Section 3
Evaluation of Current Water Supplies in the Region [31 TAC §357.7(a)(3)]

3.1 Surface Water Supplies

Streamflow in the Brazos River and its tributaries, along with reservoirs in the Brazos River Basin, comprise a vast supply of surface water in the Brazos G Area. Diversions and use of this surface water occurs throughout the entire region with over 1,000 water rights currently issued. These water rights provide authorization for an owner to divert, store and use the water, however, they do not guarantee that a dependable supply will be available from the water source. The availability of water to a water right is dependent on several factors including hydrologic conditions (i.e., rainfall, runoff, springflow), priority date of the water right, quantity of authorized storage, and any special conditions associated with the water right (i.e., instream flow conditions, maximum diversion rate).

3.1.1 Texas Water Right System

The State of Texas owns the surface water within the state watercourses and is responsible for the appropriation of these waters. Surface water is currently allocated by the Texas Commission on Environmental Quality (TCEQ) for the use and benefit of all people of the state. Historically, Texas water law is based on the riparian and prior appropriation doctrines. The riparian doctrine extends from the Spanish and Mexican governments that ruled Texas prior to 1836. After 1840, the riparian doctrine provided landowners the rights to make reasonable use of water for irrigation or for other consumptive uses. In 1889, the prior appropriation doctrine was first adopted by Texas, which is based on the concept of "first in time is first in right." Over the years, the combination of riparian and prior appropriation doctrines resulted in an essentially unmanageable system. Various types of water rights existed simultaneously and many rights were unrecorded. In 1967, the Texas Legislature passed the Water Rights Adjudication Act that merged the riparian water rights into the prior appropriation system, creating a unified water rights system. The adjudication process has taken many years, and is essentially complete, pending some final adjudications in the Rio Grande Basin. In the end, Certificates of Adjudication have been issued for entities recognized as having legitimate water rights. Today,

individuals or groups seeking a new water right must submit an application to the TCEQ. The TCEQ determines if the water right will be issued and under what conditions. The water rights grant a certain quantity of water to be diverted and/or stored, a priority date, and often come with some restrictions on when and how the right may be utilized. Restrictions may include a maximum diversion rate and/or an instream flow restriction to protect existing water rights and provide environmental protection.

The priority date of a water right is essential to the operation of the water rights system. Each right is issued a priority date based on the date of first capture, or the appropriation date. The established priority system must be adhered to by all water right holders when diverting or storing water for use. A right holder must pass all water to downstream senior water rights when conditions are such that the senior water rights would not be satisfied otherwise.

3.1.2 Types of Water Rights

There are various types of water rights: Certificates of Adjudication, permits, term permits, and temporary permits. Certificates of Adjudication were issued in perpetuity for approved claims during the adjudication process. This type of water right was issued based on historical use rather than water availability. As a consequence, the amount of water to which rights exist exceeds the amount of water available during a drought for some streams. The TCEQ issues new permits only where drought flows are sufficient to meet the requested amount. Permits, like Certificates of Adjudication, are issued in perpetuity and may be bought and sold like other property interests. Term permits may be issued by the TCEQ in areas where waters are fully appropriated, but not yet being fully used. Term permits are usually issued for 10 years and may be renewed if, after 10 years, other water right holders are still not fully utilizing the water in the basin. Temporary permits are issued for up to 3 years. Temporary permits are issued mainly for road construction projects, where water is used to suppress dust, to compact soils, and to start the growth of new vegetation.

Water rights can include the right to divert and/or store the appropriated water. A run-of-the-river water right provides for the diversion of streamflows and does not include storage of water for use during dry periods. These rights have no authorization to store water, only the right to take water from the stream. A run-of-the-river right may be limited by streamflow, pumping rate, or diversion location.

Water rights including provisions for storage of water allow a water right holder to impound streamflows for use at a later time. The storage provides water for use during dry periods, when water may not be available due to hydrologic conditions or because current flows are required to be passed to downstream senior water rights.

While most water rights are diverted and used within the river basin of origin, water rights that divert from one river basin to another basin require an interbasin transfer permit. Several types of transfers that receive special consideration include emergency transfers, transfers of water from a river basin for use in an adjoining coastal basin (such as from the Brazos River Basin to the San Jacinto-Brazos Coastal Basin), diversions of less than 3,000 acft/yr, and diversions within any city or county that has any portion in the basin of origin.

3.1.3 Water Rights in the Brazos River Basin

A total of 1,123 water rights exist in the Brazos River Basin, with a total authorized diversion of 2,664,000 acft/yr. It is important to note that a small percentage of the water rights make up a large percentage of the authorized diversion volume. In the Brazos River Basin, 39 water rights (3.4 percent) make up 2,372,000 acft/yr (89 percent) of the authorized diversion volume. The remaining 1,084 water rights primarily consist of small irrigation rights distributed throughout the river basin. Figure 3.1-1 shows a comparison of significant water rights in the Brazos River Basin by number of rights and diversion volume.

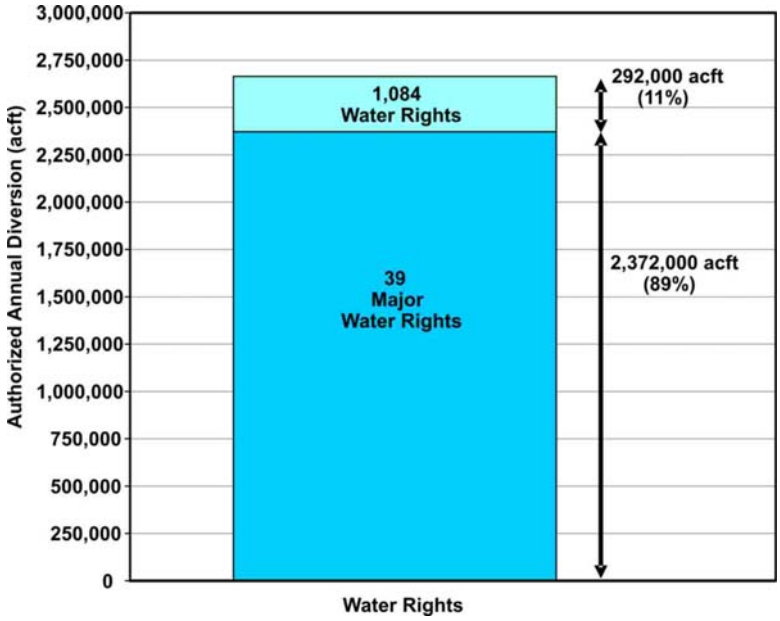

Figure 3.1-1. Comparison of Water Rights in the Brazos River Basin

Region G includes the majority of the water rights in the Brazos River Basin. A total of 992 water rights (88 percent) exist in Region G, making up 1,379,000 acft/yr (52 percent) of the total authorized diversion in the river basin. Region H, located downstream of Region G, has a total of only 39 water rights (4 percent) in the Brazos River Basin, but these include some very large rights and make up 1,168,000 acft/yr (44 percent) of the total authorized diversions. Other regions make up a small percentage of the remaining water rights and total authorized diversion, as shown in Figure 3.1-2. The authorized diversions in Region H generally consist of very large, senior priority, run-of-the-river water rights. In comparison, water rights in Region G are larger in number and diversion volume; however, the water rights are generally junior in priority to those downstream in Region H. Therefore, in times of drought, when streamflows are low, diversions of water from streams in Region G may be restricted for several of the water right

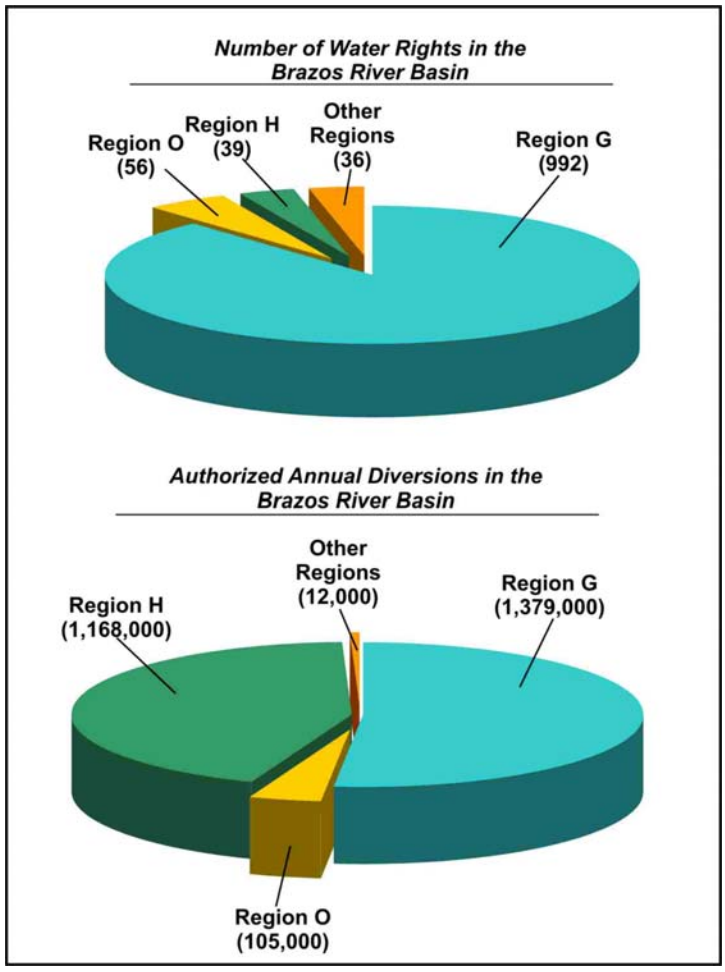

Figure 3.1-2. Comparison of Significant Water Rights in the Brazos River Basin by Number of Rights and Diversion Volume

holders. A comparison of the quantity of authorized diversions relative to the priority date of the water rights in Region G and Region H is presented in Figure 3.1-3. Major water rights are defined as having an authorized diversion of greater than 10,000 acft/yr or 5,000 acft of authorized storage. Figure 3.1-4 shows the location of major water rights in the Brazos River Basin, and a list of all water rights, summarized from the TCEQ water right database for all rights in Region G, is provided in Appendix G.

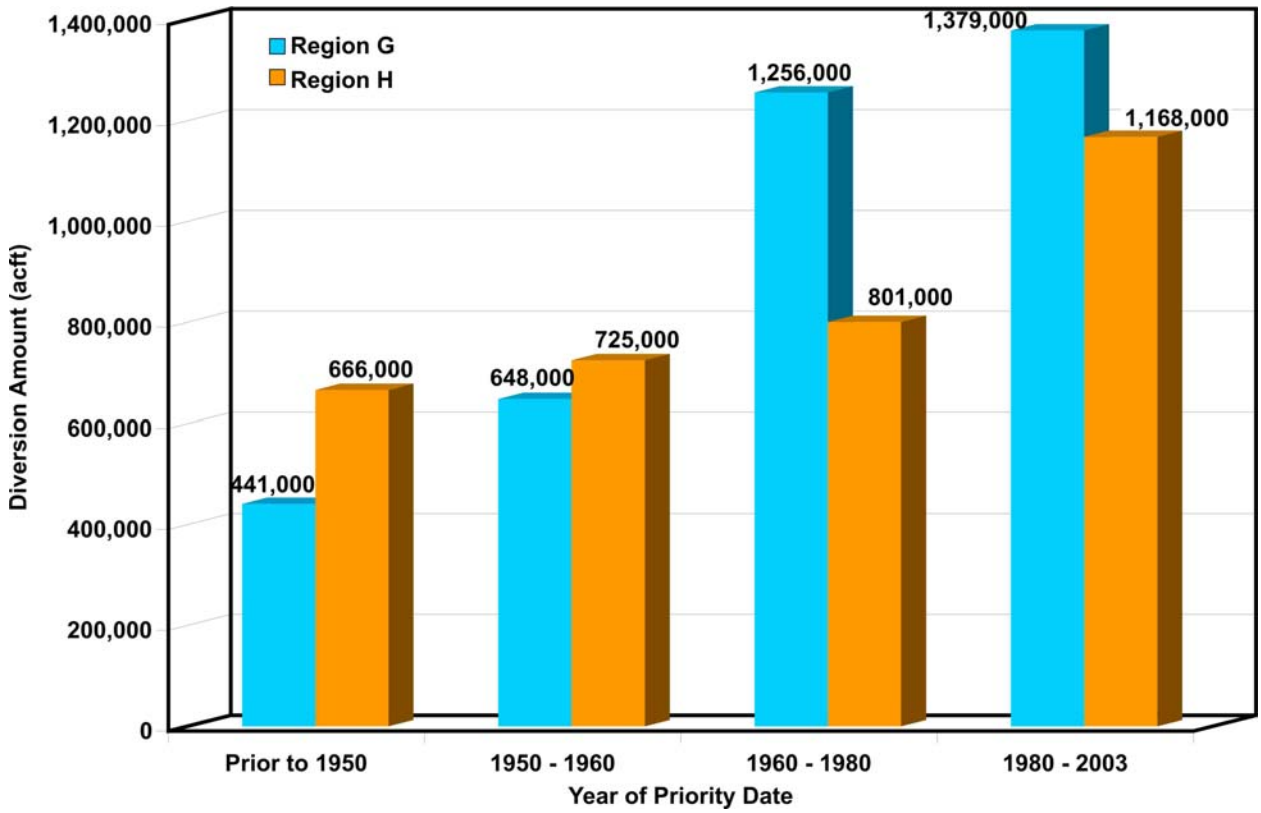

Figure 3.1-3. Comparison of Cumulative Diversion Volume and Priority Date for Region G and Region H

While Region H includes a large quantity of senior priority water rights, most of these water rights have very little storage associated with them and, therefore, may be described primarily as run-of-the-river water rights. The water rights in Region G are generally junior to those water rights in Region H; however, there is a substantial volume of reservoir storage associated with the water rights in Region G to provide a firm supply. The total authorized storage in the Brazos River Basin is approximately 4,057,000 acft, with 3,550,000 acft (88 percent) located in Region G. In Region H, the quantity of reservoir storage is 231,000 acft,

Water Right	Name	Diversion Amount (acft)	Storage Capacity (acft)	Priority Date
2315	City of Waco	39,100	104,100	01/10/1929
2315	City of Waco	19,100		04/16/1958
2315	City of Waco	900		02/21/1979
5094	City of Waco	20,770	87,962	09/12/1986
2936	U.S. Dept. of the Army	10,000	12,000	01/24/1953
2936	U.S. Dept. of the Army	2,000		08/23/1954
2938	City of Temple	15,804	500	10/30/1915
2938	City of Temple	20,000		01/11/1957
2939	Brazos Electric Cooperative	38,800		02/07/1949
3758	Aluminum Co. of America	18,000		12/12/1951
4031	Palo Pinto Co. MWD 1	16,000	44,100	07/03/1962
4031	Palo Pinto Co. MWD 1	2,500	24	09/08/1964
4097	Texas Utilities Electric Co.	23,180	151,500	04/25/1973
4139	City of Abilene		608	08/03/1949
4155	City of Lubbock	56,200	115,937	10/05/1981
4161	City of Abilene	30,690	73,960	03/25/1937
4213	West Central Texas MWD	52,800	317,750	05/28/1957
4213	West Central Texas MWD	3,200		08/14/1972
4340	City of Lubbock	22,910		03/07/1983
4342	Texas Utilities Electric Co.	12,000	37,800	08/21/1926
4342	Texas Utilities Electric Co.	15,000		09/16/1966
4345	Texas Utilities Electric Co.	10,000	8,500	03/06/1951
5155	Brazos River Authority	230,750	724,739	04/06/1938
5156	Brazos River Authority	61,562	155,000	02/13/1964
5157	Brazos River Authority	8,336	50,000	08/30/1982
5158	Brazos River Authority	7,943	52,400	10/25/1976
5159	Brazos River Authority	19,658	59,400	12/16/1963
5160	Brazos River Authority	100,157	457,600	12/16/1963
5161	Brazos River Authority	67,768	235,700	12/16/1963
5162	Brazos River Authority	13,610	37,100	02/12/1968
5163	Brazos River Authority	19,840	65,500	02/12/1968
5164	Brazos River Authority	48,000	160,110	12/16/1968
5164	Millsap Water Supply Corp.	90	215	12/11/1987
5165	Brazos River Authority	65,074	225,400	05/06/1974
5168	Gulf Coast Water Authority	99,932		01/15/1926
5168	Gulf Coast Water Authority		7,308	03/17/1947
5171	Gulf Coast Water Authority	75,000		02/01/1939
5171	Gulf Coast Water Authority	50,000		12/12/1950
5272	Aluminum Co. of America	14,000	15,650	12/12/1951
5272	City of Gilmer	750		12/14/1989
5287	Bistone Municipal WSD	2,952	9,600	04/15/1957
5298	Texas Utilities Electric Co.	30,319	30,319	07/01/1974
5320	Richmond Irrigation Co.	40,000		10/23/2026
5322	Chocolate Bayou Co.	155,000	864	02/08/1929
5325	Houston L&P Co - Parish	28,711	18,750	12/16/1955
5328	Dow Chemical Co.	85,000	21,973	02/28/1929
5328	Dow Chemical Co.	150,000	10,200	02/14/1942
5328	Dow Chemical Co.	7,500	600	04/03/1951

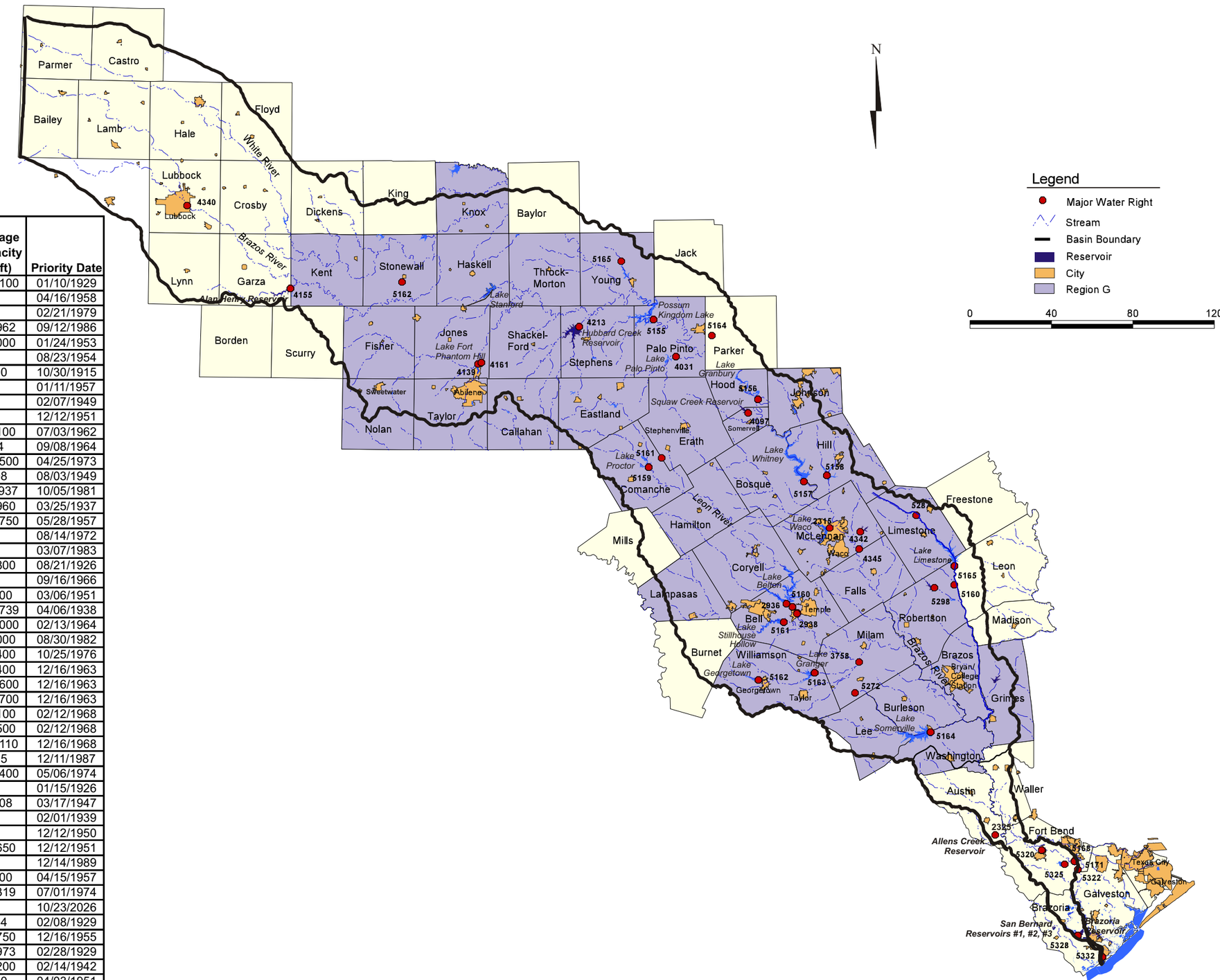

Figure 3.1-4. Major Water Rights and Reservoirs in the Brazos River Basin

or 5.7 percent of the total authorized storage volume in the river basin. The large quantity of reservoir storage in Region G provides for a firm supply of water during drought conditions, when streamflows are low and may be required to be passed through to downstream senior water rights in Region H. Figure 3.1-5 presents a comparison of the total authorized storage and annual diversion volume for Region G and Region H.

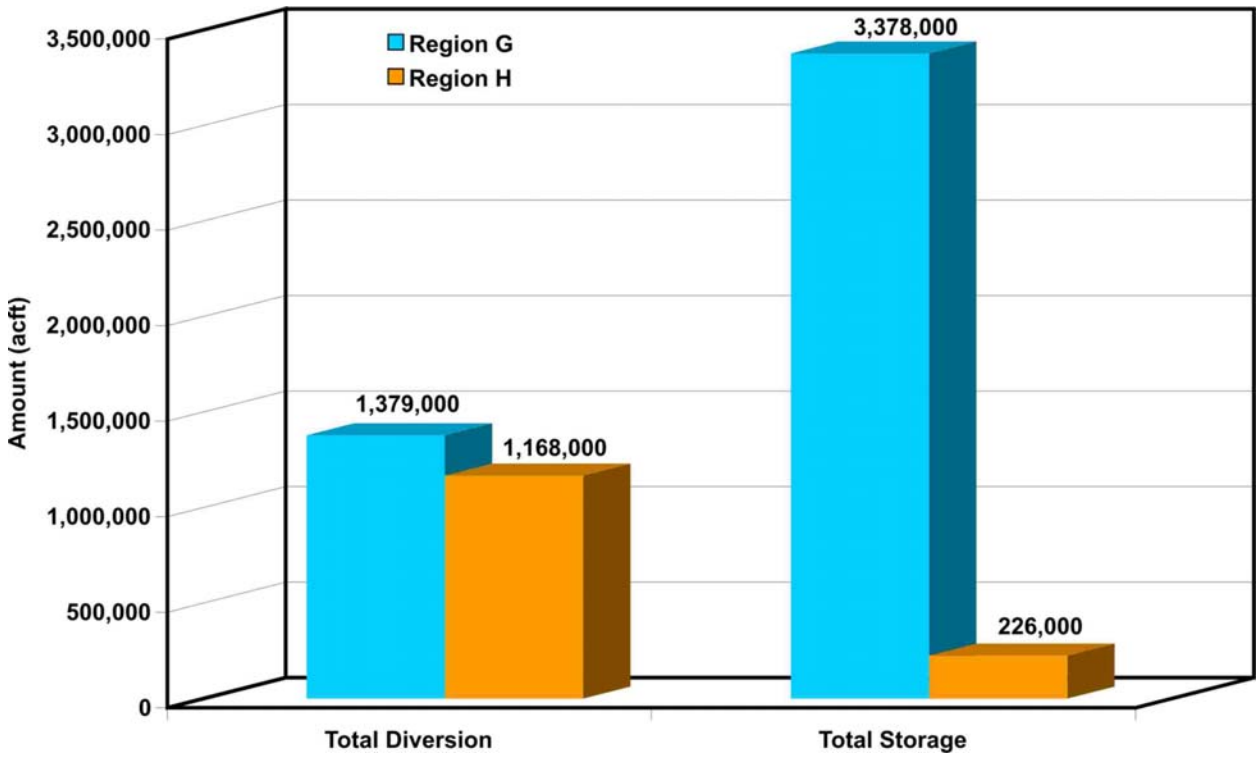

Figure 3.1-5. Comparison of Storage and Diversion Volume for Regions G and H

A total of 48 major reservoirs, with capacities greater than 5,000 acft, exist in the river basin. The U.S. Army Corps of Engineers (USCOE) owns several of these reservoirs, including Lake Georgetown, Lake Aquilla, Lake Granger, Lake Proctor, Lake Somerville, Lake Waco, Lake Belton, Lake Stillhouse Hollow, and Lake Whitney. These reservoirs were built for the primary purpose of flood control; however, they also included other benefits such as water supply and recreation. For purposes of water supply, the USCOE has contracted conservation storage in each reservoir to the BRA. The BRA owns the water right permit for each reservoir and manages the water supply conservation storage in each reservoir. Other major reservoirs in

the basin that provide municipal, industrial, and irrigation water supply are owned by the BRA, City of Waco, City of Abilene, City of Mineral Wells, Palo Pinto County MWD No. 1, West Central Texas MWD, City of Cisco, City of Breckenridge, City of Sweetwater, City of Cleburne, and City of Stamford. A summary of major reservoirs in the Brazos River Basin is presented in Table 3.1-1 and the locations of the reservoirs are shown in Figure 3.1-4.

A number of interbasin transfer permits exist in the Brazos River Basin. These permits include both authorizations for diversions from the Brazos River Basin to adjacent river basins and from adjacent river basins to the Brazos River Basin. Most of the interbasin transfer permits are obviously located along the basin divide. Examples of interbasin transfers that authorize diversions from an adjacent river basin to the Brazos River Basin include: Lake Meredith (Canadian River Basin) to the Lubbock and Plainview areas in Lubbock and Hale County; Oak Creek Reservoir (Colorado River Basin) to the City of Sweetwater in Nolan County; and Lake Travis (Colorado River Basin) to the City of Cedar Park in Williamson County. Interbasin transfers authorized for diversion from the Brazos River Basin to other river basins include: Lake Mexia in Limestone County to part of the City of Mexia that lies in the Trinity River Basin; Teague City Lake in Freestone County to part of the City of Teague that lies in the Trinity River Basin; and Lake Granbury in Hood County to part of Johnson County that lies in the Trinity River Basin. A summary of interbasin transfers (excluding transfers authorized to adjacent coastal basins) associated with the Brazos River Basin is presented in Table 3.1-2.

3.1.4 Water Supply Contracts

Many entities within Region G obtain surface water through water supply contracts. These supplies are usually obtained from entities that own surface water rights, and the contracts specify the quantity of water each year to a buyer for an established unit price. The BRA is the largest provider of water supply contracts in Region G, and has contracted to sell 600,640 acft/yr from its system of reservoirs in the Brazos River Basin. The BRA contracts raw water to various entities for long-term supply as well as short-term supply for municipal, industrial, and irrigation uses. Other water right holders that contract large quantities of raw water supply to other entities include the West Central Texas MWD and the Palo Pinto County MWD No. 1. The West Central Texas MWD contracts raw water from Hubbard Creek Reservoir for municipal use to the Cities of Abilene, Albany, Anson, and Breckenridge. The City of Abilene contracts raw water

Table 3.1-1. Major Reservoirs[1] of the Brazos River Basin

Reservoir	*Water Right Owner*	*Authorized Storage (acft)*	*Authorized Diversion (acft)*	*Priority Date*	*County*	*Planning Region*
Abilene	City of Abilene	11,868	1,675	1/23/18	Taylor	G
Alcoa Lake	Aluminum Co. of America	15,650	14,000	12/12/51	Milam	G
Alan Henry	Brazos River Authority	115,937	35,200	10/5/81	Garza	O
Allens Creek	Brazos River Authority City of Houston TWDB	145,553	99,650	9/1/99	Austin	H
Aquilla	Brazos River Authority	52,400	13,896	10/25/76	Hill	G
Belton	Brazos River Authority	457,600	100,257	12/16/63	Bell	G
Brazoria Reservoir–Off-Channel	Dow Chemical	21,700	0	4/7/52	Brazoria	H
Cisco	City of Cisco	45,000	1,971 56	4/16/20 9/5/78	Eastland	G
Daniel	City of Breckenridge	11,400	2,100	4/26/46	Stephens	G
Dansby Power Plant	City of Bryan	15,227	850	5/30/72	Brazos	G
Eagle Nest Lake	T L Smith Trust Et Al	18,000 11,315	4,000 1,800	1/15/48 9/9/93	Brazoria	H
Fort Phantom Hill	City of Abilene	73,960	30,690	3/25/37	Jones	G
Georgetown	Brazos River Authority	37,100	13,610	2/12/68	Williamson	G
Gibbons Creek Power	Texas Municipal Power	26,824 5,260	9,740	2/22/77 3/9/89	Grimes	G
Graham/Eddleman	City of Graham	4,503 39,000 8,883	5,000 15,000	11/21/27 11/15/54 9/16/57	Young	G
Granbury	Brazos River Authority	155,000	64,712	2/13/64	Hood	G
Granger	Brazos River Authority	65,500	19,840	2/12/68	Williamson	G
Harris Reservoir–Off-Channel	Dow Chemical	10,200	0	2/14/42	Brazoria	H
Hubbard Creek Lake	West Central Texas MWD	317,750	52,800 3,200	5/28/57 8/14/72	Stephens	G
Leon	Eastland Co WSD	28,000	1,265 2,438 2,598	5/17/31 3/21/52 3/25/86	Eastland	G
Limestone	Brazos River Authority	217,494 7,906	65,450	5/1/74 9/4/79	Robertson	G
Miller's Creek	North Central Texas MWA	30,696	5,000	10/1/58	Baylor	B
Palo Pinto	Palo Pinto Co. MWD 1	34,250 9,874	10,000 2,500 6,000	7/3/62 9/8/64 7/3/62	Palo Pinto	G
Pat Cleburne Reservoir	City of Cleburne	25,600	5,760 240	8/6/62 3/29/76	Johnson	G
Proctor	Brazos River Authority	59,400	19,658	12/16/63	Comanche	G
Smithers Lake	Houston L&P	18,750	28,711	12/16/55	Fort Bend	H

Page 1 of 2

Table 3.1-1 (concluded)

Reservoir	*Water Right Owner*	*Authorized Storage (acft)*	*Authorized Diversion (acft)*	*Priority Date*	*County*	*Planning Region*
Somerville	**Brazos River Authority**	**160,110**	**48,000**	**12/16/63**	**Washington**	**G**
Squaw Creek Reservoir	**Texas Utilities Electric Co.**	**151,500**	**23,180**	**4/25/73**	**Somervell**	**G**
Stamford	**City of Stamford**	**60,000**	**10,000**	**6/8/49**	**Haskell**	**G**
Stillhouse Hollow	**Brazos River Authority**	**235,700**	**67,768**	**12/16/63**	**Bell**	**G**
Sweetwater	**City of Sweetwater**	**10,000**	**3,740**	**10/17/27**	**Nolan**	**G**
Tradinghouse Steam	**Texas Utilities Electric Co.**	**37,800**	**12,000**	**8/21/26**	**McLennan**	**G**
			15,000	**9/16/66**		
Twin Oak Steam Electric	**Texas Utilities Electric Co.**	**30,319**	**13,200**	**7/1/74**	**Robertson**	**G**
Waco	**City of Waco**	**104,100**	**39,100**	**1/10/29**	**McLennan**	**G**
			19,100	**4/16/58**		
			900	**2/21/79**		
	City of Waco	**87,962**	**20,770**	**9/12/86**		
Whitney	**Brazos River Authority**	**50,000**	**18,336**	**8/30/82**	**Hill**	**G**
White River Reservoir	**White River MWD**	**33,160**	**6,000**	**9/22/58**	**Crosby**	**O**
		5,072		**11/21/60**		
		6,665		**8/16/71**		

[1] Major Reservoirs are defined as having a capacity of 5,000 acft or greater.

Table 3.1-2.
Summary of Interbasin Transfers
Associated with the Brazos River Basin[1]

River Basin of Origin	Location of Use			Description	Authorized Diversion (acft/yr)	Priority Date
	River Basin	Planning Region	County			
Brazos	Trinity	G	Johnson	Lake Granbury to Johnson County	2,600	11/7/86
Brazos	Trinity	G	Limestone	Lake Mexia to part of Mexia	N/A	N/A
Brazos	Trinity	C	Freestone	Teague City Lake to part of Teague	N/A	N/A
Brazos	Colorado	G	Lampasas	Brazos River to City of Lampasas	180	6/23/14
Brazos	Trinity	C	Multiple	Lake Possum Kingdom to Trinity Basin	5,240	4/6/38
Canadian	Brazos	O	Lubbock	Lake Meredith to Lubbock Co. Area	151,200	1/30/56
Colorado	Brazos	G	Fisher	Lake J B Thomas to Fisher Co.	N/A	N/A
Colorado	Brazos	G	Nolan	Oak Creek Res. to Lk Trammel/Sweetwater	3,000	N/A
Colorado	Brazos	G	Callahan	Lake Clyde to Clyde	200	2/2/65
Colorado	Brazos	G	Taylor	Lake O H Ivie to Abilene	15,000	2/2/78
Colorado	Brazos	G	Williamson	Lake Austin to Williamson Co.	N/A	N/A
Colorado	Brazos	G	Williamson	Lake Travis to Cedar Park	16,500	N/A
Colorado	Brazos	G	Williamson	Lake Travis to Leander	6,400	N/A
Colorado	Brazos	F	Fisher	Snyder to City of Rotan	N/A	N/A
Red	Brazos	B	Archer	Small Lakes to Megargel	N/A	N/A
Red	Brazos	B	Archer	Lake Cooper & Olney to Olney	35	8/11/80
Red	Brazos	O	Floyd	Lake MacKenzie to Floydada & Lockney	N/A	N/A
Trinity	Brazos	C	Parker	Lake Weatherford to part of Weatherford	N/A	N/A

[1] Excludes transfers authorized to adjacent coastal basins.

from Fort Phantom Hill Reservoir to West Texas Utilities for industrial use as well as municipal supply to several other surrounding cities and water supply corporations. The Palo Pinto County MWD No. 1 contracts raw water from Lake Palo Pinto for industrial use to Brazos Electric Co-op as well as for municipal use for the City of Mineral Wells and several smaller water supply corporations. Table 3.1-3 provides a summary of all the contracts held by the identified Wholesale Water Providers within Region G. These contracts make up the bulk of water contracts in the region, however, there are numerous smaller entities which often contract between each other for emergency supplies or various other reasons which are not summarized here. The list also excludes WWPs located primarily outside Region G such as the Lower Colorado River Authority and the Colorado River Municipal Water District. These supplies are summarized in Table 3.5-1.

Table 3.1-3.
Water Supply Contracts Held by WWPs in Region G (all values in acft/yr)
(Note: Increasing contracts represent projected demands for "meets" contracts)

Wholesale Water Supplier	*Year*						
	2000	*2010*	*2020*	*2030*	*2040*	*2050*	*2060*
BRA (LAKE AQUILLA)							
Contracts							
Aquilla WSD	5,953	5,953	5,953	5,953	5,953	5,953	5,953
City of Cleburne	5,300	5,300	5,300	5,300	5,300	5,300	5,300
Lake Whitney Water Company	150	150	150	150	150	150	150
Total Contracts	11,403	11,403	11,403	11,403	11,403	11,403	11,403
BRA (LITTLE RIVER SYSTEM)							
Contracts							
439 WSC	1,409	1,409	1,409	1,409	1,409	1,409	1,409
ALCOA	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Bell County WCID #1	49,509	49,509	49,509	49,509	49,509	49,509	49,509
Bluebonnet WSC	8,301	8,301	8,301	8,301	8,301	8,301	8,301
Brushy Creek MUD	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Central Bosque WSC	100	100	100	100	100	100	100
Central Texas WSC	12,795	12,795	12,795	12,795	12,795	12,795	12,795
Chisholm Trail SUD	4,760	4,760	4,760	4,760	4,760	4,760	4,760
City of Belton	2,500	2,500	2,500	2,500	2,500	2,500	2,500
City of Gatesville	5,448	5,448	5,448	5,448	5,448	5,448	5,448
City of Georgetown	6,720	6,720	6,720	6,720	6,720	6,720	6,720
City of Georgetown	15,448	15,448	15,448	15,448	15,448	15,448	15,448
City of Harker Heights	3,150	3,150	3,150	3,150	3,150	3,150	3,150
City of Lampasas	3,500	3,500	3,500	3,500	3,500	3,500	3,500
City of McGregor	810	810	810	810	810	810	810
City of Round Rock	6,720	6,720	6,720	6,720	6,720	6,720	6,720
City of Round Rock	18,134	18,134	18,134	18,134	18,134	18,134	18,134
City of Taylor	8,525	8,525	8,525	8,525	8,525	8,525	8,525
City of Temple	27,953	27,953	27,953	27,953	27,953	27,953	27,953
Coryell City WSD	300	300	300	300	300	300	300
Country Harvest	8	8	8	8	8	8	8
High Gabriel WSC	310	310	310	310	310	310	310
Jarrell-Schwertner WSC	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Jerry Glaze	100	100	100	100	100	100	100
Jonah Water SUD	2,439	2,439	2,439	2,439	2,439	2,439	2,439
Kempner WSC	5,150	5,150	5,150	5,150	5,150	5,150	5,150
Lake Proctor Irrigation Authority	2,743	2,743	2,743	2,743	2,743	2,743	2,743
Lakeview Golf & Country Club	70	70	70	70	70	70	70
Multi-County WSC	450	450	450	450	450	450	450
North Leon River Irrigation Corporation	3,909	3,909	3,909	3,909	3,909	3,909	3,909
Okie Pecan Farm	48	48	48	48	48	48	48
Salado WSC	1,600	1,600	1,600	1,600	1,600	1,600	1,600
Sun City Georgetown	15	15	15	15	15	15	15

Table 3.1-3 (continued)

Wholesale Water Supplier	Year						
	2000	2010	2020	2030	2040	2050	2060
The Grove WSC	460	460	460	460	460	460	460
Upper Leon River MWD	6,439	6,439	6,439	6,439	6,439	6,439	6,439
Wildflower County Club	200	200	200	200	200	200	200
Total Contracts	210,023	210,023	210,023	210,023	210,023	210,023	210,023
BRA (MAIN STEM)							
Contracts							
Acton MUD	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Acton MUD	3,000	3,000	3,000	3,000	3,000	3,000	3,000
AES Wolf Hollow	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Basa Resources	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Bluegree Southwest One, LP	200	200	200	200	200	200	200
Brazos Electric Power Coop.	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Carr-Thomas Ranch	50	50	50	50	50	50	50
Citation Oil & Gas Corp.	175	175	175	175	175	175	175
City of Abilene	50	50	50	50	50	50	50
City of Brenham	3,535	3,535	3,535	3,535	3,535	3,535	3,535
City of Cleburne	4,700	4,700	4,700	4,700	4,700	4,700	4,700
City of Graham	1,000	1,000	1,000	1,000	1,000	1,000	1,000
City of Granbury	6,179	6,179	6,179	6,179	6,179	6,179	6,179
City of Granbury	4,621	4,621	4,621	4,621	4,621	4,621	4,621
City of Keene	2,040	2,040	2,040	2,040	2,040	2,040	2,040
City of Lorena	1,000	1,000	1,000	1,000	1,000	1,000	1,000
City of Lubbock	961	961	961	961	961	961	961
City of Marlin	1,200	1,200	1,200	1,200	1,200	1,200	1,200
City of Rosebud	100	100	100	100	100	100	100
City of Stamford	1,820	1,820	1,820	1,820	1,820	1,820	1,820
City of Whitney	750	750	750	750	750	750	750
Decordova Bend States Owners	400	400	400	400	400	400	400
Double Diamond, Inc.	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Double Diamond, Inc.	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Dow Pipeline Company	16,000	16,000	16,000	16,000	16,000	16,000	16,000
Fred T. Owen Jr.	60	60	60	60	60	60	60
Granbury Recreational Association	50	50	50	50	50	50	50
Gulf Coast Water Authority	32,668	32,668	32,668	32,668	32,668	32,668	32,668
Hill Country Harbor Village	250	250	250	250	250	250	250
Horizon Turf Grass	150	150	150	150	150	150	150
Island Condominium Owners	20	20	20	20	20	20	20
Johnson County Fresh WSD #1	1,665	1,665	1,665	1,665	1,665	1,665	1,665
Johnson County SUD	13,210	13,210	13,210	13,210	13,210	13,210	13,210
Lenmo Inc.	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Mirant Texan Management, Inc.	3,500	3,500	3,500	3,500	3,500	3,500	3,500
Monarch Utilities I, L.P.	600	600	600	600	600	600	600
North Ridge Corporation	235	235	235	235	235	235	235

Table 3.1-3 (continued)

Wholesale Water Supplier	Year						
	2000	2010	2020	2030	2040	2050	2060
Patterson Petroleum, Inc.	120	120	120	120	120	120	120
Pecan Plantation Owners Association	500	500	500	500	500	500	500
Pecan Plantation Owners Association	250	250	250	250	250	250	250
Possum Kingdom WSC	410	410	410	410	410	410	410
Ranch Owner's Association	250	250	250	250	250	250	250
Reliant Energy	83,000	83,000	83,000	83,000	83,000	83,000	83,000
Rex R. Worrell	300	300	300	300	300	300	300
Robo Investments, Inc.	100	100	100	100	100	100	100
Shackleford WSC	353	353	353	353	353	353	353
SLC Water Supply	200	200	200	200	200	200	200
South Texas Water Company	5,625	5,625	5,625	5,625	5,625	5,625	5,625
Sportsmans World MUD	125	125	125	125	125	125	125
Stephens County RWSC	800	800	800	800	800	800	800
Sugar Tree, Inc.	400	400	400	400	400	400	400
Sugar Tree, Inc.	100	100	100	100	100	100	100
Texas A&M University	6,945	6,945	6,945	6,945	6,945	6,945	6,945
Texas Forest Service	0	0	0	0	0	0	0
Texas Genco	18,000	18,000	18,000	18,000	18,000	18,000	18,000
Texas Municipal Power Agency	3,600	3,600	3,600	3,600	3,600	3,600	3,600
TPWD	800	800	800	800	800	800	800
Turfgrass American, L.P.	1,300	1,300	1,300	1,300	1,300	1,300	1,300
TXU Electric	57,447	57,447	57,447	57,447	57,447	57,447	57,447
TXU Electric	40,000	40,000	40,000	40,000	40,000	40,000	40,000
TXU Electric	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Vulcan Construction Materials	1,800	1,800	1,800	1,800	1,800	1,800	1,800
Wellborn SUD	4,000	4,000	4,000	4,000	4,000	4,000	4,000
Total Contracts	379,214	379,214	379,214	379,214	379,214	379,214	379,214
AQUILLA WATER SUPPLY							
Contracts							
Brandon-Irene WSC	280	280	280	280	280	280	280
Chatt WSC (Hill C-O)	84	84	84	84	84	84	84
Files Valley WSC	1,008	1,008	1,008	1,008	1,008	1,008	1,008
Hill County WSC (Hill C-O)	336	336	336	336	336	336	336
Hillsboro	4,200	4,200	4,200	4,200	4,200	4,200	4,200
Menlow WSC (Hill C-O)	45	45	45	45	45	45	45
Total Contracts	5,953	5,953	5,953	5,953	5,953	5,953	5,953
BELL COUNTY WCID #1							
Contracts							
439 Water Supply Corp.	750	750	750	750	750	750	750
City of Belton	4,966	4,966	4,966	4,966	4,966	4,966	4,966
City of Copperas Cove	7,824	7,824	7,824	7,824	7,824	7,824	7,824

Table 3.1-3 (continued)

Wholesale Water Supplier	Year						
	2000	2010	2020	2030	2040	2050	2060
City of Harker Heights	5,265	5,265	5,265	5,265	5,265	5,265	5,265
City of Killeen	29,964	29,964	29,964	29,964	29,964	29,964	29,964
City of Nolanville	740	740	740	740	740	740	740
Total Contracts	49,509	49,509	49,509	49,509	49,509	49,509	49,509
BLUEBONNET WSC							
Contracts							
Bruceville-Eddy	689	827	964	1,081	1,200	1,275	1,389
Elm Creek WSC	80	480	580	580	680	680	780
City of McGregor	948	933	923	913	902	894	899
Moffat WSC	351	402	430	457	468	477	488
City of Moody	199	202	203	203	204	206	212
Pendleton WSC	231	250	265	273	278	282	287
Spring Valley WSC (McLennan C-O)	177	250	298	331	336	331	331
Total Contracts	2,675	3,344	3,663	3,838	4,068	4,145	4,386
CENTRAL TEXAS WSC							
Contracts							
Armstrong WSC (Bell C-O)	92	92	92	92	92	92	92
City of Bartlett	0	180	180	180	180	180	180
Bell County WCID No. 5 (Bell C-O)	37	37	37	37	37	37	37
Bell-Milam-Falls WSC	446	446	446	446	446	446	446
Dog Ridge WSC	671	671	671	671	671	671	671
East Bell County WSC	341	341	341	341	341	341	341
City of Holland	258	258	258	258	258	258	258
Kempner WSC	3,500	5,500	5,500	5,500	5,500	5,500	5,500
Little Elm Valley WSC (Milam C-O)	147	147	147	147	147	147	147
City of Lott	184	184	184	184	184	184	184
City of Rodgers	368	368	368	368	368	368	368
City of Rosebud	500	500	500	500	500	500	500
Town of Buckholts-Water Dept. (Milam C-O)	174	174	174	174	174	174	174
Town of Oenaville and Belfalls (Bell C-O)	57	57	57	57	57	57	57
West Bell County WSC	921	921	921	921	921	921	921
Westphalia WSC (Falls C-O)	45	45	45	45	45	45	45
Total Contracts	7,741	9,921	9,921	9,921	9,921	9,921	9,921
UPPER LEON MWD							
Contracts							
City of Comanche	552	634	632	622	605	587	568
City of De Leon	286	280	280	274	265	256	248
City of Dublin	454	485	516	544	576	682	753
City of Gorman	143	137	134	127	120	113	108

Table 3.1-3 (continued)

Wholesale Water Supplier	Year						
	2000	2010	2020	2030	2040	2050	2060
City of Hamilton	2,000	2,000	2,000	2,000	2,000	2,000	2,000
City of Stephenville	1,862	1,862	1,862	1,862	1,862	1,862	1,862
Total Contracts	5,297	5,398	5,424	5,429	5,428	5,500	5,539
EASTLAND CO WSD							
Contracts							
City of Eastland	1,791	1,791	1,791	1,791	1,791	1,791	1,791
City of Carbon	73	73	73	73	73	73	73
Westbound WSC	47	47	47	47	47	47	47
City of Ranger	710	710	710	710	710	710	710
Total Contracts	2,621	2,621	2,621	2,621	2,621	2,621	2,621
PALO PINTO CO MWD							
Contracts							
City of Mineral Wells	3,412	3,653	3,802	3,928	4,008	4,151	4,337
City of Palo Pinto	179	179	179	179	179	179	179
Santo WSC	331	331	331	331	331	331	331
Sturdivant-Progress WSC	17	17	17	17	17	17	17
North Rural WSC	368	368	368	368	368	368	368
Parker County WSC	294	294	294	294	294	294	294
Millsap WSC	184	184	184	184	184	184	184
City of Graford	92	92	92	92	92	92	92
Lake Palo Pinto Water Assoc.	100	100	100	100	100	100	100
Palo Pinto County SE	2,024	2,024	2,024	2,024	2,024	2,024	2,024
Total Contracts	7,001	7,242	7,391	7,517	7,597	7,740	7,926
WEST CENTRAL TEXAS MWD							
Contracts							
City of Abilene	20,361	20,361	20,361	20,361	20,361	20,361	20,361
City of Albany	2,197	2,197	2,197	2,197	2,197	2,197	2,197
City of Anson	2,409	2,409	2,409	2,409	2,409	2,409	2,409
City of Breckenridge	2,881	2,881	2,881	2,881	2,881	2,881	2,881
Total Contracts	27,848	27,848	27,848	27,848	27,848	27,848	27,848
NORTH CENTRAL TEXAS MWD							
Contracts							
City of Aspermont	93	93	93	93	93	93	93
City of Benjamin (Knox C-O)	8	8	8	8	8	8	8
City of Goree (Knox C-O)	63	63	63	63	63	63	63
City of Haskell	504	504	504	504	504	504	504
City of Knox City	267	267	267	267	267	267	267
City of Munday	281	281	281	281	281	281	281
City of O'Brien (Haskell C-O)	6	6	6	6	6	6	6

Table 3.1-3 (continued)

Wholesale Water Supplier	Year						
	2000	2010	2020	2030	2040	2050	2060
City of Rochester (Haskell C-O)	13	13	13	13	13	13	13
City of Rule	30	30	30	30	30	30	30
Paint Creek WSC (Haskell C-O)	54	54	54	54	54	54	54
Total Contracts	1,319	1,319	1,319	1,319	1,319	1,319	1,319
ABILENE							
Contracts							
Blair Water Supply Corp. (Taylor C-O)	107	107	107	107	107	107	107
City of Baird	138	138	138	138	138	138	138
City of Clyde	307	307	307	307	307	307	307
City of Hamlin	307	307	307	307	307	307	307
City of Merkel	384	384	384	384	384	384	384
City of Stamford	537	537	537	537	537	537	537
City of Tye	138	138	138	138	138	138	138
Eula WSC (Callahan C-O)	61	61	61	61	61	61	61
Hamby Water Supply Corp. (Taylor C-O)	307	307	307	307	307	307	307
Hawley WSC	307	307	307	307	307	307	307
Potosi Water Supply Corp.	307	307	307	307	307	307	307
Steamboat Mountain WSC	460	460	460	460	460	460	460
Sun Water Supply Corp. (Taylor C-O)	307	307	307	307	307	307	307
View-Caps Water Supply Corp. (Taylor C-O)	368	368	368	368	368	368	368
Manufacturing (Taylor County)	789	972	1,081	1,177	1,270	1,349	1,462
Total Contracts	4,824	5,007	5,116	5,212	5,305	5,384	5,497
CEDAR PARK							
Contracts							
Indian Springs Subdiv. (Williamson C-O)	9	9	9	9	9	9	9
Williamson Co. Mud #3 (Williamson C-O)	722	722	722	722	722	722	722
Williamson-Travis Co. MUD #1	510	770	1,085	1,462	1,865	2,320	2,807
Blockhouse MUD	578	903	1,288	1,749	2,242	2,796	3,389
Total Contracts	1,819	2,404	3,104	3,942	4,838	5,847	6,927
ROUND ROCK							
Contracts							
Brushy Creek MUD	3,360	0	0	0	0	0	0
Fern Bluff MUD	745	1,339	2,049	2,882	3,805	4,810	5,888
William County MUD #9 (Williamson C-O)	190	230	257	269	278	282	288
Total Contracts	4,295	1,569	2,306	3,151	4,083	5,092	6,176

Table 3.1-3 (concluded)

Wholesale Water Supplier	Year						
	2000	2010	2020	2030	2040	2050	2060
SWEETWATER							
Contracts							
Bitter Creek WSC	460	460	460	460	460	460	460
City of Blackwell (Nolan C-O)	168	168	168	168	168	168	168
City of Bronte (OoR)	504	504	504	504	504	504	504
City of Roby	350	350	350	350	350	350	350
City of Trent (Taylor C-O)	187	187	187	187	187	187	187
Fort Chadborne Ranch (Nolan C-O)	135	135	135	135	135	135	135
Manufacturing (Nolan)	550	550	550	550	550	550	550
West Texas Utilities (Nolan SE)	800	800	800	800	800	800	800
Total Contracts	3,154	3,154	3,154	3,154	3,154	3,154	3,154
WACO							
Contracts							
City of Bellmead	2,477	2,622	2,751	2,873	2,984	3,065	3,202
City of Northcrest (McLennan C-O)	208	202	191	183	180	179	178
City of Hewitt	1,838	2,029	2,237	2,395	2,571	2,684	2,877
City of Lacy-Lakeview	678	835	989	1,116	1,256	1,338	1,477
City of Woodway	2,974	2,944	2,925	2,903	2,882	2,867	2,874
City of Beverly Hills	412	414	416	416	414	416	424
Total Contracts	8,587	9,046	9,509	9,886	10,287	10,549	11,032

[1]Excludes WWPs located primarily in other regions.

Page 7 of 7

3.2 Determination of Surface Water Availability

3.2.1 Modified TCEQ Water Availability Model of the Brazos River Basin (Brazos G WAM)

Determination of water availability for existing water rights is based on a rather complex function of location, hydrologic conditions, diversion volume, reservoir storage, and priority date. Computer models that are capable of analyzing these complex inter-relationships are typically employed to determine water availability for water rights. Water availability estimates for the Brazos G Area were developed using a computer model for the Brazos River Basin. The Water Rights Analysis Package (WRAP) computer model was developed at Texas A&M University for use as a water resources management tool. The model can be used to evaluate the reliability of existing water rights and to determine unappropriated streamflow potentially available for new water right permits. WRAP simulates the management and use of streamflow

and reservoirs over a historical period of record, adhering to the prior appropriation doctrine, which governs Texas' water right priority system.

The TCEQ maintains a Brazos River Basin water availability model (TCEQ WAM) that contains information on all water rights in the basin. The TCEQ WAM is the fundamental tool used to determine surface water availability throughout the Brazos Basin for water rights permitting. Embedded within this model are certain assumptions that the TCEQ specifies when analyzing water right reliabilities. These assumptions are not necessarily the most appropriate to apply to the regional water planning process. For example, the TCEQ WAM utilizes permitted storage capacities for all reservoirs, whereas, water supply planning should be based upon current and future sedimentation conditions in the reservoirs.

The BGRWPG has approved (and the TWDB has authorized) several assumptions to be incorporated into the TCEQ WAM for purposes of determining surface water availability. With these modifications, the TCEQ WAM with hereinafter be referred to as the "Brazos G WAM." These assumptions include the following items.

- Inclusion of a certain level of current and future return flows by entities located throughout the basin. These return flows were based on historical return flow information as well as projected future rates assuming an aggressive plan for future reuse. The return flow amounts were reviewed and acknowledged by each entity and by the BGRWPG before being included in the model. Table 3.2-1 lists the entities and the annual amount of return flows approved for use in the Brazos G WAM.
- The TCEQ WAM assumes all diversions from storage occur lakeside and does not take into account BRA contracts located throughout the basin. Therefore the Brazos G WAM was modified with all BRA contracts located and modeled at their actual diversion locations and able to receive releases from multiple reservoirs if applicable.
- The Brazos G WAM uses Year 2000 and Year 2060 elevation-area-capacity information for all reservoirs greater than 5,000 acft storage capacity.
- The Brazos G WAM also includes three subordination agreements as agreed to by the TWDB:
  - Possum Kingdom Reservoir is subordinated to Lake Alan Henry,
  - Possum Kingdom Reservoir is subordinated to the City of Stamford's California Creek pump-back operation into Lake Stamford, and
  - Lake Waco is subordinated to the City of Clifton's 1996 priority date water right.

Table 3.2-1.
Return Flows Included in the Brazos G WAM

Facility	*Stream*	*2000 Returns (MGD)[1]*	*Confirmed Estimated 2060 Discharge (MGD)[2]*
Acton MUD	Brazos River	0.09	1.20
Acton MUD	Brazos River	0.11	1.00
Bell County WCID	Nolan Creek	3.27	9.25
Bell County WCID	Nolan Creek	7.87	10.44
Block House MUD	Brushy Creek	0.22	0.00
BRA CRWTF	Brazos River	2.12	2.50
BRA SLRSS	Steep Bank Creek	3.69	3.60
BRA SWATS	Brazos River	0.28	2.00
BRA TBRSS	Nolan Creek	5.32	6.88
BRA/LCRA BCRWSS West	Brushy Creek	7.07	12.27
Brushy Creek MUD	Brushy Creek	0.21	0.00
City of Abilene	Deadman Creek	11.36	0.00
City of Brenham	Hog Branch	1.61	1.43
City of Bryan[3]	Trib to Carters Creek	4.46	4.84
City of Bryan[3]	Still Creek	1.66	2.28
City of Cedar Park	Unnamed Trib to Brushy Creek	1.51	5.00
City of College Station[3]	Carters Creek	5.45	6.80
City of Copperas Cove	Clear Creek	0.47	2.00
City of Copperas Cove	House Creek	1.42	2.00
City of Freeport	Brazos River	1.36	3.50
City of Gatesville-2	Leon River	1.21	2.10
City of Georgetown	San Gabriel River	1.67	3.25
City of Georgetown	Unnamed Trib to San Gabriel River	0.54	3.16
City of Graham	Salt Creek	0.97	0.95
City of Granbury	Brazos River	0.73	3.10
City of Harker Heights	Nolan Creek	1.15	1.87
City of Hempstead	Brazos River	0.23	0.95
City of Hillsboro	Hackberry Creek	0.90	3.20
City of Lake Jackson	Brazos River	2.50	2.50
City of Leander	Brushy Creek	0.48	15.00
City of Rosenberg	Brazos River	1.21	2.00
City of Rosenberg-1	Seabourne Creek	1.30	4.50
City of Stephenville	North Bosque River	1.17	1.46
City of Sugarland	Steep Bank Creek	3.88	3.50
City of Taylor	Mustang Creek	1.44	0.00
City of Temple	Unnamed Trib to Little Elm Ck	2.06	2.06
City of Waco WMRSS	Brazos River	21.92	0.00
City of West Columbia	Brazos River	1.02	0.76
Pecan Grove MUD	Unnamed Trib to the Brazos River	1.05	1.20
Texas A&M University	Brazos River	1.74	0.00
Texas A&M University	Unnamed Trib to White Creek	1.05	0.00
	Total:	**107.76**	**128.56**
	Total (acft/yr):	**120,691**	**143,987**

[1] 2000 return flow estimates derived from TCEQ WAM.

[2] Initial estimated assume 75% of Y2000 will continue to be discharged (assumed 25% reuse) and 50% of wastewater flows in excess of Y2000 levels will be discharged (50% reuse of any future effluent). Final estimates were refined after consultation with local dischargers.

[3] Bryan and College Station have filed applications pursuant to Tex. Water Code § 11.042, requesting authorization to reuse their current and future return flows derived from privately owned groundwater.

These assumptions were used throughout the regional planning process for runs that were used to determine surface water availability for existing rights, and also for runs that were used to determine the potential yield of new water management strategies.

The Brazos G WAM contains 77 primary control points that contain naturalized flow information, and 67 evaporation data sets used to calculate evaporation for the 650 reservoirs included in the model. The period of record for the TCEQ WAM is 1940-1997. This is also true for the Brazos G WAM, although Section 3.2.2 will discuss some updates made to more accurately reflect current drought conditions in the upper Brazos Basin. Water availability computations are performed at over 3,800 control points located throughout the river basin in the process of operating over 1,700 water right records. The Brazos G WAM contains water right data available from the TCEQ for all water rights in the Brazos Basin as of November 2002. Water right applications submitted or approved after this date are not reflected in the model. A summary of yield data for major reservoirs analyzed in the Brazos G WAM are discussed in Section 3.2.3.

3.2.2 Reliability of Surface Water Supplies and New Upper Basin Drought of Record

Hydrologic conditions are a primary factor that affect the reliability of a water right. Severe drought periods have been experienced in all areas of Region G in the Brazos River Basin. The drought of record for most areas of Region G occurred in the 1950s with other less severe drought periods occurring in the 1960s, 1970s, 1980s and even recently in the 1990s. In some parts of the upper Brazos Basin, the recent drought of the 1990s has continued past the turn of the century, and in many places streamflow data indicate that its severity is greater than that of the drought that occurred in the 1950s. For the past 6.5 years, streamflows in the area have averaged between 31 and 52 percent of flows occurring during the first 6.5 years of the previous drought of record, which occurred from 1943 through 1956. Figure 3.2-1 illustrates this with a comparison of cumulative gaged flows for the Clear Fork at Nugent gage during the drought of the 1950s and the current drought. During the current drought, several area reservoirs have experienced record drawdowns and there appears to be no end in sight to these severe drought conditions, despite some recovery since June of 2004. The City of Abilene, located in this upper portion of the Brazos Basin, initiated a study to quantify the current drought and its effect on the supplies of the region. The drought primarily affected the upper parts of the Brazos Basin,

specifically those reservoirs upstream of Possum Kingdom Reservoir located in the Clear Fork of the Brazos watershed, and others in close proximity. A new tool was developed to analyze the current drought, given that the period of record of the existing Brazos G WAM only extends through 1997.

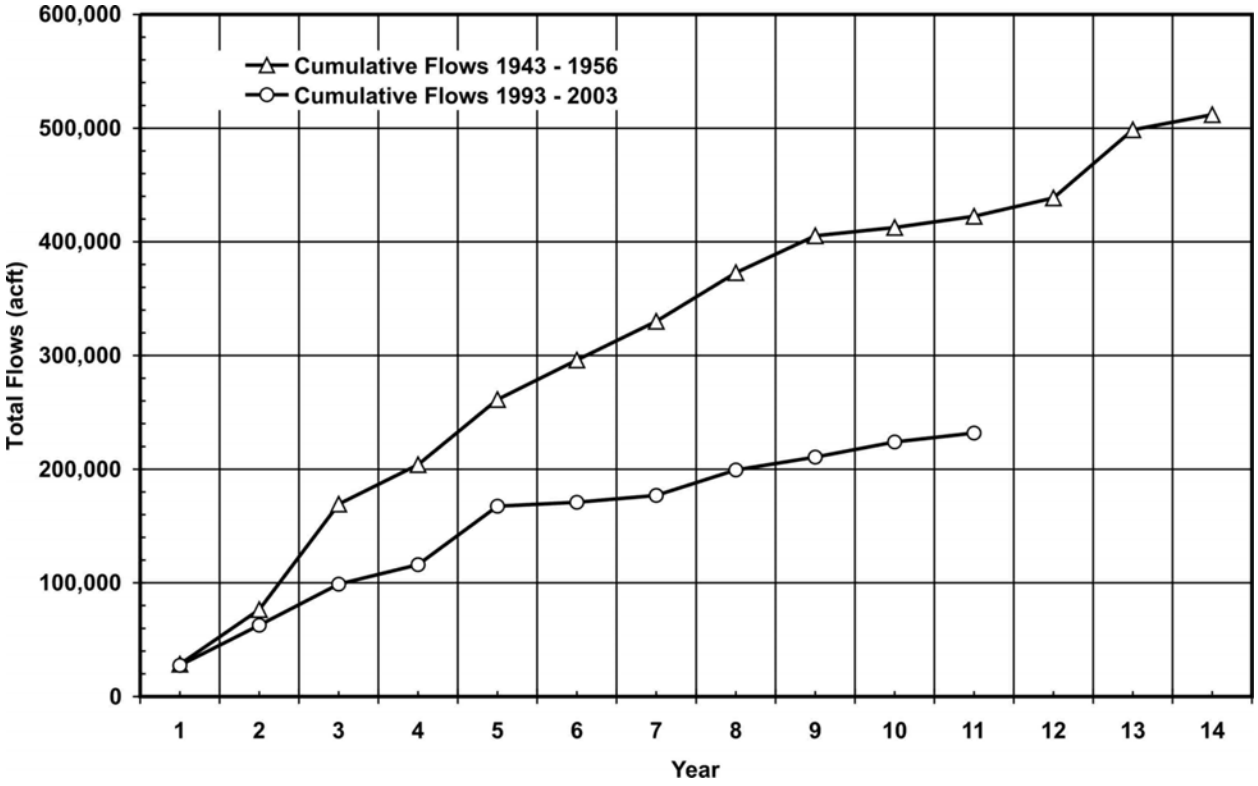

Figure 3.2-1. Cumulative Gaged Flows at Clear Fork of the Brazos near Nugent

Several possible studies and tools were evaluated to determine their effectiveness at quantifying the current drought. The selected tool was a modified version of the existing Brazos G WAM. The hydrology of the Brazos G WAM was extended through June of 2004 for the primary control points located within the drought-stricken area with the last control point in the model being the Brazos River at Palo Pinto. Naturalized flows were updated using the latest information for the 16 primary controls included in this segmented version of the Brazos G WAM, and 15 evaporation data sets were updated for inclusion into this model. All water rights and control points outside the updated drought study area were removed and not included in the analysis.

The modified Brazos G WAM was used to determine safe yields of reservoirs upstream of Possum Kingdom Reservoir (see Section 3.2.3), which should be considered as interim

estimates. For those reservoirs for which the current drought through June 2004 is more than the 1950s drought, the current drought cycle has not ended in the upper basin and yields might be less than estimated using the modified Brazos G WAM.

3.2.3 Yield Analysis for Large Reservoirs

Water availability estimates for large reservoirs were evaluated using the Brazos G WAM. Year 2000 and 2060 yields were determined for all large reservoirs with greater than 5,000 acft of authorized storage and municipal supply reservoirs greater than 1,000 acft of authorized storage. Yields were limited to authorized diversions.

Firm yields were calculated for reservoirs located below and including Possum Kingdom Reservoir. The period of record for the firm yield analyses was 1940-1997.

Safe yields were calculated for Palo Pinto Reservoir and all reservoirs located above Possum Kingdom Reservoir. Safe yield is defined as the amount of water that can be diverted from a reservoir during a repeat of the worst drought of record while still maintaining a reserve capacity equal to a 1-year supply. Utilization of safe yield versus firm yield is a common practice in west Texas where droughts are frequent and severe, and water managers are acutely aware that a drought more severe than recent recorded history could occur. Safe yield provides additional assurance of supply in an area where water resource alternatives are limited. Modifications were made to the Brazos G WAM to more accurately simulate current drought conditions in the upper Brazos Basin by extending the period of record through June 2004 for parts of the upper basin (Section 3.2.2).

A summary of firm and safe yield estimates for large reservoirs is presented in Table 3.2-2.

3.2.4 Reliability of Run-of-the-River and Small Reservoir Water Rights

The results of the Brazos G WAM simulations include water availability estimates for each water right located in the Brazos Basin. Summaries of water available to run-of-the-river water rights (including rights with small reservoirs) are presented in Appendix G. If the supply for a water right was determined by a firm or safe yield analysis then this number is shown in the appendix. Water availability for other rights is expressed in terms of the minimum annual

Table 3.2-2.
Yields for Large Reservoirs in the Brazos G Area (acft/yr)

Reservoir	*Year 2000 Yield*	*Year 2060 Yield*	*Firm or Safe Yield*	*1997 or 2004 Hydrology*
Abilene	1,200	525	Safe	2004
ALCOA[1]	7,800	7,700	Firm	1997
Anson	120	120	Firm	1997
Anson North	65	194	Safe	2004
Aquilla	13,896	5,142	Firm	1997
Baird	385	385	Firm	1997
Belton	98,534	97,217	Firm	1997
Cisco	1,340	1,340	Safe	2004
Daniel	180	150	Safe	2004
Dansby Power Plant	85	85	Firm	1997
Lake Eastland (C3465)	520	520	Firm	1997
Fort Phantom Hill	7,430	6,940	Safe	2004
Georgetown	12,025	12,003	Firm	1997
Gibbons Creek[1]	6,310	6,310	Firm	1997
City of Gordon (C4355)	5	5	Firm	1997
Graham/Eddleman	4,550	3,650	Safe	2004
Granbury	64,712	63,212	Firm	1997
Granger	19,840	9,219	Firm	1997
Hubbard Creek	17,440	16,750	Safe	2004
Kirby	500	320	Safe	2004
Lake Creek Steam-Electric	10,000	9,945	Firm	1997
Lake Davis	100	0	Safe	2004
Leon	5,960	5,870	Firm	1997
Limestone	65,074	55,744	Firm	1997
City of Marlin Reservoirs (C4355)	2650	2650	Firm	1997
Mart	No Yield	No Yield	Firm	1997
McCarty Lake	100	370	Safe	2004
Mexia	1,180	144	Firm	1997
Miller's Creek	700	0	Safe	2004
Mineral Wells	2,520	2,430	Firm	1997
Palo Pinto	8,500	6,660	Safe	1997
Pat Cleburne	5,275	4,837	Firm	1997
Possum Kingdom	230,750	230,750	Firm	1997
Post Dam (North Fork)	5,500	5,250	Firm	1997

Page 1 of 2

Table 3.2-2 (concluded)

Reservoir	*Year 2000 Yield*	*Year 2060 Yield*	*Firm or Safe Yield*	*1997 or 2004 Hydrology*
Proctor	19,658	13,492	Firm	May 2001[2]
Robinson	2510	2510	Firm	1997
Somervell	850	850	Firm	1997
Somerville	43,370	42,043	Firm	1997
Squaw Creek	8,830	8,710	Firm	1997
Stamford	5,890	5,300	Safe	2004
Stillhouse Hollow	67,768	67,768	Firm	1997
Sweetwater	1,035	980	Safe	2004
Trammel	717	717	Firm	1997
Throckmorton	325	325	Firm	1997
Tradinghouse	4,120	4,120	Firm	1997
Twin Oaks	2,750	2,600	Firm	1997
Waco	79,869	79,869	Firm	1997
White River Reservoir	2,915	8	Firm	1997
Whitney	18,336	18,336	Firm	1997

[1] Yields include BRA contracts and operational constrains limiting reservoir drawdown.

[2] Lake Proctor yield determined by study conducted for BRA using hydrology through May 2001.

supply, which is defined as the water available during the most severe drought year over the 58-year simulation period of 1940 to 1997. Water right reliabilities were calculated for the year 2000 and 2060 conditions. The minimum annual supply values for the water rights are used to determine the supplies available by use and county for comparison with demands as described in Section 4A.1.

Minimum annual supplies for individual irrigation rights were calculated and are included as part of the results presented in Appendix G. For irrigation water rights, another definition for supply is used by the BGRWPG commonly referred to as the 75/75 convention. The 75/75 convention defines a reliable irrigation supply as that quantity of which at least 75% can be diverted at least 75% of the time. The 75/75 estimates were developed for irrigation water rights grouped by county for those in the Brazos River Basin located within Region G. The results of the 75/75 irrigation water availability analysis for each county are presented Table 3.2-3. This analysis was completed for the year 2000 and 2060 conditions; however, only the 2060 results are shown because most of the run-of-the-river rights are only marginally affected by the different scenarios and the values do not vary significantly when all rights in a county are aggregated.

Table 3.2-3.
Summary of Irrigation Rights by County
75/75 Reliability Analysis
(Year 2060 Conditions)

County	*75/75 Supply Reliability (acft/yr)*
Brazos	7,382
Bell	5,805
Bosque	6,966
Burleson	4,177
Callahan	42
Comanche	20,582
Coryell	1,739
Eastland	2,441
Erath	5,344
Falls	5,101
Fisher	743
Grimes	1,082
Hamilton	3,426
Haskell	827
Hill	1,040
Hood	13,296
Johnson	811
Jones	2,366
Kent	307
Knox	2,930
Lampasas	1,255
Lee	128
Limestone	19
McLennan	8,379
Milam	10,822
Nolan	120
Palo Pinto	6,961
Robertson	4,669
Shackleford	82
Somervell	1,378
Stephens	796
Stonewall	11
Taylor	223
Throckmorton	12
Washington	4,696
Williamson	1,027
Young	891
Total	127,874

3.2.5 Unappropriated Flows in the Region

The Brazos G WAM calculates unappropriated flow each month for the 1940 – 1997 period at each modeled location in the basin. Unappropriated flow is the flow that could potentially be made available to a new water right permit. This unappropriated flow is computed assuming no additional instream flow restrictions and full use of all existing water rights. The quantity of unappropriated flow varies throughout the river basin depending on location. Summaries of unappropriated flows from the Brazos G WAM were developed at the following locations:

- Brazos River at South Bend (BRSB23),
- Brazos River near Glen Rose (BRGR30),
- Brazos River near Aquilla (BRAQ33),
- Bosque River near Waco (BOWA40),
- Little River at Cameron (LRCA59),
- Brazos River near Bryan (BRBR59),
- Brazos River near Hempstead (BRHE68), and
- Brazos River at Richmond (BRRI70).

These locations effectively summarize flow conditions throughout the river basin and are located at current or discontinued USGS streamflow gaging stations. Table 3.2-4 summarizes the monthly and annual unappropriated flows at these selected locations. Figures 3.2-2 through 3.2-9 illustrate the annual time series of unappropriated flows at each location. As shown in these figures, unappropriated flow is not available at the South Bend gage location for most years, especially during the drought years. Conversely, unappropriated flow is potentially available in most years at Richmond in the lower basin, and often in large quantities. Unappropriated flow is not available at Richmond during the severe drought year of 1951, which is the lowest flow year during the 1940 to 1997 period. As Table 3.2-4 and Figures 3.2-2 through 3.2-9 show, location further downstream on major streams tend to have more unappropriated flow than those upstream with less contributing drainage area. These data suggest that any new potential water rights requiring a firm supply would need to be permitted with storage. In order to provide a firm supply the right would have to operate to fill the

reservoir and meet diversions in wet times, while relying on stored water to meet diversions during drought times.

Table 3.2-4.
Summary of Unappropriated Flow
at Selected Brazos G WAM Locations

Control Point	Unappropriated Flow Estimates							
	Monthly Unappropriated Flows (acft)				Annual Unappropriated Flows (acft)			
	Maximum	Minimum	Mean	Median	Maximum	Minimum	Mean	Median
BRSB23	1,219,081	0	22,037	0	2,756,889	0	264,443	89,111
BRGR30	2,507,807	0	41,806	0	3,397,776	0	501,672	283,983
BRAQ33	2,737,974	0	53,280	0	2,737,974	0	639,363	401,129
BOWA40	524,951	0	19,937	0	946,025	0	239,242	188,413
LRCA58	1,401,725	0	74,984	0	3,880,936	0	899,805	731,643
BRBR59	4,314,330	0	189,603	0	9,848,053	0	2,275,235	1,945,178
BRHE68	4,986,393	0	230,754	493	11,839,932	0	2,769,046	2,450,151
BRRI70	5,561,864	0	317,671	63,122	13,652,968	0	3,812,047	3,511,584

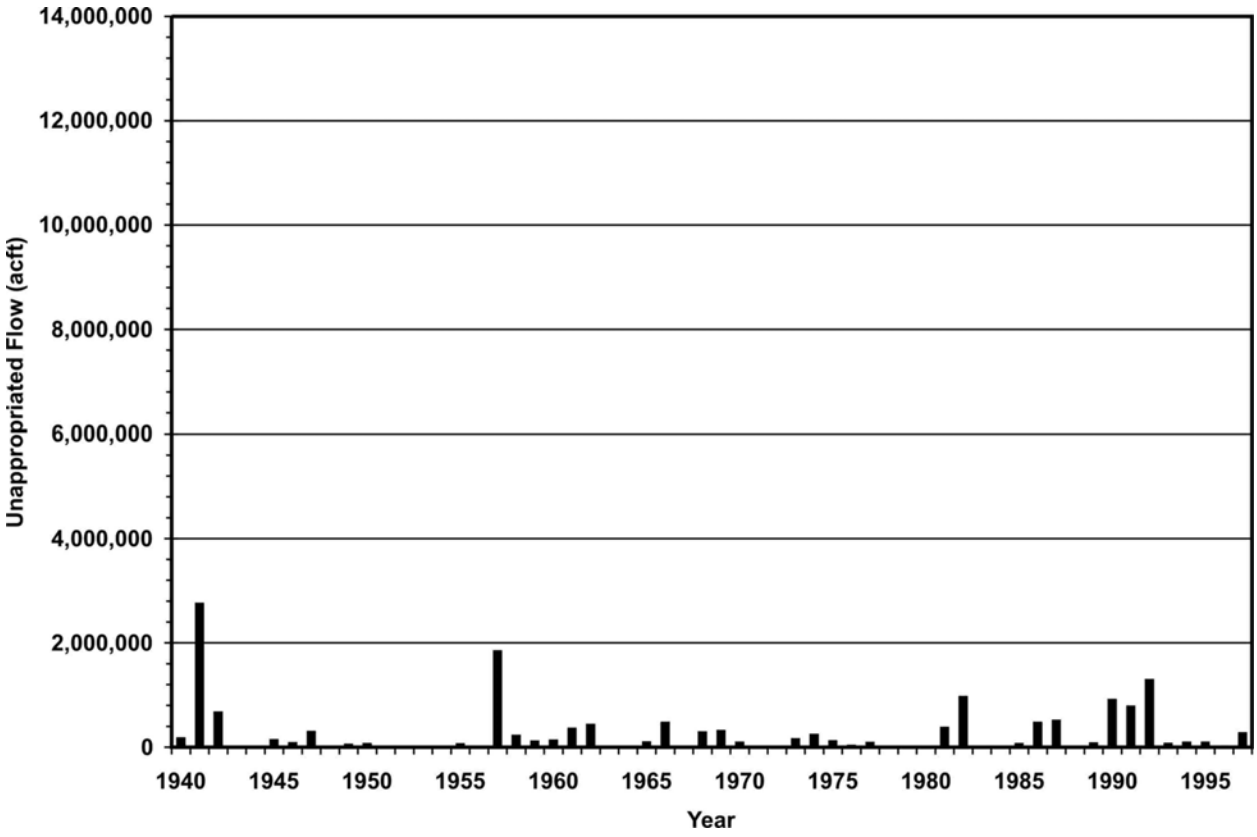

Figure 3.2-2. Estimated Annual Unappropriated Flow at Brazos River at South Bend

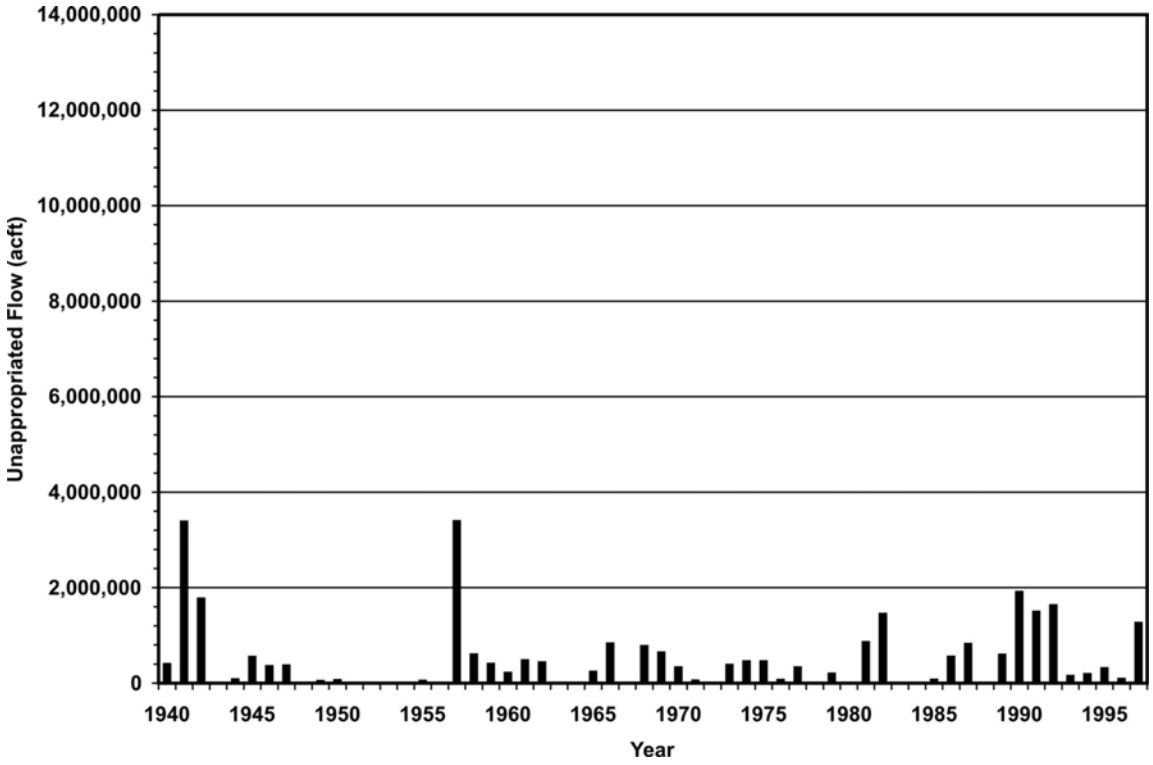

Figure 3.2-3. Estimated Annual Unappropriated Flow at Brazos River near Glen Rose

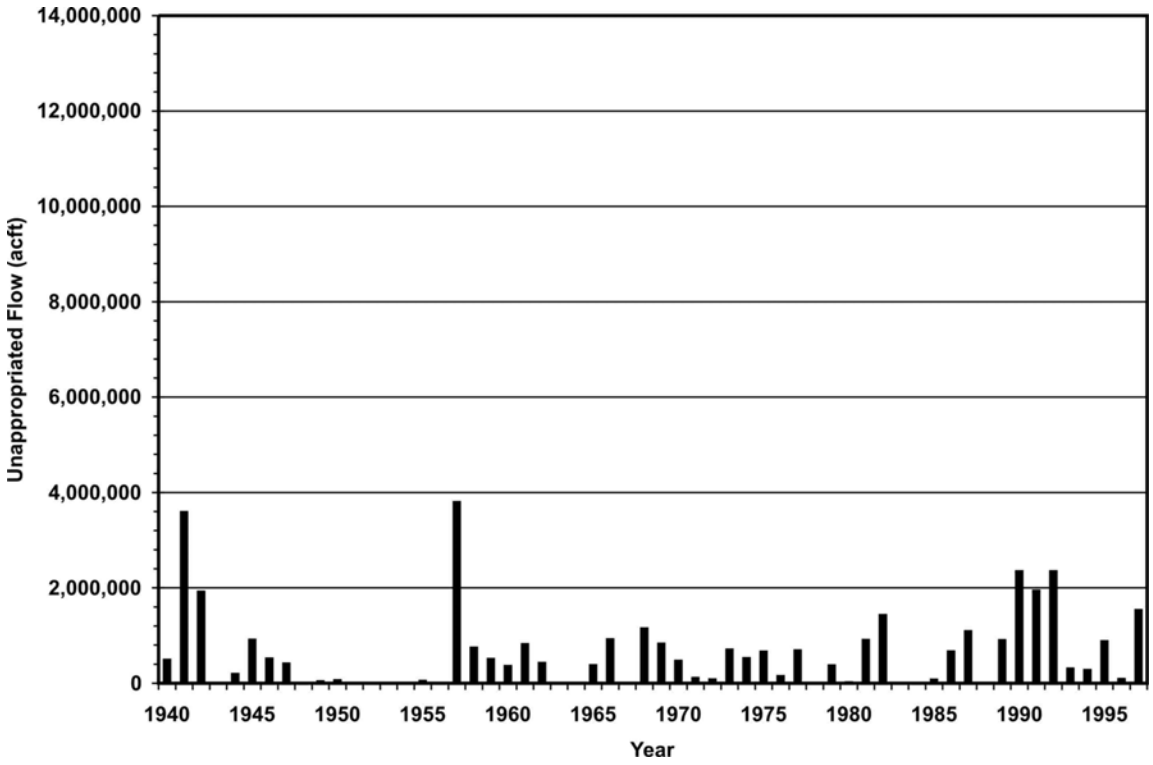

Figure 3.2-4. Estimated Annual Unappropriated Flow at Brazos River near Aquilla

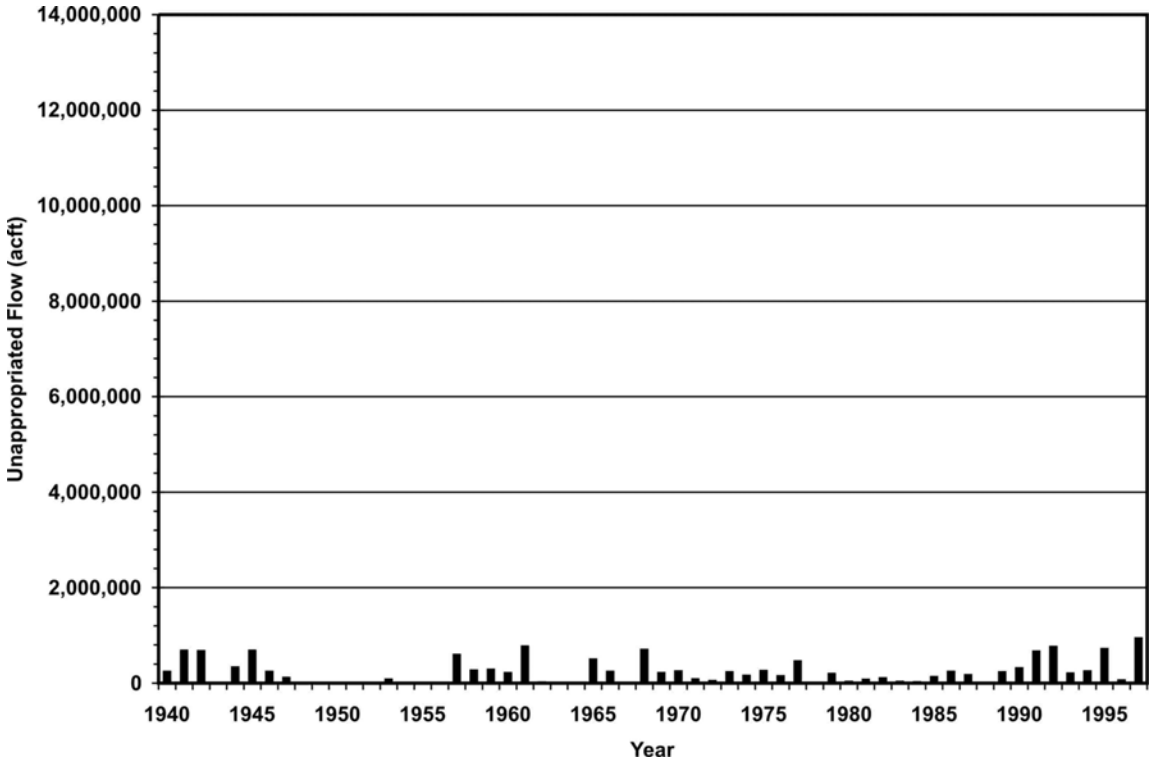

Figure 3.2-5. Estimated Annual Unappropriated Flow at Bosque River near Waco

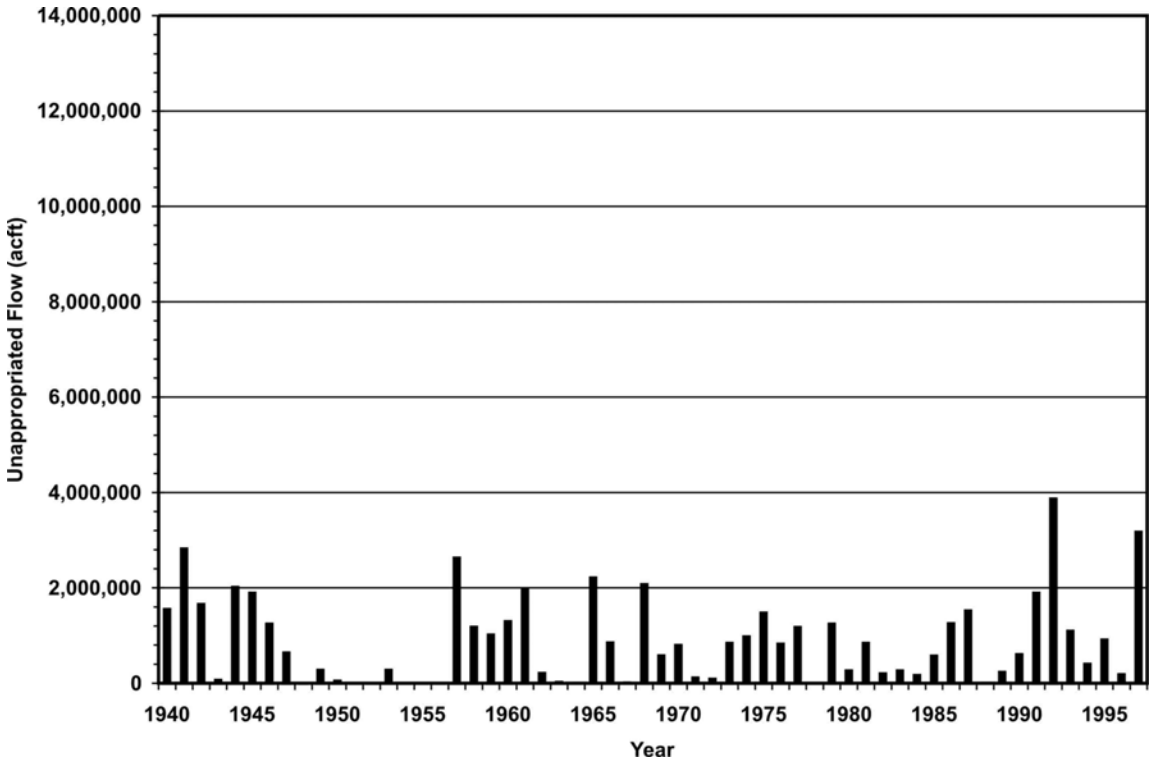

Figure 3.2-6. Estimated Annual Unappropriated Flow at Little River at Cameron

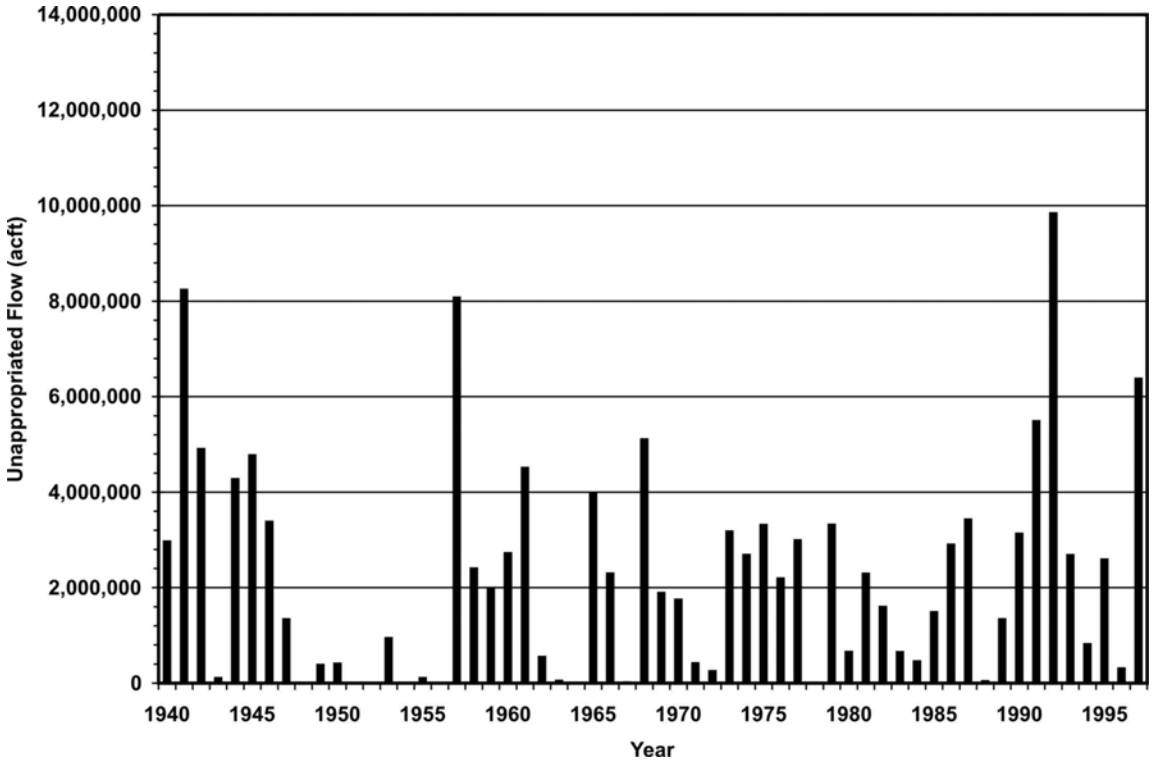

Figure 3.2-7. Estimated Annual Unappropriated Flow at Brazos River near Bryan

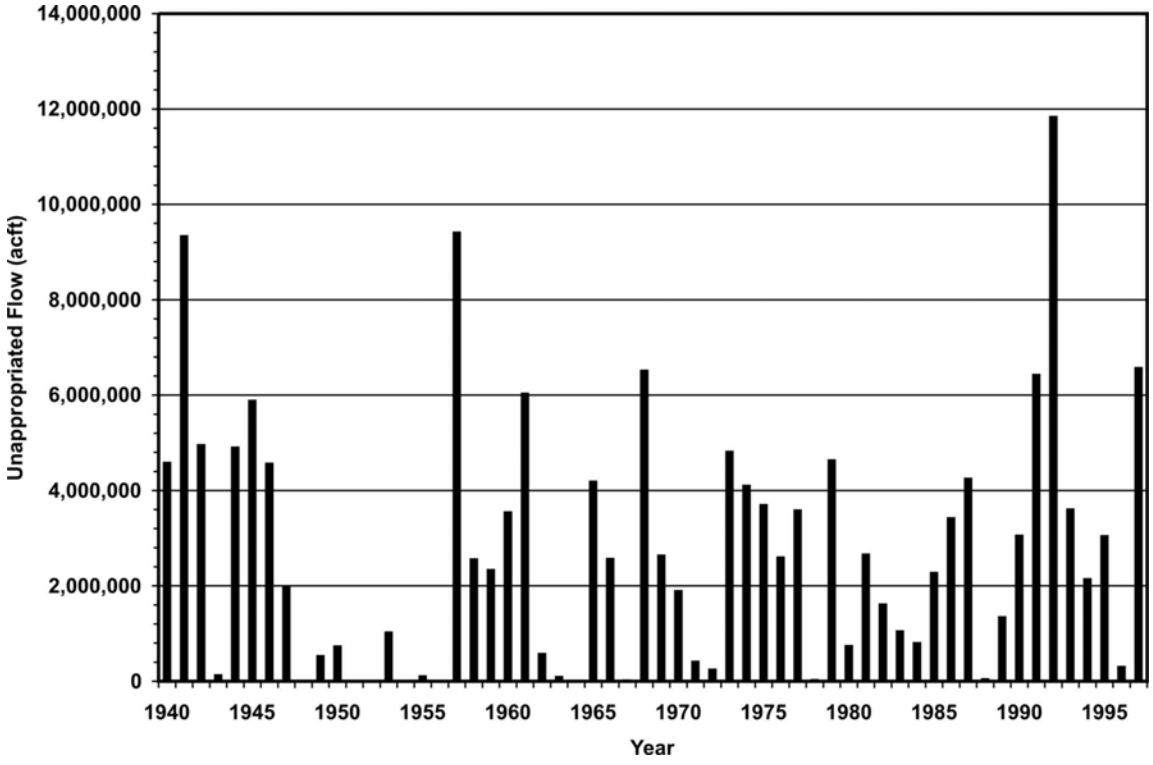

Figure 3.2-8. Estimated Annual Unappropriated Flow at Brazos River near Hempstead

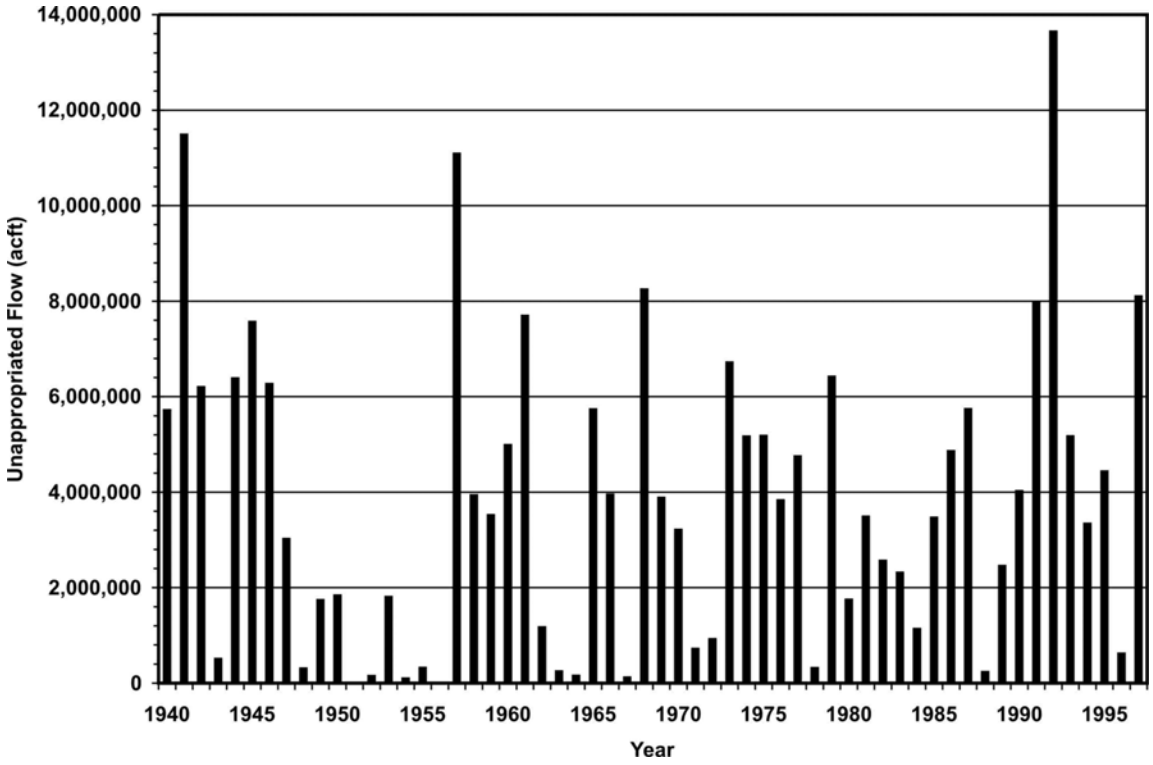

Figure 3.2-9. Estimated Annual Unappropriated Flow at Brazos River at Richmond

3.3 Water Quality Considerations Affecting Supply

The Brazos G WAM model addresses the quantity of water available to existing water rights. However, water quality issues for some sources of water for existing water rights and contracts may limit the availability of water for certain beneficial uses. Water quality that does not meet criteria for designated uses such as public water supply, contact recreation, and aquatic life support is very important to water supply considerations.

3.3.1 Point and Non-Point Source Pollution Water Quality

A number of stream segments and lakes in the Brazos G Regional Water Planning Area do not meet water quality standards due to point and/or non point source pollution. The TCEQ and USEPA (40 CFR 130.7) have the responsibility to identify water bodies that do not meet, or are not expected to meet, applicable water quality standards for designated uses.[1] These stream segments and lakes are identified in Section 303(d) list as impaired or threatened water bodies.[2] The summary of these segments is contained in Table 3.3-1.[3] The TCEQ has the responsibility to identify and prioritize water bodies that may require a Total Maximum Daily Load (TMDL) allocation to address the cause and source of a water quality impairment. TMDL studies of bacteria are currently underway for the Leon River below Lake Proctor (segment 1221). Goose Branch in Erath County (and associated tributary) has been identified with a low priority for a TMDL study.

These water quality issues are beyond the scope of regional water planning activities. The Brazos G Regional Water Planning Group encourages TCEQ and USEPA to take responsibility and aggressively pursue their obligation to restore water quality to meet intended uses.

[1] Texas Commission on Environmental Quality, *TMDL Guidance Document Outline*. http://www.tnrcc.state.tx.us
[2] Texas Commission on Environmental Quality, *State of Texas 1999 Clean Water Act Section 303(d) List and Schedule for Development of Total Maximum Daily Loads*. SFR-58/99, April 1, 1999.
[3] Texas Commission on Environmental Quality, *DRAFT Texas 2004 Section 303(d) List (May 13, 2005).* http://www.tnrcc.state.tx.us/water/quality/04_twqi303d/04_303d/04_303d.pdf.

Table 3.3-1.
DRAFT 2004 Texas 303(d) List (May 13, 2005)
Brazos G Regional Water Planning Area

Segment Number	*Segment Name*	*Category*	*Rank*	*Source*	*Parameter of Concern*
1209	Navasota River Below Lake Limestone	5c	D	Nonpoint	Bacteria
1209A	Country Club Lake (Brazos County)	5c	D	Point	Chronic toxicity in sediment to aquatic organisms; metals in sediment
1209B	Fin Feather Lake (Brazos County)	5c	D	Point	Chronic toxicity in sediment to aquatic organisms; arsenic, copper and lead in sediment
1209C	Carters Creek (Brazos County)	5c	D	Point and Nonpoint	Bacteria
1209G	Cedar Creek (Robertson County)	5c	D	Nonpoint	Bacteria
1209I	Gibbons Creek (Grimes County)	5c	D	Nonpoint	Depressed dissolved oxygen; bacteria
1209K	Steele Creek (Limestone County)	5c	D	Nonpoint	Bacteria
1210	Lake Mexia	5b	S	Nonpoint	Depressed dissolved oxygen
1210A	Navasota River above Lake Mexia	5c	D	Nonpoint	Bacteria
1211A	Davidson Creek (Burleson County)	5c	D	Nonpoint	Bacteria
1212	Lake Somerville	5c	D	Nonpoint	Low and high pH
1212B	East Yegua Creek (Lee/Milam Counties)	5c	D	Nonpoint	Bacteria
1217	Lampasas River above Stillhouse Hollow Lake	5c	D	Nonpoint	Bacteria
1218	Nolan Creek South Nolan Creek	5c	D	Nonpoint	Bacteria
1221	Leon River below Proctor Lake	5a	U	Nonpoint	Bacteria
1221A	Resley Creek (Comanche County)	5c	D	Nonpoint	Bacteria
1222	Proctor Lake	5c	D	Point and Nonpoint	Depressed dissolved oxygen
1222A	Duncan Creek (Comanche County)	5c	D	Nonpoint	Bacteria
1226B	Green Creek (Erath County)	5c	D	Nonpoint	Bacteria
1226E	Indian Creek (Erath County	5c	D	Nonpoint	Bacteria
1226F	Sims Creek (Erath County	5c	D	Nonpoint	Bacteria
1227	Nolan River	5b 5c	S D	Nonpoint Point and Nonpoint	Sulfate Bacteria
1238	Salt Fork Brazos River	5b	S	Nonpoint	Total dissolved solids; chloride
1240	White River Lake	5b	S	Nonpoint	Chloride
1241A	North Fork Double Mountain Fork Brazos River	5c	D	Point and Nonpoint	Bacteria
1242	Brazos River above Navasota River	5c	D	Nonpoint	Bacteria
1242D	Thompson Creek	5c	D	Point and Nonpoint	Bacteria
1242I	Campbells Creek	5c	D	Point and Nonpoint	Bacteria
1242K	Mud Creek (Robertson County)	5c	D	Point and Nonpoint	Bacteria
1242L	Pin Oak Creek (Robertson County)	5c	D	Point and Nonpoint	Bacteria
1242M	Spring Creek (Robertson County)	5c	D	Nonpoint	Bacteria
1242N	Tehuacana Creek (Hill County)	5c	D	Point and Nonpoint	Bacteria
1242P	Big Creek (Falls County)	5c	D	Point and Nonpoint	Bacteria
1243	Salado Creek	5c	D	Nonpoint	Depressed dissolved oxygen

Table 3.3-1.
DRAFT 2004 Texas 303(d) List (May 13, 2005)
Brazos G Regional Water Planning Area (concluded)

Segment Number	*Segment Name*	*Category*	*Rank*	*Source*	*Parameter of Concern*
1245	Upper Oyster Creek	5a 5c	U D	Nonpoint Point and Nonpoint	Bacteria; Depressed dissolved oxygen
1246E	Wasp Creek (McLennan/Coryell Counties)	5c	D	Nonpoint	Bacteria
1247A	Willis Creek (Williamson County)	5c	D	Nonpoint	Bacteria
1248	San Gabriel/ North Fork San Gabriel River	5c	D	Nonpoint	Total dissolved solids
1248C	Mankins Branch (Williamson county)	5c	D	Nonpoint	Bacteria
1254	Aquilla Reservoir	5c	D	Nonpoint	Depressed dissolved oxygen
1255	Upper North Bosque River	5c	D	Nonpoint	Bacteria
1255A	Goose Branch (Erath County)	5a	L	Nonpoint	Bacteria
1255B	North Fork Upper North Bosque River (Erath County)	5c	D	Nonpoint	Bacteria
1255C	Scarborough Creek (Erath County)	5c	D	Nonpoint	Bacteria
1255D	South Fork North Bosque River (Erath County)	5c	D	Nonpoint	Bacteria
1255E	Unnamed tributary of Goose Branch (Erath County)	5a	L	Nonpoint	Bacteria
1255F	Unnamed tributary of Scarborough Creek (Erath County)	5c	D	Nonpoint	Bacteria
1255G	Woodhollow Branch (Erath County)	5c	D	Nonpoint	Bacteria

Explanation of Column Headings:

Segment Number:	This is the classified segment number to a water body or a portion of a water body in the Texas Surface Water Quality Standards. A letter designation following the segment number indicates an unclassified water body that is located within the watershed of the classified segment whose number is shown before the letter.
Segment Name:	The name of the water body.
Category:	Category 5- The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants. 5a- A TMDL is underway, scheduled, or will be scheduled. 5b- A review of the water quality standards will be conducted before a TMDL is scheduled. 5c- Additional data and information will be collected before a TMDL is scheduled.
Rank:	For Category 5a, a rank of High (H), Medium (M), or Low (L) is given for the urgency to initiate a TMDL. For water bodies in Category 5b, a ranking of "S" has been assigned to indicate that a standards review will be conducted before a TMDL is scheduled. For water bodies in Category 5c, a ranking of "D" has been assigned to indicate that additional data and information will be collected before a TMDL is scheduled.
Parameters of Concern:	Those pollutants or water quality conditions for which screening procedures indicate an existing impairment, or a threat of within the next two years.

3.3.2 Comparison of Supplies with Water Quality Standards

The Salt Fork of the Brazos River watershed is the primary source of natural salt in the Brazos Basin, and although it contributes only 14 to 18 percent of the total flow of the Brazos River, it contributes 45 to 55 percent of total dissolved minerals and 75 to 85 percent of dissolved salt.[4] As a result of this high mineral content in these Brazos River headwater tributaries, the principal water quality issue in the Brazos River Basin is generally associated with total dissolved solids (TDS), chloride (Cl), and sulfate ($-SO^4$) concentrations on the main stem of the Brazos River. Water sources with TDS, Cl, and $-SO^4$ concentrations exceeding TCEQ Drinking Water Standards of 1,000 mg/l, 300 mg/l, and 300 mg/l respectively, are generally considered as low quality and may require higher cost advanced treatment methods for use as a municipal or industrial supply.

The Brazos River above Possum Kingdom Lake (from Stonewall County through Knox, Baylor, and Young Counties) is not impaired according to TCEQ standards; however monitoring data indicates increasing levels of TDS, chloride, and sulfate.[4] On the main stem of the Brazos River, the Draft 2004 Texas Water Quality Inventory includes a list of water bodies in Brazos G with water quality concerns. A summary of water bodies in Brazos G that have high TDS, chloride, and/or sulfate concentrations that may affect regional surface water supplies are summarized in Table 3-3.2. The largest impacts in terms of quantity of supply are associated with Possum Kingdom Lake, Lake Granbury, and Lake Whitney. These reservoirs have a combined 2060 firm yield of 312,298 acft/yr. Other surface water supplies with water quality concerns include Lake Stamford, Lake Sweetwater, and the Brazos River above the Navasota River. While not listed by TCEQ for impairments, Lake Georgetown and Granger Lake water quality exhibit increasing trends in chloride, sulfate, and/or TDS.[4] Advanced treatment is being utilized by some of the water right and contract holders that divert water directly from these reservoirs in order to meet drinking water standards. Other contract holders divert stored water released from these reservoirs at locations farther downstream, at which point the water quality is improved as it blends with downstream tributary streamflow.

[4] Brazos River Authority, "Basin Highlights Report, 2005 Annual Water Quality Report."

Table 3.3-2.
Water Bodies with Concerns for Meeting Public Water Quality Standards in the Brazos G Area

Water Body No.	Water Body Name	Public Water Supply Concern(s)				Texas Water Quality Standard		
		TDS	Chloride	Sulfate	Increased costs for demineralization	TDS (mg/l)	Chloride (mg/l)	Sulfate (mg/L)
1203	Lake Whitney		✓			1,500	670	320
1205	Lake Granbury	✓	✓		✓	2,500	1,000	600
1207	Possum Kingdom Lake	✓	✓	✓	✓	3,500	1,200	500
1235	Lake Stamford	✓	✓	✓		2,100	580	400
1237	Lake Sweetwater			✓		730	250	225
1242	Brazos River above Navasota River				✓	1,000	350	200

3.3.3 Special Water Quality Studies and Activities in the Brazos River Basin

There are several special water quality studies that are on-going in the Brazos River Basin as described in the Brazos River Authority's 2005 Basin Highlights Report. A brief summary of these projects is described below.

3.3.3.1 Natural Salt Pollution Control

High concentrations of salt enter the Brazos River Basin from the semi-arid Upper Brazos Basin Region, consisting of salt and gypsum encrusted hills and canyon-like valleys. Major tributaries include the Salt and Double Mountain Forks of the Brazos River. Representatives from Stonewall, Kent, and Garza Counties have formed a Salt Fork Water Quality Corporation (SFWQC) to evaluate brine control to reduce chloride concentrations in the Brazos River. Preliminary studies have shown that pumping brine water using shallow recovery wells in Stonewall and Kent could reduce chloride concentration by an estimated 55 to 65 percent above Possum Kingdom Lake. The planning stage of the project is on-going and includes an environmental site assessment; geophysical studies on Salt Croton Creek, Croton Creek, and Short Croton Creek; pipeline routing options; and financial analysis.

3.3.3.2 Lake Granbury Escherichia coli Study

In May 2002, a study of Escherichia coli for Lake Granbury commenced and included 53 monitoring locations. The objective of the program was to assess potential impacts of on-site

sewage facilities. By 2004, several areas were identified where on-site systems were failing or improperly maintained. In August 2004, the monitoring program was revised and twelve sites were eliminated from future sampling.

3.3.3.3 Mining and Rock Quarry Operations

In October 2003, the TCEQ conducted an investigation of rock mining operations and determined that two operations in the Brazos River below Possum Kingdom Lake (Segment 1206) were noncompliant in controlling stormwater runoff. A target monitoring program was established to assess impacts of these operations on water quality.

3.3.3.4 Compost Effectiveness Monitoring

In September 2000, the Texas Soil and Water Conservation Board initiated the Dairy Manure Export Support (DMES) project to remove a large portion of dairy waste from the North Bosque Watershed. From 2000 through 2003, nearly 64 percent of dairy manure produced was hauled to composting facilities. A monitoring program of seven sites was established and has demonstrated statistically significant water quality improvement with declines in phosphorous levels. A pilot project to use a digester pond to convert manure slurry to methane gas for electricity is expected to open in the summer of 2005 near Hico, Texas in Hamilton County.

3.3.3.5 Bacterial Source Tracking

Several agencies are compiling a reference library to profile bacterial sources for Lake Waco and Lake Belton, as well as source waters for those reservoirs. Final development and classification of the reference library is expected to be completed in 2005.

3.3.3.6 North Bosque River Watershed Activity Coordination Project

The Brazos River Authority, Texas State Soil and Water Conservation Board, and EPA are engaged in an effort to identify pollution prevention projects for the North Bosque River watershed. Funding for this project runs through March 2006.

3.3.3.7 North Bosque River- PL566 Reservoir Evaluation

In October 2004, the Brazos River Authority funded a test pilot program to use alum to "fix" phosphorous in a flood control reservoir north of Stephenville. The process binds

orthophosphate phosphorous to alum in an insoluble form. The treatment system is expected in summer 2005.

3.3.3.8 Brazos Navasota Watershed Management Project

The Brazos Navasota Watershed Management Project, funded by the EPA and managed by the Brazos River Authority, is a multiple-phase approach to water quality management which includes creation of a stakeholder group, development of a water quality database, water quality monitoring, evaluation of poultry production practices, and recommendations of specific management techniques to protect water quality.

3.3.3.9 Nutrient Special Study in Brazos/ Navasota Watersheds

This special study is designed to determine if a relationship exists between support of aquatic life and nutrient-related water quality parameters. The study area includes Carters Creek, Cedar Creek, Cottonwood Creek, and Thompson Creek. These creeks were selected based on historical data showing high nitrogen and phosphorus concentrations. Study results will be submitted to the EPA in August 2005.

3.3.3.10 Dissolved Oxygen Special Study in Brazos/ Navasota Watersheds

The Watershed Task Force has initiated a study of Gibbons Creek to evaluate dissolved oxygen concentrations. The study includes 24-hour dissolved oxygen monitoring, biological assessment, and streamflow data collection on Gibbons Creek. A summary of results will be included in the Brazos/Navasota Watershed Management Plan.

3.4 Groundwater Availability

Fifteen aquifers underlie parts of the Brazos G Area, including six of the major and nine of the minor aquifers in Texas.[5] As presented earlier, Figures 1-9 and 1-10 show locations of the major and minor aquifers. A description of each aquifer, including groundwater availability, is presented in Appendix B. Table 3.4-1 summarizes groundwater availability by aquifer and by area. Table 3.4-2 is a compilation of groundwater availability and estimated supply by county. The availability estimates do not include saline water (greater than 1,000 milligrams per liter of total dissolved solids) and assumes a uniform distribution of withdrawals.

Table 3.4-1.
Groundwater Availability from BGRWPA Aquifers

Aquifer	*2060 Availability (acft/yr)*	*Typical Range in Well Yields (gpm)*
Western Area		
Seymour	67,055	100 to 1,000
Dockum	3,700	100 to 400
Blaine	1,333	less than 25
Edwards-Trinity (Plateau)	1,500	5 to 300
Subtotal:	73,588	
Central Area		
Trinity	77,563	50 to 500
Edwards-BFZ (Northern Segment)	12,500	200 to 2,000
Woodbine	2,432	50 to 150
Marble Falls	4,183	less than 100
Ellenburger-San Saba	551	
Hickory	ND	ND
Subtotal:	97,229	
Southeastern Area		
Brazos River Alluvium	66,700	250 to 500
Carrizo-Wilcox	251,000	100 to 3,000
Queen City	3,459	200 to 500
Sparta	10,333	200 to 600
Gulf Coast	28,296	300 to 800
Subtotal:	359,788	
Other and Undifferentiated	2,915	—
Total:	533,520	

BFZ – Balcones Fault Zone.
ND indicates not determined.

[5] Texas Water Development Board, *Water for Texas,* 1997.

Table 3.4-2.
Groundwater Availability and Supply from BGRWPA Counties and Aquifers

County	*Aquifer*	*Availability (acft/yr)*	*2010 Supply (acft/yr)*	*2060 Supply (acft/yr)*
Bell	Edwards-BFZ (Northern Segment)	2,500	1,200	1,200
	Trinity	2,169	1,383	1,353
	Subtotal:	4,669	2,583	2,553
Bosque	Brazos River Alluvium	2,500	671	598
	Trinity	1,718	1,718	1,718
	Subtotal:	4,218	2,389	2,316
Brazos	Brazos River Alluvium	12,500	2,074	1,620
	Carrizo-Wilcox	53,000	37,282	37,282
	Gulf Coast	1,177	0	0
	Queen City	645	285	285
	Sparta	2,107	2,103	2,107
	Subtotal:	69,429	41,744	41,294
Burleson	Brazos River Alluvium	9,400	8,583	6,914
	Carrizo-Wilcox	44,000	2,873	2,873
	Queen City	672	612	612
	Sparta	1,666	1,301	1,300
	Subtotal:	55,738	13,369	11,699
Callahan	Trinity	3,787	1,971	1,919
	Subtotal:	3,787	1,971	1,919
Comanche	Trinity	21,976	20,772	19,775
	Subtotal:	21,976	20,772	19,775
Coryell	Trinity	1,791	484	494
	Subtotal:	1,791	484	494
Eastland	Trinity	4,853	4,853	4,853
	Subtotal:	4,853	4,853	4,853
Erath	Trinity	20,165	14,820	14,284
	Subtotal:	20,165	14,820	14,284
Falls	Brazos River Alluvium	15,600	1,230	1,041
	Carrizo-Wilcox	1,000	0	0
	Trinity	161	161	161
	Subtotal:	16,761	1,391	1,202
Fisher	Dockum	100	100	100
	Seymour	7,000	2,809	2,463
	Subtotal:	7,100	2,909	2,563

Page 1 of 3

Table 3.4-2 (continued)

County	*Aquifer*	*Availability (acft/yr)*	*2010 Supply (acft/yr)*	*2060 Supply (acft/yr)*
Grimes	Brazos River Alluvium	1,700	0	0
	Carrizo-Wilcox	5,000	171	172
	Gulf Coast	14,083	4,614	4,620
	Queen City	462	0	0
	Sparta	2,044	379	379
	Subtotal:	23,289	5,164	5,171
Hamilton	Trinity	2,146	1,142	1,118
	Subtotal:	2,146	1,142	1,118
Haskell	Seymour	20,055	20,000	20,000
	Subtotal:	20,055	20,000	20,000
Hill	Trinity	2,383	2,081	2,081
	Woodbine	1,433	458	447
	Subtotal:	3,816	2,539	2,528
Hood	Trinity	6,163	5,909	5,909
	Subtotal:	6,163	5,909	5,909
Johnson	Trinity	2,053	2,053	2,053
	Woodbine	866	553	553
	Subtotal:	2,919	2,606	2,606
Jones	Seymour	8,000	4,245	3,703
	Subtotal:	8,000	4,245	3,703
Kent	Dockum	100	0	0
	Seymour	5,700	1,263	1,130
	Subtotal:	5,800	1,263	1,130
Knox	Blaine	1,333	0	0
	Seymour	24,000	23,910	23,910
	Subtotal:	25,333	23,910	23,910
Lampasas	Ellenburger-San Saba	551	0	0
	Marble Falls	4,183	33	27
	Trinity	2,145	906	889
	Subtotal:	6,879	939	916
Lee	Carrizo-Wilcox	45,000	9,138	3,616
	Queen City	1,240	924	892
	Sparta	3,900	150	150
	Subtotal:	50,140	10,212	4,658
Limestone	Carrizo-Wilcox	20,000	13,604	13,627
	Trinity	66	0	0
	Woodbine	33	0	0
	Subtotal:	20,099	13,604	13,627

Table 3.4-2 (concluded)

County	*Aquifer*	*Availability (acft/yr)*	*2010 Supply (acft/yr)*	*2060 Supply (acft/yr)*
McLennan	Brazos River Alluvium	15,600	2,359	2,300
	Trinity	1,718	1,718	1,718
	Woodbine	100	11	11
	Subtotal:	17,418	4,088	4,029
Milam	Carrizo-Wilcox	45,000	17,239	14,719
	Trinity	321	0	0
	Subtotal:	45,321	17,239	14,719
Nolan	Dockum	3,500	3,500	3,500
	Edwards-Trinity (Plateau)	1,000	836	836
	Subtotal:	4,500	4,336	4,336
Palo Pinto	Trinity	286	49	48
	Subtotal:	286	49	48
Robertson	Brazos River Alluvium	6,300	5,150	38
	Carrizo-Wilcox	38,000	28,037	21,490
	Queen City	440	0	0
	Sparta	616	0	0
	Subtotal:	45,356	33,187	21,528
Shackelford		0	0	0
	Subtotal:	0	0	0
Somervell	Trinity	1,233	1,233	1,233
	Subtotal:	1,233	1,233	1,233
Stephens	Other Aquifer	705	705	705
	Subtotal:	705	705	705
Stonewall	Seymour	2,300	465	419
	Subtotal:	2,300	465	419
Taylor	Edwards-Trinity (Plateau)	500	28	25
	Trinity	679	424	476
	Subtotal:	1,179	452	501
Throckmorton	Other Aquifer	364	89	101
	Subtotal:	364	89	101
Washington	Brazos River Alluvium	3,100	0	0
	Gulf Coast	13,036	4,957	4,998
	Subtotal:	16,136	4,957	4,998
Williamson	Edwards-BFZ (Northern Segment)	10,000	10,000	10,000
	Trinity	1,750	1,750	1,750
	Other Aquifer	665	665	665
	Subtotal:	12,415	12,415	12,415
Young	Other Aquifer	1,181	541	602
	Subtotal:	1,181	541	602
Total:		533,520	278,591	253,878

Page 3 of 3

3.4.1 Method of Analysis

The adopted process for estimating groundwater availability for the 2006 Brazos G Regional Water Plan consisted of appointing a Groundwater Work Group (GWG) to work with groundwater specialists and to provide recommendations to the BGRWPG. Under guidance and direction of the GWG, the groundwater specialists conducted several technical analyses and presented the findings at GWG meetings. After considerable discussion in public meetings, the GWG formulated recommendations and submitted them to the BGRWPG.

The process began on June 25, 2003, with a description of the aquifers in Brazos G and the methods that have been used in the past to estimate groundwater availability. At an October 14, 2003 meeting of the GWG, the groundwater specialist provided the results of the 2001 Brazos G groundwater availability estimates by aquifer and by county and recommendations for 2006 Brazos G estimates along with a discussion on applying TWDB's Groundwater Availability Models (GAMs), where available. At this meeting, the previous estimates were recommended by the GWG and were subsequently adopted by the BGRWPG for the Blaine, Brazos River Alluvium, Ellenburger-San Saba, Gulf Coast, Marble Falls, Queen City, Sparta, Trinity, and Woodbine Aquifers.

At an October 24, 2003 meeting which was focused on the Carrizo-Wilcox Aquifer, results of three simulations of the Central Carrizo-Wilcox GAM were presented and discussed. These simulations were at 75, 100, and 125 percent of the 2001 Brazos G availability estimates for the Carrizo-Wilcox. At the December 12, 2003 meeting of the BGRWPG and on the basis of guidance of the GWG, the groundwater specialists presented an analysis and recommendations of groundwater availability for the Seymour, Dockum, Edwards-Trinity (Plateau), Edwards-BFZ (Northern Segment), and Carrizo-Wilcox Aquifers. The BGRWPG adopted groundwater availability estimates for all these aquifers except the Carrizo-Wilcox.

At a February 11, 2004 BGRWPG meeting, results of simulations requested by the BGRWPG with pumping at 33, 80, and 100 percent of the previously recommended availability estimates were presented. Following considerable discussion, the recommended availability estimates were adopted by the BGRWPG. In a GWG meeting on February 15, 2005 and a BGRWPG meeting on February 22, 2005, the groundwater availability estimates for Lee County were reconsidered at the request of the Lost Pines Groundwater Conservation District. After considerable debate, the BGRWPG let stand the previously adopted estimates for Lee County.

In the overall development of groundwater availability estimates for the 2006 Brazos G Regional Water Plan, five approaches were used. The approaches are briefly described in Table 3.4-3 along with the applicable aquifers.

Table 3.4-3.
Summary of Methods Used to Estimate Groundwater Availability

Method of Analysis	*Description of Method*	*Aquifers*
Application of TWDB's Groundwater Availability Model (GAM)	Several GAM simulations with various pumping levels were performed to calculate regional and local groundwater drawdowns[1]. The estimated groundwater availability is equal to the greatest pumping rate that produced acceptable drawdowns.	Carrizo-Wilcox
Historical Performance	Historical data on groundwater levels, pumpage, and precipitation were studied to evaluate the past performance of the aquifer. This performance was used to estimate the potential level of groundwater development.	Dockum, Edwards-Trinity (Plateau), and Seymour
Application of TWDB's Groundwater Availability Model (GAM) and Historical Performance	Combining the two above methods	Edwards-BFZ (Northern Segment)
TWDB	Estimates developed using various methods for 1997 State Water Plan.	Blaine, Brazos River Alluvium, Ellenburger-San Saba Gulf Coast, Marble Falls, Queen City, Sparta, and Woodbine
2001 Brazos G	Estimates developed using various methods for 1997 State Water Plan with revisions to selected counties on the basis of aquifer performance.	Trinity

[1] Aquifer drawdown information is shown in Appendix B.

A description of each of the aquifers is provided in Appendix B. For the aquifers with updates from the Brazos G 2001 Regional Water Plan (i.e., Carrizo-Wilcox, Dockum, Edwards-Trinity (Plateau), Edwards-BFZ (Northern Segment), and Seymour), documentation on the analysis is also provided.

The distribution of groundwater availability is summarized by dividing the BGRWPA into three areas. As tabulated in Table 3.4-1 and shown in Figure 3.4-1, the groundwater in Region G is not uniformly distributed, with about 14 percent occurring in the western area, about 18 percent in the central area, and about 68 percent in the eastern area.

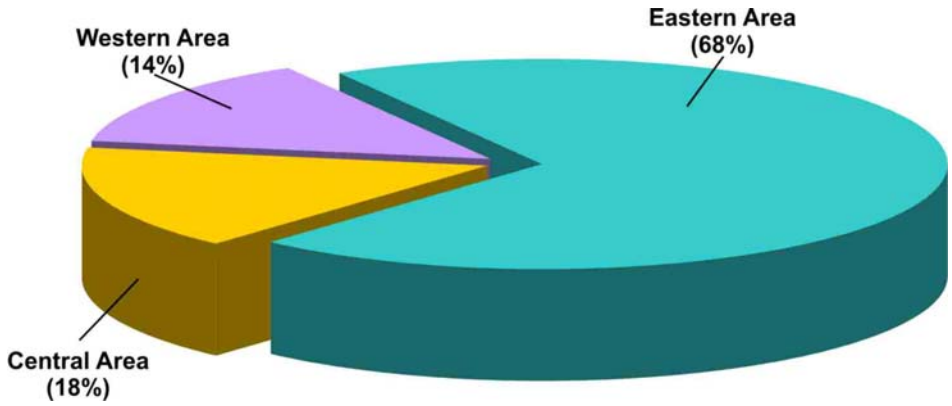

Figure 3.4-1. Distribution of Groundwater by Area — 533,520 acft/yr

3.4.2 Western Area

Only part of the western area is underlain by a major or minor aquifer, as shown in Figures 1-9 and 1-10. Together, the four aquifers—Blain, Dockum, Edwards-Trinity (Plateau), and Seymour—can supply up to 73,588 acft/yr. Of the four aquifers, the Seymour Aquifer has nearly 91 percent of the supplies and is scattered in six counties (Figure 3.4-2); however, about two-thirds of the supply is in Knox and Haskell Counties. The Dockum Aquifer exists only on the western fringe and can contribute about 5 percent of the groundwater supply in the area. Undifferentiated aquifers underlie some of the area, including all of Shackelford, Stephens, Throckmorton, and Young Counties. At best, the undifferentiated aquifers can provide only meager supplies for livestock and domestic uses.

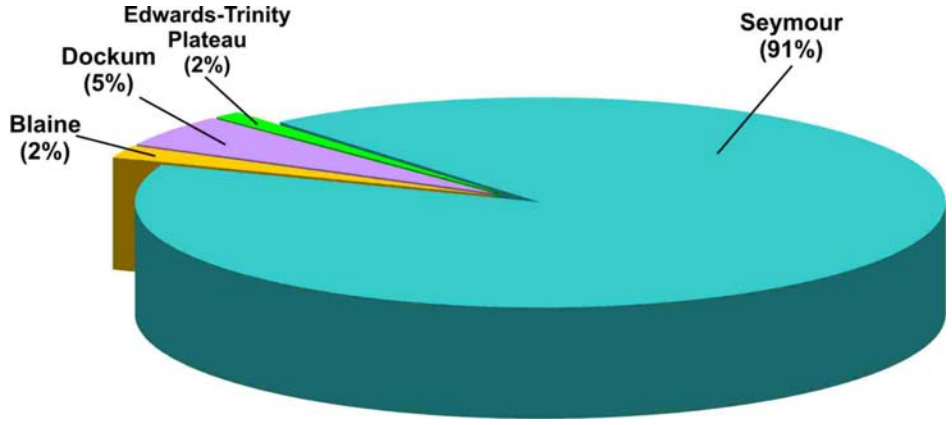

Figure 3.4-2. Groundwater Availability in the Western Area — 73,588 acft/yr

3.4.3 Central Area

Major or minor aquifers exist in the southeastern two-thirds of the central area, as shown in Figures 1-9 and 1-10. Together, the five aquifers (Edwards-BFZ (Northern Segment), Ellenburger-San Saba, Marble Falls, Trinity, and Woodbine) can provide up to 97,229 acft/yr. Of the five aquifers, the Trinity Aquifer is most extensive and has about 80 percent of the supplies (Figure 3.4-3). Although the Trinity Aquifer as a whole can provide 77,563 acft/yr, local areas have been severely over-drafted and cannot yield substantial supplies in the current planning period. The Edwards-BFZ (Northern Segment) only exists in parts of Bell and Williamson Counties and has about 13 percent of the area's groundwater supply.

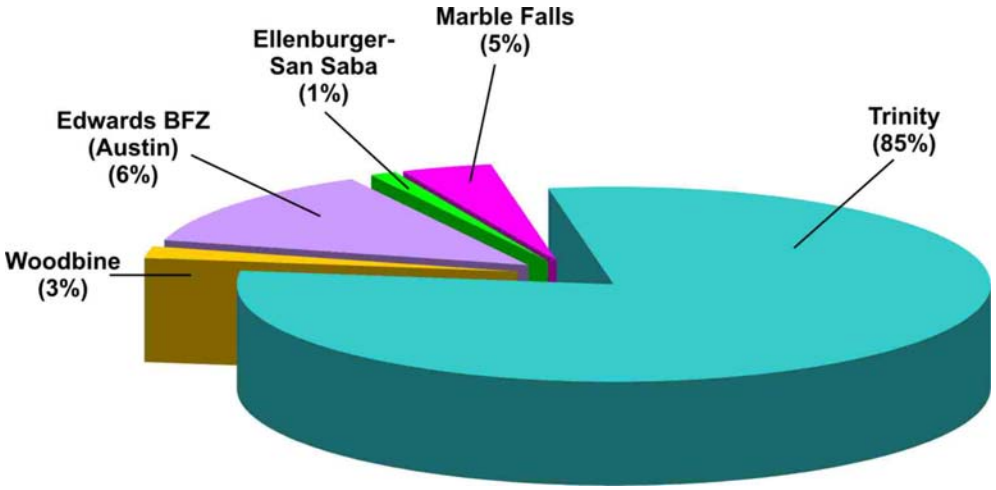

Figure 3.4-3. Groundwater Availability in the Central Area — 97,229 acft/yr

3.4.4 Eastern Area

Major or minor aquifers exist throughout the eastern area except in the western fringe, as shown in Figures 1-9 and 1-10. Together, the five aquifers (Brazos River Alluvium, Carrizo-Wilcox, Gulf Coast, Queen City, and Sparta) can provide up to 359,788 acft/yr. Of the five aquifers, the Carrizo-Wilcox Aquifer is most extensive and has about 70 percent of the supplies (Figure 3.4-4). The Brazos River Alluvium has about 18 percent of the supplies.

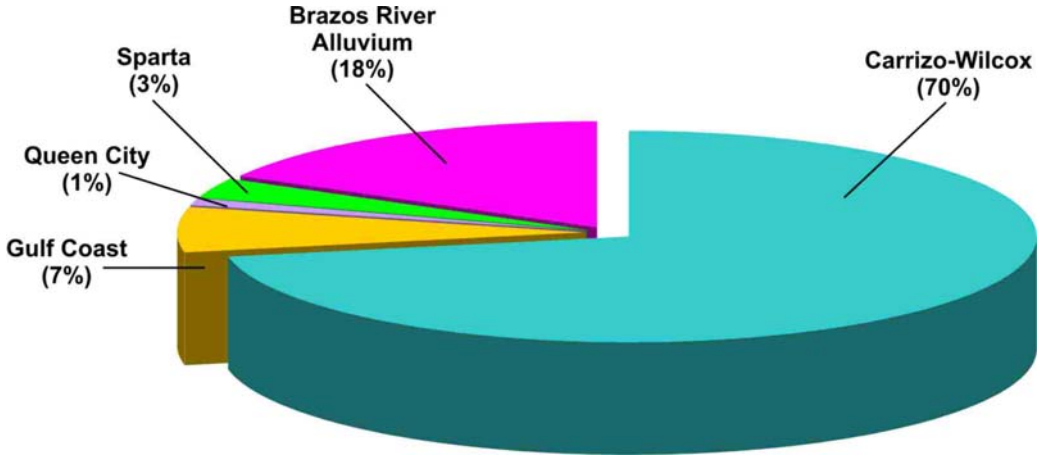

Figure 3.4-4. Groundwater Availability in the Eastern Area — 359,788 acft/yr

3.4.5 Data and Information Needs

To make major improvements in the accuracy and reliability of existing groundwater availability estimates, the following data, analyses, and tools are suggested.

- Water levels measurements:
  - Frequency (daily or monthly): At a relatively few and key locations, water level data for long periods of time provide documentation on trends and a means of determining if the availability estimates can or should be modified.
  - Coverage: Infrequent (annual) water level measurements made at many locations over a relatively short period of time provides a key data element in constructing water level maps that can show the regional flow patterns and extent of influence from pumping centers.
- Recharge:
  - Outcrop areas: Estimates (actually assumptions at this time) can be greatly improved by establishing a data collection network of precipitation gages and shallow water level monitoring wells in the outcrop areas.
  - Streams: Estimates can be made by conducting streamflow gain-loss studies and the establishment of monitoring networks to measure stage and discharge of streams and water levels in nearby shallow wells.
  - Cross-formational flow: These estimates would be made with existing hydrogeologic information, development of models and a rather dense network of water level monitoring wells.
- Discharge:
  - Wells: The existing estimates of pumpage are believed to be rather inaccurate. In the calculation of availability, withdrawals are a very strong control in aquifer conditions and directly influence the results.

- Streams, evapotranspiration, and wetlands areas: Estimates can be improved with rather dense networks of water level monitoring wells and flow-net analyses.
- Modeling: The best method to develop a water budget for an aquifer and the calculation of groundwater availability is the development of a groundwater flow model. Once the model has been tested, it is very useful in testing various groundwater development scenarios. The TWDB has completed GAMs for eight of the nine major aquifers and four of the 20 minor aquifers in Texas. Continued development and refinement of these models will greatly aid future estimates of groundwater availability.
- Water Quality: Networks of wells and periodic sampling are needed in areas where the water is vulnerable to contamination. This is most important in outcrop areas where there is considerable activity and development.

3.4.6 Comparison of Groundwater Availability Estimates to Groundwater Conservation District Estimates

One of the requirements in State statues for the groundwater conservation districts is developing a groundwater management plan that includes an estimate of groundwater availability. Likewise, the regional planning requires estimating groundwater availability to determine the total water supplies within a county and in the planning region. A compilation of these two sources of groundwater availability estimates is provided in Table 3.4-4.

Table 3.4-4 shows the Lee County groundwater availability estimates by Lost Pines GCD and BGRWPG to be nearly the same. However, the district originally estimated the Lee County groundwater availability from the Carrizo-Wilcox to be equal to recharge in Lee County, as determined by the Central Carrizo-Wilcox GAM, which is 7,500 acft/yr. This availability estimate was changed by the district to 46,458 acft/yr for the appearance of eliminating the apparent conflict with the 2001 Brazos G Regional Water Plan in order to obtain a determination of administrative completeness from the TWDB. This change was made under protest to the TWDB and to the BGRWPG.

One of the notable differences in groundwater availability estimates is in Lampasas County where the district's estimate is nearly three times greater than the Brazos G estimate. The district and Brazos G reference TWDB estimates that were prepared at different times and by different methods.

Table 3.4-4.
Comparison of Groundwater Availability Estimates by Groundwater Conservation Districts and Brazos G Regional Water Planning Group

Groundwater Conservation District (GCD)	Counties in Brazos G	Aquifer(s)	Groundwater Availability Estimates (acft/yr)	
			GCD	Brazos G
Western Area				
Clear Fork	Fisher	Dockum	N/A	100
		Seymour	N/A	7,000
		Total		7,100
Salt Fork	Kent	Dockum	N/A	100
		Seymour	N/A	5,700
		Total	4,964	5,800
Wes-Tex	Nolan		N/A	4,500
Rolling Plains	Knox and Haskell	Blaine	1,333	1,333
		Seymour	47,000	44,000
		Total	48,333	45,333
Central Area				
Clearwater	Bell	Edwards-BFZ (Northern Segment)	1,315	2,500
		Trinity	3,318	2,169
		Total	4,673	4,669
Middle Trinity	Erath and Comanche	Edwards-Trinity	42,141	42,141
Saratoga	Lampasas	Ellenburger-San Saba	N/A	551
		Marble Falls	N/A	4,183
		Trinity	N/A	2,145
		Total	18,150	6,879
Eastern Area				
Post Oak Savannah	Milam and Burleson	Brazos River Alluvium	9,400	9,400
		Carrizo-Wilcox	92,916	90,000
		Queen City	672	672
		Sparta	1,666	1,666
		Trinity	321	321
		Total	111,854	100,559
Brazos Valley	Brazos and Robertson	Brazos River Alluvium	25,500	18,800
		Carrizo-Wilcox	92,900	90,000
		Gulf Coast	1,177	1,177
		Queen City	1,085	1,085
		Sparta	4,146	2,723
		Total	124,808	113,785
Lost Pines	Lee	Carrizo-Wilcox	46,458[1]	45,000
		Queen City	N/A	1,240
		Sparta	N/A	3,900
		Total	N/A	50,140
Bluebonnet	Grimes	Brazos River Alluvium	1,700	1,700
		Carrizo-Wilcox	6,789	5,000
		Gulf Coast	14,083	14,083
		Queen City	462	462
		Sparta	2,044	2,044
		Total	25,078	23,289

[1] The Lost Pines GCD originally estimated the Lee County groundwater availability from the Carrizo-Wilcox to be equal to recharge in Lee County, as determined by the Central Carrizo-Wilcox GAM, which is 7,500 acft/yr. This availability estimate was changed by the district to 46,458 acft/yr for the appearance of eliminating the apparent conflict with the 2001 Brazos G Regional Water Plan in order to obtain a determination of administrative completeness from the TWDB. This change was made under protest to the TWDB and to the BGRWPG.

3.5 Supplies from Other Regions

A limited number of entities within the Brazos G Area obtain water from sources located outside of the region. These other sources are Benbrook Reservoir, Navarro Mills Reservoir, the Colorado River MWD System, Lake Livingston (Trinity River Authority), and the Highland Lakes System (LCRA). Table 3.5-1 summarizes the current supplies from other regions to the Brazos G Area.

Table 3.5-1.
Water Supplies from Other Regions

Receiving Entity	*Source*	*Source Region*	*Amount Supplied (acft/yr)*
Burleson	Lake Benbrook	C	2,330
Mansfield	Lake Benbrook	C	Meets
Hill County – Other	Navarro Mills Reservoir	C	353
Abilene	Colorado River MWD System	F	6,720
Hubbard	Navarro Mills Reservoir	C	Meets
Grimes County SE	Lake Livingston (TRA)	H	6,721
Cedar Park	Highland Lakes System	K	18,000
Leander	Highland Lakes System	K	6,400
Lometa	Highland Lakes System	K	Meets
Blockhouse MUD	Highland Lakes System	K	Included in Cedar Park
Wells Branch MUD	Highland Lakes System	K	Meets
Williamson-Travis County MUD #1	Highland Lakes System	K	Included in Cedar Park

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