direct Reuse	Tractabel Steam Electric Power Plant	direct	Ellis	919	919	919	919	919	919
Fort Worth	Fort Worth Village Creek Direct Reuse		direct	Tarrant	3,469	3,526	3,526	3,526	3,526	3,526
Fort Worth	Waterchase Golf Course Direct Reuse	Golf Course	direct	Tarrant	897	897	897	897	897	897
Gainesville	Gainesville Direct Reuse	City of Gainesville - Keneteso Park	direct	Cooke	4	4	4	4	4	4
Garland/ Forney	Garland Direct Reuse (sales through Forney)	FPLE Steam Electric Power Plant	direct	Kaufman	9,196	9,196	9,196	9,196	9,196	9,196
Grapevine	Grapevine Reuse (Lake Grapevine) DCPCMUD	Lake Grapevine	indirect	Tarrant	3,295	3,659	3,698	3,683	3,680	3,679
Millsap ISD	Millsap WWTP Reuse	Millsap High School Athletic Fields	direct	Parker	2	2	2	2	2	2

Provider	Project Name	Description	Type	County	2020	2030	2040	2050	2060	2070
NTMWD/ Frisco	Stewart Creek West Reuse	Trails of Frisco Golf Course	direct	Collin	1,401	1,401	1,401	1,401	1,401	1,401
NTMWD	Rowlett Creek Reuse	Los Rios Country Club, Golf Center of Plano, Pecan Hollow Municipal Golf Course	direct	Collin	1,540	1,540	1,540	1,540	1,540	1,540
NTMWD	Wilson Creek Direct Reuse	Pasture Land	direct	Collin	100	100	100	100	100	100
NTMWD	Buffalo Creek Reuse	Buffalo Creek Golf Course	direct	Rockwall	672	672	672	672	672	672
NTMWD	Lavon Watershed Reuse	Lake Lavon	indirect	Collin	48,896	58,626	69,999	73,014	73,014	73,014
NTMWD	East Fork Reuse	Trinity River	indirect	Kaufman	96,047	102,000	102,000	102,000	102,000	102,000
Pinnacle Club	Pinnacle Club Direct Reuse	Pinnacle Club Golf Course	direct	Henderson	32	32	32	32	32	32
The Colony	Stonebriar County Club (golf irrigation)	Stonebriar Country Club	direct	Collin	457	457	457	457	457	457
TRA/DCURD	TRA/Las Colinas Indirect Reuse (Dallas County Irrigation)	Las Colinas - golf course irrigation, landscape irrigation, and lake level maintenance	indirect	Dallas	8,000	8,000	8,000	8,000	8,000	8,000
TRA	TRA/Waxahachie Indirect Reuse	Lake Bardwell	indirect	Ellis	3,479	3,882	4,614	5,129	5,129	5,129
TRA	TRA Ten Mile Creek WWTP Reuse	Pecan Orchard	direct	Dallas	125	125	125	125	125	125
TRA/Irving	Irving Indirect for Municipal Use	Irving	indirect	Dallas	486	486	486	486	486	486
TRWD	Richland-Chambers Reuse	Richland Chambers	indirect	Navarro	100,465	100,465	100,465	100,465	100,465	100,465
Trophy Club	Denton County Direct Reuse (Golf irrigation)	Trophy Club Country Club	direct	Denton	800	800	800	800	800	800
Denton County FWSD#1/ UTRWD/ Lewisville	UTRWD Direct Reuse	Castle Hills Golf Course	direct	Denton	897	897	897	897	897	897
UTRWD	UTRWD Lake Chapman Reuse	Lake Chapman	indirect	Denton	3,970	4,178	4,383	4,584	4,558	4,531

Provider	Project Name	Description	Type	County	2020	2030	2040	2050	2060	2070
Weatherford	Lake Weatherford Direct Reuse	City of Weatherford/Golf Course Irrigation	direct	Parker	269	316	334	456	456	456
Total in Acre-Feet per Year					337,067	361,209	378,854	391,173	403,239	411,487
Total in MGD					301	322	338	349	360	367

E.8 Desalination

Two desalination facilities are currently operated by public water systems within Region C. The City of Sherman operates a 10 MGD electro dialysis reversal membrane plant to treat brackish water from Lake Texoma and has recently expanded its treatment capacity with a 10 MGD expansion reverse osmosis facility. The City of Bardwell operates a reverse osmosis facility to treat brackish groundwater. These supplies are included in the total supplies from reservoirs (Sherman) and groundwater (Bardwell). In addition, the Brazos River Authority (BRA) operates the Lake Granbury Surface Water and Treatment System (SWATS). Although Lake Granbury is located in Region G, BRA provides water from SWATS to the Johnson County SUD, which serves customers within Region C. The amount of water provided by SWATS is accounted for in Table E.5 (imports to Region C).

E.9 Groundwater

Groundwater supplies in Region C are obtained from the following;

- Two major aquifers (Carrizo-Wilcox and Trinity),
- Four minor aquifers (Woodbine, Nacatoch, newly designated Cross Timbers, Queen City), and
- Locally undifferentiated formations, referred to as “other aquifers.”

As required by regional planning rules, Modeled Available Groundwater (MAG) estimates provided by the TWDB were used to determine groundwater availability. For Region C, TWDB provided estimates for the Carrizo-Wilcox, Trinity, Woodbine and Queen City aquifers. Groundwater Management Area 8 (GMA 8) and GMA 11 deemed the Nacatoch aquifer “non-relevant”, and new

water availability estimates for this aquifer were not included in the MAGs developed by TWDB. Therefore, availability for this aquifer was assumed to be the same as the amounts used in the *2016 Region C Water Plan*.

There are sixteen Groundwater Management Areas in Texas. GMA 8 covers all of Region C except for Jack County, Henderson County, and a small portion of Navarro County. GMA 11 and GMA 12 cover small portions of Region C. The GMAs are responsible for developing Desired Future Conditions (DFCs) for aquifers within their respective areas. The TWDB quantifies Modeled Available Groundwater (MAG) based on the DFCs provided by the GMAs. The regional water planning groups must use MAG estimates as the basis for existing groundwater supplies for all locations that have a DFC⁽²⁾. The groundwater availability for “other aquifer” are based on historical pumping data obtained from the TWDB⁽³⁾⁴. The Cross Timbers aquifer was designated as a new minor aquifer in 2017. No desired future conditions have been established by the groundwater conservation district for this aquifer, therefore no MAG amounts are available. For this reason, the availability from this aquifer is assumed to be the “other aquifer” availability used in the 2016 Region C Water Plan for the areas where “other aquifer” overlaps the newly designated Cross Timbers aquifer. **Table E.9** details the groundwater availability for Region C.

There are currently seven Groundwater Conservation Districts (GCDs) that include one or more counties in Region C:

- Upper Trinity GCD (Wise and Parker Counties)
- Northern Trinity GCD (Tarrant County)
- Neches and Trinity Valleys GCD (Henderson County)

- Mid-East Texas GCD (Freestone County)
- Prairielands GCD (Ellis County)
- North Texas GCD (Collin, Cooke, and Denton Counties)
- Red River GCD (Grayson and Fannin Counties)

The overall groundwater availability in Region C is greater than the availability shown in the *2016 Region C Water Plan*⁽¹⁾. The increase is largely due to changes to the availability from the Trinity aquifer. The availability from the Trinity aquifer has

increased by approximately 13,000 acre-feet per year since the *2016 Region C Water Plan*. The availability from the Carrizo-Wilcox increased by a maximum of 7,036 acre-feet per year since the *2016 Region C Water Plan*. The availability from the Woodbine decreased by a maximum of 3,957 acre-feet per year since the *2016 Region C Water Plan*. **Figure E.1** compares the 2020 Region C groundwater availability from the 2021 Region C Water Plan water availability estimates to the availability reported in the *2016 Region C Water Plan*⁽¹⁾.

Figure E.1 Region C Groundwater Availability in 2020

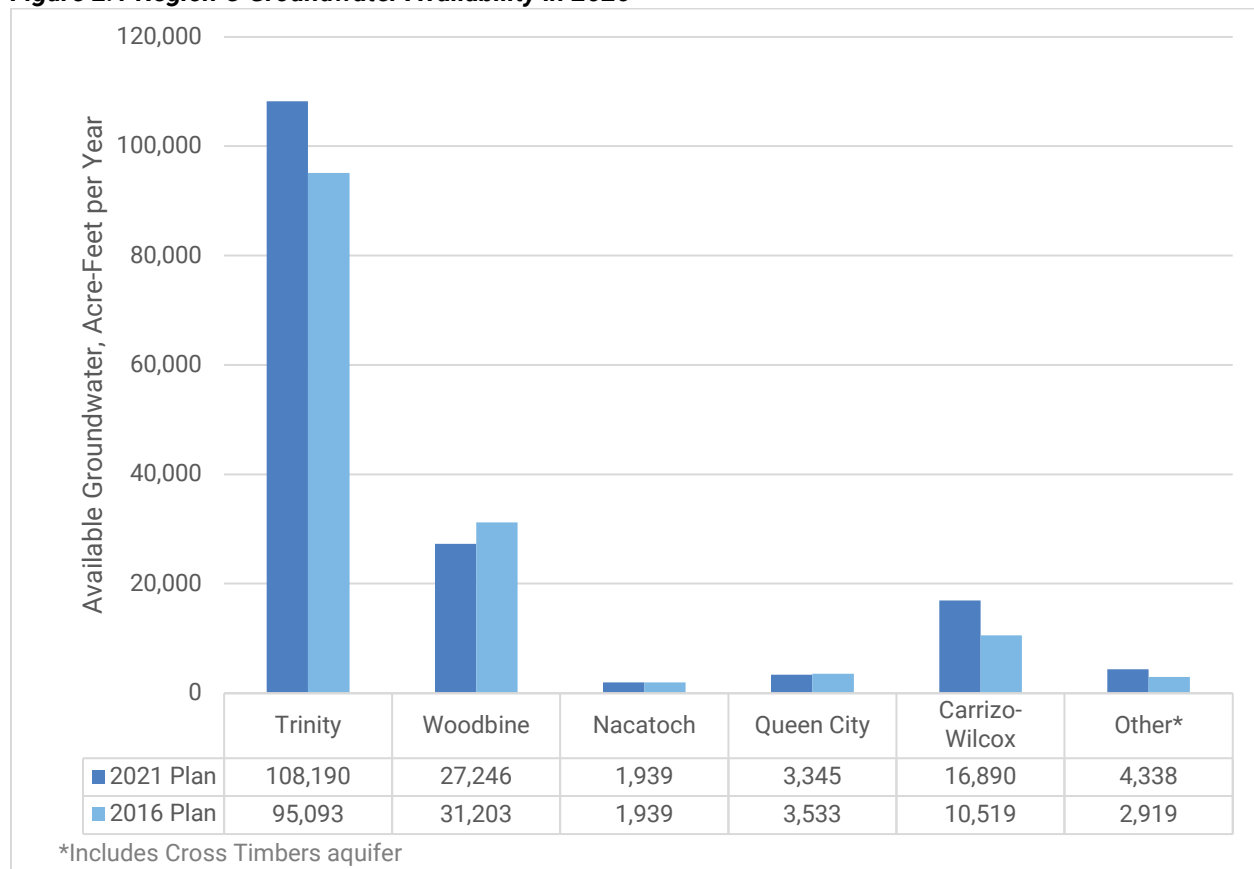


Table E.9 Groundwater Availability for Region C

Values in Ac-Ft/Yr																				
Aquifer	County	Basin	Groundwater Availability in 2021 Plan						Groundwater Availability in 2016 Plan						Change in Groundwater Availability since 2016 Plan					
			2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
Trinity	Collin	Sabine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trinity	Collin	Trinity	5,807	5,792	5,807	5,792	5,807	5,792	2,104	2,104	2,104	2,104	2,104	2,104	3,703	3,688	3,703	3,688	3,703	3,688
Woodbine	Collin	Sabine	0	0	0	0	0	0	40	40	40	40	40	40	-40	-40	-40	-40	-40	-40
Woodbine	Collin	Trinity	4,263	4,251	4,263	4,251	4,263	4,251	2,469	2,469	2,469	2,469	2,469	2,469	1,794	1,782	1,794	1,782	1,794	1,782
	Collin		10,070	10,043	10,070	10,043	10,070	10,043	4,613	4,613	4,613	4,613	4,613	4,613	5,457	5,430	5,457	5,430	5,457	5,430
Trinity	Cooke	Red	2,191	2,184	2,191	2,184	2,191	2,184	1,284	1,284	1,284	1,284	1,284	1,284	907	900	907	900	907	900
Trinity	Cooke	Trinity	8,353	8,330	8,353	8,330	8,353	8,330	5,566	5,566	5,566	5,566	5,566	5,566	2,787	2,764	2,787	2,764	2,787	2,764
Woodbine	Cooke	Red	262	261	262	261	262	261	18	18	18	18	18	18	244	243	244	243	244	243
Woodbine	Cooke	Trinity	540	538	540	538	540	538	136	136	136	136	136	136	404	402	404	402	404	402
	Cooke		11,346	11,313	11,346	11,313	11,346	11,313	7,004	7,004	7,004	7,004	7,004	7,004	4,342	4,309	4,342	4,309	4,342	4,309
Trinity	Dallas	Trinity	3,699	3,688	3,699	3,688	3,699	3,688	5,458	5,458	5,458	5,458	5,458	5,458	-1,759	-1,770	-1,759	-1,770	-1,759	-1,770
Woodbine	Dallas	Trinity	2,804	2,796	2,804	2,796	2,804	2,796	2,313	2,313	2,313	2,313	2,313	2,313	491	483	491	483	491	483
	Dallas		6,503	6,484	6,503	6,484	6,503	6,484	7,771	7,771	7,771	7,771	7,771	7,771	-1,268	-1,287	-1,268	-1,287	-1,268	-1,287
Trinity	Denton	Trinity	30,151	30,068	30,151	30,068	30,151	30,068	19,333	19,333	19,333	19,333	19,333	19,333	10,818	10,735	10,818	10,735	10,818	10,735
Woodbine	Denton	Trinity	3,616	3,607	3,616	3,607	3,616	3,607	4,126	4,126	4,126	4,126	4,126	4,126	-510	-519	-510	-519	-510	-519
	Denton		33,767	33,675	33,767	33,675	33,767	33,675	23,459	23,459	23,459	23,459	23,459	23,459	10,308	10,216	10,308	10,216	10,308	10,216
Nacatoch	Ellis	Trinity	20	20	20	20	20	20	20	20	20	20	20	20	0	0	0	0	0	0
Trinity	Ellis	Trinity	5,539	5,524	5,539	5,524	5,539	5,524	3,959	3,959	3,959	3,959	3,959	3,959	1,580	1,565	1,580	1,565	1,580	1,565
Woodbine	Ellis	Trinity	2,078	2,073	2,078	2,073	2,078	2,073	5,441	5,441	5,441	5,441	5,441	5,441	-3,363	-3,368	-3,363	-3,368	-3,363	-3,368
	Ellis		7,637	7,617	7,637	7,617	7,637	7,617	9,420	9,420	9,420	9,420	9,420	9,420	-1,783	-1,803	-1,783	-1,803	-1,783	-1,803
Trinity	Fannin	Red	0	0	0	0	0	0	617	617	617	617	617	617	-617	-617	-617	-617	-617	-617
Trinity	Fannin	Sulphur	2,092	2,087	2,092	2,087	2,092	2,087	0	0	0	0	0	0	2,092	2,087	2,092	2,087	2,092	2,087
Trinity	Fannin	Trinity	0	0	0	0	0	0	83	83	83	83	83	83	-83	-83	-83	-83	-83	-83
Woodbine	Fannin	Red	3,553	3,544	3,553	3,544	3,553	3,544	2,676	2,676	2,676	2,676	2,676	2,676	877	868	877	868	877	868
Woodbine	Fannin	Sulphur	551	550	551	550	551	550	21	21	21	21	21	21	530	529	530	529	530	529
Woodbine	Fannin	Trinity	829	827	829	827	829	827	600	600	600	600	600	600	229	227	229	227	229	227
Other	Fannin	Red	2,919	2,919	2,919	2,919	2,919	2,919	2,919	2,919	2,919	2,919	2,919	2,919	0	0	0	0	0	0
	Fannin		9,944	9,927	9,944	9,927	9,944	9,927	6,916	6,916	6,916	6,916	6,916	6,916	3,028	3,011	3,028	3,011	3,028	3,011
Carrizo-Wilcox	Freestone	Trinity	7,713	7,924	8,122	8,290	8,498	8,498	4,420	4,448	4,452	4,414	4,411	4,385	3,293	3,476	3,670	3,876	4,087	4,113
Carrizo-Wilcox	Freestone	Brazos	1,333	1,343	1,362	1,374	1,400	1,400	885	869	863	848	848	838	448	474	499	526	552	562
	Freestone		9,046	9,267	9,484	9,664	9,898	9,898	5,305	5,317	5,315	5,262	5,259	5,223	3,741	3,950	4,169	4,402	4,639	4,675
Trinity	Grayson	Red	6,678	6,660	6,678	6,660	6,678	6,660	7,722	7,722	7,722	7,722	7,722	7,722	-1,044	-1,062	-1,044	-1,062	-1,044	-1,062
Trinity	Grayson	Trinity	4,059	4,048	4,059	4,048	4,059	4,048	1,678	1,678	1,678	1,678	1,678	1,678	2,381	2,370	2,381	2,370	2,381	2,370
Woodbine	Grayson	Red	5,615	5,599	5,615	5,599	5,615	5,599	6,590	6,590	6,590	6,590	6,590	6,590	-975	-991	-975	-991	-975	-991
Woodbine	Grayson	Trinity	1,926	1,922	1,926	1,922	1,926	1,922	5,497	5,497	5,497	5,497	5,497	5,497	-3,571	-3,575	-3,571	-3,575	-3,571	-3,575
	Grayson		18,278	18,229	18,278	18,229	18,278	18,229	21,487	21,487	21,487	21,487	21,487	21,487	-3,209	-3,258	-3,209	-3,258	-3,209	-3,258
Carrizo-Wilcox	Henderson	Trinity	7,829	7,829	7,829	7,732	7,577	7,548	5,187	5,187	5,187	5,187	5,187	5,187	2,642	2,642	2,642	2,545	2,390	2,361
Nacatoch	Henderson	Trinity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Queen City	Henderson	Trinity	3,345	3,345	3,345	3,345	3,345	3,345	3,533	3,533	3,533	3,533	3,533	3,533	-188	-188	-188	-188	-188	-188

Values in Ac-Ft/Yr

Aquifer	County	Basin	Groundwater Availability in 2021 Plan					Groundwater Availability in 2016 Plan					Change in Groundwater Availability since 2016 Plan							
			2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070	2020	2030	2040	2050	2060	2070
	Henderson		11,174	11,174	11,174	11,077	10,922	10,893	8,720	8,720	8,720	8,720	8,720	8,720	2,454	2,454	2,454	2,357	2,202	2,173
Cross Timbers	Jack	Brazos	284	284	284	284	284	284	284	284	284	284	284	284	0	0	0	0	0	0
Cross Timbers	Jack	Trinity	650	650	650	650	650	650	650	650	650	650	650	650	0	0	0	0	0	0
	Trinity	Jack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Trinity	Jack	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jack		934	934	934	934	934	934	934	934	934	934	934	934	0	0	0	0	0	0
Nacatoch	Kaufman	Sabine	49	49	49	49	49	49	49	49	49	49	49	49	0	0	0	0	0	0
Nacatoch	Kaufman	Trinity	877	877	877	877	877	877	877	877	877	877	877	877	0	0	0	0	0	0
	Trinity	Kaufman	0	0	0	0	0	0	45	45	45	45	45	45	-45	-45	-45	-45	-45	-45
	Trinity	Kaufman	0	0	0	0	0	0	1,136	1,136	1,136	1,136	1,136	1,136	-1,136	-1,136	-1,136	-1,136	-1,136	-1,136
Woodbine	Kaufman	Trinity	0	0	0	0	0	0	200	200	200	200	200	200	-200	-200	-200	-200	-200	-200
	Kaufman		926	926	926	926	926	926	2,307	2,307	2,307	2,307	2,307	2,307	-1,381	-1,381	-1,381	-1,381	-1,381	-1,381
Carrizo-Wilcox	Navarro	Trinity	15	15	15	15	15	15	15	15	15	15	15	15	0	0	0	0	0	0
Nacatoch	Navarro	Trinity	980	980	980	980	980	980	980	980	980	980	980	980	0	0	0	0	0	0
	Other	Navarro	435	435	435	435	435	435	0	0	0	0	0	0	435	435	435	435	435	435
	Trinity	Navarro	0	0	0	0	0	0	1,873	1,873	1,873	1,873	1,873	1,873	-1,873	-1,873	-1,873	-1,873	-1,873	-1,873
Woodbine	Navarro	Trinity	68	68	68	68	68	68	300	300	300	300	300	300	-232	-232	-232	-232	-232	-232
	Navarro		1,498	1,498	1,498	1,498	1,498	1,498	3,168	3,168	3,168	3,168	3,168	3,168	-1,670	-1,670	-1,670	-1,670	-1,670	-1,670
Cross Timbers	Parker	Trinity	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cross Timbers	Parker	Brazos	50	50	50	50	50	50	50	50	50	50	50	50	0	0	0	0	0	0
	Trinity	Parker	9,665	9,637	9,665	9,637	9,665	9,637	12,449	12,449	12,449	12,449	12,449	12,449	-2,784	-2,812	-2,784	-2,812	-2,784	-2,812
	Trinity	Parker	2,232	2,226	2,232	2,226	2,232	2,226	2,799	2,799	2,799	2,799	2,799	2,799	-567	-573	-567	-573	-567	-573
	Parker		11,947	11,913	11,947	11,913	11,947	11,913	15,298	15,298	15,298	15,298	15,298	15,298	-3,351	-3,385	-3,351	-3,385	-3,351	-3,385
Nacatoch	Rockwall	Trinity	13	13	13	13	13	13	13	13	13	13	13	13	0	0	0	0	0	0
	Trinity	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Trinity	Rockwall	0	0	0	0	0	0	958	958	958	958	958	958	-958	-958	-958	-958	-958	-958
Woodbine	Rockwall	Trinity	0	0	0	0	0	0	144	144	144	144	144	144	-144	-144	-144	-144	-144	-144
	Rockwall		13	13	13	13	13	13	1,115	1,115	1,115	1,115	1,115	1,115	-1,102	-1,102	-1,102	-1,102	-1,102	-1,102
	Trinity	Tarrant	17,964	17,915	17,964	17,915	17,964	17,915	18,747	18,747	18,747	18,747	18,747	18,747	-783	-832	-783	-832	-783	-832
Woodbine	Tarrant	Trinity	1,141	1,138	1,141	1,138	1,141	1,138	632	632	632	632	632	632	509	506	509	506	509	506
	Tarrant		19,105	19,053	19,105	19,053	19,105	19,053	19,379	19,379	19,379	19,379	19,379	19,379	-274	-326	-274	-326	-274	-326
	Trinity	Wise	9,760	9,734	9,760	9,734	9,760	9,734	9,282	9,282	9,282	9,282	9,282	9,282	478	452	478	452	478	452
	Wise		9,760	9,734	9,760	9,734	9,760	9,734	9,282	9,282	9,282	9,282	9,282	9,282	478	452	478	452	478	452
	Region C Total		161,948	161,800	162,386	162,100	162,548	162,150	146,178	146,190	146,188	146,135	146,132	146,096	15,770	15,610	16,198	15,965	16,416	16,054

Table E.10 Summary of Water Availability Models (WAMs) Use by Region C

WAM/GAM Model Version	Modifications to Model	Date Modifications Approved by EA	Entity That Performed Model Run	Date of Model Run
TCEQ Trinity WAM Run 3	See hydraulic variance request letter dated April 13, 2018	June 21, 2018	Freese and Nichols, Inc	May 2018
TCEQ Sulphur WAM Run 3 through 1996. Reservoir Operation Model from 1997-2017.	See hydraulic variance request letter dated April 13, 2018	June 21, 2018	Freese and Nichols, Inc	May 2018
TCEQ Red WAM Run 3	See Hydrologic Variance Request Letter dated April 13, 2018	June 21, 2018	Freese and Nichols, Inc	December 2013
TCEQ Sabine WAM Run 3	See Hydrologic Variance Request Letter from Region I Planning Group.	See Region I Plan	Freese and Nichols, Inc	June 2018

Appendix E List of References

- (1) Freese and Nichols, Inc., Alan Plummer Associates, Inc., CP&Y, Inc., and Cooksey Communications, Inc.: *2016 Region C Water Plan*, prepared for the Region C Water Planning Group, Fort Worth, December 2015.
- (2) Texas Water Development Board, *Exhibit C Second Amended General Guidelines for Regional Water Plan Development* (April 2018), Austin, [Online] Available URL: http://www.twdb.texas.gov/waterplanning/rwp/planningdocu/2021/doc/current_docs/contract_docs/2ndAmendedExhibitC.pdf?d=11541.199999992386, August 21, 2018.
- (3) Texas Water Development Board: *Water Use Summary Estimates by County*, Austin, [Online] Available URL: <http://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/index.asp>, September 2017.
- (4) Texas Water Development Board: *Groundwater Pumpage Estimates, Pumpage Detail, 2000 and Later*, Austin, [Online] Available URL: <http://www.twdb.texas.gov/waterplanning/waterusesurvey/historical-pumpage.asp>, November 2017.