CHAPTER 3

EVALUATION OF CURRENT WATER SUPPLIES

TEXAS STATE WATER PLAN

REGION B

JUNE 2005

EVALUATION OF CURRENT WATER SUPPLIES

TEXAS STATE SENATE BILL 1

REGION B

Under Senate Bill 1 planning guidelines, each region is to identify currently available water supplies to the region by 1) source and 2) user. The supplies available by source are based on the water available during drought of record conditions. For surface water reservoirs, this is the equivalent of firm yield supply or permitted amount (whichever is lower). For diversions directly from a stream or river (run-of-the-river), this is the minimum supply available in a year over the historical record. Groundwater supplies are defined by availability by county and aquifer. Generally, groundwater supply is the supply available with acceptable long-term impacts to water levels. These impacts may vary with users and locations.

In addition to surface water and groundwater supplies, there are available supplies from reuse and local supplies. The available supply from reuse is based on permitted authorizations and facilities. Current reuse in Region B is negligible and limited to municipal irrigation. Local supplies generally include stock ponds for livestock.

3.1 Existing Surface Water Supply

Water users in the Region B planning area receive surface water from sources in the Brazos, Trinity, and Red River Basins. In accordance with the Texas Water Development Board's (TWDB) established procedures, the surface water supplies for the 2006 regional water plans are determined using the TCEQ-approved Water Availability Models (WAM). Water Availability Models have been completed for each of the major river basins in Texas. The Water Availability Models were developed for the purpose of reviewing and granting new surface water rights permits. The assumptions in the Water Availability Models are based on the legal interpretation of water rights and in some cases do not accurately reflect current operations. For planning purposes, adjustments were made to the Water Availability Models to better reflect current and future surface water conditions in the region.

Generally, changes to the Water Availability Models included:

- Assessment of reservoir sedimentation rates and calculation of area-capacity conditions for current (2000) and future (2060) conditions. (See Section 3.1.2)
- Inclusion of system operation of the Lake Kemp/Lake Diversion system
- Other corrections

Table 3.1 summarizes the currently available surface water supplies by reservoir source in Region B in acre-feet per year. Run of the river supplies and local surface water supplies are presented in Table 3.2. The Water Availability Models were also used to determine the run of the river supplies. Local supplies shown in Table 3.2 are the historical surface water use for livestock or mining reported by the TWDB. It is assumed that these estimates represent available surface water from stock ponds, which are not required to have a water right and are not included in the WAMs. Brief descriptions of reservoirs in the region are included in Section 3.1.1. Water rights associated with run of the river supplies are discussed in Section 3.1.5.

Table 3.1
Currently Available Surface Water Supplies – Reservoirs
(acre-feet per year)

	Basin	2000	2010	2020	2030	2040	2050	2060
WATER SUPPLY SYSTEMS								
Lake Kemp/ Diversion System	Red	100,650	90,417	80,184	69,951	59,718	49,485	39,250
Wichita System Kickapoo Arrowhead	Red	50,830	49,939	49,048	48,157	47,266	46,375	45,480
Subtotal		**151,480**	**140,356**	**129,232**	**118,108**	**106,984**	**95,860**	**84,730**
RESERVOIRS IN REGION B								
Lake Amon Carter	Trinity	2,210	2,108	2,006	1,904	1,802	1,700	1,600
Lake Electra	Red	470	462	454	446	438	430	420
North Fork Buffalo Creek Reservoir	Red	840	840	840	840	840	840	840
Santa Rosa Lake	Red	3,075	3,075	3,075	3,075	3,075	3,075	3,075
Lake Pauline	Red	1,284	1,284	1,284	1,284	1,284	1,284	1,284
Lake Cooper/Olney	Red	961	961	961	961	961	961	961
Lake Nocona	Red	1,260	1,260	1,260	1,260	1,260	1,260	1,260
Subtotal		**10,100**	**9,990**	**9,880**	**9,770**	**9,660**	**9,550**	**9,440**
RESERVOIRS OUTSIDE REGION B								
Greenbelt Reservoir	Red	8,985	8,854	8,723	8,592	8,461	8,330	8,200
TOTAL		**170,565**	**159,200**	**147,835**	**136,470**	**125,105**	**113,740**	**102,370**

Table 3-2
Summary of Local Surface Water Supplies for Region B
(acre-feet per year)

	Use	County	Basin	2000	2010	2020	2030	2040	2050	2060
LOCAL RUN-OF-THE-RIVER SUPPLIES										
Run-of-the-River	Irrigation	Archer	Red	7	7	7	7	7	7	7
Run-of-the-River	Irrigation	Baylor	Red	0	0	0	0	0	0	0
Run-of-the-River	Irrigation	Baylor	Brazos	17	17	17	17	17	17	17
Run-of-the-River	Irrigation	Clay	Red	1,809	1,809	1,809	1,809	1,809	1,809	1,809
Run-of-the-River	Irrigation	Cottle	Red	11	11	11	11	11	11	11
Run-of-the-River	Irrigation	Hardeman	Red	116	116	116	116	116	116	116
Run-of-the-River	Irrigation	Montague	Red	47	47	47	47	47	47	47
Run-of-the-River	Irrigation	Wichita	Red	325	325	325	325	325	325	325
Run-of-the-River WCWID #2	Irrigation	Wichita	Red	8,850	8,850	8,850	8,850	8,850	8,850	8,850
Run-of-the-River	Irrigation	Wilbarger	Red	779	779	779	779	779	779	779
Run-of-the-River - Archer City Lake	Municipal -	Archer	Red	314	314	314	314	314	314	314
Run-of-the-River - Petrolia	Municipal -	Clay	Red	67	67	67	67	67	67	67
Run-of-the-River Henrietta	Municipal -	Clay	Red	1,499	1,499	1,499	1,499	1,499	1,499	1,499
Run-of-the-River - Iowa Park/Gordon	Municipal -	Wichita	Red	538	538	538	538	538	538	538
Run-of-the-River	Municipal	Wilbarger	Red	115	115	115	115	115	115	115
Run-of-the-River	Industrial	Clay	Red	141	141	141	141	141	141	141
Run-of-the-River	Mining	Clay	Red	1	1	1	1	1	1	1
Run-of-the-River	Mining	Wilbarger	Red	30	30	30	30	30	30	30
Subtotal				**14,666**	**14,666**	**14,666**	**14,666**	**14,666**	**14,666**	**14,666**

Table 2 (continued)

	Use	County	Basin	2000	2010	2020	2030	2040	2050	2060
Local Supply	Livestock[1]	Archer	Red	1,948	2,049	2,049	2,049	2,049	2,049	2,049
Local Supply	Livestock	Archer	Brazos	116	122	122	122	122	122	122
Local Supply	Livestock	Archer	Trinity	256	268	268	268	268	268	268
Local Supply	Livestock	Baylor	Red	566	566	566	566	566	566	566
Local Supply	Livestock	Baylor	Brazos	333	333	333	333	333	333	333
Local Supply	Livestock	Clay	Red	1,567	1,784	1,784	1,784	1,784	1,784	1,784
Local Supply	Livestock	Clay	Trinity	175	198	198	198	198	198	198
Local Supply	Livestock	Cottle	Red	449	449	449	449	449	449	449
Local Supply	Livestock	Foard	Red	251	251	251	251	251	251	251
Local Supply	Livestock	Hardeman	Red	288	288	288	288	288	288	288
Local Supply	Livestock	King	Red	219	437	437	437	437	437	437
Local Supply	Livestock	King	Brazos	129	257	257	257	257	257	257
Local Supply	Livestock	Montague	Red	770	949	949	949	949	949	949
Local Supply	Livestock	Montague	Trinity	581	716	716	716	716	716	716
Local Supply	Livestock	Wichita	Red	404	704	704	704	704	704	704
Local Supply	Livestock	Wilbarger	Red	959	1,617	1,617	1,617	1,617	1,617	1,617
Local Supply	Livestock	Young	Brazos	0	301	301	301	301	301	301
Local Supply	Livestock	Young	Trinity	0	20	20	20	20	20	20
Local Supply	Mining	Hardeman	Red	7	7	7	7	7	7	7
Subtotal				**9,018**	**11,316**	**11,316**	**11,316**	**11,316**	**11,316**	**11,316**

[1] TWDB historical livestock surface water use. Year 2000 supplies are the reported usage in year 2000 by the TWDB.

3.1.1 Existing Water Supply Reservoirs

Greenbelt Lake

Greenbelt Lake is located in the Panhandle Planning Area (Region A), but water from the lake is used to supply several cities in Region B. The lake is owned and operated by the Greenbelt Municipal and Industrial Water Authority, and is located on the Salt Fork of the Red River in Donley County near the City of Clarendon. Construction of Greenbelt Lake was completed in 1968, and the lake had an initial conservation capacity of 60,400 acre-feet. Greenbelt Municipal and Industrial Water Authority has a diversion right of 12,000 acre-feet per year from the lake to provide municipal, industrial, mining, and irrigation water supply. The firm yield of the reservoir in year 2000 was estimated to be 8,985 acre-feet per year.

Lake Pauline

Lake Pauline is located on the upper reaches of Wanderers Creek near Quanah in Hardeman County. The dam was completed in 1928 and the reservoir had a reported conservation capacity of 4,137 acre-feet in 1968 (Bisset, 1999). Lake Pauline is owned and operated by American Electric Power. The lake is permitted for 3,616 acre-feet per year of consumptive use, which includes 3,000 acre-feet per year of diversions from Groesbeck Creek. Its primary use was for cooling water for the Lake Pauline power plant. This plant has recently been moth-balled and is not operating at this time. The estimated firm yield for Lake Pauline with diversions from Groesbeck Creek is 1,284 acre-feet per year.

Lakes Kemp and Diversion

Lake Kemp is located on the Wichita River, immediately upstream of State Highway 183 in Baylor County. The original storage was estimated at 268,000 acre-feet. Lake Diversion was constructed approximately 20 miles downstream of Lake Kemp for secondary storage with a capacity of 40,000 acre-feet. The reservoir lies in both Archer and Baylor counties.

Lake Diversion is operated in conjunction with Lake Kemp to provide water supply for municipal, industrial, irrigation, mining, and recreational purposes. The City of Wichita Falls and Wichita County Water Improvement District No. 2 own the water rights in Lakes Kemp and Diversion. Water released from Lake Kemp travels to Lake Diversion for distribution. Irrigation water is diverted into canal systems.

Due to high salinity loads in the tributaries that flow to Lake Kemp, most of the water use from Lake Kemp historically has been limited to irrigation and industrial purposes. The City of Wichita Falls is completing a reverse osmosis water treatment plant and infrastructure to utilize water from Lake Kemp for municipal purposes. This project is expected to be operational by 2006.

To improve the water quality of the Wichita River, the Red River Authority sponsors a chloride control project that diverts saline water from the South Wichita River above Lake Kemp to Truscott Brine Reservoir in Knox County. Recent evaluations of the effectiveness of the project found these diversions reduce the total chloride load to Lake Kemp by approximately 25 percent. This results in a lower flow-weighted chloride concentration in the reservoir. However, there still is a significant chloride load to the reservoir system from the North and Middle Wichita Rivers. Future proposed low flow diversions from these tributaries should further reduce the chloride loading into Lake Kemp.

The yield of Lake Kemp and Lake Diversion was evaluated as a system with releases made to Lake Diversion when the water elevation at Lake Diversion dropped to 1049.5 feet mean sea level (MSL). The total permitted diversion for the system is 193,000 acre-feet per year. The water right allows the district to divert a portion of the irrigation right (16,660 acre-feet per year) directly from the Wichita River for irrigation purposes. This portion of the water right was evaluated as a run of the river supply and is not part of the firm yield of the system. Under these assumptions, the projected yield of the Lake Kemp/Lake Diversion System in 2000 was 100,650 acre-feet per year.

Santa Rosa Lake

Santa Rosa Lake is located in Wilbarger County on Beaver Creek. It was constructed in 1929 by the Waggoner Estate for irrigation and had an original capacity of 15,755 acre-feet. Current use is for livestock and irrigation. It is permitted for 3,075 acre-feet per year, but recent historical use is much lower. According to a representative of the Waggoner Estate, the lake went totally dry in 1971. Recent reported use from the lake is approximately 100 to 300 acre-feet per year. The Red River Basin Water Availability Model shows a firm yield of in excess of its permitted diversion. However, in light of historical performance, Santa Rosa Lake has little reliable supply, and is not considered a major water supply source for planning purposes.

Lake Electra

Lake Electra is located on Camp Creek near the City of Electra in Wichita County. It is owned and operated by the City of Electra and has a diversion right of 600 acre-feet per year for municipal use. At normal pool elevation (1,111 feet MSL), the storage capacity of Lake Electra is 5,626 acre-feet. However, due to the relatively small drainage area (14.5 square miles), the lake is usually below its normal pool elevation. Previous reports indicate the lake may never have completely filled since construction was completed in 1950. The WAM shows the firm yield of Lake Electra is 470 acre-feet per year.

Over the past eight years Lake Electra has experienced continued low lake levels and may be in a critical drought. To supplement Lake Electra, the City has a permit to divert up to 800 acre-feet per year from Beaver Creek for emergency municipal use. This right has been used on occasion, but there is no permanent diversion structure or transmission line. A review of available flows in Beaver Creek indicates that during some years there is very little flow during the hot dry months. In 1984, the total flow during the dry spring and summer months was less than 800 acre-feet. Also, Beaver Creek has a higher salinity level than Lake Electra. Large diversions from Beaver Creek may require additional treatment, which is currently undesirable. During a drought, diversions from Beaver Creek will be minimal because of the water quality and low flow conditions. To fully utilize this emergency right, diversions from Beaver Creek must be planned over the year. Since there is no existing diversion system in place and this water is only available for emergencies, it is assumed that this supply is currently not available to Electra.

North Fork Buffalo Creek Reservoir

The North Fork Buffalo Creek Reservoir was constructed in 1964 to provide additional water for the City of Iowa Park. The dam is located below the confluence of North Fork Buffalo Creek and Lost Creek in Wichita County. The reservoir had an original storage capacity of 15,400 acre-feet with a drainage area of 33 square miles. The current permitted water right for the reservoir is 840 acre-feet per year. North Fork Buffalo Creek Reservoir is owned and operated by the City of Iowa Park.

North Fork Buffalo Creek Reservoir is currently in drought of record conditions. During 2004, the content in the reservoir dropped to less than 400 acre-feet, which is approximately two percent of its conservation storage. The City stopped using water from North Fork Buffalo Creek and is purchasing water from the City of Wichita Falls. Previous studies as well as the Red River WAM report firm yield estimates at about 2,000 acre-feet per year. Based on the current performance of the lake, the firm yield is most likely much less. For this plan, it is assumed that the firm supply available from North Fork Buffalo Creek Reservoir is 840 acre-feet per year.

Wichita System

The Wichita System consists of Lake Kickapoo and Lake Arrowhead. These lakes are owned and operated by the City of Wichita Falls for municipal and industrial supply. Water from the lakes is transported to Wichita Falls' water treatment plants for treatment and distribution. Some raw water is sold directly to wholesale customers. A brief description of each lake follows:

Lake Kickapoo

Lake Kickapoo was built by the City of Wichita Falls in 1946 for municipal water supply with an initial conservation storage capacity of 106,000 acre-feet. The reservoir is located on the North Fork of the Little Wichita River in Archer County. It is owned and operated by the City of Wichita Falls. The diversion rights from the lake total 41,720 acre-feet per year.

Lake Arrowhead

Lake Arrowhead was built in 1966 by the City of Wichita Falls for municipal, industrial, and recreational use. The lake is located on Little Wichita River in Clay County, about 12 miles southeast of Wichita Falls. The lake is owned and operated by the City of Wichita Falls. The diversion rights from Lake Arrowhead total 45,000 acre-feet per year; however, the maximum diversion from both Lake Arrowhead and Kickapoo cannot exceed 65,000 acre-feet per year. This water right condition was considered in the evaluation of the system yield. The firm yield of the Wichita System in 2000 was estimated at 50,830 acre-feet per year.

Lakes Olney and Cooper

Lakes Olney and Cooper are a twin-lake system located on Mesquite Creek in Archer County. Lake Olney dam was constructed in 1935 to provide municipal water for the City of Olney. In 1953 the dam for Lake Cooper was built for additional storage. Collectively, the lakes have a conservation storage capacity of 6,650 acre-feet, with diversion rights of 1,260 acre-feet per year. The firm yield of these lakes is estimated at 961 acre-feet per year.

Lake Nocona

Lake Nocona is a 25,400 acre-foot reservoir located on Farmers Creek in Montague County, approximately eight miles northeast of the City of Nocona. Construction was completed in 1960 to provide municipal water supply to the City of Nocona. The lake is owned and operated by the North Montague County Water Supply District. The original permit for Lake Nocona allowed the diversion and use of 4,500 acre-feet per year for municipal, industrial, and mining purposes. In 1984, the final determination of water rights for the Middle Red River segment of the Red River Basin reduced the authorized diversion to 645 acre-feet per year for municipal use only. Subsequent studies reported the firm yield of the reservoir to be 1,260 acre-feet per year through year 2030 (F&N, 1986). The water right permit for diversions from Lake Nocona was amended in 1987 to 1,260 acre-feet per year for municipal, irrigation, and recreational uses. The reported firm yield for Lake Nocona using the Red River WAM greatly exceeded the permitted amount. For this plan, the firm supply from Lake Nocona is 1,260 acre-feet per year.

Amon G. Carter

Lake Amon G. Carter is located on Big Sandy Creek in Montague County, about six miles south of the City of Bowie, Texas. The lake was originally constructed in 1956 and enlarged in 1979. It has a current storage capacity of 28,600 acre-feet and an estimated firm yield of 2,210 acre-feet per year. The lake is owned and operated by the City of Bowie for water supply. The existing water right permit allows for a diversion of 5,000 acre-feet per year for municipal, industrial, and mining water use.

Miller's Creek Reservoir

Miller's Creek Reservoir is located about 7 miles southeast of Bomarton, Texas in the Brazos River Basin. The dam was constructed in 1977 on Miller's Creek in Baylor County, and the reservoir extends southwest into Throckmorton County. It is owned and operated by the North Central Texas Municipal Water Authority. It has a permitted diversion of 5,000 acre-feet per year for municipal, industrial, and mining uses. Water from this reservoir is currently used exclusively in the Brazos G Region. The yield for Miller's Creek Reservoir was determined by the Brazos G Region. Under safe yield analysis, the Brazos G reports a reliable supply of 583 acre-feet per year in 2010, reducing it to little to no reliable supply by 2060.

Other Lakes and Reservoirs in the Region

Lake Wichita

Lake Wichita is located south of the City of Wichita Falls and lies in Archer and Wichita Counties. It was constructed in 1901 on Holliday Creek for irrigation and municipal use, but little water has been used for municipal purposes since Lake Kickapoo water supply became available. Presently, Lake Wichita is used for recreational purposes only.

Lake Iowa Park

Lake Iowa Park is located on Stevens Creek, northwest of the City of Iowa Park, and has been a source of water for the City of Iowa Park since 1949. The lake has a storage capacity of 2,565 acre-feet and the water right permit allows a diversion of 500 acre-feet per year for municipal use. The lake has recently experienced severe drought conditions and was nearly dry in years 2000 and 2004. The City of Iowa Park is no longer using this lake for water supply.

3.1.2 Sedimentation and Impacts to Reservoir Yields

Sediment production rates in Region B vary considerably due to land use, soil types and topography. Wind erosion is quite active across the rolling prairies and cultivated fields. The USGS and U.S. Soil Conservation Services have compiled much of the sedimentation data available for reservoirs in Region B. Lakes Kickapoo, Arrowhead and Nocona have recently published volumetric surveys, which were used to estimate sedimentation rates. Estimates of sedimentation rates for the other lakes were developed from several sources. For sedimentation rates developed from the Texas Board of Water Engineers Report 5912, the effects of SCS structures and development were considered. Estimates of reservoir capacities for years 2000 and 2060, based on the reservoir's drainage area and sedimentation rate, are presented in Table 3-3. Since the yield of a reservoir is affected by the reservoir's area-capacity relationship, high sedimentation rates will reduce the reservoir's storage capacity and firm yield. The projected reservoir yields over the planning period are shown in Table 3-1.

Table 3-3: Estimated Sedimentation Rates and Projected Capacities

Reservoir	Drainage Area (Sq mi)	Sediment Rate (af/yr/sq mi)	Year of Initial Capacity	Capacities (Ac-ft)			Source (sediment rate)
				Initial	2000	2060	
Lake Pauline	42.6	0.68	1971	4,137	3,297	1,559	TBWE 1959
Lake Kemp	2086	1.13	1973[1]	268,000	205,160	65,506	F&N 1976
Santa Rosa Lake	334	0.14	1929	15,755	8,245	5,434	Espey 2002
Lake Electra	14.5	0.69	1998[2]	5,626	5,606	5,006	TBWE 1959
North Fork Buffalo Creek	33	0.86	1964	15,400	14,378	12,676	TBWE 1959
Lake Kickapoo	275	1.325	1946	106,400	86,280	64,417	TWDB, 2001
Lake Arrowhead	832	0.98	1966	262,100	237,150	185,974	TWDB 2001
Olney/Cooper	12.3	0.68	1935/1953	6,650	6,165	5,663	TBWE 1959
Lake Nocona	94	0.48	1961	25,400	21,819	19,112	TWDB 2002
Amon Carter	101	0.51	1980[3]	28,589	27,876	24,772	HDR 1979

1. Revised construction was completed in 1973. At that time, COE re-surveyed the lake.
2. 1998 area-capacity data. Previous survey conducted in 1987 indicated much larger capacity. This difference is currently being investigated.
3. Enlargement of the Lake Amon Carter was completed in 1980 and area-capacity was determined at that time.

3.1.3 Reservoir Water Rights

Water rights for reservoirs located in Region B are summarized on Table 3-4. Comparisons of rights to firm yields indicate that water rights for several of the reservoirs in Region B exceed firm yield. For Lake Kemp, the 2000 firm yield was approximately 57 percent of the permitted right. By 2060, the projected yield of the Lake Kemp system is only 22 percent of the permitted diversion. Presently, water from Lake Kemp is used only for irrigation and industrial uses, with occasional emergency municipal use. As Wichita Falls begins using water from Lake Kemp and industrial demands increase, the total demand on this resource will likely exceed the available supplies during drought of record conditions.

A summary of the existing known contracts by reservoir is presented on Table 3-5. With the exception of the City of Wichita Falls, the primary water right holders are not included on Table 3-5.

Table 3-4: Summary of Reservoir Water Rights

Reservoir	Water Right No.	Priority Date	Holder	Water Right Amount (acre-feet/year)						2000 Yield (ac-ft/yr)
				Mun	Ind	Irr	Mining	Rec	Total	
Greenbelt	5233	08/11/58	Greenbelt MIWA	14,530	500	250	750		16,030	8,985
Pauline/ Groesbeck	5230	06/27/14 03/05/45	American Electric Power		3,600	16		0	3,616	1,284
Kemp/ Diversion	5123	10/02/20	Wichita Co WID#2 Wichita Falls	25,150	40,000	103,340[1]	2,000	5,850	176,340[1]	100,650
Santa Rosa	5124	06/30/26	W.T. Waggoner Estate			3,075			3,075	3,075
Electra	5128 5128	03/29/49 02/25/74	City of Electra Emergency supply	600 800					600 800	470 0
Kickapoo	5144	06/21/44	Wichita Falls	40,000					40,000	50,830
Arrowhead	5150	06/20/62	Wichita Falls	45,000					45,000	
Olney/ Cooper	5146	03/26/53	City of Olney	1,260					1,260	910
N.F. Buffalo Creek	5131	09/19/62	City of Iowa Park	840					840	840
Iowa Park/ Lake Gordon	5132 5133	08/03/49 11/22/38	City of Iowa Park	500 300					800	538
Nocona	4879	10/09/58	North Montague Co. WSD	1,080		100		80	1,260	1,260
Amon Carter	3320	07/12/54	City of Bowie	3,500	1,300		200		5,000	2,210

Mun – Municipal Use Ind – Industrial Use Irr – Irrigation Use Rec – Recreational Use

1. Water right 5123 includes a diversion of 16,660 acre-feet per year directly from the river for irrigation. This portion of the right is not included in this table. The total permitted diversion for irrigation by the Wichita County WID #2 is 120,000 acre-feet per year. The total permitted diversion for water right 5123 is 193,000 acre-feet per year.

Source: Texas Commission on Environmental Quality, Water Rights Database, 2004.

Table 3-5: Summary of Existing Water Supply Contracts in Region B

Source Name	Contract Holder	Contract Amount		Comment
		MGD	AF/YR	
Greenbelt	Crowell		273	No Contract Amount – 2000 Historical Use
Greenbelt	Quanah		598	No Contract Amount – 2000 Historical Use
Greenbelt	Red River Authority		260	No Contract Amount – 2000 Historical Use
Kemp/Diversion	American Electric Power		20,000	Contract
Kemp/Diversion	TPW Dundee Fish Hatchery		2,200	
Nocona	Nocona Hills Owners Assoc		246	Contract
Wichita System	Archer City	0.060		Contract – Lake Kickapoo
Wichita System	Archer County MUD #1	0.150		Contract, No Expiration Date
Wichita System	Burkburnett	3.300		Contract
Wichita System	Dean Dale WSC	0.825		Contract, No Expiration Date
Wichita System	Friberg-Cooper WSC	0.250		
Wichita System	Henrietta			Wichita Falls must meet Henrietta's senior water right
Wichita System	Holliday		294	No Contract Amount – 2000 Demands
Wichita System	Iowa Park	2.000		
Wichita System	Lakeside City	0.350		
Wichita System	Olney	1.000		Contract – Lake Kickapoo
Wichita System	Pleasant Valley		121	No Contract Amount – 2000 Demands
Wichita System	Red River Authority	0.750		
Wichita System	Scotland	0.250		
Wichita System	Sheppard AFB			Part of Wichita Falls 2000 Demands
Wichita System	Wichita Falls		21,943	2000 Demands
Wichita System	Wichita Valley WSC	1.250		
Wichita System	Windthorst WSC	0.750		

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3.1.4 Run-of-the-River Supplies

Portions of three river basins are located in Region B. The Red River and its tributaries represent the largest river system, flowing across the central and northern areas of the region. The Brazos River flows through the southern portion of King and Baylor Counties, and the upper tributaries of the Trinity River lie in southwest Montague County.

The Red River forms the northern boundary of Region B and flows eastward along the Texas – Oklahoma border. Tributaries within the region include the Pease River, Wichita River, and Little Wichita River. High concentrations of total dissolved solids, sulfate, and chloride are concerns for the upper reaches of these streams during low flow conditions. Naturally occurring salt springs, seeps and gypsum outcrops are found in the area westward of Wichita County to the High Plains Caprock Escarpment in the Panhandle Region Planning Area. As a result water from these rivers in Cottle, Foard, King, Hardeman, and parts of Baylor and Wilbarger Counties is generally not used or is restricted to irrigation use only. The quality of the water gradually improves downstream toward the eastern portion of the region.

Existing run-of-the river water rights for the Red River system in Region B are shown on Table 3-6 and include rights on the Red River in Clay County, Little Wichita River, Wichita River, and Beaver Creek. Beaver Creek is a tributary to the Wichita River, and flows eastward from Foard County to the Wichita River in Wichita County. Groesbeck Creek, which has a large water right associated with Lake Pauline, is addressed with this reservoir. Generally, rights associated with reservoirs, unnamed tributaries, or smaller rivers and streams are not included on Table 3-6.

The total available supplies from the run-of-the-river diversions are shown on Table 3-2. These supplies were determined using the Water Availability Models and represent the minimum diversion in a year over the historical record in the respective model.

Table 3-6: Run of the River Water Rights

Water Right	County	Amount (af/yr)	Use	Owner
Red River				
5143	Clay	200	Irrigation	Joe J. Parker
Little Wichita River				
4268	Clay	3,600	Irrigation	A.L. Rhodes
5152	Clay	1,560	Municipal	City of Henrietta
Wichita River				
4433	Wichita	300	Irrigation	Alvin & Nana Robertson
5123	Wichita	16,660	Irrigation	WCWID #2
5135	Clay	357	Irrigation	Eagle Farms, Inc.
5136	Clay	200	Irrigation	Joe L. Hale Estate
5138	Clay	55	Irrigation	M.E. McBride
5139	Clay	30	Irrigation	Bob Brown
5140	Clay	270	Industrial	Red River Feed Yard, Inc.
5152A	Wichita	2,352	Recreation	City of Wichita Falls
5530	Wichita	32	Irrigation	Joe L. Burton
Beaver Creek				
5125	Wilbarger	675	Irrigation	W.T. Waggoner Estate
5126	Wilbarger	60	Municipal	W.T. Waggoner Estate
5127	Wilbarger	85	Municipal, Mining	W.T. Waggoner Estate
5129	Wichita	404	Irrigation	Harry L. Mitchell
5393	Wichita	450	Irrigation	James Brockriede
5128[1]	Wilbarger	800	Municipal	City of Electra

1. This water right is associated with Lake Electra. It is a right to divert water from Beaver Creek to Lake Electra for emergency municipal use.

Source: Texas Commission on Environmental Quality, Water Rights Database, 2004.

3.2 Groundwater Supplies

3.2.1 General Description

Groundwater is primarily supplied in Region B by two aquifers, the Seymour and the Blaine. The Seymour is designated a major aquifer and is found in the central and western portions of the region. It is currently used in Hardeman, Wilbarger, Wichita, Clay, Baylor, Foard, and Cottle Counties. The Blaine is considered a minor aquifer and useable groundwater is limited to the westernmost portion of the region. These aquifers provide a large percentage of available supply in these counties. In addition, the upper portion of the Trinity Aquifer occurs in Montague County in the eastern part of the region. Limited quantities of groundwater are used from the Trinity for municipal and irrigation uses. There are also other formations within the region that are used for groundwater supply in limited areas. The TWDB identifies these sources as "Undifferentiated Other Aquifer". These formations are not well defined in the literature, but still provide substantial quantities of water in Archer, Clay, Cottle, Montague, and Wichita Counties. For purposes of this report, the groundwater availability for "Other Aquifers" will be determined from the reported historical use.

Seymour Aquifer

The Seymour Formation consists of isolated areas of alluvium that vary in saturated thickness from less than 10 feet to over 80 feet. This aquifer is relatively shallow and exists under water table conditions in most of its extent. Artesian conditions can occur where the water-bearing zone is overlain by clay. The upper portion of the Seymour consists of fine-grained and cemented sediments. The basal portion of the formation has greater permeability and produces greater volumes of water. Yields of wells typically range from 100 gpm to 1,300 gpm, depending on the saturated thickness, and average about 300 gpm.

Recharge to the Seymour is largely due to direct infiltration of precipitation over the outcrop area. Surface streams adjoining the outcrop are at elevations lower than the water levels in the Seymour Aquifer and do not contribute to recharge. Other possible sources of recharge include infiltration from irrigation or upward leakage of water from underlying Permian formations, but these amounts are insignificant.

Natural discharge from the Seymour occurs through seeps and springs, evapotranspiration, and leakage to the Permian. It is estimated that a large part of the Seymour's total natural discharge is from evapotranspiration from plants and is considerably larger than discharges to seeps and springs (TWDB Report 337, 1992).

Water quality of the Seymour is variable throughout the region, and generally ranges from fresh to slightly saline. Brine pollution from earlier oil activities and excessive pumping has caused localized concentrations of minerals in the alluvium, limiting the full utilization of the water resource. In addition, high nitrate concentrations occur in the groundwater over a wide area. These nitrate concentrations are often due to agricultural practices, and can be attributed to nitrogen fertilizer or leaching from areas formerly covered by nitrogen fixing vegetation such as grasses or mesquite groves. Other sources of nitrate include organic matter from poorly functioning septic systems, infiltration of animal wastes, or naturally occurring sources.

Blaine Aquifer

The Blaine Formation extends in a narrow outcrop band from Wheeler to King Counties. Groundwater occurs in numerous solution channels and caverns in beds of gypsum and anhydrite. In most places the aquifer exists under water table conditions, but it is also artesian where overlain by the Dog Creek Shale. Saturated thickness of the aquifer approaches 300 feet in its northern extent, and is generally less in the Region B area. Well yields vary considerably from one location to another due to the nature of solution channels. It is common for dry holes to be found adjacent to wells of moderate to high yield. The average well yield is 400 gpm.

The primary source of recharge to the Blaine Aquifer is precipitation that falls on the High Plains Escarpment to the west and the Blaine outcrop area. The solution openings and fractures in the gypsum provide access for water to percolate downward. The Blaine Aquifer may also receive some recharge from the overlying Dog Creek Shale.

Water in the Blaine Aquifer generally moves eastward through the solution channels, dissolving mineral deposits along the way, and discharging to low topographic areas. The dissolved solids concentrations in the aquifer increase with depth and generally range from 1,000 to over 10,000 mg/l. Due to the high mineral content, the TWDB has limited the extent of the Blaine Aquifer to areas with water less than 10,000 mg/l of dissolved solids.

Natural salt springs and seeps from the Blaine formation contribute to increased salinity of surface water. Due to the high mineral content the Blaine Aquifer has been used primarily for irrigation of salt tolerant crops.

Trinity Aquifer

The Trinity Group consists of three formations, the Travis Peak, Glen Rose, and Paluxy. In the northern part of its extent, the Glen Rose thins out and the Travis Peak and Paluxy coalesce into a single geologic unit known as the Antlers Formation. In Region B, the Trinity Group outcrops in the eastern portion of Montague County. The thickness of the Trinity Aquifer ranges from less than ten feet to 600 feet. Water table conditions occur in outcrop areas, while artesian conditions exist in the downdip formation. Well yields in the Trinity Aquifer range from moderate to low. The effective recharge for the entire Trinity Aquifer as determined by TDWR is 1.5 percent of the mean annual precipitation over the outcrop area (TDWR, 1982).

Limited amounts of good quality water can be obtained from the Trinity in Montague County. Groundwater is generally used for municipal, mining, irrigation, and livestock purposes. Water level declines have been recorded in heavily pumped areas to the south and southeast of Montague County.

3.2.2 Groundwater Availability and Recharge

The average annual groundwater availability is the amount of water that could be reasonably developed from the aquifer. It is comprised of the annual effective recharge plus the amount of water that can be recovered annually from storage over a specified period without causing excessive drawdown or irreversible harm, such as subsidence or water quality deterioration.

As part of Senate Bill 1 the TWDB initiated a comprehensive groundwater availability modeling program to assist groundwater conservation districts and regional water planning groups in determining available groundwater supplies. The groundwater model for the Seymour and Blaine formation was released by the TWDB in November 2004. This was after the analyses of supplies for the region was completed. A review of the results of the Seymour Groundwater Availability Model found that the available supplies from this source were consistent with the supplies determined for the 2006 plan, and no further analyses were conducted.

The supplies from the Seymour and Blaine Aquifers were determined using previous studies. As part of the 1997 State Water Plan, the TWDB evaluated the groundwater availability for the major and minor aquifers of the state. Previous publications and water well data were used to derive annual groundwater availability. Effective recharge was determined by applying a percentage of the mean annual precipitation upon the aquifer's outcrop area. For the Seymour, the TWDB used a conservative estimate of five percent of the average annual precipitation for the entire Seymour formation. This percentage was generally based on the low flow analyses used in the groundwater studies of Baylor and Jones Counties (TDWR Report 238, 1979). In addition, an estimated annual amount recoverable from storage was determined based on using 75 percent of the total storage over the 57-year period from 1974 through 2030. After 2030, it was assumed no water would be available from storage, limiting availability to recharge.

Reviews of previous groundwater publications found a range of reportable recharge rates and availability estimates for the Seymour Aquifer. The Baylor study (TDWR, 1978) indicated an effective recharge rate of 10 percent of the average annual precipitation for the year 1969. However, groundwater availability was limited in some areas due to thin saturated thickness and high loss to evapotranspiration. The Baylor study also did not include mining of groundwater from storage due to the nature of the near surface aquifer (i.e., did not want to create abnormally low water levels.) More recently, a study by Woodward Clyde for the City of Vernon estimated the recharge to the Seymour in the Odell-Lockett area in Wilbarger County to be approximately 15 percent of the average rainfall (Woodward-Clyde, 1998).

This higher estimate of recharge appears to be limited to specific areas and cannot be applied over the regional aquifer. Also, it is unrealistic to expect that all aquifer recharge will be available for development. The TWDB estimate of five to seven percent of the annual precipitation is a reasonable estimate of effective recharge for the Seymour, and is appropriate for regional water planning purposes. However, since the Seymour Aquifer is a near-surface unconfined aquifer and is sensitive to recharge and withdrawals, mining of the aquifer may adversely affect the water supply. Therefore, for this plan, the mining of storage is not included in the groundwater availability estimates for the Seymour.

For the Blaine Aquifer, comparisons of declines of water levels and pumpage were used to estimate effective recharge. In Hardeman County, Maderak (TDWR, 1972) determined the effective recharge to the Blaine to be between five and seven percent of the average annual precipitation. The TWDB used a conservative estimate of five percent for water availability planning. No recoverable storage from the Blaine Aquifer was included in the availability estimates. For the Blaine, the groundwater estimates include water with total dissolved solids (TDS) up to 10,000 mg/l. For the other aquifers in the region, the availability estimates were limited to water containing less than 3,000 mg/l of total dissolved solids (TDS).

The TWDB methodology for groundwater availability for the Blaine Aquifer is appropriate for this planning effort. However, the Blaine Aquifer has a large amount of groundwater with moderate to high salinity. As a result much of the water from this formation is not used in the region. Therefore, the groundwater availability from the Blaine is broken down by TDS level. Based on historical water quality data, there is little to no water available for municipal purposes. (Small amounts of water from the Blaine Aquifer are currently being used for municipal purposes in areas with limited water resources.) Water with TDS levels between 1,000 and 3,000 mg/l is appropriate for irrigation, livestock, mining, and some industrial uses. Water with TDS levels greater than 3,000 mg/l may be available with treatment or irrigation of salt tolerant crops.

The effective recharge for the Trinity Aquifer within the Brazos, Trinity, and Red River Basins was determined by the trough method (TDWR Report 238, 1979). Using this method, it was determined that approximately 1.5 percent of the annual precipitation over the outcrop area is available for development as effective recharge. In addition, the TWDB estimated that one million acre-feet of water could be withdrawn from artesian storage within the Trinity. However, much of the Trinity Aquifer within Montague County is not artesian and the storage values may be less.

Since much of the Trinity Aquifer is artesian and the outcrop area is used to recharge the downdip portion of the aquifer, a direct application of effective recharge over the outcrop area is not appropriate to determine groundwater availability. For this planning effort, the availability estimates determined by TWDB for the Trinity Aquifer will be used.

Groundwater availabilities for the Seymour and Blaine Aquifers were re-calculated as five percent of the mean annual rainfall over the outcrop area, using the latest precipitation data and the most recent delineation of recharge areas. The availability estimates for the Trinity were taken directly from the 1997 Water Plan. A summary of groundwater availability by aquifer and county is presented in Table 3-8. Table 3-9 shows the availability in the Blaine Aquifer by concentration of TDS.

Table 3-8: Groundwater Availability – Region B

County Name	Basin	Aquifer Name	Groundwater Availability (af/yr)	Effective Recharge Rate (in/yr)
Baylor	Brazos	Seymour	8,205	1.35
Baylor	Red	Seymour	1,485	1.35
Baylor	***Total***	***Seymour***	***9,690***	***1.35***
Clay	Red	Seymour	7,870	1.39
Cottle	Red	Seymour	8,410	1.11
Cottle	Red	Blaine	27,100	1.01
Foard	Red	Seymour	12,130	1.23
Foard	Red	Blaine	15,390	1.19
Hardeman	Red	Seymour	15,390	1.18
Hardeman	Red	Blaine	23,770	0.92
King	Red	Blaine	17,590	1.10
Montague	Red	Trinity	239	0.51
Montague	Trinity	Trinity	2,443	0.51
Montague	***Total***	***Trinity***	***2,682***	***0.51***
Wichita	Red	Seymour	13,920	1.38
Wilbarger	Red	Seymour	30,500	1.28

Table 3-9: Availability in Blaine Aquifer by TDS

County	Basin	Groundwater Availability (af/yr)			
		Total	*TDS (mg/l):*		
			1,000 - 3,000	*3,000 - 10,000*	*>10,000*
Cottle	Red	27,100	6,494	18,153	2,453
Foard	Red	15,390	10,945	4,445	0
Hardeman	Red	23,770	13,601	10,169	0
King	Red	17,590	3,706	13,884	0

As shown on the above tables, there are large quantities of water available in the Seymour and Blaine Aquifers, and limited quantities in the Trinity Aquifer. However, the water in the Blaine is unsuitable for municipal use without additional treatment, and only a portion is readily available for other uses. Water quality issues associated with the Seymour Aquifer (nitrates and TDS) also limit the usefulness of this resource. Historical use indicates that with the exception of Wilbarger County, much of the groundwater is not fully developed or not currently being used. A comparison of the 1999 historical use and groundwater availability estimates is shown on Table 3-10.

Table 3-10: Groundwater Historical Use

County	Aquifer	Availability (af/yr)	Historical Use-1999 (af/yr)
Baylor	Seymour	9,690	2,467
Clay	Seymour	7,870	923
Cottle	Seymour	8,410	27
Cottle	Blaine	27,100	7,403
Foard	Seymour	12,130	5,267
Foard	Blaine	15,390	24
Hardeman	Seymour	15,390	149
Hardeman	Blaine	23,770	5,350
King	Blaine	17,590	269
Montague	Trinity	2,682	430
Wichita	Seymour	13,920	3,107
Wilbarger	Seymour	30,500	36,716

Source: TWDB, historical groundwater pumpage data, 2004.

The groundwater availability for "Other Aquifer" was based on historical use. A summary of supplies from this source is shown in Table 3-11.

Table 3-11

Supplies from Other Aquifers in Region B

County	Basin	Groundwater Availability (ac-ft/yr)
Archer	Red	335
Archer	Brazos	43
Archer	Trinity	50
Clay	Red	734
Clay	Trinity	118
Cottle	Red	836
King	Red	179
King	Brazos	66
Montague	Red	654
Montague	Trinity	603
Wilbarger	Red	658

Note: Region B also receives 86 acre-feet per year of groundwater from Dickens County in Region O.

3.2.3 Reliability of Local Supplies

Many of the local cities and communities in Region B rely on groundwater for all or a portion of their municipal supply. Those communities that use groundwater exclusively include the cities of Vernon, Seymour, Paducah, Saint Jo, and Montague. The cities of Electra, Burkburnett, and Chillicothe use a combination of groundwater and surface water. Also, several water supply corporations use groundwater to supply rural areas. Based on surveys of the water users in Region B, some of these users are experiencing lower water table elevations, nitrate contamination, and/or salt water intrusion of their groundwater supplies. Nitrate contamination is a particular concern in the Seymour Aquifer.

3.3 Inter-Basin Transfers and Inter-Region Transfers

There is only one known inter-basin transfer in Region B. This is from Lake Kickapoo in the Red River Basin to the City of Olney in the Brazos Basin. The City of Olney has a contract with the City of Wichita Falls to provide one-million gallons per day (MGD) of water during peak demands. Most years this additional supply is not used or minimally used.

Inter-regional transfers occur from the Panhandle Planning Area to Region B through the Greenbelt Municipal and Industrial Water Authority. In addition, a small amount of groundwater from Dickens County in Region O is supplied to Guthrie in King County. There are no other existing inter-regional transfers. These transfers are included in the total available supply to the region.

3.4 System Operations and Reliability

The analysis for current surface water supplies within the region is based on the firm yield of the reservoirs. This approach is required by the Senate Bill 1 regulations, but it is often not reflective of how reservoir yields have been determined in other planning efforts. Firm yield analyses determine the amount of water that is available on an annual basis during a repeat of historical drought of record conditions assuming all the water in the reservoir is available for use. This means that the reservoir content will approach zero sometime during the drought period if the firm yield is used. This analysis is also based on the historical rainfall and runoff for each reservoir. Experts at the University of Arizona's Climate Assessment Project for the Southwest recently indicated that Texas might be heading into a significant dry period. Since 1995 climatic patterns have shifted, bringing warmer drier weather to the Southern United States. This phenomenon called the Pacific Decadal Oscillation usually lasts 20 to 30 years (San Antonio Express News, 2/7/00). If this happens, then the region may be entering a new drought period that may surpass the historical drought of record and the firm yield may overestimate the available water supply. However, it is still too early to assess the impact of this weather shift.

Based on these concerns and the uncertainties inherent with the yield analyses, the available water supply for the region may be less than shown on Table 3-1. For these reasons, most water supply systems will not allow their reservoir contents to drop to very low levels without utilizing alternative supplies and implementing drought contingency measures. Many cities within Region B have initiated drought contingency measures in the past decade in response to continuing dropping reservoir levels and are actively considering alternative water sources.

To provide a more conservative estimate of the available surface water supply within the region, safe yield analyses were conducted for the municipal reservoirs in Region B. The safe yield analysis utilizes the same historical hydrology as the firm yield analysis, but assumes that a one-year supply of water is reserved in the reservoir at all times. This analysis has been commonly used for water resource planning in this region in the past. However, the one-year reserve amount may still be less than the preferred minimum operating content. For the City of Wichita Falls, severe drought contingency measures are initiated when the content of the Wichita System drops below 40 percent (137,000 acre-feet), which is much greater than a one-year reserve. Using the Water Availability Models (WAMs), the safe yields for reservoirs in Region B are shown on Table 3-12.

Table 3-12

Summary of Safe Yield Analyses

Reservoir	2000	2010	2020	2030	2040	2050	2060
Wichita System	36,700	35,809	34,918	34,027	33,136	32,245	30,250
Lake Electra	230	225	220	215	210	205	200
North Fork Buffalo Creek	700	690	680	670	660	650	640
Amon Carter	1,650	1,589	1,528	1,467	1,406	1,345	1,285
Olney/Cooper	770	770	770	770	770	770	770
Greenbelt	7,470	7,331	7,192	7,053	6,914	6,775	6,635

3.5 Allocation of Existing Supplies

3.5.1 Water User Groups

To assess the projected water shortages in the region, the currently available supplies were allocated to each water user. Surface water allocations are based on current water rights, contracts, available yields, and current infrastructure capacities, accounting for the most restraining limitation. Groundwater allocations are based on current developed well fields, considering aquifer limits and availability. Surface water use reported to TWDB for livestock watering was assumed supplied by on farm stock ponds.

The supplies to each water user are shown in the Water User Group Summary Tables in Appendix A. A summary of the currently available supplies by county is presented in Table 3-13.

Table 3-13

Summary of Currently Available Supplies by County

County	2000	2010	2020	2030	2040	2050	2060
Archer	10,998	8,577	8,205	7,856	7,500	7,119	6,771
Baylor	4,452	4,452	4,452	4,452	4,452	4,452	4,452
Clay	8,818	9,053	8,829	8,616	8,414	8,227	8,094
Cottle	5,788	5,790	5,792	5,793	5,795	5,795	5,795
Foard	6,038	6,081	6,066	6,052	6,040	6,032	6,021
Hardeman	8,349	8,729	8,712	8,719	8,705	8,705	8,656
King	946	1,295	1,296	1,295	1,295	1,294	1,294
Montague	6,176	6,429	6,368	6,307	6,246	6,185	6,125
Wichita	109,981	104,932	97,509	90,065	82,601	75,159	66,533
Wilbarger	52,419	53,077	51,266	48,945	46,624	44,303	41,980
Young (P)	1,043	1,379	1,379	1,379	1,379	1,379	1,379
TOTAL	**215,009**	**209,795**	**199,874**	**189,480**	**179,052**	**168,650**	**157,100**

3.5.2 Wholesale Water Providers

There is one wholesale water provider in Region B: the City of Wichita Falls. The city currently receives water from two primary sources: Lake Arrowhead and Lake Kickapoo. Wichita Falls also receives water from Lake Kemp when water levels in Lakes Kickapoo and Arrowhead are low. The city is completing a reverse osmosis water treatment plant, which will enable the city to treat and use up to 10 MGD of water from Lake Kemp. Wichita Falls also has water rights for Lake Wichita, but this lake is currently used only for recreational purposes. The total available supply to Wichita Falls is shown in Table 3-14.

Table 3-14

Available Supply to Wichita Falls (ac-ft/yr)

Safe Yield[1]	2000	2010	2020	2030	2040	2050	2060
Kickapoo	14,210	13,822	13,434	13,046	12,658	12,270	10,250
Arrowhead	22,490	21,987	21,484	20,981	20,478	19,975	20,000
Wichita System	***36,700***	***35,809***	***34,918***	***34,027***	***33,136***	***32,245***	***30,250***
		0	0	0	0	0	
Kemp Municipal[2]	10,766	9,672	8,578	7,484	6,389	5,295	4,199
Total – Wichita Falls	**47,466**	**45,481**	**43,496**	**41,511**	**39,525**	**37,540**	**34,449**

1. Safe yield was calculated for the Wichita System.
2. Proportional firm yield supply was used for Lake Kemp, with an assumed treatment loss of 25 percent.

3.6 Summary of Currently Available Supplies

The total amount of supply currently available to Region B is approximately 385,000 acre-feet per year, as shown on Table 3-15. This represents firm supply available to the region. However, the supply that is available to each user is less due to operational and contractual constraints, infrastructure limitations, and water treatment capacities. A comparison of the regional firm supply to the total currently available supply to the water users is shown on Figure 3-1.

By 2060, the supply to Region B decreases by nearly 70,000 acre-feet per year. This is mostly due to the reduced storage capacities of existing reservoirs due to sediment accumulation. The Lake Kemp and Diversion system was found to have significant reductions in firm yield due to reduced storage capacity, and this system accounts for most of the regional supply reduction.

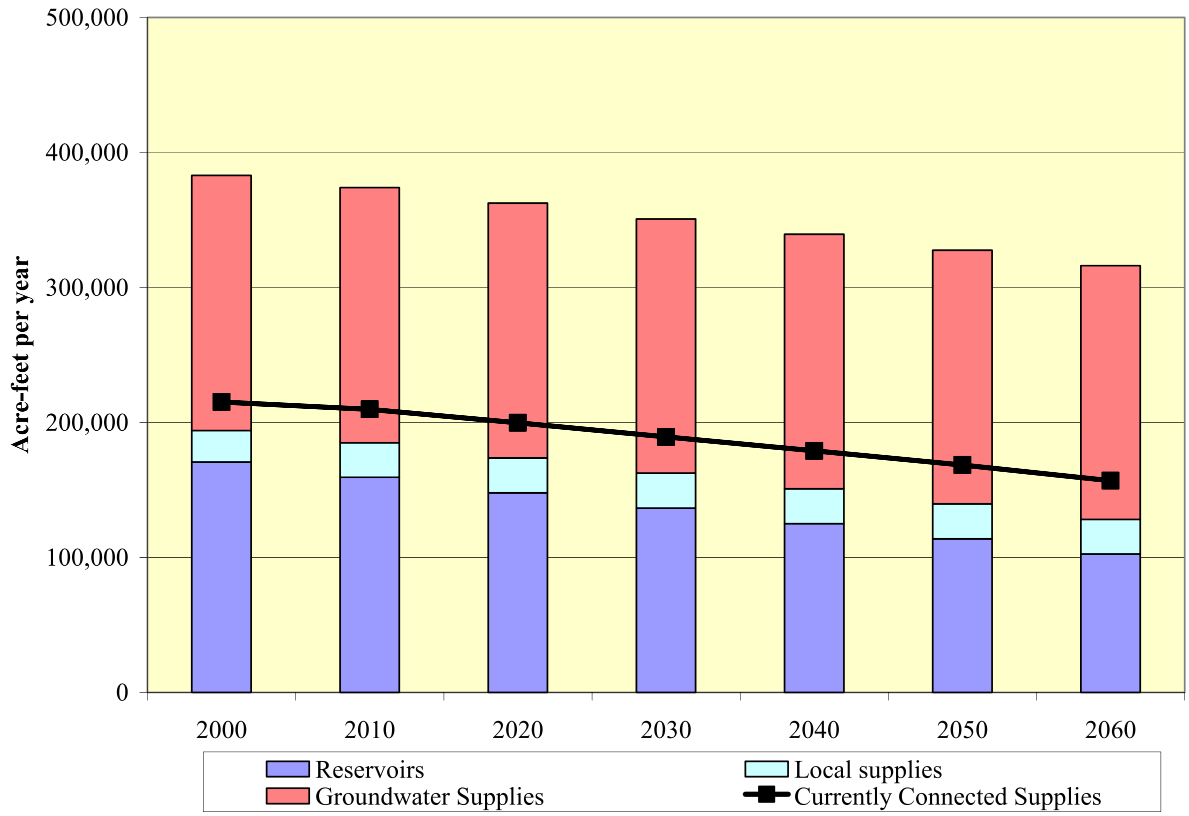
Table 3-15

Summary of Firm Supplies to Region B

	2000	2010	2020	2030	2040	2050	2060
Reservoirs in Region B	161,580	150,346	139,112	127,878	116,644	105,410	94,170
Reservoirs outside Region B	8,985	8,854	8,723	8,592	8,461	8,330	8,200
Run-of-the-River Supplies	14,666	14,666	14,666	14,666	14,666	14,666	14,666
Local Supplies	9,018	11,316	11,316	11,316	11,316	11,316	11,316
Groundwater Supplies	188,819	188,804	188,804	188,354	188,354	187,952	187,952
Total	**383,068**	**373,986**	**362,621**	**350,806**	**339,441**	**327,674**	**316,304**

Figure 3-1

Comparison of Firm Supplies to Supplies Available to Water Users



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