3.3 SURFACE WATER RESOURCES PERSPECTIVE

As specified in Chapter 16.051 of the Texas Water Code, the Board is also required to "define and designate river basins and watersheds as separate units . . . "for consideration in planning, projection of in-basin water uses and supply needs, and contemplation of interbasin water transfers." The Board has defined fifteen major river and eight coastal basins for Texas for such purposes (see Figure 2-3).

As also discussed in Section 2, various planning and modeling considerations were made in the water supply allocation studies for the State's river basins, including water rights considerations, enhanced conservation practices, water marketing, reuse limitations, limits on ground-water availability, reservoir releases or stream by-pass provisions for instream flows and bay and estuary needs, and other water management issues.

Both in-basin water uses and out-of-basin export uses were projected to determine the total use for a particular basin's water resources. The total use of the basin's resources was then compared against available current water supplies from in-basin resources and imported water supplies. In general where supply shortages exist (even after conservation measures are implemented) and the development of sufficient additional local ground-water resources is not practical, further surface water supplies were projected to be made available. New conveyance systems from existing reservoirs, new river diversions, water reuse, supply imports from other river basins, or new reservoir projects are recommended, as necessary, taking into account the specific circumstances of the area, the volume of water needed, cost-effectiveness, and potential environmental effects.

A schematic representation of the basin boundaries; the major river and its primary tributaries; existing major water supply reservoirs; state-permitted, but, as yet unbuilt reservoirs; and recommended new reservoir projects are indicated. Not shown are reservoirs whose substantive use involves non-consumptive activities (i.e., recreation, fish and wildlife enhancement, hydropower generation purposes, etc.). A larger-scale mapping of existing, recommended, and state-permitted major water supply projects can be found on the fold-out map contained in the map pocket at the end of the report.

Also shown are pertinent key statistics for existing, permitted, and recommended new water supply reservoirs. Further, the current and projected (supply and demand) water balance is shown for each basin. At the end of 50 years, all non-irrigation water demands of the State were met with adequate supplies. An adjustment was made to the irrigation forecasts, prepared early in the planning process, to reflect irrigation water use that can not be "economically" supported in the future, given declining water supply availability for this purpose (primarily groundwater) and the relatively high cost of replacement supplies. In economic terms, this is not a true "shortage or deficit" in that supplies could be made available, but can not be afforded by this use. The net water balance shown at the bottom of each table is a conservative estimate of potentially-available remaining supplies. Further supplements to the State's water supply inventory could be made through additional development of surface and groundwater, where feasible and appropriate.

Information characterizing the water quality of the basin and selected river segments is also presented from the TNRCC's The State of Texas Water Quality Inventory and from information developed from the regionally-sponsored Clean Rivers Program of the TNRCC.

Summary data on water uses, supplies, features and problems of the eight smaller Texas coastal basins follows the discussion of the major river basins in this section. Further detail on individual regional and municipal water issues can be found in the preceding Section 3.2. Information on an area's ground-water resources can be found following Section 3.4.

Canadian River Basin

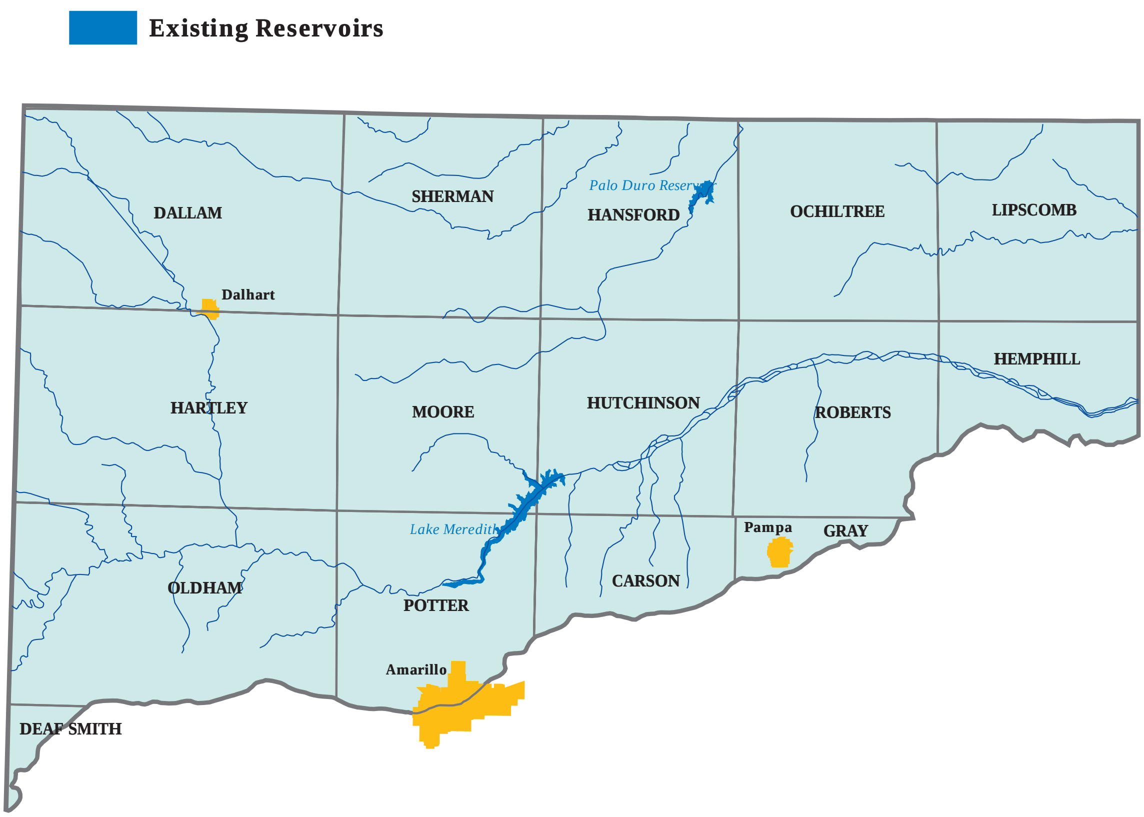

Figure 3-34

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	39,804	41,921
Manufacturing	32,382	45,423
Steam Electric	5,000	20,000
Mining	4,987	2,686
Irrigation	1,552,317	1,339,561
Irrigation Adjustment	(0)	(459,347)
Livestock	33,056	33,056
Total in-Basin Demands	1,667,546	1,023,300
IN-BASIN SUPPLIES		
Groundwater	1,625,293	948,022
Surface Water	105,121	115,036
Total In-Basin Supplies	1,730,414	1,063,058
TRANSFERS		
Import Supplies	0	0
Export Demands	58,068	71,440
NEW SUPPLIES	0	40,000
NET AVAILABILITY	4,800	8,318

Reservoir NameStatus		Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Palo Duro	Built	2,892.0	2,413	60,897	4,800
Meredith	Built	2,941.3	17,320	920,300	74,350

3.3.1 Major River Basins

3.3.1.1 Canadian River Basin

Basin Description. Beginning in northeastern New Mexico, the Canadian River flows eastward across the Texas Panhandle into Oklahoma and merges with the Arkansas River in eastern Oklahoma (see Figure 3-34). Total drainage area of the basin is 12,700 square miles. Oil and gas production, agriculture, agribusiness, manufacturing, and wholesale and retail trades are the predominant sectors of the basin economy. From 1980 to 1990, population in the basin declined by 5,650. The consensus population projection for the basin anticipates a reversal of the 1980-1990 trend with a year 2050 population of about 210,000. The major population centers within the basin and their latest population estimates include all or portions of the cities of Amarillo (167,548), Pampa (19,810), Borger (15,508), Dumas (13,439), Perryton (7,569), Dalhart (6,619), Spearman (3,015), Canadian (2,244), and Stinnett (2,271).

Current Water Uses. Approximately 99 percent of the annual basin water use is supplied from ground-water resources. In 1990, water used for municipal, industrial, and agricultural purposes totaled approximately 1.695 million acre-feet (ac-ft) as compared to the 1980 total water use of 1.846 million ac-ft. The reduction of 151,122 ac-ft over the 1980-1990 period is largely attributable to a decline of 149,505 ac-ft of water requirements for irrigated agriculture. Currently, water for irrigated agriculture accounts for more than 94 percent of the annual quantity of water use in the basin. During the 1980-1990 period, municipal water use increased by 11 percent. In 1990, 37,030 ac-ft of water was exported to the Brazos River Basin, 14,434 ac-ft was exported to the Red River Basin, and 2,850 ac-ft was exported to the Colorado River Basin from the Canadian River Basin for municipal and industrial use.

Current Water Supplies. The basin is supplied primarily by groundwater from the large multistate Ogallala Aquifer, which ranges in saturated thickness from 20 to 540 feet, but is realizing regional long-term declining water level trends. Yields of large capacity wells typically range between 500 to 2,000 gallons per minute (g.p.m.). The City of Amarillo operates well fields in Carson, Randall, and Deaf Smith counties. Other aquifers in the basin include the Rita Blanca and the Dockum.

There are three major surface water major reservoirs located in the basin, of which two are water-supply reservoirs. Lake Meredith, constructed by the U.S. Bureau of Reclamation and operated by the Canadian River Municipal Water Authority, supplies water within the Basin to the cities of Borger and Pampa. Lake Palo Duro will provide water to the Palo Duro River Authority's member cities. Rita Blanca Lake, constructed by the U.S. Soil Conservation Service, is operated by Dallam and Hartley counties for recreational purposes. A U.S. Supreme Court lawsuit brought by Texas and Oklahoma against New Mexico for depletion of Canadian River flows in violation of the interstate compact has been resolved in favor of Texas and Oklahoma.

Basin Water Districts/Authorities. There are two primary authorities that manage the surface water resources of the basin and one interstate compact.

Canadian River Municipal Water Authority (CRMWA). Created in 1953 by the Texas Legislature, the Authority operates Lake Meredith for the Federal Bureau of Reclamation. It provides water to Borger and Pampa in the Canadian Basin; Amarillo in the Canadian and Red River basins; Lubbock, Levelland, Slaton, Plainview, Tahoka, and O'Donnell in the Brazos River Basin; and Brownfield and Lamesa in the Colorado River Basin. Studies conducted by the Authority have reduced the estimated yield available from Lake Meredith to about 70% of the original permitted amount, decreasing to 50% over the planning period. The 44,977 acre Lake Meredith National Recreational Area is a unit of the National Park Service (NPS), managed by the NPS under a cooperative agreement with the U.S. Bureau of Reclamation.

Palo Duro River Authority (PDRA). Created in 1973, the Authority owns and operates Lake Palo Duro for its member cities of Gruver, Spearman, Sunray, Stinnett, Dumas and Cactus. Distribution lines to transport water to all the member cities are planned for future construction.

Canadian River Compact. Entered into by New Mexico, Oklahoma and Texas, the compact guarantees that Oklahoma shall have free and unrestricted use of all waters of the Canadian River in Oklahoma and that Texas shall have free and unrestricted use of all water of the Canadian River in Texas subject to limitations upon storage of water (500,000 ac-ft of storage in Texas until such time as Oklahoma has acquired 300,000 ac-ft of conservation storage, at which time Texas' limitation shall be 200,000 ac-ft plus the amount stored in Oklahoma reservoirs). New Mexico shall have free and unrestricted use of all waters originating in the drainage basin of the Canadian River above Conchas Dam, and free and unrestricted use of all waters originating in the drainage basin of the Canadian River below Conchas Dam, provided that the amount of conservation storage in New Mexico available for impounding waters originating below Conchas Dam shall be limited to 200,000 ac-ft.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, the principal water quality problems in the Canadian River Basin are elevated total dissolved solids and chloride levels. The Canadian River at the New Mexico-Texas state line is moderately saline during low flow due to natural conditions. Additionally, a natural brine artesian aquifer with total dissolved solids greater than 30,000 mg/L seeps into the river near the Texas-New Mexico border. The high chloride levels affect water quality in Lake Meredith. The City of Dalhart discharges treated domestic wastewater directly to Rita Blanca Lake. As a result, the reservoir has become very biologically productive and experiences algal blooms and elevated pH levels.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-35.

Future Water Uses. Basin-wide water use is projected to decline over the 1990-2050 planning period with an anticipated total water use of about 1.023 million ac-ft in the year 2050. This decline is due in part to a projected reduction of nearly 45 percent in water requirements for irrigated agriculture. The decline in irrigation water demands is due primarily to estimated declines in ground- water availability resulting in insufficient quantities of groundwater to meet

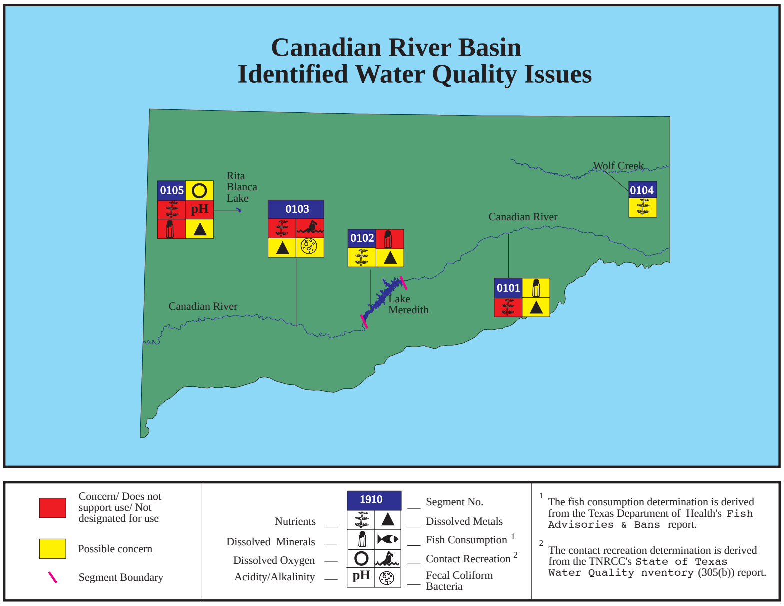

Figure 3-35
Ambient Water Quality Summary for the Canadian River Basin

current and projected future levels of irrigation water demands, combined with increased irrigation technology associated with potential irrigation water use savings. Even with this anticipated decline in water requirements for irrigated agriculture, water used for irrigation purposes is projected to account for about 86 percent of the total basin water use by the year 2050. With continued improvements in municipal, manufacturing, and irrigated agriculture conservation practices and programs, annual water savings in the basin are projected to reach nearly 74,000 ac-ft by the year 2020, and 134,000 ac-ft annually by the year 2050.

Future Water Supplies. Due to the scarcity of locally-developable surface water supplies, any additional water needed for the basin will likely come from reuse of present supplies, development of additional well fields in the Ogallala Aquifer, and possible new development in minor aquifers present in the basin. It is estimated that by 2050 over 21,000 ac-ft per year of the basin needs will be supplied by reuse. A recent example of additional well field development is the planned Canadian River Municipal Water Authority's well fields in Roberts County which are expected to supplement, and improve the quality of Lake Meredith's surface water. The Authority is permitted to use a maximum of 40,000 ac-ft of groundwater per year from these wells, and up to 50,000 ac-ft under unusual or emergency conditions. This approach cannot necessarily be used throughout the area; however, there are certain areas of the Ogallala that could be developed.

In order to maintain the continued suitability of water from Lake Meredith for municipal and manufacturing purposes, the Bureau of Reclamation and the Canadian River Municipal Water Authority are jointly funding and developing a salinity control project near Logan, New Mexico. Although some difficulties have been experienced with the project, construction is slated to begin in early 1998.

Red River Basin

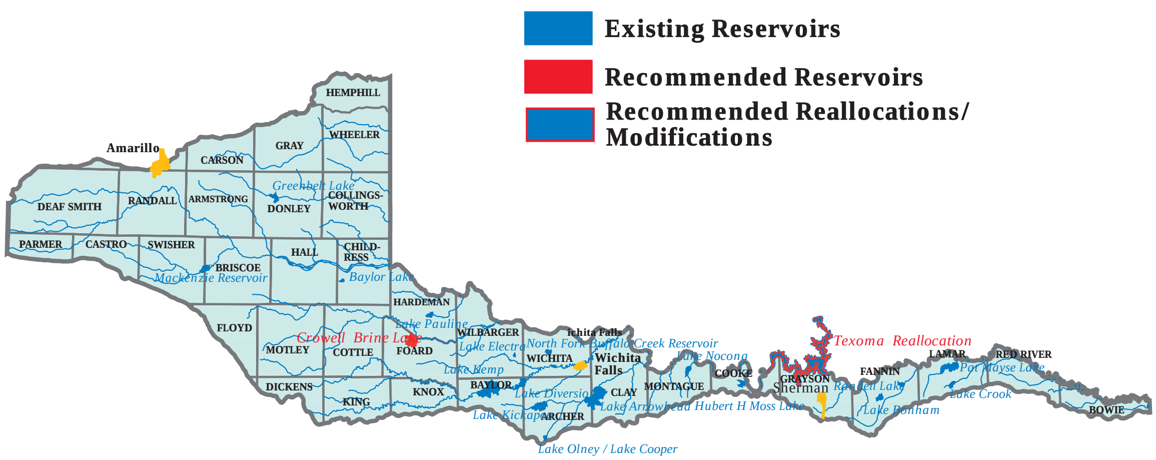

Figure 3-36

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	114,628	129,103
Manufacturing	17,404	25,121
Steam Electric	17,000	42,000
Mining	5,426	4,097
Irrigation	1,020,713	906,796
Irrigation Adjustment	(21,056)	(562,752)
Livestock	56,654	56,654
Total in-Basin Demands	1,210,769	601,019
IN-BASIN SUPPLIES		
Groundwater	1,014,736	357,633
Surface Water	481,443	474,940
Total In-Basin Supplies	1,496,179	832,573
TRANSFERS		
Import Supplies	30,354	48,498
Export Demands	72,196	168,056
NEW SUPPLIES	0	72,500
NET AVAILABILITY	243,568	184,496

Reservoir Name	Status	Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Mackenzie Res.	Built	3,100.0	896	46,450	5,200
Greenbelt Lake	Built	2,664.0	2,025	60,400	9,400
Baylor	Built	1,820.0	610	9,220	1,300
Kemp	Built	1,144.0	15,590	268,000	116,000
Diversion	Built	1,051.0	3,419	40,000	1,100
Electra	Built	1,110.0	600	8,050	600
Kickapoo	Built	1,045.0	6,200	106,000	16,072
Olney/Cooper	Built	n.a.	n.a.	6,650	1,260
Buffalo Creek.	Built	1,048.0	1,500	15,400	840
Arrowhead	Built	926.0	16,200	262,100	29,532
Nocona	Built	827.0	1,470	25,400	4,500
H. H. Moss	Built	715.0	1,125	23,210	4,500
Texoma	Built	617.0	88,000	2,643,300	147,500
Texoma Realloc.	*Recommended*				*72,500*
Randall	Built	618.8	280	5,400	5,280
Bonham	Built	565.0	1,020	12,000	7,138
Pat Mayse Lake	Built	451.0	5,993	124,500	59,900
Crook	Built	476.0	1,226	9,664	1,000

3.3.1.2 Red River Basin

Basin Description. The Red River Basin is bounded on the north by the Canadian River Basin and on the south by the Brazos, Trinity, and Sulphur river basins (see Figure 3-36). The Red River extends from the northeast corner of the State, along the Texas/Arkansas and Texas/Oklahoma state borders, across the Texas Panhandle to its headwaters in eastern New Mexico. The Red River Basin has a drainage area of 48,030 square miles, of which 24,463 square miles occur within the State. Agriculture, oil and gas production, agribusiness, manufacturing, and retail and wholesale trade are the major sectors of the basin economy. Population of the Basin increased from 506,030 in 1980 to 513,007 in 1990. The basin population is projected to be about 728,000 by the year 2050. Major population centers and their latest population estimates include all or portions of the cities of Amarillo (167,548), Wichita Falls (97,322), Texarkana (33,096), Sherman (32,465), Paris (25,257), Denison (21,723), Hereford (14,633), Vernon (12,460), Canyon (12,457), and Burkburnett (11,045).

Current Water Uses. Ground-water resources supply more than 88 percent of the total Basin water use with surface water supplying the remaining 12 percent. In 1990, water used for all purposes in the Basin totaled about 1.224 million acre-feet. Basin water use declined 296,000 acre-feet between 1980 and 1990. This reduction in water use is primarily attributable to a decline in water requirements for irrigated agriculture of more than 313,000 acre-feet. Water used for irrigated agriculture accounts for about 86 percent of the water used for all purposes in the basin. Municipal water use increased slightly over the 1980-1990 decade. In 1990, 1,549 acre-feet of water was exported to the Brazos River Basin from the Red River Basin for municipal and industrial purposes.

Current Water Supplies. Ground-water demands are supplied from eight primary and secondary aquifers underlying the basin. From upper basin to lower basin, these aquifers include the Ogallala, Dockum, Seymour, Blaine, Trinity, Woodbine, Blossom and Nacatoch.

There are 23 surface water reservoirs within the Red River Basin of which the majority are water-supply reservoirs which have the potential to supply a total of over 555,000 ac-ft per year of water to in-basin and out-of-basin users (the 17 largest reservoirs listed in the basin table provide 411,122 ac-ft/yr). In terms of major basin imports or exports, portions of the City of Amarillo receive imports from the Canadian River via the Canadian River Municipal Water Authority in the upper basin, while Lake Texoma in the middle Red River Basin provides exports to the North Texas Municipal Water District in the adjacent Trinity Basin.

Basin Water Districts/Authorities. There are two primary authorities that manage the surface water resources of the basin and one interstate compact.

Red River Authority. One of the primary water suppliers in the basin is the Red River Authority (RRA), created by the Texas Legislature in 1959 to effectuate flood control and the conservation and use of storm, flood and unappropriated waters of the Red River Watershed and its Texas tributaries. The RRA's territorial jurisdiction encompasses all or part of 42 Texas counties lying within the Red River Basin. It includes all Texas counties bordering

Oklahoma and most Texas counties north and east of Lubbock County except for five counties in the far north Texas panhandle. Two of the major activities of the RRA are water supply and chloride control. The RRA water supply network is made up of over 30 water supply wells, pumping stations, over 2,100 miles of distribution pipelines, and surface water contracts to supply water from lakes Texoma and Arrowhead. To control natural chloride pollution within the Red River Basin, the RRA is a cooperating sponsor of a federal chloride control project which will impound high chloride waters flowing from natural brine springs.

Red River Compact. The Red River Compact was entered into by the states of Arkansas, Oklahoma, Louisiana and Texas for the purpose of apportioning the water of the Red River and its tributaries. The Red River is defined as the stream below the crossing of the Texas-Oklahoma state boundary at longitude 100 degrees west. The two reaches pertinent to the states of Oklahoma and Texas are Reach I and Reach II. Reach I is defined as the Red River and its tributaries from the New Mexico-Texas state boundary to Denison Dam. Reach II is defined as the Red River from Denison Dam to the point where it crosses the Arkansas-Louisiana state boundary and all tributaries which contribute to the flow of the River within this Reach.

In Reach I, four subbasins are defined and the annual flow within these subbasins is apportioned as follows: 60 percent to Texas and 40 percent to Oklahoma in subbasin 1; Oklahoma has free and unrestricted use of water in subbasin 2; Texas has free and unrestricted use of water in subbasin 3; and equal quantities to both states of the annual flows and storage capacity of Lake Texoma in subbasin 4. In Reach II, annual flow in subbasin 1 is apportioned wholly to Oklahoma, while annual flow in subbasin 2 is apportioned wholly to Texas.

Greater Texoma Water Authority (GTWA). The GTWA has rights to about 70,000 ac-ft of water per year in Lake Texoma. GTWA has developed diversion facilities in conjunction with the NTMWD and provides water to the Sherman-Denison area.

Greenbelt M&I Authority. The Authority has a small service area in Donley County with the right to divert and impound water in Greenbelt Lake.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, excessive concentrations of total dissolved solids, sulfate, and chloride are a general problem in most streams of the Red River Basin under low flow conditions. The high salt concentrations are caused, in large part, by natural conditions due to the presence of salt water springs, seeps, and gypsum outcrops. Salt water springs are located in the western portion of the basin in the upper reaches of the Wichita River, the North and South Forks of the Pease River, and the Little Red, which is a tributary to the Prairie Dog Town Fork of the Red River. Gypsum outcrops are found in the area ranging westward from Wichita County to the High Plains Caprock Escarpment. The water from these areas usually contains extremely high levels of dissolved solids. At times, the total dissolved solids are comparable to those found in sea water. The quality of the water gradually improves downstream before the entrance to Lake Texoma on the main stem of the Red River. Tributary inflow to Lake Texoma reduces the total dissolved solids concentration before being released from the reservoir.

Occasional violations of the water quality standards occur throughout the basin, but are usually the result of natural conditions. The Wichita River, below Diversion Lake, and the Pease River experience elevated nutrient levels as a result of irrigation return flows and periodic low dissolved oxygen levels. Low dissolved oxygen levels in McKinney Bayou are primarily due to the bayou's sluggish nature, lack of inflow, floating aquatic macrophytes, and low reaeration capacity. Elevated water temperatures occur during summer months in stream segments with clear, shallow water where energy from the sun is easily absorbed. During periods of low flow and high evaporation, many shallow stretches of the river exhibit wide swings in dissolved oxygen due to high rates of algal metabolism.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-37.

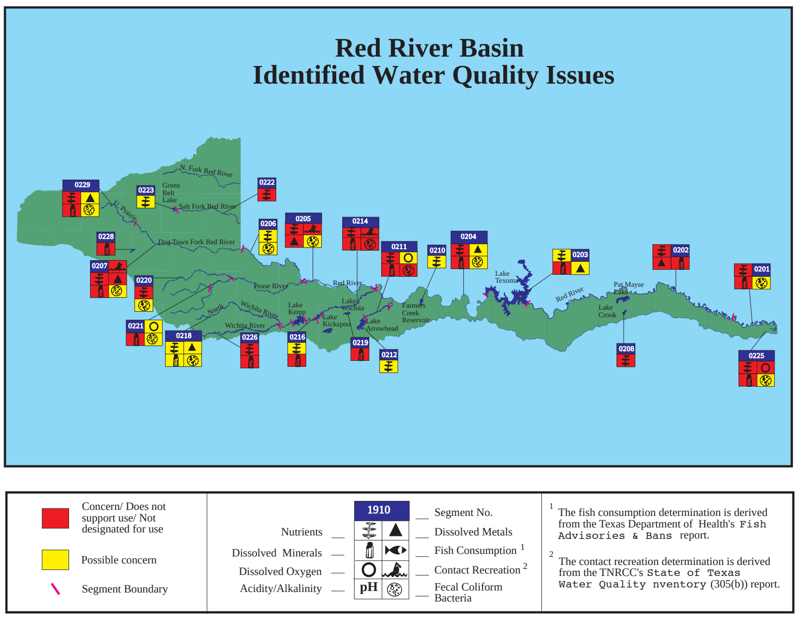

Figure 3-37
Ambient Water Quality Summary for the Red River Basin

Future Water Uses. Total water use for the basin is projected to decline over the 1990-2050 planning horizon with a projected total water use of about 600,000 acre-feet by the year 2050. This projected decline in total water use is primarily due to an anticipated reduction in irrigation water use of about 67 percent below current levels. The reduction in irrigation water requirements is due primarily to estimated declines in groundwater availability resulting in insufficient quantities of groundwater to meet current and projected future levels of irrigation water requirements, combined with increased irrigation technology associated with irrigation water use savings. Most of the anticipated reduction in irrigation water requirements is projected to occur in the upper part of the Red River Basin in the High Plains area. Overall, the water use pattern of the basin is not anticipated to change significantly over the planning horizon with water requirements for irrigated agriculture continuing to be the major water use category in the basin through the year 2050. With continued improvements in municipal, manufacturing, and irrigation water conservation practices and programs, water savings are anticipated to reach nearly 58,000 acre-feet by the year 2020 and about 102,000 acre-feet by the year 2050.

Future Water Supplies. Due to the scarcity of locally-developable surface water supplies in the High Plains portion in the upper basin, any additional supplies needed for this area will likely come from reuse of present supplies, development of additional well fields in the Ogallala Aquifer, and possible new development in minor aquifers present in the basin. No major water supply reservoirs are currently proposed for the Red River Basin. Reallocation and permitting of the unappropriated portion of Texas' share of Lake Texoma is recommended to take place in the 2045-2050 planning period, which will result in additional availability of surface water from Lake Texoma. There are no additional imports into the Red River Basin recommended for the future. Future exports are recommended for Hubert H. Moss Lake in Cooke County to the City of Gainesville (Trinity Basin) for additional water supplies in the 2005-2010 planning period; and an increase is recommended to the amount of the existing conveyance from Lake Texoma to the North Texas Municipal Water District near Dallas (Trinity Basin) in the 2045-2050 planning period. Some cities that are currently on groundwater will, in the future, need to convert to surface water supplies which have already been developed within the basin. Also, some of the smaller communities with ground-water problems will have to develop surface water projects that are considered local in nature (less than 1,000 ac-ft capacity). In addition, construction of the federal chloride control project, Crowell Brine Lake and diversion facilities, is recommended to improve water quality and to expand future useable supplies from existing reservoirs in the basin. Effects of the chloride control projects already built and those recommended for construction, on water quality, recreation, the aquatic community, and the entire ecosystem must also be monitored and evaluated.

Sulphur River Basin

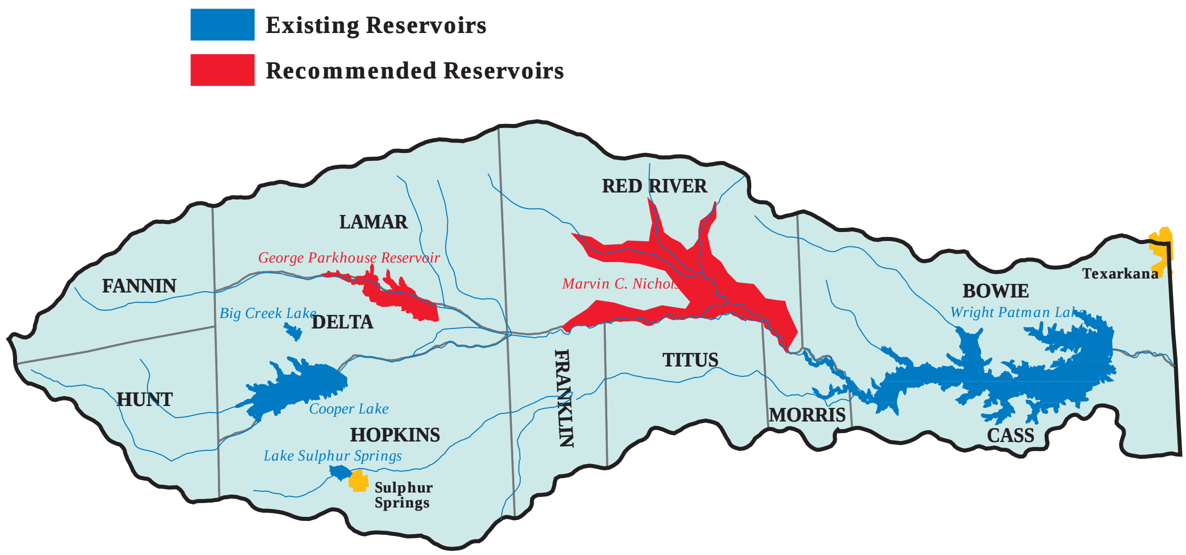

Figure 3-38

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	29,286	28,621
Manufacturing	87,627	93,844
Steam Electric	1,500	5,000
Mining	1,725	1,202
Irrigation	2,044	1,933
Irrigation Adjustment	(0)	(0)
Livestock	9,934	9,934
Total in-Basin Demands	132,116	140,534
IN-BASIN SUPPLIES		
Groundwater	13,134	12,225
Surface Water	356,269	356,324
Total In-Basin Supplies	369,403	368,549
TRANSFERS		
Import Supplies	13,129	18,671
Export Demands	88,025	287,135
NEW SUPPLIES	0	604,645
NET AVAILABILITY	162,391	564,196

Reservoir Name	Status	Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Cooper	Built	440.0	19,280	310,000	146,520
Parkhouse II	*Recommended*	*401.0*	*12,250*	*243,613*	*134,232*
Marvin NicholsI	*Recommended*	*312. 0*	*62,159*	*1,369,717*	*560,151**
Sulphur Sprgs.	Built	457.0	1,557	14,370	7,800
Wright Patman	Built	227.5	33,750	265,300	180,000

* Supply of Nichols I Reservoir could be reduced to approx. 470,000 ac-ft/yr, if Parkhouse I Reservoir is built first.

3.3.1.3 Sulphur River Basin

Basin Description. The Sulphur River Basin in northeast Texas is bounded on the north by the Red River Basin, on the west by the Trinity River Basin, on the south by the Sabine and Cypress river basins, and on the east by the Texas-Arkansas border (see Figure 3-38). The Sulphur River flows into the Red River in Arkansas. Total drainage area of the basin in Texas is 3,558 square miles. The economy of the area is based on manufacturing, retail and wholesale trade, government, agriculture, and agribusiness. The basin population increased from 154,016 in 1980 to 162,158 in 1990. By the year 2050, population of the basin is projected to reach about 196,000. Major population centers within the basin and their latest population estimates include all or portions of the cities of Texarkana (33,096), Paris (25,257), Sulphur Springs (14,966), Commerce (7,143), Atlanta (6,180), New Boston (5,111), Wake Village (5,239), Clarksville (4,345), Mount Vernon (2,366), and Nash (2,337).

Current Water Use. Surface water resources supply more than 91 percent of the water used for all purposes in the basin with ground-water resources supplying the remaining nine percent. Over the 1980-1990 period, total water use within the Sulphur River Basin increased by nearly 52 percent from 84,691 acre-feet (ac-ft) in 1980 to 128,306 ac-ft in 1990. This significant increase in total water use was due to an increase of 43,162 ac-ft in manufacturing water use. Water used for manufacturing purposes accounts for almost 69 percent of all water used within the basin. Municipal water use in 1990 totaled 25,770 ac-ft and represents a decline from the 1980 municipal water use of 28,063 ac-ft.

Current Water Supplies. There are three existing major water-supply reservoirs in the Sulphur Basin; Lake Sulphur Springs, Lake Wright Patman and Lake Cooper. The reservoirs are capable of supplying nearly 335,000 ac-ft per year and will meet the surface-water needs of the basin. Lake Cooper alone is authorized to supply 146,520 ac-ft per year of surface water to the City of Irving, the North Texas Municipal Water District and the Sulphur River Municipal Water District. Lake Cooper is also used to provide flood protection to the Sulphur Basin. Lake Wright Patman is the supply source for Texarkana and also provides water for a number of cities in Bowie County as well as major industrial needs of the County. Lake Patman also provides flood protection in the floodplains of the Sulphur and Red River basins in Arkansas and Louisiana. The basin is a very prolific water resource.

In addition to surface water, major ground-water supplies are available in the basin from the Carrizo-Wilcox Aquifer, with lesser supplies available from the Trinity, Woodbine, Blossom, Nacatoch, and Queen City aquifers.

Basin Water Districts/Authorities. The Sulphur River Basin has three major water authorities operating within its boundaries. Management and development in the basin is also controlled by the Red River Compact.

Sulphur River Basin Authority (SRBA). The SRBA is the largest water management entity in the basin. The authority was created in 1985 and serves 11 counties in the Sulphur River Basin. Active in the management and protection of the resources of the basin, it was the lead agency in the study of the waste management problems of the Basin and how to protect surface water supplies. The Authority also serves as the lead agency in the Clean Rivers program, and along with the TWDB, has evaluated the resource needs of Bowie and Red River counties.

Sulphur River Municipal Water District (SRMWD). The District was created in 1955 and serves Delta, Hopkins and Hunt counties. The SRMWD owns 26.282 percent of water stored in Lake Cooper and will use that water to fulfill the needs of its customer cities (Cooper, Commerce and Sulphur Springs). Over the next 50 years, the member cities could have excess supplies in Lake Cooper. In fact, the Upper Trinity Regional Water District (UTRWD) has entered into an agreement with the City of Commerce for the interim purchase of water from Commerce's share of Lake Cooper water for fifty to one hundred years. The interim water would be used by UTRWD to meet the need in Denton County by transporting the water to Lake Lewisville, along with Irving's water from Lake Cooper. Any other excess water the District's member cities have could be used in the Dallas/Fort Worth metroplex through interbasin transfer.

North Texas Municipal Water District (NTMWD). Created in 1951, the District serves Dallas, Rockwall, Collin and Kaufman counties. Although the water district does not serve any customers in the Sulphur River Basin, it is a part owner of Lake Cooper. The District, in conjunction with the City of Irving, has constructed the intake structure and pipeline from Lake Cooper to Lake Lavon. The intake structure also will be used by SRMWD. Irving will use the pipeline to move its share of Lake Cooper water to the Trinity Basin.

Red River Compact. Entered into by the states of Arkansas, Oklahoma, Louisiana and Texas, the Compact apportions waters of the Red River, Sulphur River and Cypress River and their tributaries to the signatory states. The compact was ratified in 1979 by the Texas Legislature, and divides the Red River Basin into five reaches. Reach II includes the Red River and tributaries from Denison Dam to the point where the Red River crosses the Arkansas-Louisiana state boundary, and includes the Sulphur Basin.

The apportionment of water is expressed in terms of percentages of flows and specified volumes of storage contained in existing reservoirs lying within the specified reaches. In the Reach II subbasin 4, Texas shall have the free and unrestricted use of water of this subbasin. Under the compact, Texas has the right to construct reservoir storage capacity if such storage does not adversely affect the delivery of apportioned water to any other state.

Current Water Quality. According to the TNRCC's 1996 <u>The State of Texas Water Quality Inventory,</u> sluggish flow, coupled with municipal wastewater discharges, contribute to elevated levels of nutrients and fecal coliform in the Sulphur River Basin. Depressed dissolved oxygen concentrations also occur in some streams in the basin. The concentrations of dissolved metals in water exceed applicable criteria in the Sulphur/South Sulphur River (Segment 0303).

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-39.

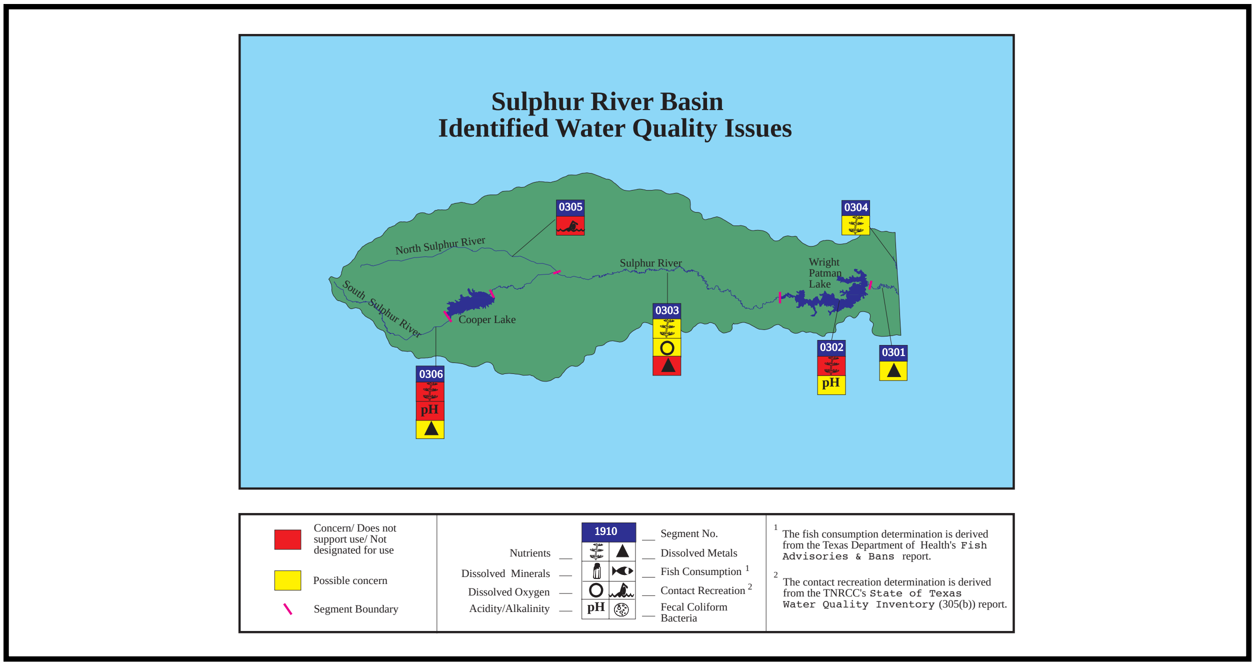

Figure 3-39
Ambient Water Quality Summary for the Sulphur River Basin

Future Water Uses. The water use pattern for the basin is not anticipated to change significantly over the 1990-2050 planning period with manufacturing accounting for about 67 percent of the basin's total water use by the year 2050. Total water use in the basin is projected to reach nearly 141,000 ac-ft by the year 2050. Water savings associated with improved municipal, manufacturing, and irrigated agriculture water conservation practices are anticipated to reduce annual water use by 5,900 ac-ft by the year 2020, and 9,100 ac-ft by the year 2050 over scenarios with no conservation.

Future Water Supplies. Two new water supply projects are recommended for development in the basin, George Parkhouse II and Marvin Nichols I. These projects could be used to meet local need as well as the needs of the Dallas/Fort Worth Metroplex. Under one development alternative, Parkhouse II would be built by the year 2015 to meet the needs of the NTMWD member cities and customers. By 2040, Nichols I should be developed to meet additional needs in the Dallas/Ft Worth Metroplex. If other projects recommended in the plan (Trinity River reuse) are not developed, then the Nichols site should be developed earlier by 2015 to meet the needs of the Dallas/Ft Worth area. The surface water providers of the area including Dallas Water Utilities, NTMWD, Tarrant Regional Water District and UTRWD could share in the development.

George Parkhouse II Reservoir. This project would be located on the North Fork of the Sulphur River in Lamar and Delta counties. The reservoir would control the flow from 377 square miles of the Sulphur Basin. There are no major water supply projects upstream of the reservoir and only 102 ac-ft per year of upstream water rights that could affect the inflow to the project, adding to the viability of the site.

The project would have to pass up to 24,771 ac-ft per year of inflows to meet downstream water rights and an average of 3,981 ac-ft per year (based on inflows, not storage) to meet estimated environmental water needs criteria. The Parkhouse II project is recommended to be developed to meet the needs of the NTMWD and local needs in the basin. It is estimated that by 2020 the District could need more than 24,000 ac-ft of additional water, depending on the magnitude of conservation efforts adopted by the District. The Parkhouse project was recommended over other options available to the District due to the amount of water developed at the site, environmental considerations, location of other District facilities, and the cost of the water. The Parkhouse II project would provide enough water to the District to meet its needs for about 25 years. This project would inundate 11,018 acres, including an estimated 1,865 acres of mixed bottomland hardwood forest.

Marvin Nichols I Reservoir. This project would be located on the Sulphur River and has a total drainage area of 1,941 square miles, 1,088 square miles of which have not been impacted by upstream water development. Most of the project would be located in Red River County.

The supply available in Nichols I, assuming the Parkhouse II project was not developed first, would be 560,151 ac-ft per year. If Parkhouse II was developed first, then the supply available from Nichols I would be 470,413 ac-ft per year. The Nichols I project would have to pass up to 103,570 ac-ft per year to meet downstream water rights and an average of 37,144 ac-ft per year (based on inflows, not storage) to meet consensus environmental planning criteria. This recommended project was selected over other options available because of the amount of water that could be developed from the site. However, there is a significant amount of high quality bottomland hardwoods at this site, but the tremendous supply of Nichols I could offset the need to build 4 to 5 alternative reservoir sites with their associated impacts. Marvin Nichols would inundate 67, 957 acres, including an estimated 36,178 acres of mixed bottomland hardwoods and hardwoods swamp.

Conveyance facilities would have to be constructed to deliver the supplies in Parkhouse and Nichols to the Dallas-Fort Worth area. It is possible that Lake Cooper and the present rights- of-way could be used for some of the delivery system.

Cypress River Basin

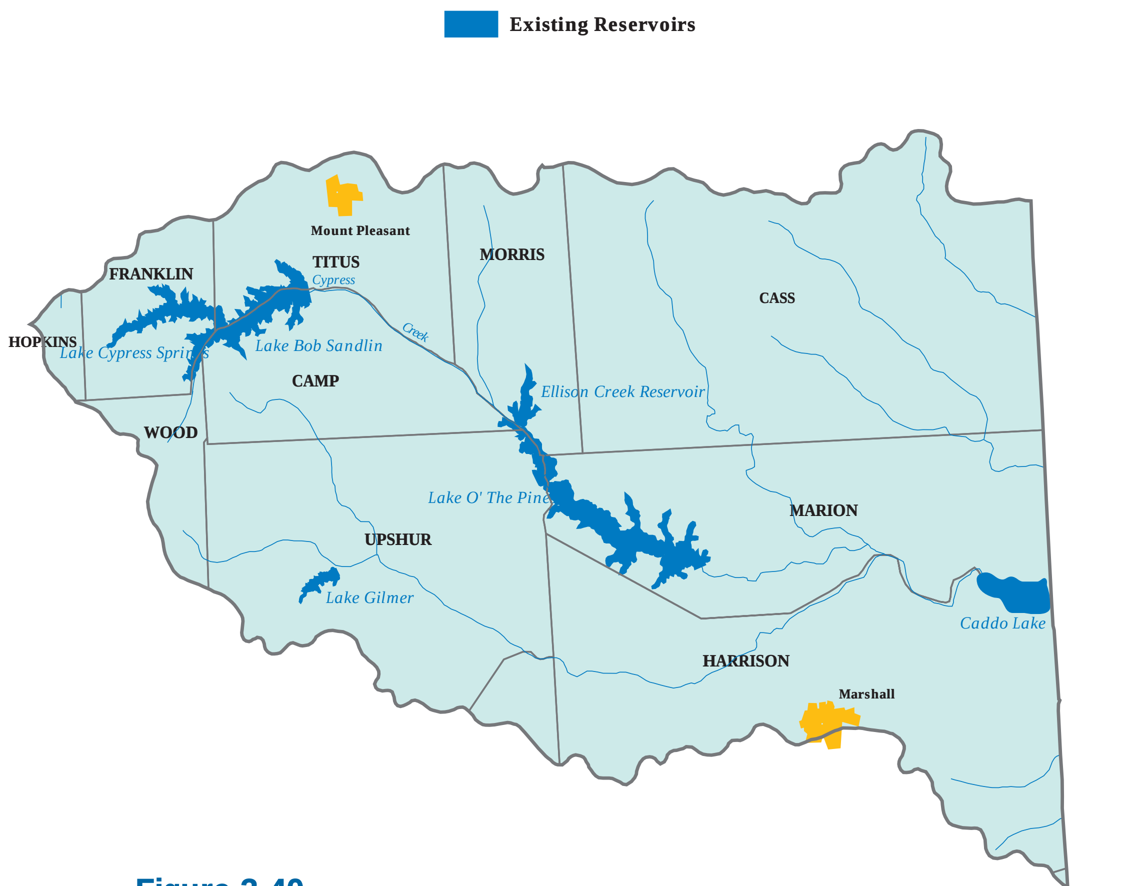

Figure 3-40

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	19,687	18,816
Manufacturing	136,387	119,648
Steam Electric	38,000	55,000
Mining	4,357	2,761
Irrigation	458	448
Irrigation Adjustment	(0)	(0)
Livestock	5,365	5,365
Total in-Basin Demands	204,254	202,038
IN-BASIN SUPPLIES		
Groundwater	21,723	18,718
Surface Water	339,965	321,550
Total In-Basin Supplies	361,688	340,268
TRANSFERS		
Import Supplies	1,479	1,458
Export Demands	10,439	57,567
NEW SUPPLIES	0	0
NET AVAILABILITY	148,474	82,121

Reservoir NameStatus		Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Cypress Springs	Built	378.0	3,400	72,800	15,300
Bob Sandlin	Built	337.5	9,460	213,350	48,500
Ellison Creek	Built	268.1	1,516	24,700	22,100
Lake O Pines	Built	230.0	19,780	254,900	130,600
Caddo	Built	168.5	26,800	129,000	10,000
Gilmer	under const.	315.0	895	12,720	7,470

3.3.1.4 Cypress Creek (River) Basin

Basin Description. The Cypress Creek Basin is bounded on the north by the Sulphur River Basin, on the west and south by the Sabine River Basin, and on the east by the Texas-Arkansas and Texas-Louisiana borders (see Figure 3-40). Total drainage area of the basin in Texas is 2,812 square miles. Manufacturing, retail and wholesale trade, mineral production, agriculture, and agribusiness are the primary sectors of the basin-wide economy. The basin population increased from 118,192 in 1980 to 124,177 in 1990. Population of the basin is projected to increase to about 147,000 by the year 2050. Major population centers in the basin and their latest population estimates include all or portions of the cities of Marshall (24,064), Mount Pleasant (13,466), Atlanta (6,180), Gilmer (5,313), Pittsburg (4,369), Winnsboro (3,180), Daingerfield (2,628), Linden (2,368), Hughes Springs (2,087), and Waskom (1,850).

Current Water Uses. Surface water resources supply about 89 percent of the total basin water needs with ground-water resources supplying the remaining 11 percent. Manufacturing and steam- electric power generation are the major surface water uses in the basin. In 1990, water used for all purposes within the basin totaled 194,572 acre-feet (ac-ft). This represents a reduction in total basin water use of nearly 55,000 ac-ft below the 1980 total water use. This decline was due primarily to a reduction in manufacturing water use of more than 68,000 ac-ft over this same period of time. By far, the largest water use category in the basin is manufacturing which accounts for nearly 67 percent of all water used, while municipal water use accounts for about 10 percent. In 1990, 10,762 ac-ft of water was exported to the Sabine River Basin and 596 ac-ft was exported to the Sulphur River Basin from the Cypress Creek Basin for municipal and industrial purposes.

Current Water Supplies. The Cypress Basin is one of the most developed basins in the State for its size. Eight major water supply reservoirs in the 2,812 square mile basin supply a total of 254,900 ac-ft of water per year (the six reservoirs shown in the basin table provide 233,970 ac-ft/yr). Most of the ground-water supplies are obtained from the Carrizo-Wilcox Aquifer with lesser amounts available from the Queen City Aquifer.

Basin Water Districts/Authorities. There are several water providers in the basin, including Franklin County Water District, Titus County Fresh Water Supply District (FWSD) #1 and Northeast Texas Municipal Water District. Owing to the complexities arising from the appropriation of water in the Cypress Basin and the varying use of these supplies, an operating agreement between the various water rights holders and districts has been developed with the aid of TWDB. This agreement provides an accounting of water held in storage and specifies the operation of water storage in lakes Bob Sandlin and Cypress Springs, subject to calls by Lake O' the Pines for water releases. Development in the basin is controlled by the Red River Compact because Cypress Creek is a tributary of the Red River.

Northeast Texas Municipal Water District (NETMWD). Created in 1953, the District serves Marion, Upshur, Morris, Cass, and Camp counties. The District owns storage rights in the Lake O' the Pines Reservoir and supplies water to its member cities, as well as municipal customers, industries and steam-electric power plants in the Cypress and Sabine basins.

The District currently supplies water to the Brandy Branch cooling lake which is located in the Sabine River Basin and has contracted to supply up to 20,000 ac-ft to the City of Longview in the Sabine Basin with an option for another 20,000 ac-ft. The District has excess supplies that can be used to meet demands in the Cypress or Sabine basins.

Franklin County Water District (FCWD). The District was created in 1965 and provides water to Franklin County from Cypress Springs Lake. The District also provides cooling water to Texas Utilities Generating Company. The District used the TWDB state participation program to enable the project to be developed. In 1968, TWDB invested over $1.9 million in this project and the District is now in the process of buying the state's share of the project.

Titus County Freshwater Supply District #1 (TCFWSD #1). The District was created in 1966 by the County to finance and construct Lake Bob Sandlin. The lake provides water for a number of cooling lakes and municipal water supplies for the City of Mt. Pleasant. Lake Bob Sandlin was developed through the state participation program. TWDB purchased a 59% interest in the project for $14.992 million in 1974, and the District has since bought TWDB's share.

Red River Compact. Entered into by the states of Arkansas, Oklahoma, Louisiana and Texas, the Compact apportions waters of the Red River, Sulphur River and Cypress Creek and their tributaries to the signatory states. The compact was ratified in 1979 by the legislature. The Compact divides the Red River Basin into five reaches. Reach III described below includes the Cypress Creek Basin.

> Reach III - tributaries west of the Red River which cross the Texas-Louisiana state boundary or the Arkansas-Louisiana state boundary or both the Texas-Arkansas and Arkansas-Louisiana state boundaries.

The apportionment of water is expressed in terms of percentages of flows and specified volumes of storage contained in existing reservoirs lying within the specified Reaches. In Reach III , Texas is apportioned sixty (60) percent of the runoff of this subbasin 1. In subbasin 3, Texas has the unrestricted rights to all water above the Marshall, Lake O' The Pines and Black Cypress dam sites and Texas shall have the right to 50% of the storage capacity of any future enlargement of Caddo Lake. Under the compact, Texas has the right to construct reservoir storage capacity if such storage does not adversely affect the delivery of apportioned water to any other state.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, streams in the Cypress Basin periodically exhibit low dissolved oxygen concentrations. Many of the streams in this basin have sluggish flow characteristics, receive significant natural organic loads, and are heavily shaded by riparian tree cover. The discharge of treated domestic and industrial wastewaters compound these natural problems in some streams. The concentration of dissolved metals in water exceed applicable criteria in three segments. The concentration of toxic substances in sediment exceed screening levels in five segments. The Texas

Department of Health has issued restricted-consumption advisories for Caddo Lake and Big Cypress Creek below Lake O' the Pines, due to elevated levels of mercury in fish tissue. The advisories apply to largemouth bass and freshwater drum.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-41.

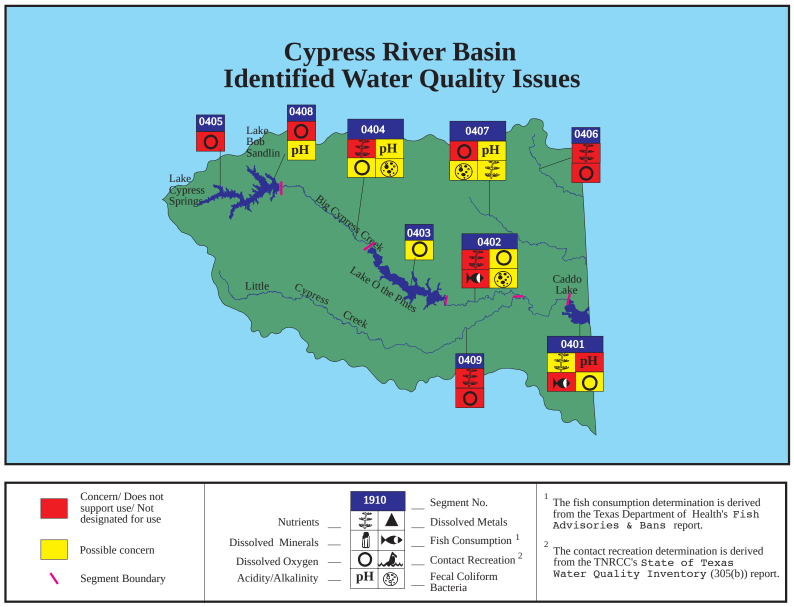

Figure 3-41
Ambient Water Quality Summary for the Cypress River Basin

Future Water Uses. By the year 2050, total water use in the basin is projected to reach about 202,000 ac-ft which represents an increase of about four percent above the 1990 total water use. This relatively slow growth in water use is attributable to a projected decline in manufacturing water use of about eight percent over the same period of time. Even with this anticipated decline, manufacturing water use is projected to remain the largest water using sector in the basin, accounting for approximately 59 percent of the total basin water use by the year 2050. Continued implementation of municipal, manufacturing, and irrigated agriculture conservation practices and programs is anticipated to reduce annual water use by 4,200 ac-ft in the year 2020 and 6,200 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. Approximately 56,000 ac-ft per year of future water needs will be met through (wastewater) reuse by the year 2050. Reuse can provide a source of water for some of the steam-electric power generation and industrial water needs in the basin. The City of Shreveport, Louisiana has indicated a desire to use Caddo Lake as a water supply source. However, the Board's forecasts suggest that environmental impacts from the potential significant lowering of Caddo Lake levels through expanded water supply use, especially during dry weather periods, should preclude it from being a viable site for additional future water supplies. Further, potential industrial needs in Harrison County could also be met with water from Lake O' the Pines.

The Northeast Texas Municipal Water District's contract with the City of Longview for up to 20,000 ac-ft should meet Longview's long-term water needs. It is anticipated that the City would need to construct a pipeline from Lake O' The Pines by 2005.

Sabine River Basin

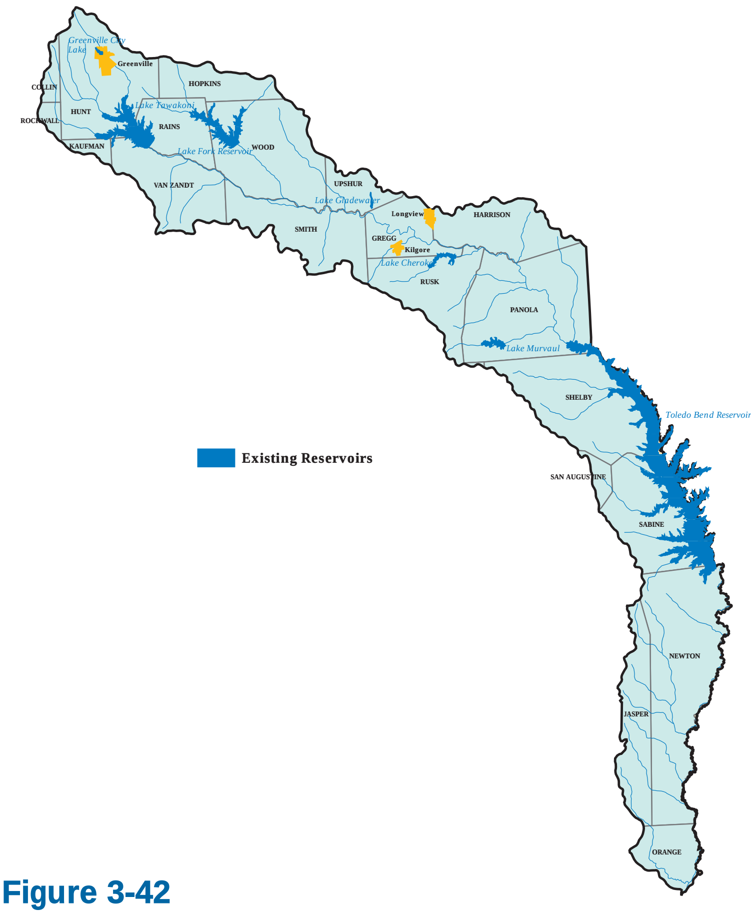

Figure 3-42

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	79,731	86,746
Manufacturing	182,110	286,587
Steam Electric	44,300	109,000
Mining	7,953	22,780
Irrigation	5,160	4,899
Irrigation Adjustment	(0)	(0)
Livestock	13,638	13,638
Total in-Basin Demands	332,892	523,650
IN-BASIN SUPPLIES		
Groundwater	53,396	84,780
Surface Water	1,486,356	1,461,840
Total In-Basin Supplies	1,539,752	1,546,620
TRANSFERS		
Import Supplies	14,937	67,281
Export Demands	216,223	411,100
NEW SUPPLIES	0	0
NET AVAILABILITY	1,005,574	679,151

Reservoir NameStatus		Conservation Pool			
		Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Greenville	Built	n.a.	n.a.	6,864	4,159
Tawakoni	Built	437.5	36,200	927,440	235,160
Lake Fork	Built	403.0	27,960	675,819	179,142
Gladewater	Built	300.0	800	6,950	1,679
Cherokee	Built	280.0	3,987	46,700	22,500
Murvaul	Built	265.0	3,800	44,650	22,400
Toledo Bend	Built	172.0	181,600	4,477,000	750,000

3.3.1.5 Sabine River Basin

Basin Description. The Sabine River Basin in Texas is bounded on the north by the Sulphur River and the Cypress Creek basins, on the west by the Trinity and Neches river basins, and on the east by the Texas-Louisiana border (see Figure 3-42). Total drainage area of the basin is 9,756 square miles, of which 7,426 square miles are within the State. The economy of the area is based on manufacturing, agriculture, agribusiness, mineral production, retail and wholesale trade, and recreation. In 1980, the population of the basin totaled about 407,282 and had increased to 442,358 by 1990, representing an increase of about nine percent above the 1980 population. By the year 2050, the basin population is projected to increase to an estimated 628,000 residents. Major population centers in the Sabine River Basin and their latest population estimates include all or portions of the cities of Longview (73,939), Greenville (23,096), Orange (20,220), Marshall (24,064), Kilgore (11,503), Bridge City (8,479), and Gladewater (6,190).

Current Water Uses. Surface water resources supply more than 81 percent of the total basin water needs with ground-water resources supplying the remaining 19 percent. In 1990, water used for all purposes in the basin totaled 276,898 acre-feet (ac-ft) and represented an increase of nearly 42 percent above the 1980 total water use of 195,194 ac-ft. This significant increase in water use is attributable to an increase in manufacturing water use of more than 56,000 ac-ft or an increase of 67 percent over the 1980-1990 period. Over this same period of time, municipal water use increased nearly 6,500 ac-ft. In 1990, 115,862 ac-ft of water was exported to the Trinity River Basin, 1,434 ac-ft was exported to the Neches River Basin, and 1,171 ac-ft was exported to the Sulphur River Basin from the Sabine River Basin for municipal and industrial purposes.

Current Water Supplies. The surface water within the Sabine River Basin was apportioned between the states of Louisiana and Texas by the Sabine River Compact in 1953. Of the 12 major reservoirs within the Texas portion of the basin, five are used for recreation and flood regulation. The remaining seven reservoirs can supply 1,215,040 ac-ft per year of surface water to users within the basin and in portions of the Neches, Sulphur, and Trinity river basins. Groundwater is obtained from the Carrizo-Wilcox, Nacatoch, Trinity, Queen City, Sparta, and Gulf Coast aquifers. Other basin water-supply issues include flooding and drainage, environmental concerns, and conflicts over local use versus out-of-basin water use.

Basin Water Districts/Authorities. Three of the seven reservoirs (Lake Fork, Lake Tawakoni and Toledo Bend Reservoir) are owned and operated by the Sabine River Authority (SRA), Toledo Bend being jointly owned by the SRA of Texas and Louisiana. Other lakes are managed by different authorities or districts. The development of the resources of the basin must also comply with the Sabine River Compact.

Sabine River Authority (SRA). The Authority was created by the Texas Legislature in 1949 as a conservation and reclamation district to control, store, preserve, and distribute the waters of the Sabine River and its tributaries for beneficial purposes. The service area of the SRA includes all or parts of twenty-one counties. The Authority provides laboratory services for local needs and has been the lead agency in the Clean Rivers program in the Sabine Basin.

The Sabine River Authority, along with the City of Houston and other participants, has undertaken a multi-year, multi-regional planning study of the area from the Sabine River to the Brazos River along the coast.

Panola County FWD#1. Created in 1953, the District owns and operates Lake Murvaul. The District provides water to Carthage and other water utilities in Panola County.

Cherokee Water Company. Cherokee WC is a private water utility that owns and operates Lake Cherokee in Gregg and Rusk counties. The Company provides water to the City of Longview and to Southwestern Electric Power Company.

Sabine River Compact. Entered into by the states of Louisiana and Texas, the Compact mandates that neither state shall authorize any uses (projects) which would have the effect of reducing Stateline flow to less than 36 cubic feet per second. "Stateline" is defined as the point on the Sabine River where its waters in downstream flow first touch the states of both Louisiana and Texas. The right of each state to construct impoundment reservoirs and other works of improvement on the Sabine River or its tributaries located wholly within its boundaries is recognized. The compact was ratified in 1953 by the 53rd Texas Legislature.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, low dissolved oxygen concentrations occur in several segments in the basin. Point source discharges of treated wastewater, coupled with natural organic loading and sluggish flow, contribute to this problem. Concentrations of dissolved metals exceed applicable criteria in two segments, concentrations of toxic substances in sediments exceed screening levels in six segments, and the concentrations of toxic substances in fish tissue exceed screening levels in two segments.

The Texas Department of Health has issued restricted consumption advisories for Toledo Bend Reservoir for elevated levels of mercury in fish tissue and for Brandy Branch and Martin Creek reservoirs due to elevated levels of selenium in fish tissue. The advisories apply to largemouth bass and freshwater drum from Toledo Bend and for all species in Brandy Branch and Martin Creek reservoirs.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-43.

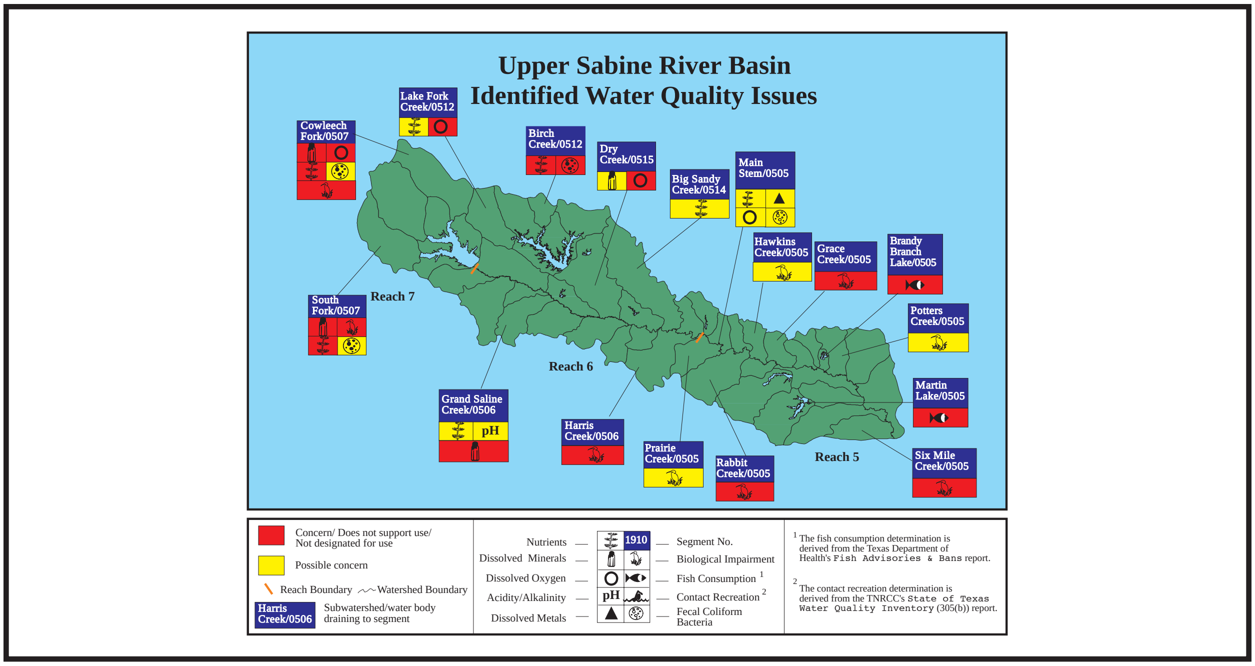

Figure 3-43
Ambient Water Quality Summary for the Sabine River Basin

Future Water Uses. Total water use in the basin is projected to increase by 89 percent over the 1990-2050 planning horizon with a projected total water use of about 524,000 ac-ft by the year 2050. The stimulus for this increase in total water use over the planning period is a projected increase in manufacturing water use of nearly 146,000 ac-ft. The water use pattern of the basin is not anticipated to change significantly over the planning period with manufacturing water use accounting for approximately 55 percent and municipal water use accounting for about 17 percent of the total basin water use by the year 2050. Water savings associated with continued improvement in municipal water conservation practices and programs, and manufacturing water use efficiencies are anticipated to reduce manufacturing and municipal water use by nearly 39,000 ac-ft in the year 2020, and about 67,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. No major water supply reservoirs are currently proposed for the Sabine River Basin. In order to accommodate possible changes in the rate or pattern of growth, discovery of unknown, significant environmental effects, changing regulations, new technical knowledge about the resource, and to allow local flexibility, the Water Plan includes possible alternative water supply projects (see Figure 3-15). To meet future needs in the upper basin, it is anticipated that additional groundwater will be developed, primarily for mining and steam-electric power generation, and a pipeline will be constructed from Toledo Bend Reservoir to the Gregg-Harrison county area. There are no additional imports to the Sabine River Basin recommended for the future; however, several important exports are recommended to occur during the planning period. Depending upon the degree of water conservation savings that can be realized in the Houston area, up to 92,000 ac-ft per year of surface water will need to be exported from Toledo Bend Reservoir to the San Jacinto River Basin to meet the future needs in the Houston area that are not met with other supplies. Also, existing surface water supply in Lake

Fork Reservoir under contract to Dallas Water Utilities (Trinity Basin), is projected to be exported to the Dallas area through construction of major conveyance facilities before 2010.

At the present time, the acceptance of a Federal non-development easement precludes the development of the Waters Bluff Reservoir Project in the Upshur-Gregg county area without Congressional approval. If developable through Congressional concurrence, the project could provide over 320,000 ac-ft per year to meet future in-basin or out-of-basin needs.

Neches River Basin

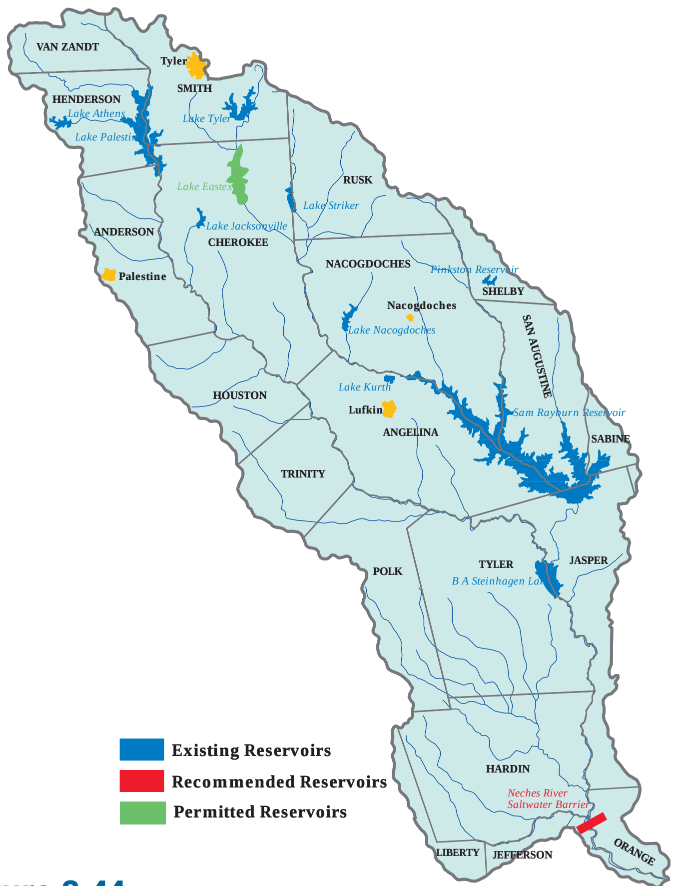

Figure 3-44

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	98,791	113,372
Manufacturing	172,273	223,918
Steam Electric	8,000	51,000
Mining	10,675	9,250
Irrigation	15,389	13,684
Irrigation Adjustment	(0)	(0)
Livestock	10,847	10,847
Total in-Basin Demands	315,975	422,071
IN-BASIN SUPPLIES		
Groundwater	126,341	161,127
Surface Water	1,443,899	1,436,638
Total In-Basin Supplies	1,570,240	1,597,765
TRANSFERS		
Import Supplies	486	515
Export Demands	238,761	334,927
NEW SUPPLIES	0	0
NET AVAILABILITY	1,015,990	841,282

Reservoir NameStatus		Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Athens	Built	440.0	1,520	32,790	7,100
Palestine	Built	345.0	25,560	411,840	212,700
Jacksonville	Built	422.0	1,320	30,500	5,000
Tyler	Built	375.4	4,880	80,900	38,500
Eastex	Permitted	315.0	10,000	187,839	53,307
Striker	Built	292.0	2,400	26,960	20,600
Nacogdoches	Built	279.0	2,210	41,140	22,000
Pinkston	Built	298.0	523	7,380	3,800
Sam Rayburn	Built	164.4	114,500	2,898,500	820,000
Steinhagen	Built	83.0	13,700	94,200	131,800

3.3.1.6 Neches River Basin

Basin Description. The Neches River Basin is bounded on the north and east by the Sabine River Basin, on the west by the Trinity River Basin, and on the south by the Neches-Trinity Coastal Basin (see Figure 3-44). Total drainage area of the basin is 10,011 square miles with the northeastern portion of the basin being drained by the Angelina River. The economy of the basin is predominately based on manufacturing, forestry, agriculture, agribusiness, retail and wholesale trades, and oil and gas production. Population of the basin increased from 506,358 in 1980 to 554,402 in 1990. Over the 1990-2050 planning horizon, the basin population is projected to increase by 52 percent with an anticipated population of nearly 841,000 by the year 2050. Major population centers in the basin and their latest population estimates include all or portions of the cities of Beaumont (115,797), Tyler (79,812), Nacogdoches (32,229), Lufkin (32,522), Palestine (17,911), Nederland (16,803), Groves (16,739), Port Neches (13,111), and Jacksonville (13,193).

Current Water Uses. Surface water resources supply about 55 percent of the water used for all purposes within the basin, while ground-water resources supply the remaining 45 percent. Total water use in the basin declined from 318,207 acre-feet (ac-ft) in 1980 to 303,553 ac-ft in 1990. A primary reason for this reduction in total water use was the decline in manufacturing water use of 18,019 ac-ft over this same period of time. Manufacturing is the largest water use category in the basin accounting for about 54 percent of the total basin water use followed by municipal water use which accounts for nearly 28 percent. Over the 1980-1990 period, municipal water use increased 6,214 ac-ft. In 1990, over 275,000 ac-ft of water was exported to the Neches-Trinity Coastal Basin, 4,534 ac-ft was exported to the Trinity River Basin, and 1,775 ac-ft was exported to the Sabine River Basin from the Neches River Basin for municipal, industrial and agricultural irrigation purposes.

Current Water Supplies. There are ten major water-supply reservoirs in the basin. These projects, along with run-of-the-river flows, are capable of supplying nearly 1,460,000 ac-ft of dependable surface water per year. Several of the reservoirs provide water to cities outside the basin. For example, Lake Athens provides water to the City of Athens in the Trinity River Basin, and Lake Pinkston provides water to the City of Center located in the Sabine River Basin. Over 53 percent of Lake Palestine is owned by the City of Dallas in the Trinity River Basin. The Neches Basin is a prolific water resource and could be used to supply additional water both inside and outside the basin. Even during the 1951-1956 drought period, the average annual runoff for the basin was 312 ac-ft per square mile.

Groundwater from the Carrizo-Wilcox, Queen City, Sparta, and Gulf Coast aquifers supplies almost all of the current ground-water needs of the basin.

Other current water supply issues in the basin include environmental concerns associated with the Big Thicket and other bottom-land hardwood habitats, and salt water intrusion in the tidally-influenced reaches of the Neches River.

Basin Water Districts/Authorities. There are 3 major water districts/authorities serving the Neches River Basin.

Upper Neches River Municipal Water Authority (UNRMWA). The Authority was created in 1953 and serves Anderson, Henderson, Smith and Cherokee counties. The Authority is primarily responsible for supplying water from Lake Palestine to its customer cities and contract buyers. The UNRMWA is permitted to supply 238,110 ac-ft of water per year and is also heavily involved in monitoring water quality in its service area. Although the Authority is not involved in water/wastewater treatment, it monitors return flows from treatment plants to verify compliance with water quality standards.

Lower Neches Valley Authority (LNVA). The Authority was created in 1933 and serves Jefferson, Chambers, Hardin, Liberty and Tyler counties. The Authority provides water from Sam Rayburn and B.A. Steinhagen reservoirs to its customer cities, as well as industrial complexes in the cities of Beaumont and Port Arthur, and irrigators in Jefferson County. The authority has the capacity to distribute over one billion gallons of water per day through over 400 miles of canal systems. The LNVA also operates a 22 MGD industrial wastewater treatment facility for the Beaumont area. The proposed salt water barrier on the lower Neches River is sponsored by the authority.

Angelina & Neches River Authority (ANRA). The authority was created in 1935 as the Sabine-Neches Conservation District. The District was changed to the Neches River Conservation District in 1949 when the Sabine River Authority was created. The Neches RCD was changed to the present authority in 1977. The authority serves all of the counties in the Lower Neches River sub-basin and some counties in the Upper Neches River sub-basin. The Authority has a state permit for the as yet unconstructed Lake Eastex project which could possibly provide water supplies for Smith, Rusk, Cherokee, Nacogdoches, and Angelina counties, if needed. The Authority provides laboratory service and water quality monitoring for the region, and owns/operates rural water and wastewater utilities. ANRA was also the lead agency for the statewide Clean Rivers program for the basin. The Authority, through a grant from TWDB, has been studying the composting of a number of waste products from industries and the solids from municipal wastewater treatment plants in the service area.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, low levels of dissolved oxygen persist in the headwater region of Sam Rayburn Reservoir and in the lower part of the Angelina River upstream of the reservoir. This is due to naturally sluggish stream flow and other natural conditions. The discharge and assimilation of water from Paper Mill Creek further aggravates these conditions. Dissolved oxygen levels are also depressed in the Angelina River upstream of the Paper Mill Creek confluence. Elevated cadmium levels in water cause nonsupport of the aquatic life use in the Neches River downstream of B.A. Steinhagen Reservoir and the Neches River downstream of Lake Palestine. Zinc, aluminum, and silver levels in the water cause nonsupport of the aquatic life use in the Neches River upstream of Lake Palestine, the Angelina River upstream of Sam Rayburn Reservoir, and Attoyac Bayou, respectively.

Fecal coliform densities are elevated in Pine Island Bayou and in the headwaters of Sam Rayburn Reservoir, and cause nonsupport of the contact recreation use. Nutrient levels are elevated in the Neches River downstream of Lake Palestine, the Neches River upstream of Lake Palestine, Sam Rayburn Reservoir, and the Angelina River upstream of Sam Rayburn Reservoir. Except for the upper part of Sam Rayburn Reservoir, nutrient levels do not appear to affect dissolved oxygen or chlorophyll a. However, elevated nutrient levels have the potential to cause increased algal growth.

Due to the occurrence of elevated mercury levels in fish in B.A. Steinhagen and Sam Rayburn reservoirs, the Texas Department of Health issued restricted-consumption advisories in November, 1995 for the general population, children, and women of childbearing age. The sediments of the basin tend to accumulate metals. Elevated concentrations of various metals are found in seven of 14 segments within the basin.

In the tidal portion of the basin, near the cities of Beaumont and Port Arthur, water quality problems have been recurrent over the past several decades. Low dissolved oxygen levels, elevated fecal coliform densities, and dark colored water were due primarily to large domestic and industrial wastewater loadings. Other contributing factors include dredging of the ship channels, installation of saltwater barriers, and diversion of freshwater inflow for irrigation and consumptive uses. There have been very few violations of water quality criteria in the past four years. Implementation of more efficient wastewater technology since the mid-1970s has substantially reduced pollutant loadings to the segment. For the past several years, the Texas Department of Health has advised that fish taken from the upper tidal portion of the Neches River are potentially contaminated with dioxins and should not be eaten. However, the Texas Department of Health recently rescinded the consumption advisory, as fish taken from this segment indicate that dioxin has decreased to acceptable levels.

Extremely low stream gradients and poorly defined natural drainage systems produce swampy areas in the tidal reaches of the basin. Low dissolved oxygen and pH levels naturally develop due to forest drainage, natural canopy shading, and sluggish velocities. These natural conditions are further aggravated by point and nonpoint source pollutant loads. Pine Island Bayou, a tributary to the Neches River tidal, experiences low dissolved oxygen levels resulting mainly from natural factors during summertime low-flow sluggish conditions.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-45. The Clean Rivers Program included the Neches-Trinity Coastal Basin in the Neches Basin description.

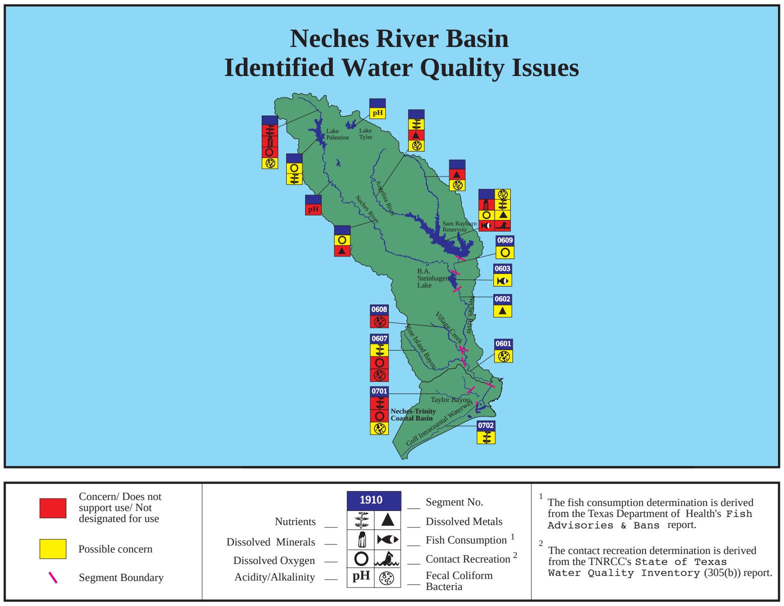

Figure 3-45

Ambient Water Quality Summary for the Neches River Basin

Future Water Uses. Total water use in the basin is projected to increase by about 39 percent or nearly 119,000 ac-ft over the 1990-2050 planning horizon. The impetus for this increase in total water use is the projected increase in manufacturing water use of 38 percent or nearly 62,000 ac-ft over this same time period. Municipal water use is projected to increase from 86,290 ac-ft in 1990 to about 113,400 ac-ft by the year 2050. Additional improvements in municipal water conservation and manufacturing water use efficiencies are expected to occur over the planning period with anticipated annual water savings for the two major water using categories reaching more than 33,000 ac-ft by the year 2020, and nearly 56,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. In the future, ground-water use will increase in the basin. A salt water barrier is recommend to be constructed on the Neches River near Beaumont to protect water supplies from sea water intrusion.

Neches River Salt Water Barrier. This structure would be located north of Beaumont below the confluence of the Neches River and Pine Island Bayou. The project would control salt water intrusion up the Neches River. At the present time, during periods of low flow in the river, LNVA has to install temporary sheet piling in the river to protect the authority's intakes or has to release water from Sam Rayburn to keep a salt water wedge from intruding up the river past the authority's water intake structures. The project would be a permanent barrier with locks to enable small crafts to by-pass the barrier. The estimated cost for the project is $78 million.

Eastex. The Angelina and Neches River Authority has received a state permit to construct the Eastex Reservoir project on Mud Creek, but has yet to apply for the necessary federal permits. This project has a state permit to supply 85,100 ac-ft of water per year for municipal and industrial use. The estimated cost for the Eastex project (in 1996 dollars) is $122 million. Studies conducted by TWDB staff on the ground-water resources of the region indicate that there should be adequate supplies in the region to meet the long range needs of the area at a cheaper cost than the Eastex project.

Trinity River Basin

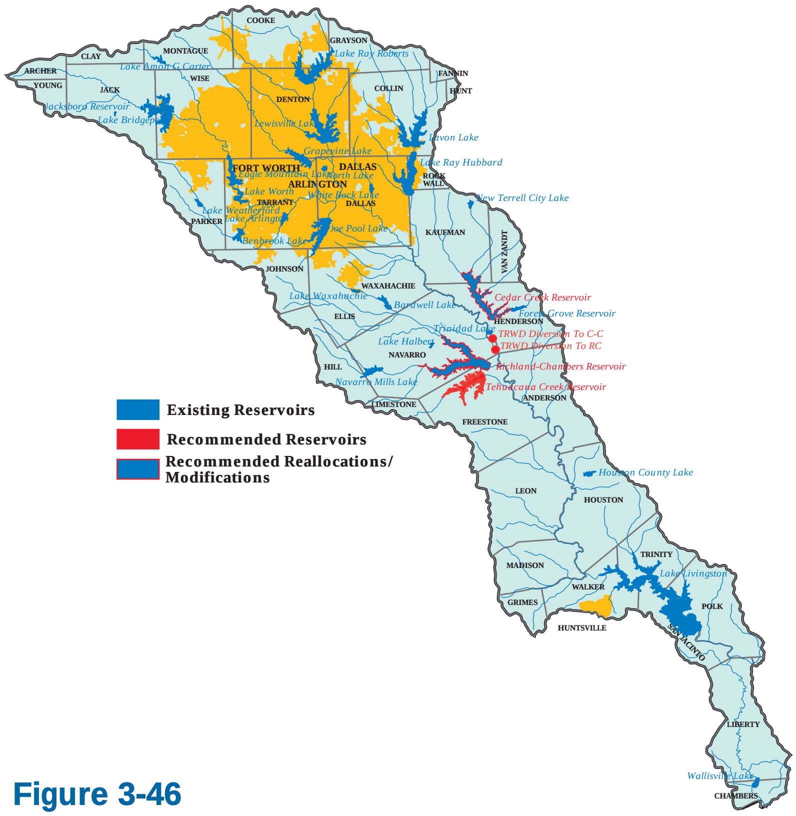

Figure 3-46

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	1,101,059	1,645,254
Manufacturing	111,828	199,278
Steam Electric	42,250	111,600
Mining	31,009	37,202
Irrigation	92,170	71,082
Irrigation Adjustment	(0)	(0)
Livestock	25,476	24,476
Total in-Basin Demands	1,403,792	2,089,892
IN-BASIN SUPPLIES		
Groundwater	112,041	109,106
Surface Water	2,277292	2,215,554
Total In-Basin Supplies	2,389,333	2,324,660
TRANSFERS		
Import Supplies	364,243	847,828
Export Demands	575,054	1,111,706
NEW SUPPLIES	0	139,547
NET AVAILABILITY	774,730	110,437

Reservoir NameStatus		Conservation Pool			
		Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Bridgeport	Built	836.0	13,000	386,420	79,000
Eagle Mountain	Built	649.0	9,200	190,460	
A.G. Carter	Built	920.0	1,848	28,589	2,600
Worth	Built	594.3	3,560	38,130	2,400
Weatherford	Built	896.0	1,210	19,470	2,000
Benbrook	Built	694.0	3,770	88,250	9,800
Grapevine	Built	535.0	7,380	188,550	27,240
R. Roberts	Built	632.5	29,350	799,600	110,000
Lewisville	Built	522.0	29,592	640,986	110,800
Arlington	Built	550.0	2,275	45,710	7,050
Joe Pool	Built	522.0	7,470	181,200	16,900
Lavon	Built	492.0	21,400	456,500	104,000
Ray Hubbard	Built	435.5	22,745	490,000	63,100
Terrell	Built	504.0	830	8,712	1,650
Cedar Creek	Built	322.0	33,750	679,200	162,500
Diversion to Cedar Creek	*Recommended*				17,500
Waxahachie	Built	531.5	690	13,500	2,400
Bardwell	Built	421.0	3,570	54,900	8,300
Halbert	Built	368.0	650	7,420	600
Navarro	Built	424.5	5,070	63,300	23,100
Richland-chambers	Built	315.0	44,752	1,181,866	210,000
Diversion to Richland-Chambers	*Recommended*				56,000
Tehuacana	Recommended	315.0	14,938	337,947	65,547
Houston Co.	Built	260.0	1,282	19,500	7,000
Jacksboro	Built	1,008.0	368	11,961	1,468
Wallisville	under const.				89,600
Livingston	Built	131.0	82,600	1,750,00	1,225,200

3.3.1.7 Trinity River Basin

Basin Description. The Trinity River Basin is bounded on the north by the Red River Basin, on the east by the Sabine River Basin, and on the west by the Brazos and San Jacinto river basins (see Figure 3-46). Total drainage area of the basin is 17,969 square miles. Finance, manufacturing, services, transportation, agriculture, agribusiness, and recreation are the major sectors of the basin-wide economy. The Trinity River Basin is the most populated basin in Texas with a population of 4.209 million in 1990. From 1980 to 1990, the basin population increased by 993,000 residents. By the year 2050, the basin population is projected to reach about 9.1 million and is anticipated to remain the most populated basin in the state. Major population centers in the basin and their latest population estimates include all or portions of the cities of Dallas (1,048,882), Fort Worth (473,291), Arlington (286,545), Garland (189,816), Irving (169,265), Plano (168,026), Grand Prairie (107,954), Mesquite (110,510), Huntsville (33,467), Corsicana (23,857), and Waxahachie (19,181).

Current Water Uses. Surface water resources supply about 90 percent of the water used for all purposes in the basin with ground-water resources supplying the remaining 10 percent. Total basin water use increased from 939,574 acre-feet (ac-ft) in 1980 to about 1.145 million ac-ft in 1990. Over this same period of time, municipal water use increased by 189,280 acre-feet (ac-ft), representing a 28 percent increase over the ten-year period. The largest water use category is municipal which accounts for 75 percent all water used in the basin. Water used for agricultural irrigation accounts for about 10 percent of the total basin water use, with manufacturing accounting for about eight percent. In 1990, 343,00 ac-ft of water was exported to the Trinity-San Jacinto Coastal Basin, 640 ac-ft was exported to the Neches-Trinity Coastal Basin, and 333 ac-ft was exported to the Neches River Basin from the Trinity River Basin for municipal, industrial, and agricultural irrigation purposes.

Current Water Supply. Twenty-six of the thirty major reservoirs within the Trinity River Basin are for water supply purposes, providing over 2.3 million acre-ft per year (amounts listed in the preceding table are year 2000 yield estimates with reductions for sedimentation). Lake Livingston contains over half of the basin's total surface water supply and provides water to Houston and users in the coastal basins. Major water suppliers in the upper portion of the basin are Dallas Water Utilities, Tarrant Regional Water District and North Texas Municipal Water District (NTMWD). Ground-water supplies are obtained from seven aquifers within the basin boundary; the Trinity, Woodbine, Carrizo-Wilcox, Gulf Coast, Queen City, Sparta and Nacatoch. Water supply problems include poor stream and ground-water quality in specific portions of the basin, water-level declines and depletion of storage in the aquifers, flooding and drainage, environmental concerns for wetland areas and the Trinity-San Jacinto Estuary, and intrusion of saline water from the estuary into the lower reaches of the Trinity River.

Basin Water Districts/Authorities. There are a number of districts and authorities that manage the water resources of the basin. Included in the lower basin are the City of Houston and the Liberty-Chambers Navigation District which export water outside of the basin.

Tarrant Regional Water District (formerly Tarrant County Water Control and Improvement District #1). The District (TRWD) presently owns and operates four reservoirs, Eagle Mountain, Bridgeport, Cedar Creek, and Richland-Chambers, and has storage rights in Benbrook Reservoir. TRWD provides raw water to the cities of Arlington, Mansfield, and Fort Worth, which then sell treated water to most of the cities in Tarrant County. The District also provides water and has contracts to sell additional water to entities in Parker, Ellis, Wise, Jack, Henderson, and Kaufman counties. The District provides water to the Trinity River Authority, which then sells treated water to the cities of Bedford, Euless, North Richland Hills, Grapevine, Colleyville, and several other small communities and water supply corporations. In addition, the District will augment the raw water supplies of Weatherford and Benbrook in the future. The development of additional supplies by the District will be required by the year 2030 in order to meet its customers' needs. Recommended projects, anticipated to be needed by year 2025, include the diversion of Trinity River (wastewater) return flow from the Fort Worth area into the District's lower reservoirs, Richland-Chambers and Cedar Creek, and the eventual construction of the Tehuacana Reservoir project for use by the year 2050. If the Trinity River reuse project is proven to be infeasible, sufficient supplies could be obtained from the recommended Nichols I Reservoir project located in the Sulphur River Basin. The District believes that it also will be able to increase its firm water supply by adopting a coordinated system operation of its reservoirs and is studying the potential amount of the increase.

North Texas Municipal Water District (NTMWD). The NTMWD currently provides roughly 180,000 ac-ft of water per year, supplying the water needs of nearly one million people in a service area which covers over 1,600 square miles. Supply sources for the district include three reservoirs, Lavon, Texoma and Cooper. The development of additional supplies and conveyance systems will be required by the year 2015 to meet demands by the District's member cities. Recommended projects include the construction of Parkhouse II Reservoir and associated conveyances by the year 2015. The Nichols I Reservoir project, if constructed early and depending upon regional cooperation, could offset the need for the Parkhouse II Reservoir. If the Red River Chloride Control Project successfully increases the quantity of usable water supplies in Lake Texoma, the reallocation and permitting of the unappropriated portion of Texas' share of Lake Texoma water is recommended by 2050 in order to provide additional supplies to the District. This will also necessitate the construction of a new conveyance system to transport the additional water.

The District owns and/or operates more than a dozen regional and subregional wastewater collection and treatment facilities in Collin, Dallas and Rockwall counties. Plano, McKinney, Mesquite and Rockwall are some of the cities served by these facilities. Growth in the area has led to expansion and upgrades to several of the plants serving the area over the last few years.

Dallas Water Utilities. Dallas Water Utilities (DWU) provides treated and raw water to over 30 municipalities and water supply corporations in Dallas, Denton and Collin counties. Water supplies for DWU are provided by seven surface water reservoirs; Grapevine, Lewisville, Ray Roberts, Tawakoni, Ray Hubbard, Palestine, and Fork. Transmission facilities are not yet constructed to Lake Palestine and Lake Fork, but will eventually be necessary. Total available supplies to DWU exceed 650,000 ac-ft per year. Projections for DWU include construction of transmission facilities from Lake Fork to Dallas in 2005, and from Lake Palestine in 2015. Other recommended projects include the construction of the Nichols I Reservoir which is expected to be needed by DWU customers by 2040.

DWU also operates two of the largest wastewater treatment facilities in Texas, the Dallas Central Plant with 150 MGD treatment capacity and the Southside Plant with a 90 MGD treatment capacity. Both plants have recently undergone extensive upgrading and modernization programs. The City also maintains a collection system that transports wastewater to a treatment facility operated by the Trinity River Authority.

Trinity River Authority (TRA). The Trinity River Authority, operating under a master plan originally adopted in 1958 and revised periodically, implements water supply and wastewater projects serving cities and special districts throughout the Trinity Basin. The Trinity River Authority (TRA) is the local sponsor of Joe Pool Reservoir and provides water to the Midlothian Water District. The TRA provides water to the cities of Corsicana, Waxahachie and other Ellis County communities through Lake Bardwell and Navarro Mills Reservoir. In addition, the TRA provides water to the cities of Bedford, Euless, North Richland Hills, Grapevine, and Colleyville through its contract with the TRWD. TRA provides water to Huntsville and developments around Lake Livingston. TRA, as a co-owner with the City of Houston of the water rights in Lake Livingston, potentially could be a major supplier of water to the City of Houston's service area.

The TRA is the State's largest operator of regional wastewater treatment works. The Central Plant (135 MGD capacity) and interceptor system services 19 cities in the "mid-cities" area of Dallas and Tarrant counties, including portions of Fort Worth, Dallas, and the D/FW Airport. In addition, the Ten Mile Creek Regional System (permitted capacity of 24 MGD) and the Red Oak Creek Regional System serve 12 cities in the Dallas and Ellis county area, and the Denton Creek Regional System serves another 5 cities and two municipal utility districts located in southern Denton County.

Upper Trinity Regional Water District. The Upper Trinity Regional Water District was created in 1989 to provide regional water and wastewater services for the Denton County area. The service area for the District, which includes nearly all of Denton County and a portion of Collin County, is within the water supply planning boundaries of the Dallas Water Utilities. Since Dallas has planned future water supplies for the majority of Denton County, the District obtains a substantial portion of its water supply from Dallas Water Utilities out of Lake Lewisville. In addition, the District also contracts with the City of Commerce for water supply out of Cooper Reservoir in the Sulphur River Basin. The District has long-term agreements with 12 cities and water utilities to treat and distribute water supplies.

In 1995, Lake Cities Municipal Utility Authority transferred ownership of its wastewater treatment plant to the Upper Trinity Regional Water District. The District is expanding the plant from its current capacity of 1.038 MGD to 3.5 MGD, and plans to construct approximately four miles of wastewater force mains, two lift stations, and two miles of gravity sewer lines. The plant will serve as a regional wastewater collection and treatment system for the City of Highland Village, Lake Cities Municipal Utility Authority, and the southeastern half of the City of Corinth.

Fort Worth. Fort Worth receives raw water from the TRWD. The City owns and operates four water treatment plants; North Holly, South Holly, Rolling Hills, and Eagle Mountain. The City also provides treated water to more than 20 cities in Tarrant County. Combined treatment capacity is nearly 300 MGD and is adequate to meet the water needs of the City and all of its wholesale water customers through at least the year 2020.

Coastal Water Authority (CWA). CWA provides water to Harris County, including the industrial complexes along the Houston ship-channel. Water is imported by the CWA from the Trinity Basin through a canal system and transported through the siphon under the Houston ship channel to the industrial complex and to the southeast regional water treatment plant.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, water quality in the Trinity River is affected by effluents from a number of large municipal wastewater treatment plants in the Dallas/Fort Worth area, as well as storm water runoff from urbanized areas. In the past, water quality in portions of the upper Trinity River system, especially the East Fork, was among the poorest in the state. More efficient wastewater treatment and heightened public awareness have resulted in improved water quality and aquatic life enhancement. However, certain problems still exist, mainly during dry weather, when streamflow is effluent-dominated.

Nutrient concentrations are of concern in 15 segments. Fecal coliform bacteria levels are elevated and prevent attainment of the contact recreation use in nine segments. The aquatic life use is not supported in four segments, due to elevated toxic chemical concentrations in water and/or depressed dissolved oxygen concentrations. Elevated concentrations of various metals and/or pesticides have been observed in sediment in 12 segments and in fish tissue in three segments. The Texas Department of Health has issued an aquatic life closure for all or part of four segments (West Fork below Lake Worth; Clear Fork below Benbrook Dam; lower West Fork; upper Trinity River) due to elevated chlordane concentrations in fish tissue. Closures also are in effect for three unclassified reservoirs in Fort Worth and one near Grand Prairie due to elevated concentrations of one or more of the following toxic chemicals in fish tissue: selenium, chlordane, DDE, dieldrin, and PCBs.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-47.

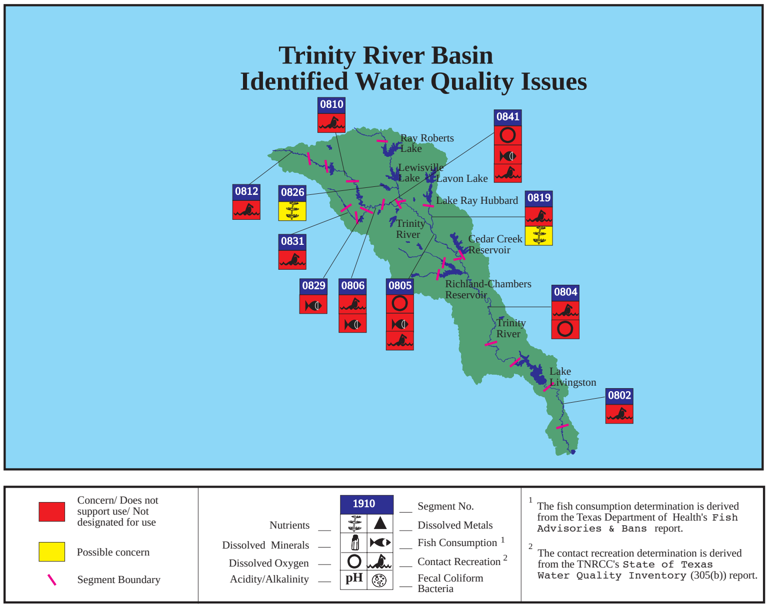

Figure 3-47
Ambient Water Quality Summary for the Trinity River Basin

Future Water Uses. Total water use in the basin is projected to increase to nearly 2.1 million ac-ft by the year 2050. This represents an increase in total water use of about 82 percent over the 1990-2050 planning period. Based on assumed dry weather conditions and a projected additional 4.9 million people living in the basin by the year 2050, municipal water use is projected to increase about 90 percent over the planning period. Continued improvements in municipal and manufacturing water conservation practices and programs are anticipated to reduce annual municipal and manufacturing water use by more than 263,000 ac-ft by the year 2020, and about 463,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. Ground-water use in the upper portion of the Trinity River Basin should decline over time as cities convert to surface water. In the central and lower portion of the basin, ground-water usage should increase. By the year 2050, an estimated 10 percent of the surface water needs for the basin is expected to be supplied by reuse, primarily for steam-electric power cooling and industrial purposes. Additional supplies to the area are recommended to be obtained from the Parkhouse II and Marvin Nichols I reservoir projects in the Sulphur River Basin, from Lake Texoma in the Red River Basin, and by new pipelines from Palestine and Lake Fork reservoirs.

Recommended development in the upper basin is as follows:

Modification to Richland-Chambers and Cedar Creek Reservoirs. This project would entail the development of diversion facilities on the Trinity and “wetlands” treatment facilities near the reservoirs to divert and treat wastewater return flows from Ft Worth to increase the available supplies from the two reservoirs. These modifications would increase the available supplies to Tarrant Regional Water District (TRWD) by over 73,000 ac-ft per year. The cost for this project and the conveyance facilities to move the additional water to the greater Ft. Worth area would be $166 million.

Tehuacana Reservoir. This project would be located on Tehuacana Creek in Freestone County south of Richland-Chambers Reservoir. The reservoir would control the flow from 315 square miles, and there are no major water supply projects upstream of this reservoir. The project is recommended to meet the needs of TRWD due to its location near other district facilities, amount of water developed and cost of the water. The project could develop over 65,000 ac-ft per year at a capital cost of $135 million. Estimated environmental flows needed to be passed through the reservoir are 2,876 ac-ft per year. The reservoir would inundate 14,804 acres including an estimated 6,993 acres of mixed bottomland hardwood forest.

With the construction of the Wallisville project, a salt water barrier in the lower basin, current supplies will meet future demands for the central and lower portions of the Trinity River Basin. Water from the Trinity River supplies much of the Houston region for municipal and industrial uses. The Trinity River Authority (TRA) has a portion of its service area lying within the Houston area, including portions of Madison, Walker, Trinity, Polk, San Jacinto and Liberty counties. TRA, as a co-owner with the City of Houston of the water rights in Lake Livingston, potentially could be a major supplier of water to the City of Houston's service area. The City of Houston owns seventy percent of the water rights from Lake Livingston. Other Houston area cities also meet their water needs from surface water from Lake Livingston, including Baytown, Pasadena and Deer Park, mostly via purchase from the City of Houston. The development of the Luce Bayou conveyance facilities will enable the City of Houston to service the northern and western parts of Harris County that presently are under Harris-Galveston Coastal Subsidence District rules that call for conversion from groundwater to at least 80% surface water surface water for all demands.

The San Jacinto River Authority (SJRA) has obtained 50,000 ac-ft of water supplies from the Trinity Basin via Devers Canal. The Authority intends to use the Trinity River water to meet the needs in eastern Harris County, freeing San Jacinto water for use in Montgomery County. The Authority will have to develop conveyance facilities to deliver the water to the Baytown area or be able to use some of the capacity of the CWA system to deliver the water to the Authority's present canal system.

San Jacinto River Basin

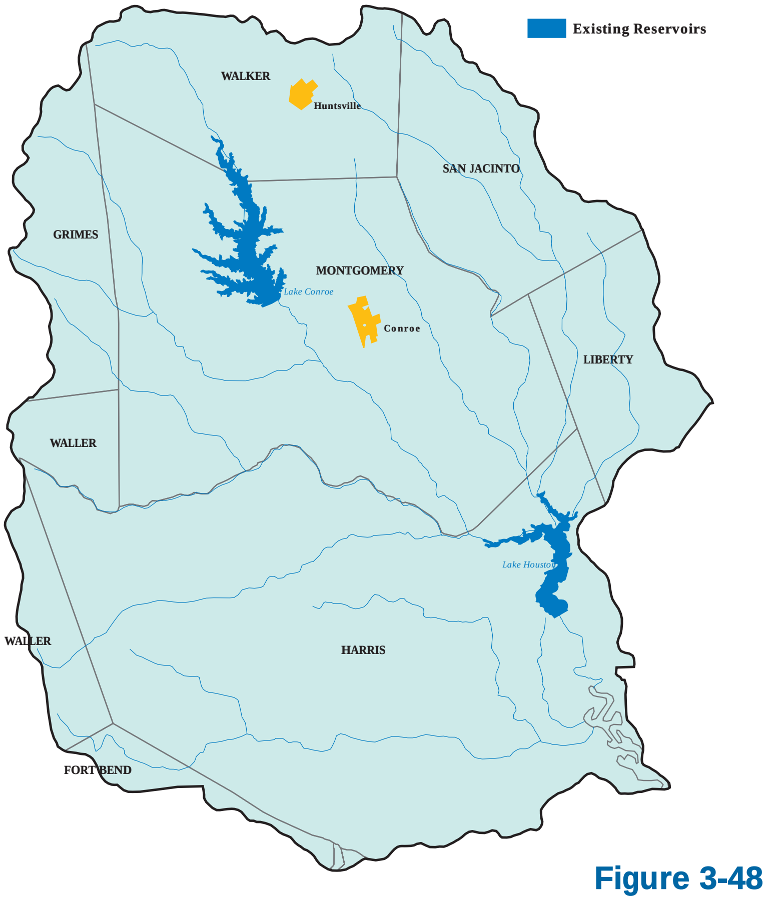

Figure 3-48

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	628,323	940,875
Manufacturing	247,795	350,724
Steam Electric	21,000	26,000
Mining	1,708	266
Irrigation	48,131	39,405
Irrigation Adjustment	(0)	(0)
Livestock	2,709	2,709
Total in-Basin Demands	949,666	1,359,979
IN-BASIN SUPPLIES		
Groundwater	449,237	274,898
Surface Water	312,877	358,208
Total In-Basin Supplies	762,114	633,106
TRANSFERS		
Import Supplies	273,373	753,982
Export Demands	62,630	20,725
NEW SUPPLIES	0	0
NET AVAILABILITY	23,191	6,384

Reservoir NameStatus		Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Houston	Built	43.8	12,240	146,700	144,600
Conroe	Built	201.0	20,985	430,260	98,200

3.3.1.8 San Jacinto River Basin

Basin Description. The San Jacinto River Basin is bounded on the north and east by the Trinity River Basin and Trinity-San Jacinto Coastal Basin, on the west by the Brazos River Basin, and on the South by the San Jacinto-Brazos Coastal Basin (see Figure 3-48). Total drainage area of the basin is 2,800 square miles. Predominate sectors of the basin economy are manufacturing, finance, services, retail and wholesale trade, commercial shipping, commercial fishing, and tourism. The San Jacinto River Basin is the second most populated basin in Texas with a 1990 population of 2.771 million. From 1980 to 1990, the basin population increased by 401,812 residents, representing an increase of 17 percent. Population of the basin is projected to double over the 1990-2050 planning horizon with a year 2050 population of more than 5.782 million. Major population centers in the basin and their latest population estimates include all or portions of Houston (1,741,257), Pasadena (129,483), Baytown (68,505), Missouri City (49,170), The Woodlands (48,950), Conroe (37,761), Huntsville (33,467), Deer Park (29,917), South Houston (15,160), Bellaire (14,722), and West University Place (13,502).

Current Water Uses. Ground-water resources supply about 59 percent of the water used for all purposes in the basin with surface water resources supplying the remaining 41 percent. In 1990, total water use in the basin was 786,351 acre-feet (ac-ft) which represents a decline of about 36,000 ac-ft from the 1980 total basin water use. This decline was attributable to a reduction of about 37,000 ac-ft of water requirements for irrigated agriculture. Municipal and manufacturing water use increased slightly over this same period of time. Municipal water use is the largest water use category in the basin accounting for about 62 percent, followed by manufacturing which accounts for about 29 percent. In 1990, over 67,000 ac-ft of water was exported to the Trinity-San Jacinto Coastal Basin and 18,574 ac-ft was exported to the San Jacinto- Brazos Coastal Basin from the San Jacinto River Basin for municipal and industrial purposes.

Current Water Supplies. Groundwater used in the basin is obtained from the Gulf Coast Aquifer for municipal, manufacturing, and agricultural purposes. However, the area within the Harris-Galveston Coastal Subsidence District has been given a mandate to convert to between 80 to 90 percent surface water usage by 2010. The basin also has two water supply reservoirs. Lake Conroe, owned jointly by the San Jacinto River Authority (SJRA) and the City of Houston and operated by the SJRA, is considered a major water supply reservoir, as is Lake Houston, owned and operated by the City of Houston for use in its service area.

Water supply problems in the basin include land-surface subsidence due to overdraft of groundwater, poor quality surface and groundwater, flooding, and environmental concerns for wetlands and Galveston Bay.

Basin Authorities/Districts. There is one river authority and two regional water providers serving the San Jacinto River Basin.

San Jacinto River Authority (SJRA). The Authority provides municipal and manufacturing water supplies to east Harris County from Lake Conroe and run-of-the-river water at Lake Houston, and provides water from Lake Conroe to Lewis Creek Reservoir for steam-electric power generation. SJRA owns and operates a pump station at Lake Houston from which it diverts raw water into an extensive system of canals for ultimate delivery to industries in east Harris County. SJRA owns and operates regional water and wastewater facilities which serve ten municipal utility districts in The Woodlands, a master- planned community. The Authority also has obtained 50,000 ac-ft of water supplies from the Trinity Basin (Devers Canal). The Authority intends to use the Trinity River water to meet the needs in east Harris County, freeing water for use in Montgomery County. SJRA operates an automated network of rainfall and stream flow monitoring stations in support of its lake operations. SJRA is participating in the development of a ground-water model for Montgomery County that should aid in evaluating the resources of the County. SJRA has developed a comprehensive water resource development plan for its service area and has participated in the multi-year, multi-regional planning study for the region.

Gulf Coast Waste Disposal Authority (GCWDA). GCWDA provides waste disposal services for approximately forty square miles in Chambers, Harris and Galveston counties, including four industrial wastewater treatment facilities located along the Houston Ship Channel, in Bayport, and Texas City, and 23 municipal wastewater treatment facilities. GCWDA also provides drinking water service through its seven water treatment plants. In addition, GCWDA handles an increasing volume of solid wastes from industrial and municipal sources and is developing regional approaches to resource recovery from municipal solid wastes and municipal sludge disposal.

Coastal Water Authority (CWA). The Authority was created in 1963 and provides water to Harris County. CWA provides water to the industrial complexes along the Houston Ship Channel. Water is imported from the Trinity Basin through a canal system and the siphon under the ship channel to the industrial complex and the new southeast regional water treatment plant.

Houston. The City of Houston owns all water diversion rights from Lake Houston and seventy percent of the water diversion rights from Lake Livingston. Additional surface water diversion facilities from the Trinity River Basin and the use of water supplies from the Sabine River Basin will be needed to meet the City's future demands, and to convert from groundwater to surface water use as required by the Harris-Galveston Coastal Subsidence District. The City of Houston also provides treated water to a number of other cities that are converting from groundwater to surface water and will continue to be a major water provider in the region. However, the Houston area will increasingly be served by water imported from the Sabine River Basin to the east. This arrangement, in turn, will create a "piggyback effect" whereby water from the more nearby sources (Lake Houston and Lake Livingston) may be used to serve customer cities in the more southerly or westerly portions of the Houston service area.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, the San Jacinto River Basin exhibits wide variations in water quality. As the Houston area expands to the north, numerous wastewater treatment plants and urban runoff increase the organic and nutrient loading and fecal coliform bacteria levels in all major tributaries to Lake

Houston. Dissolved oxygen deficiencies can also occur in these streams. The Houston metropolitan area is drained almost entirely by Buffalo Bayou, which has been channelized to form the Houston Ship Channel in its lower reach. Buffalo Bayou receives heavy municipal, industrial and urban stormwater runoff loadings. During periods of low flow, low dissolved oxygen and elevated fecal coliform levels are common. The lower portion of Buffalo Bayou and the San Jacinto River were channelized in 1915, which opened the Houston area to ship traffic. Today, the Port of Houston is the third leading shipping terminal in the United States. Oil and petrochemical industries along the channel make it one of the most highly industrialized areas of the world. The area from the Houston Ship Channel at the San Jacinto River confluence to Buffalo Bayou at US Highway 59 has been deemed desirable for navigation and industrial water use only. Over the past several years, water quality in the Houston Ship Channel has improved due to advanced wastewater treatment and reduced wasteloads. Aquatic and/or marine organisms are inhabiting areas where few had previously been found.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-49.

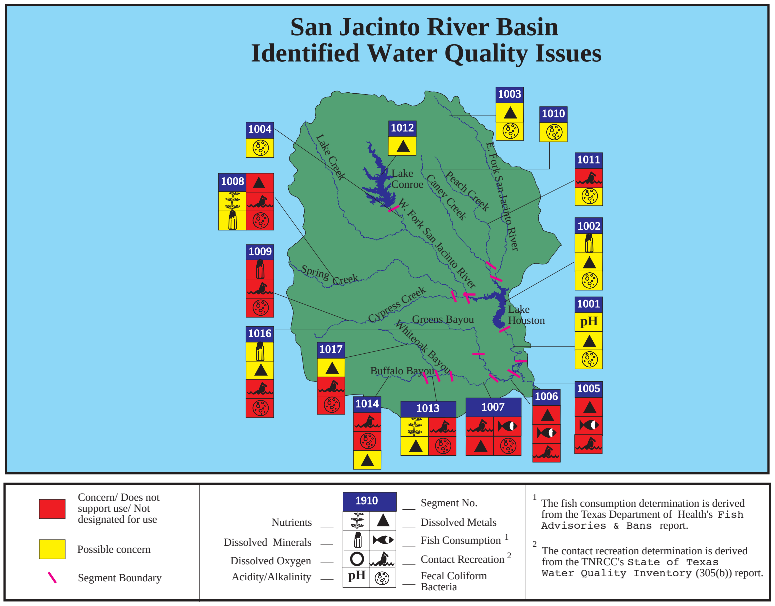

Figure 3-49
Ambient Water Quality Summary for the San Jacinto River Basin

Future Water Uses. Total water use in the basin is projected to increase by 73 percent over the 1990-2050 planning horizon resulting in a year 2050 water use of about 1.36 million ac-ft. Municipal water use is projected to account for more than 69 percent of the total basin water use by the year 2050 with a projected use of nearly 941,000 ac-ft. Manufacturing water use is projected to increase by about 122,000 ac-ft over this same time frame. The water use pattern of the basin is not anticipated to change significantly with municipal continuing to be the major water use category followed by manufacturing water use. Municipal water conservation practices and programs, along with increased efficiencies in manufacturing water use, are projected to reduce future annual municipal and manufacturing water use by more than 149,000 ac-ft by the year 2020 and more than 282,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. The basin will need new water supplies in the future. Almost all of the additional supplies will be imported into the basin from the Sabine and Trinity River basins, which will require the development of a major conveyance pipeline from the Sabine River to either the Trinity River or to terminal storage within the San Jacinto Basin. Over 92,000 ac-ft is anticipated to be imported from the Sabine Basin by 2050. In addition, by 2050, over 66,500 ac-ft per year of the total water used in the basin will be supplied by reuse of wastewater.

Brazos River Basin

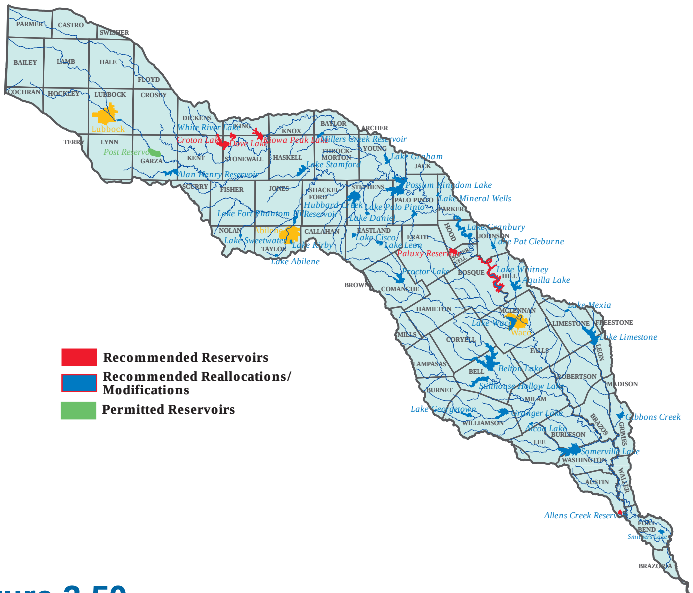

Figure 3-50

Reservoir Name	Status	Conservation Pool			
		Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Post	Permitted	2,430.0	2,280	57,420	10,600
Alan Henry	Built	2,220.0	3,504	115,937	29,900
White River	Built	2,369.2	1,808	38,600	4,000
Millers Creek	Built	1,331.0	1,900	25,520	3,100
Sweetwater	Built	2,116.5	630	11,900	1,400
Abilene	Built	2,012.3	595	7,900	1,450
Kirby	Built	1,786.0	740	7,620	300
Ft Phantom	Built	1,635.9	4,246	74,310	18,900
Stamford	Built	1,416.8	4,690	53,930	1,941
Cisco	Built	1,496.0	445	8,800	500
Hubbard Creek	Built	1,183.0	14,922	324,983	24,900
Daniel	Built	1,278.0	924	9,515	2,100
Graham/Edelman	Built	1,076.3	2,550	52,386	8,400
Possum Kingdom	Built	987.0	14,440	504,100	233,500
Palo Pinto	Built	867.0	2,498	27,650	14,100
Mineral wells	Built	863.0	646	6,760	1,500
Granbury	Built	693.0	8,700	153,500	66,500
Cleburne	Built	733.5	1,550	25,560	4,600
Paluxy	Recommended	781.0	3,848	99,674	12,000
Whitney	Built	533.0	23,560	627,100	18,300
Whitney Realloc.	Recommended				124,700
Aquilla	Built	537.5	3,280	52,400	15,756
Waco	Built	455.0	7,270	152,500	81,120
Leon	Built	1,375.0	1,590	27,290	4,500
Proctor	Built	1,162.0	4,610	59,400	20,800
Belton	Built	594.0	12,300	457,600	112,000
Stillhouse	Built	622.0	6,430	235,700	69,800
Georgetown	Built	791.0	1,310	37,100	14,857
Granger	Built	504.0	4,400	82,000	22,198
Alcoa	Built	468.5	880	14,750	9,000
Somerville	Built	238.0	11,460	160,100	41,000
Mexia	Built	448.3	1,200	10,000	3,000
Limestone	Built	363.0	14,200	217,494	66,200
Smithers	Built	65.0	2,430	16,300	1,000
Allens Creek	Recommended	121.0	7,060	143,571	74,000

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	383,420	555,835
Manufacturing	220,451	330,777
Steam Electric	187,700	272,200
Mining	19,548	16,159
Irrigation	2,375,827	2,021,014
Irrigation Adjustment	(101,832)	(1,451,149)
Livestock	77,594	77,594
Total in-Basin Demands	3,162,708	1,822,430
IN-BASIN SUPPLIES		
Groundwater	2,422,522	752,451
Surface Water	1,247,339	1,235,543
Total In-Basin Supplies	3,669,861	1,987,994
TRANSFERS		
Import Supplies	35,788	49,149
Export Demands	206,371	259,847
NEW SUPPLIES	0	218,700
NET AVAILABILITY	336,570	173,566

3.3.1.9 Brazos River Basin

Basin Description. The Brazos River Basin is bounded on the north by the Red River Basin, on the east by the Trinity River Basin, San Jacinto River Basin, and the San Jacinto-Brazos Coastal Basin, and on the south and west by the Colorado River Basin and Brazos-Colorado Coastal Basin (see Figure 3-50). Total drainage area of the Brazos River Basin in Texas is about 43,000 square miles. The overall economy of the basin is based principally on agriculture, agribusiness, mineral production, wholesale and retail trade, and varied manufacturing. In 1990, the population of the basin was 1.753 million. From 1980 to 1990, the basin population increased by 222,758 residents or an increase of about 15 percent. Population within the basin is projected to increase to about 3.499 million by the year 2050 representing an increase of more than 77 percent. Major population centers within the basin and their latest population estimates include all or portions of the cities of Lubbock (194,349), Abilene (115,293), Waco (108,192), Bryan (60,637), College Station (61,814), Temple (49,489), Sugar Land (43,182), Round Rock (45,806), Rosenburg (25,857), Georgetown (19,706), Mineral Wells (14,784), Brenham (13,560), and Belton (13,382).

Current Water Uses. Ground-water resources supply more than 82 percent of the water used for all purposes in the basin with surface water resources supplying the remaining 18 percent. In 1990, water use in the basin totaled approximately 3.171 million acre-feet (ac-ft) which represents a decline of about 851,000 ac-ft from the 1980 total basin water use. This decline in total water use is attributable to a reduction in water requirements for irrigated agriculture of more than 928,000 ac-ft. Municipal water use increased by more than 22,000 ac-ft over this same period of time. By far the largest water use category for the basin is irrigated agriculture which accounts for 77 percent of all water used. In 1990, 166,341 ac-ft of water was exported to the San Jacinto-Brazos Coastal Basin and 114 ac-ft was exported to the San Jacinto River Basin from the Brazos River Basin for municipal, industrial, and agricultural irrigation purposes.

Current Water Supplies. Groundwater from the Ogallala and Seymour aquifers supplies most water needs of the upper basin with lesser amounts supplied from the Edwards-Trinity and Dockum aquifers. The Trinity, Edwards-Balcones, and Carrizo-Wilcox aquifers provide most of the groundwater in the central basin with lesser amounts supplied from the Queen City, Sparta, and Brazos River Alluvium. The Gulf Coast Aquifer supplies the lower basin.

The abundance of surface water varies greatly over the Brazos River Basin due to its size and variation in rainfall (15 inches per year near the confluence of the Salt Fork and Double Mountain Fork of the Brazos River in Stonewall County, to 50 inches per year near the Gulf Coast). Also, in the High Plains, there are large areas characterized by playas and other natural depressions that do not contribute runoff to the defined stream systems. The principal tributaries of the mainstem Brazos River are the Salt Fork Brazos River, Clear Fork Brazos River, Bosque River, Little River, Little Brazos River, Navasota River and Yegua Creek. There are 31 major existing water supply reservoirs in the basin, which have the ability to supply over 891,000 ac-ft per year. Water is exported to the Trinity River Basin and the San Jacinto-Brazos Coastal Basin. Water is also imported from Lake MacKenzie in the Red River Basin, from Lake Meredith in the Canadian River Basin, and from Oak Creek Reservoir and Lake J. B. Thomas in the Colorado River Basin.

Basin Authorities/Districts. There are a number of districts and authorities in the basin that provide water resource management. These include:

Brazos River Authority (BRA). BRA was the first river authority established in the United States. Its activities include management of flood control operations; administration of private sewage licensing programs; operation of wastewater treatment plants and associated lines, including four regional wastewater systems; operation of a regional water treatment plant; supply and conservation of water in a 13-reservoir system with a combined total conservation storage capacity of over 2.1 million ac-ft; collection of streamflow quality and quantity data; maintenance of pollution control programs; supervision of recreational use of lakes and operation of public access areas; and generation of electric power. The Authority is the lead agency in the Clean Rivers program for the basin.

The lakes owned and operated by BRA are Granbury, Limestone, Alan Henry, and Possum Kingdom; the latter also generates hydropower as well as supplying water. Lakes owned by the U.S. Army COE are Waco, Proctor, Belton, Stillhouse Hollow, Georgetown, Granger, Somerville, Whitney and Aquilla. Water from reservoir storage not committed to local use is used to meet needs in other parts of the basin (or in other basins) under BRA's plan for system operation.

North Central Texas Municipal Water Authority. The Authority serves the cities of Goree, Knox City, Munday and Haskell via its water right authorization to divert up to 5,000 ac-ft of water per year from Millers Creek Reservoir in Baylor County for municipal, industrial and mining purposes.

White River Municipal Water District. The District owns and operates White River Reservoir, from which the District's water right authorizes the diversion of up to 6,000 ac-ft of water per year for municipal and mining purposes. The District serves cities and communities in Garza, Crosby, Dickens, Kent and Lubbock counties.

West Central Texas Municipal Water District. The District's water right in Hubbard Creek Reservoir authorizes it to divert up to 56,000 ac-ft of water per year from the reservoir for municipal, industrial, irrigation, mining, and domestic and livestock use. The District provides raw water to its member cities of Abilene, Albany, Anson and Breckenridge. Legislation passed in 1985 allows the District to undertake a wide variety of special projects for member and non-member cities, such as the contract to acquire 16 percent of Ivie Reservoir water on behalf of the City of Abilene.

Gulf Coast Water Authority (GCWA). The Authority provides water to Harris, Brazoria and Galveston counties for municipal, industrial, irrigation, mining and other purposes via its water rights from the Brazos River and Jones Creek totaling 236,932 ac-ft of water per year, and supplemented by up to 136,518 ac-ft of surface water purchased from BRA's system on the Brazos River. The Authority also owns and operates a 200 mile canal system purchased from the BRA.

Brazosport Water Authority. The Authority provides water diverted from the Brazos River via its authorized water right for up to 45,000 ac-ft of water per year for municipal purposes. The Authority's service area includes the cities of Angleton, Clute, Freeport, Richwood and Lake Jackson. A portion of this service area lies in the San Jacinto-Brazos Coastal Basin.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, elevated fecal coliform levels occur in the main stem of the Brazos River just downstream of the Navasota River, downstream of the Clear Fork of the Brazos, and near the cities of Marlin and Cameron. Tributaries to the Brazos River experiencing elevated fecal coliform levels are the Leon River downstream of Lake Proctor, Oyster Creek, North Bosque River, and Upper North Bosque River segments. Confined animal feeding and other agricultural operations are major contributors of nonpoint source loading to the Bosque River watershed. Elevated nutrient levels from several sources are contributing to excessive planktonic and attached algal growths in the Bosque River. Nonpoint source loading and excessive nutrient levels are becoming a concern in the Leon River watershed downstream of Proctor Reservoir. A fish consumption advisory has been issued by the Texas Department of Health for the tidally affected portion of the Brazos River. Fish taken from this reach of the river are potentially contaminated with dioxins and should not be eaten.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-51.

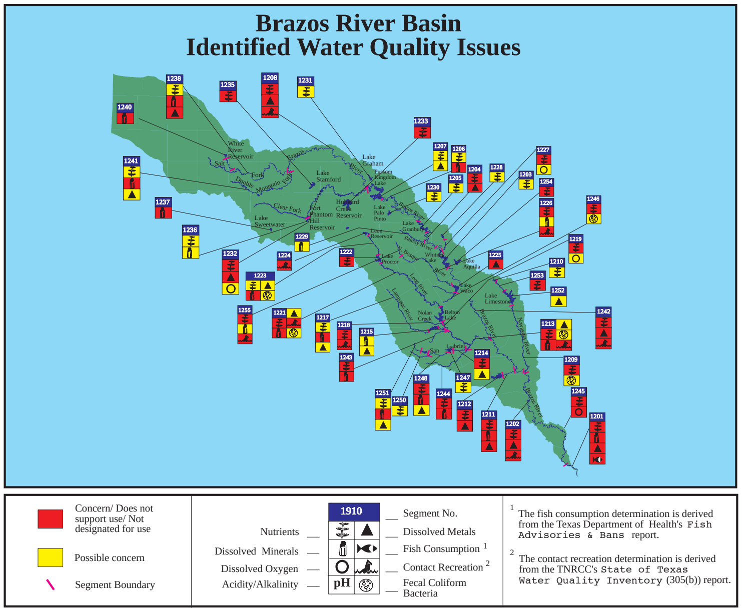

Figure 3-51
Ambient Water Quality Summary for the Brazos River Basin

Future Water Uses. Total water use in the basin is projected to decline over the 1990-2050 planning horizon with a projected total basin water use of 1.82 million acre-feet. This reduction is due to an anticipated decline in irrigation water requirements of nearly 77 percent from current levels. The anticipated decline in irrigation water requirements is due to estimated declines in ground-water availability resulting in insufficient quantities of groundwater to meet current and projected future levels of irrigation water requirements. Most of this reduction in ground-water availability is projected to occur in the upper portion of the Brazos River Basin primarily in the High Plains area. Municipal and industrial water uses are projected to increase by more than 75 percent during the 1990-2050 planning period. Continued improvements in municipal, industrial, and agricultural irrigation water conservation practices and programs are projected to result in annual water savings of more than 183,000 ac-ft by the year 2020, and nearly 320,000 ac-ft by 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. Due to the scarcity of locally-developable surface water supplies, any additional supplies needed for the Southern High Plains portion of the upper basin will likely come from reuse of present supplies, development of additional well fields in the Ogallala Aquifer, and possible new development in minor aquifers present in the basin. The recently-completed Lake Alan Henry will be required to provide additional water supplies to Lubbock. Declining water levels in the Trinity Aquifer will necessitate conversion to surface water by certain cities in the central basin. The Paluxy Reservoir is recommended for construction to meet these needs. Reallocation of flood control storage to consumptive water supply in Lake Waco was granted with the water right amendment that was recently acquired. The Allens Creek Project and the reallocation of storage in Lake Whitney will be needed to meet the future needs of the BRA system. These projects would supply the lower basin and provide for export to the San

Jacinto-Brazos Coastal Basin. These new projects combined will provide over 198,000 ac-ft per year of additional surface water supplies. Additional details on the recommended projects are discussed under each project description. Pending the availability of federal and/or state financial support, three brine-retention reservoirs (Croton, Dove, and Kiowa Peak) are recommended for construction in the upper basin to reduce the salinity and improve water quality in several of the basin's reservoirs. Effects of these chloride control facilities on water quality, recreation, the aquatic community, and the entire ecosystem must be evaluated.

The general region of Taylor, Nolan, Fisher, Jones, Shackelford and Callahan counties represents a rather complex situation illustrating the interrelation between cities of the region. The cities of Hamlin and Stamford, currently supplied by Lake Stamford, will need to obtain additional water due to future demands from the two cities and possible future sedimentation of Lake Stamford. Potential sources of raw water are Owen Ivie Reservoir (in the Colorado River Basin) from the Colorado River Municipal Water District, Owen Ivie Reservoir via the West Central Texas Municipal Water District's planned pipeline to that lake, Hubbard Creek Reservoir water under a contract with one of WCTMWD's member cities, probably the City of Anson, or purchase of treated water from the City of Abilene's system. Since the demands from Hamlin and Stamford are not great enough to justify a pipeline conveyance of regional proportions within the 50-year planning horizon, the first two options are not economically feasible until such time as the demands from the cities of Abilene and Sweetwater appreciably increase the regional demand. The third option, while viable, would require that Hamlin and Stamford increase treatment capacity or that Anson increases its treatment capacity and one of the member cities provide the raw water, if needed. The fourth option, obtaining water from Abilene's system, is presently recommended. This option would involve a longer pipeline (to Abilene rather than to Anson) and may require additional treatment capacity for Abilene sometime in the future but Hamlin and Stamford would not have to improve their treatment plants.

Williamson County is one of the fastest growing population centers in the central part of the Brazos River Basin. The anticipated growing municipal water needs for this area will require supplementing existing water supplies with water from Stillhouse Hollow Reservoir. This will require construction of a pipeline from Stillhouse Hollow Reservoir to Lake Georgetown. Even with the supplemental water from Stillhouse Hollow Reservoir, additional water is anticipated to be needed for areas in Williamson County. The current Water Plan recommendation is for this water to be supplied from Lake Belton should this water be considered surplus by the current contract holders, and marketed only with their concurrence. Other alternative recommendations for meeting the water needs of the Williamson County area may be developed through future agreements by the Colorado-Brazos Water Alliance, and other options being developed by participants of a multi-year, multi-regional study of the area which is nearing completion

The following surface water projects are permitted or recommended for development in the Brazos Basin:

Post. The White River Municipal Water District has received a state permit to construct the Post Reservoir project on the North Fork Double Mountain Fork of the Brazos River in

Garza County but has yet to apply for the necessary federal permits. The owner is authorized to impound 57,420 ac-ft of water at elevation 2,430 feet above mean sea level (msl). This project is permitted to supply 10,600 ac-ft of water per year for municipal, industrial and mining use. The estimated cost for the Post project is $35.5 million.

Paluxy Reservoir. The project was permitted by TNRCC; however, the recent court decision voided the permit and required the applicant to reapply to TNRCC for a new permit. The project would be located on the Paluxy River in Somervell and Hood counties west of Glen Rose. Paluxy is recommended to provide water to Erath and Somervell counties. It is estimated that up to 5,285 ac-ft per year would be allowed to pass through to meet the consensus environmental flow criteria. The project would need to be constructed before 2010 and would inundate 3,848 acres, including an estimated 566 acres of mixed riparian forest.

Allens Creek Reservoir. This project is recommended for development before 2030. The reservoir would be located on Allens Creek in Austin County, southeast of Sealy. The project would consist of a storage reservoir and diversion facilities on the Brazos River. It would primarily provide water to Fort Bend and Brazoria counties, and possibly other areas, according to TWDB analyses and Water Plan recommendations. Present plans call for diversions to occur when the flow in the river is greater than downstream water right totals and applicable consensus environmental planning criteria. The project would inundate 8,670 acres, including an estimated 2,640 acres of bottomland hardwoods forest.

Lake Whitney Reallocation. This would entail the conversion of hydropower storage in Lake Whitney to water supply storage. The water in Lake Whitney could then be used to meet future downstream needs. The conversion could increase the supply available in Whitney by almost 125,000 ac-ft/year. Extensive negotiations with the Corps of Engineers would be required for this reallocation and subject to Congressional approval. The cost to replace the hydropower generated by the power station has yet to be determined.

Colorado River Basin

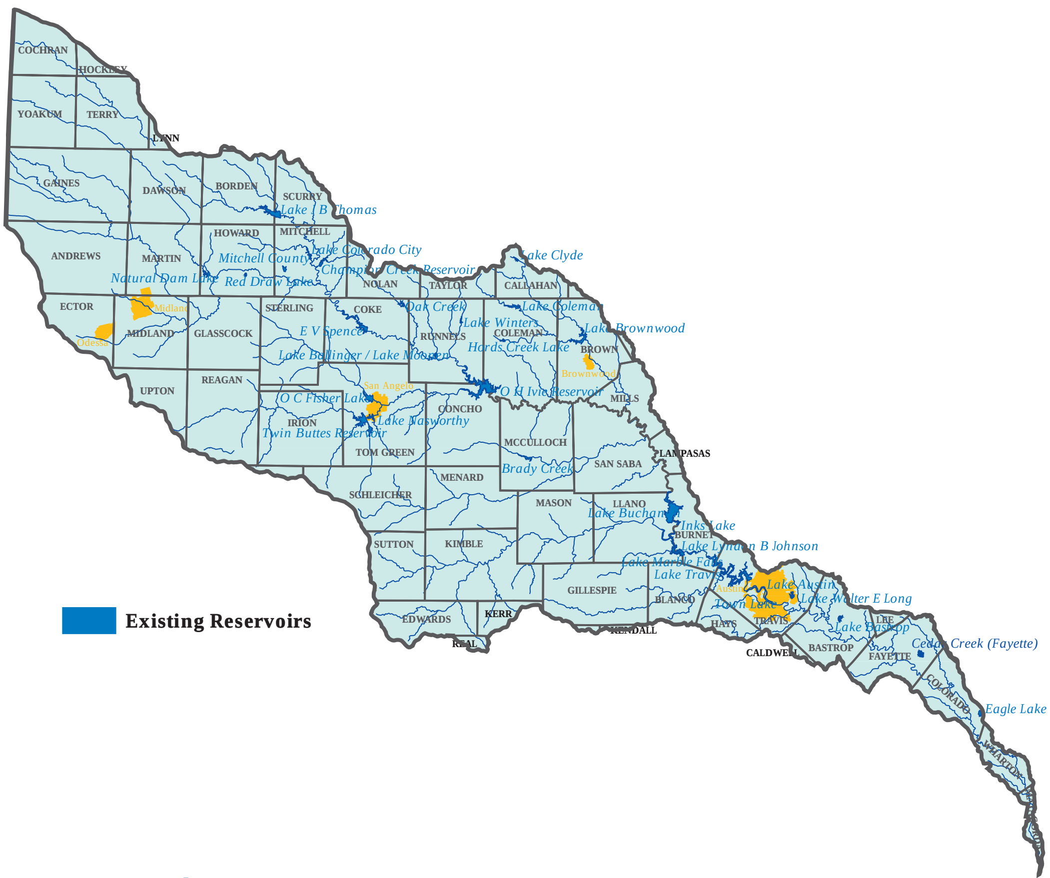

Figure 3-52

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	348,681	553,571
Manufacturing	24,500	35,093
Steam Electric	68,000	105,500
Mining	58,658	43,311
Irrigation	980,972	791,296
Irrigation Adjustment	(34,682)	(310,255)
Livestock	30,743	30,743
Total in-Basin Demands	1,476,872	1,249,259
IN-BASIN SUPPLIES		
Groundwater	994,842	546,648
Surface Water	1,197,929	1,170,916
Total In-Basin Supplies	2,192,771	1,717,564
TRANSFERS		
Import Supplies	2,103	1,492
Export Demands	339,464	328,111
NEW SUPPLIES	0	0
NET AVAILABILITY	378,538	141,686

Reservoir NameStatus		Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
J. B. Thomas	Built	2,258.0	7,820	203,600	50,800
E.V. Spence	Built	1,898.0	14,950	488,760	
Colorado City	Built	2,070.2	1,612	31,805	5,500
Champion Creek	Built	2,083.0	1,560	42,500	5,000
Oak Creek	Built	2,000.0	2,375	39,360	4,800
Fisher	Built	1,908.0	5,440	119,200	13,200
Twin Buttes	Built	1,940.2	9,080	186,200	31,400
Nasworthy	Built	1,872.2	1,596	12,390	500
Ballinger/Moonen	Built	1,568.0	n.a.	6,850	1,600
Winters	Built	n.a.	643	8,374	1,160
O.H. Ivie	Built	1,551.5	19,149	554,339	101,000
Hords Creek	Built	1,900.0	510	8,640	1,200
Coleman	Built	1,717.5	2,000	40,000	7,090
Clyde	Built	1,872.0	449	5,748	700
Brownwood	Built	1,424.6	7,300	143,400	31,400
Brady Creek	Built	1,743.0	2,020	30,430	3,100
Buchanan	Built	1,020.4	23,100	922,000	445,266
Inks	Built	888.2	803	17,500	
LBJ	Built	825.4	6,380	138,000	
Marble Falls	Built	738.5	780	8,760	
Travis	Built	681.1	18,930	1,172,600	
Austin	Built	492.8	1,830	21,000	
W. E. Long	Built	555.0	1,269	33,940	1,000

3.3.1.10 Colorado River Basin

Basin Description. The Colorado River Basin is bounded on the north and east by the Brazos River Basin and Brazos-Colorado Coastal Basin, and on the south and west by the Lavaca, Guadalupe, Nueces, and Rio Grande basins and the Colorado-Lavaca Coastal Basin (see Figure 3-52). Total drainage area of the Colorado River Basin is 41,763 square miles of which 39,893 square miles are within the State of Texas. The headwaters of the Colorado River occur in eastern New Mexico and flow to the southeast across Texas approximately 600 miles, discharging into Matagorda Bay and the Gulf of Mexico. The economy of the basin is based on mineral production, agriculture, agribusiness, manufacturing, trades, and government. The 1980 basin population totaled 1.061 million, increasing to 1.292 million in 1990 (an increase of 24 percent). By 2050, the basin population is projected to increase to more than 2.8 million. Major population centers in the basin and their latest population estimates include all or portions of the cities of Austin (547,677), Midland (97,623), Odessa (93,336), San Angelo (88,774), Big Spring (23,289), and Brownwood (19,149).

Current Water Uses. Ground-water resources supply more than 71 percent of the water used for all purposes in the basin with surface water resources supplying the remaining 29 percent. In 1990, water used for all purposes within the basin totaled approximately 1.465 million ac-ft, which represents a decline of about 291,000 ac-ft below the 1980 total basin water use. This reduction in total water use was due to a decline of more than 333,000 ac-ft of water used for irrigated agriculture. By far the largest water use category in the basin is irrigated agriculture which accounts for about 71 percent of the total basin water use. Over the 1980-1990 period, municipal water use increased by more than 29,000 ac-ft. In 1990, about 4,300 ac-ft of water was exported to the Brazos River Basin, 231,000 ac-ft was exported to the Brazos-Colorado Coastal Basin, 69,000 ac-ft was exported to the Colorado-Lavaca Coastal Basin, and 97,000 ac-ft was exported to the Lavaca River Basin from the Colorado River Basin for municipal, industrial, and agricultural irrigation purposes.

Current Water Supplies. Several aquifers provide water to the basin. The Ogallala Aquifer, along with the Edwards-Trinity and Dockum aquifers, occur in the upper part of the basin. The Edwards-Trinity and Lipan aquifers are in the west-central part. Lowering of Edwards-Balcones water levels is of concern to areas in the central basin. The Trinity, Edwards-Balcones and Carrizo-Wilcox are in the south-central basin along with minor aquifers which include the Hickory, Ellenberger-San Saba, Marble Falls, Queen City, and Sparta. The Gulf Coast Aquifer occurs in the lower basin. Use of this aquifer raises concerns over related land subsidence and its attendant problems.

The Colorado River Basin has 26 major water supply reservoirs, which along with the river flows below Austin, can provide over 1.203 million ac-ft per year of water supply. Imports to the Colorado River Basin are provided from the Canadian River Municipal Water Authority's Lake Meredith to the cities of Brownfield and Lamesa. Major water suppliers in the basin are the Colorado River Municipal Water District (CRMWD), the Lower Colorado River Authority (LCRA), and irrigation companies in the lower part of the basin below Austin.

Basin Water Districts/Authorities. There are two major water management districts/authorities in the basin; the Colorado River Municipal Water District and the Lower Colorado River Authority. Others providing water in the basin are the Garwood Irrigation Company and Brown County WID#1.

Colorado River Municipal Water District (CRMWD). The District was created by the Legislature of the State of Texas in 1949. Initially, the geographic boundaries of the CRMWD consisted of the city limits of the District's three member cities, Odessa, Big Spring, and Snyder. An amendment in 1981 included a second jurisdictional boundary encompassing the drainage area of the Colorado River above the east county line of Coleman County. This encompassed all or parts of thirty-four counties. In addition, the counties of Ector, Ward, Winkler, Loving, Reeves, and Culberson were added by the amendment to the jurisdiction of the CRMWD. The CRMWD owns and operates three reservoirs (Lakes J.B. Thomas, E.V. Spence and O.H. Ivie). The District also operates two ground-water well fields, in Ward and Martin counties.

Lower Colorado River Authority (LCRA). The LCRA is a conservation and reclamation district created by the Legislature of the State of Texas in 1934. It is a governmental agency and corporate of the State without taxing power. Its statutory boundaries encompass a ten-county region from San Saba County downstream to Matagorda County. The LCRA currently is authorized by the State to control, store, distribute, and sell waters of the Colorado River for useful purposes; to develop, generate, distribute, and sell hydroelectric and thermal electric power and energy in all or parts of its 31,000 square mile, 58-county service area in central Texas; to study, correct and control both artificial and natural pollution of the waters of the Colorado River within LCRA's district boundaries; and to develop and manage parks and recreational facilities on the lands of the LCRA. The LCRA operates six dams with hydroelectric generating capacity. Five of the dams (Buchanan, Inks, Alvin Wirtz, Max Starcke and Mansfield) are owned by the LCRA, and a sixth (Tom Miller) is leased from the City of Austin. These dams form six reservoirs known as the Highland Lakes, including lakes Buchanan, Inks, Lyndon B. Johnson, Marble Falls, Travis and Austin. By regulating discharge from the Highland Lakes, the LCRA contributes to flood control and sells water for municipal, irrigation, and industrial use in the Lower Colorado River Basin. The LCRA and the irrigation companies it owns export water out of the basin to areas in the Brazos-Colorado Coastal Basin, the Colorado-Lavaca Coastal Basin, and the Lavaca River Basin. The Authority is developing management plans that consider the bay and estuary needs for fresh water inflows, as well as any instream flow needs below Lake Travis.

Garwood Irrigation Company. This private irrigation company has rights to use 165,000 ac-ft per year of Colorado River flows for municipal and irrigation purposes. These rights are senior (oldest in time) to all other rights in the lower basin. Studies conducted by the City of Corpus Christi and the Lavaca-Navidad River Authority indicated that about 35,000 ac-ft of surplus Garwood water could be transferred to Corpus Christi from Lake Texana in the Lavaca Basin.

Brown County Water Improvement District (WID) #1. Created in 1926, the District provides irrigation water to Brown County along with municipal water to the City of Brownwood. The District owns and operates Lake Brownwood. It is permitted to use 16,800 ac-ft per year for municipal and industrial purposes and 50,590 ac-ft for irrigation purposes.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, Lake J. B. Thomas, the most upstream reservoir, has good water quality. Downstream of the reservoir, water quality deteriorates due to oil field activities and natural salt deposits. The water quality of the Concho, Llano, and Pedernales rivers is good with sporadic dissolved oxygen standard violations and elevated fecal coliform bacteria levels. A fish consumption advisory has been issued by the Texas Department of Health on Town Lake in the City of Austin. Urban runoff pollution is believed to have caused elevated chlordane levels in fish tissue. The advisory recommends fish consumption be limited to one meal per month.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-53. The Clean Rivers Program included the Colorado-Lavaca Coastal Basin in the Colorado River Basin assessment.

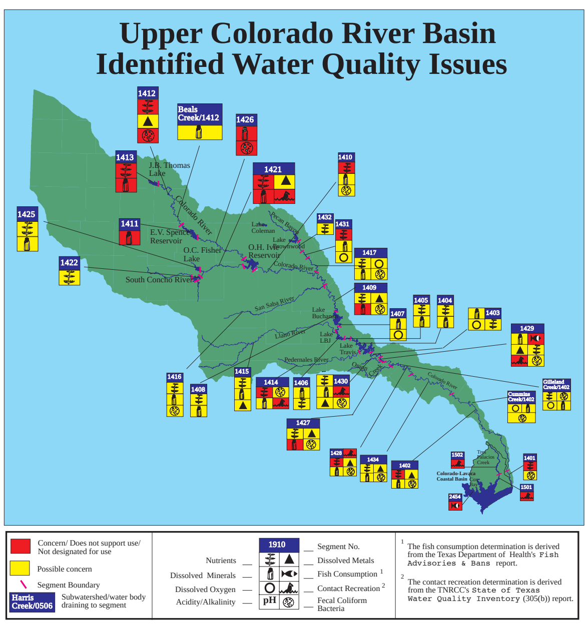

Figure 3-53
Ambient Water Quality Summary for the Colorado River Basin

Future Water Uses. Total water use in the basin is projected to decline to about 1.25 million ac-ft by the year 2050. This projected decline in water use is due to an anticipated reduction in irrigation water requirements of about 54 percent over the 1990-2050 period. The decline in irrigation water requirements is due to estimated declines in ground-water availability resulting in insufficient quantities of groundwater to meet current and projected future levels of irrigation water use, combined with increased implementation of irrigation technology associated with irrigation water use savings. These declines in ground-water availability for irrigation purposes are anticipated to occur in the upper portion of the Colorado River Basin. Based on dry weather conditions in the planning assumptions, municipal water use is projected to more than double over the planning period. Water savings from continued improvements in municipal, industrial, and irrigated agricultural water conservation practices are anticipated to reduce total annual water requirements for the basin by about 95,000 ac-ft by the year 2020, and by more than 160,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. Due to the scarcity of locally-developable surface water supplies, any additional supplies needed for the Southern High Plains portion of the upper basin will likely come from reuse of present supplies, development of additional well fields in the Ogallala Aquifer, and possible new development in minor aquifers present in the basin. No major water supply reservoirs are currently recommended for the Colorado River Basin. Groundwater will continue to be a viable water supply for the most of the basin. However, certain cities in the western and central portions of the basin will need to find alternate supplies due to increasing water quality problems with their present supplies. With the projected savings from water conservation, there are adequate ground-water and surface water supplies available to meet future demands within the Colorado River Basin. No additional imports into the Colorado River Basin are recommended during the planning period. Two important exports are recommended; Ivie Reservoir to Taylor County (Brazos Basin) during the 2025-2030 period, and the Colorado River at Garwood to Nueces County (San Antonio-Nueces Basin) in the 2035-2040 period. The Lake Ivie to Taylor County export has been permitted; the Garwood to Nueces County transfer has been applied for, but not yet permitted.

Lavaca River Basin

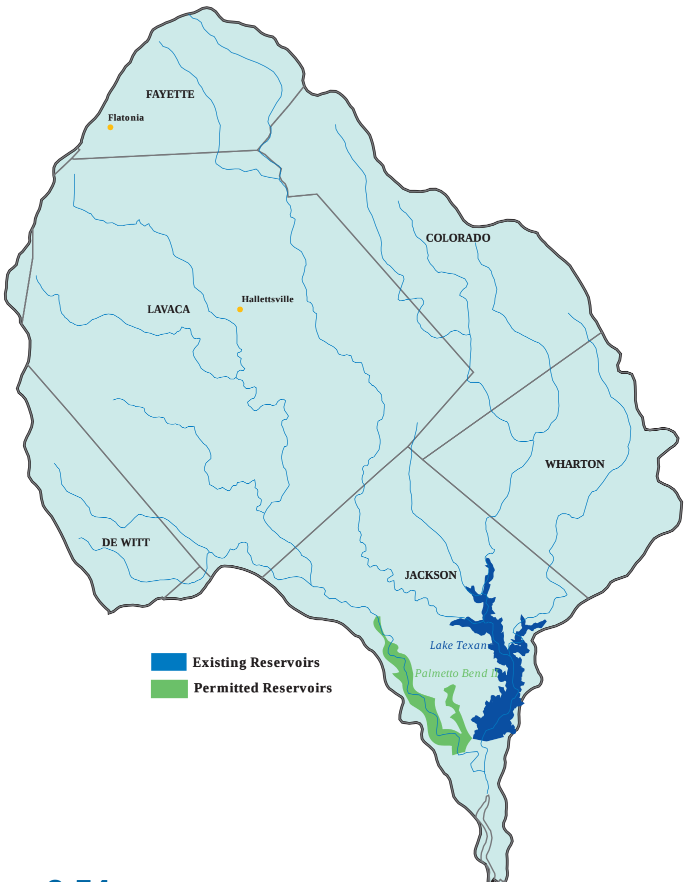

Figure 3-54

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	8,153	8,600
Manufacturing	1,430	3,330
Steam Electric	0	0
Mining	1,849	1,560
Irrigation	232,332	186,306
Irrigation Adjustment	(0)	(0)
Livestock	4,122	4,122
Total in-Basin Demands	247,886	203,918
IN-BASIN SUPPLIES		
Groundwater	151,129	125,444
Surface Water	85,613	85,608
Total In-Basin Supplies	236,742	211,052
TRANSFERS		
Import Supplies	85,652	66,467
Export Demands	15,127	71,225
NEW SUPPLIES	0	0
NET AVAILABILITY	59,381	2,376

Reservoir NameStatus		Conservation Pool			
		Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Palmetto Bend II	Permitted	44.0	6,900	93,340	30,000*
Texana	Built	44.0	10,134	163,506	74,500

3.3.1.11 Lavaca River Basin

Basin Description. The Lavaca River Basin is bounded on the north and east by the Colorado River Basin, on the west by the Guadalupe River Basin, on the southeast by the Colorado-Lavaca Coastal Basin, and on the southwest by the Lavaca-Guadalupe Coastal Basin (see Figure 3-54). Total drainage area of the basin is 2,309 square miles. The predominant sectors of the basin economy are agriculture, agribusiness, retail and wholesale trade, and manufacturing. In 1990, population of the basin was 43,931 residents. By the year 2050, the basin population is projected to increase to about 60,000 residents. Major population centers in the basin and their current population estimates include all or portions of the cities of Yoakum (6,275), Edna (6,266), Hallettsville (2,750), Schulenburg (2,923), Shiner (2,278), Weimar (2,203), Ganado (1,997), and Moulton (998).

Current Water Uses. Ground-water resources supply about 59 percent of the water used for all purposes in the basin with surface water resources supplying the remaining 41 percent. In 1990, total water use in the basin was 277,458 acre-feet (ac-ft) which represents a decline of about 52,000 acre-feet (ac-ft) from the 1980 total. This reduction in total water use was primarily due to a decline in water requirements for irrigated agriculture of about 51,000 ac-ft. The largest water use category in the basin is irrigated agriculture which accounts for nearly 96 percent of the total basin water use. In 1990, 3,562 ac-ft of water was exported to the Colorado-Lavaca Coastal Basin from the Lavaca River Basin for municipal and industrial purposes.

Current Water Supplies. The basin's present water needs are met by groundwater from the Gulf Coast Aquifer, Lake Texana, and imports of surface water from the Colorado Basin. The Lavaca-Navidad River Authority (LNRA) operates Lake Texana, the only water supply reservoir in the basin. The reservoir is permitted to divert 79,000 ac-ft of water per year, and can supply an estimated 74,500 ac-ft per year of water for municipal and industrial needs. Most cities, however, use groundwater.

Water supply issues in the basin include over-pumping from the Gulf Coast Aquifer and its related subsidence problems, and required water releases from the reservoir for bay and estuary inflow needs.

Basin Authorities/Districts. The management authority in the basin is the Lavaca-Navidad River Authority (LNRA). The LNRA is a local entity serving Jackson County alone. Its activities primarily include the operation, maintenance, and distribution of water from Lake Texana, operation of a wastewater treatment plant, collection of streamflow quantity and quality data, supervision of recreational use of Lake Texana, and operation/maintenance of public access areas. The Authority is the lead agency for the Clean Rivers Program in the basin. LNRA and the City of Corpus Christi have completed a multi-year regional planning study. Construction of a conveyance system to provide water from Lake Texana to the Corpus Christi ten-county service area has begun.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, the Lavaca River above tidal experiences frequent elevated levels of fecal coliform bacteria and nutrients. The Railroad Commission of Texas has identified oil field wastes as a problem in some of the segments. Additionally, elevated levels of nutrients have been identified, but do not appear to affect the dissolved oxygen or chlorophyll a levels.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-55.

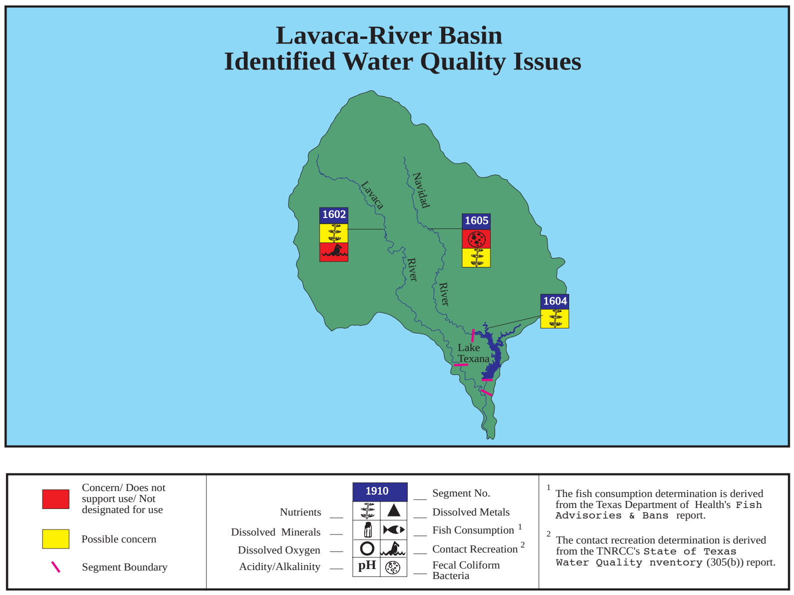

Figure 3-55
Ambient Water Quality Summary for the Lavaca River Basin

Future Water Uses. Total water use in the basin is projected to decline slightly over the 1990-2050 planning period with a projected total basin water use of about 204,000 ac-ft by the year 2050. This anticipated decline is the result of a projected reduction in water requirements for irrigated agriculture of about 79,000 ac-ft over this same time period. Municipal and industrial water use are projected to increase slightly over the planning period. Water savings associated with continued improvements in municipal and industrial water conservation practices and programs are anticipated to reduce total annual water use in the basin by 1,700 ac-ft by the 2020, and about 2,800 ac-ft by the year 2050 over planning scenarios with no conservation.

Future Water Supplies. A portion of the water from Lake Texana is anticipated to be used to meet current and future industrial growth in the adjoining Colorado-Lavaca Coastal Basin. Because of significant questions over the dependable yields of the City of Corpus Christi's surface water reservoirs and mandated environmental releases from those projects, the Board has recommended construction of a major water conveyance system (recently begun) to provide supplies from Lake Texana to the Corpus Christi area to meet its needs, even if projected water conservation savings are obtained.

There is one undeveloped permitted project in the basin, Texana (Stage II) or Palmetto Bend II.

Palmetto Bend II Reservoir. The Texas Water Development Board has a state permit to construct this reservoir on the Lavaca River south of Edna in Jackson County. The LNRA would have the obligation to purchase the Board's share prior to development of the project. The owner is authorized to impound 93,340 ac-ft of water at a normal pool elevation of 44 ft msl. The project would have a surface area of 6,900 acres. It is permitted to supply 48,122 ac-ft of water per year, 30,000 ac-ft of which is to be used for municipal and industrial purposes, and 18,122 ac-ft for maintenance of the Lavaca and Matagorda bay system. The estimated cost for the Palmetto Bend II project is $96.6 million.

Guadalupe River Basin

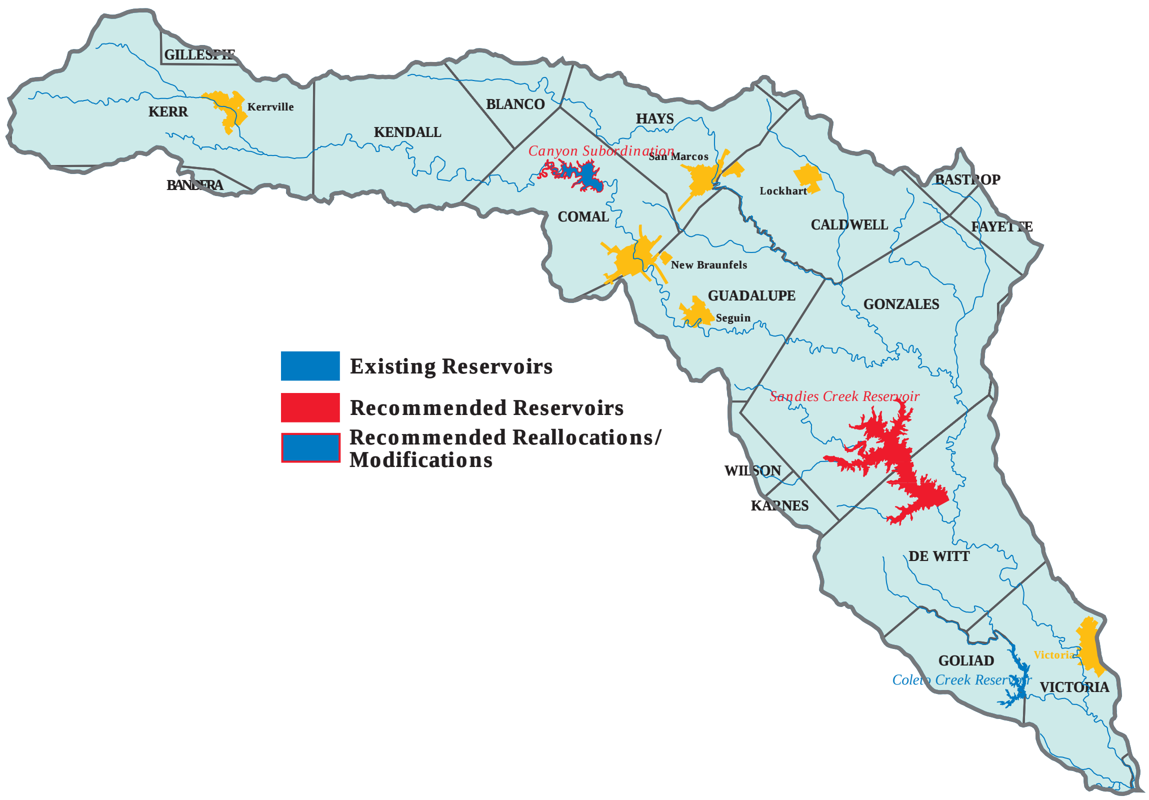

Figure 3-56

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	74,844	141,090
Manufacturing	31,086	51,855
Steam Electric	23,000	30,000
Mining	8,085	3,306
Irrigation	10,477	6,501
Irrigation Adjustment	(0)	(0)
Livestock	10,893	10,893
Total in-Basin Demands	158,385	243,645
IN-BASIN SUPPLIES		
Groundwater	80,829	89,020
Surface Water	231,662	221,262
Total In-Basin Supplies	312,491	310,282
TRANSFERS		
Import Supplies	0	0
Export Demands	48,021	161,999
NEW SUPPLIES	0	97,658
NET AVAILABILITY	106,085	2,296

Reservoir NameStatus		Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Canyon Lake	Built	909.0	8,240	386,200	50,000
Canyon Lake Subordination	*Recommended*				35,000
Sandies Creek	*Recommended*	*232.0*	*26,875*	*606,276*	*97,600*

3.3.1.12 Guadalupe River Basin

Basin Description. The Guadalupe River Basin is bounded on the north by the Colorado River Basin, on the east by the Lavaca River Basin and the Lavaca-Guadalupe Coastal Basin, and on the west and south by the Nueces and San Antonio river basins (see Figure 3-56). Total drainage area of the basin is 6,700 square miles. The prominent sectors of the basin economy are manufacturing, wholesale and retail trades, agriculture, and agribusiness. In 1990, population of the basin was 302,409 which represents an increase of more than 59,000 residents above the 1980 basin population. By the year 2050, the basin population is projected to increase to about 823,000 residents. Major population centers in the basin and their 1993 population estimates include all or portions of the cities of Victoria (60,942), San Marcos (32,451), New Braunfels (32,252), Seguin (20,606), Kerrville (20,153), Lockhart (9,441), Cuero (6,983), Gonzales (6,323), Luling (5,195), and Kyle (2,488).

Current Water Uses. Surface water resources supply about 52 percent of the water used for all purposes in the basin with ground-water resources supplying the remaining 48 percent. Total basin water use in 1990 was 116,519 acre-feet (ac-ft) which represents an increase of nearly six percent above the 1980 total basin water use. Municipal is the largest water use category in the basin accounting for more than 45 percent of the total basin water use, followed by manufacturing which accounts for about 23 percent. Additionally, over 53,400 ac-ft of water was exported to the Lavaca-Guadalupe Coastal Basin from the Guadalupe River Basin in 1990 for municipal, industrial, and agricultural irrigation purposes.

Current Water Supplies. In the upper part of the basin, the Trinity, Edwards-Trinity, and Edwards- Balcones aquifers are major sources of ground-water supplies. The Trinity and Edwards-Trinity aquifers are sources of groundwater for irrigation use in Kerr, Kendall and portions of the surrounding counties. Historically the cities of New Braunfels, San Antonio (in the San Antonio River Basin) and San Marcos have relied on groundwater from the Edwards-Balcones Aquifer, which affects the base flow of the Guadalupe River. Recently, New Braunfels switched its primary supply source from groundwater to surface water from Canyon Lake. San Antonio still relies on groundwater from the Edwards-Balcones Aquifer as its sole source of supply, but is studying other options. San Marcos and GBRA are in the process of constructing a pipeline and water treatment plant to convert the City's primary water supply source to Canyon Lake water.

In the lower portion of the basin, groundwater from the Gulf Coast Aquifer supplies the cities of Cuero and Victoria as well as several smaller communities. Victoria was recently granted a run-of-the-river permit for 20,000 ac-ft of surface water from the Guadalupe River to augment their water supply and provide for future needs. The Carrizo-Wilcox, Queen City and Sparta are other important aquifers supplying portions of the middle and lower basin with groundwater for municipal, irrigation and other purposes.

Other water supply issues in the basin include flooding, conflicts of use, concerns for bay and estuary inflow needs, and protection of Comal Springs in New Braunfels and San Marcos Springs from over-pumpage of groundwater. Additional studies are needed to determine the most efficient sites for flood control, aquifer recharge, and water supply projects.

Basin Authorities/Districts. There are two primary water management authorities in the basin.

Guadalupe-Blanco River Authority (GBRA). GBRA is a regional entity serving Hays, Comal, Guadalupe, Caldwell, Gonzales, DeWitt, Victoria, Kendall, Refugio, and Calhoun counties. GBRA's activities include supplying hydroelectric power through operation of six hydroelectric dams located on the Guadalupe River in Guadalupe and Gonzales counties; supplying potable water and treatment of wastewater to rural areas; supplying raw water and managing storage rights in Canyon Reservoir as authorized by the TNRCC and in compliance with the Army COE operating agreement for the reservoir; delivering Guadalupe River water through its Calhoun Canal system to Calhoun County rice farmers and industries along the Victoria Barge Canal; providing potable water for the cities of Port Lavaca, and Luling; providing wastewater treatment in and around the City of Victoria; and overseeing operation of Coleto Creek Reservoir, which provides cooling water for the Central Power and Light Company's power station located there. The GBRA operates a salt water barrier at the Calhoun Canal system during low flows in the Guadalupe River to prevent salt water intrusion. GBRA has also subordinated its hydroelectric water rights to the yield of Canyon Reservoir.

The GBRA is a lead agency for the Clean Rivers water quality/watershed management program and operates a water quality monitoring laboratory which performs water analyses for itself and other entities. GBRA is also a participant in the Regional Water Supply Study for the San Antonio area. The Authority most likely would be the sponsor of the recommended Sandies Creek Reservoir or other feasible projects.

Upper Guadalupe River Authority (UGRA). UGRA is an entity whose boundaries coincide with those of Kerr County. It is involved in activities primarily concerned with protection of water quality in the Guadalupe River and supply of treated water to the City of Kerrville. UGRA completed a diversion dam and water treatment plant in 1981 which freed Kerrville from relying solely on groundwater. UGRA also provides a range of water monitoring and testing services, operates a water quality monitoring and soils laboratory which performs water quality analysis for itself, the Headwaters Underground Water Conservation District and other entities, regulates the permitting, licensing and regulation of on-site septic systems, administers a water well construction program, and regulates construction and development of structures in the 100-year floodplain. UGRA operates a streamflow and rainfall monitoring system which is used for weather and flood forecasting, and is highly active in various regional water management studies. UGRA has recently obtained a permit authorizing an aquifer storage and recovery (ASR) project in the City of Kerrville. This project allows UGRA to inject surface water diverted from the Guadalupe River into a closed underground formation. The formation serves as a storage reservoir, keeping the water available for use at a later date during times of peak demand, with no losses due to evaporation.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, the Guadalupe River Basin is characterized by generally high quality throughout. Low dissolved oxygen concentrations are generally restricted to Plum Creek, possibly associated with wastewater discharge, and downstream of Canyon Dam due to the release of anoxic water from the bottom of Canyon Lake. Elevated levels of fecal coliform bacteria occur in several segments, but only Plum Creek does not support the contact recreation use. Elevated levels of nutrients occur in several segments. Elevated levels of nitrate nitrogen associated with fairly constant spring flows in the San Marcos and Comal rivers likely contribute to abundant growths of lush aquatic vegetation in these streams.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-57. The Clean Rivers Program included the Lavaca-Guadalupe Coastal Basin in the Guadalupe River Basin assessment.

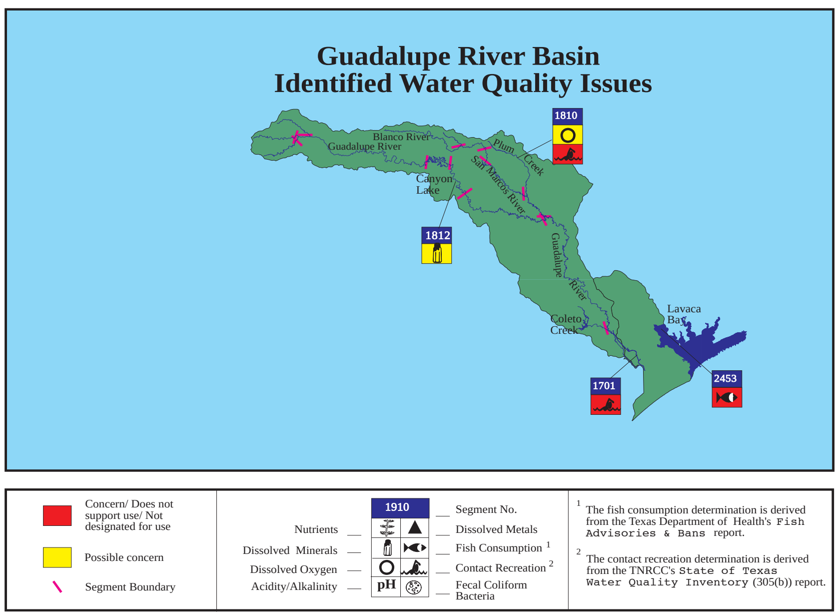

Figure 3-57
Ambient Water Quality Summary for the Guadalupe River Basin

Future Water Uses. Total water use in the basin is projected to increase to about 244,000 ac-ft by the year 2050. This increase in total water use is due primarily to the anticipated increase of municipal water use of more than 88,000 ac-ft along with a projected increase in manufacturing water requirements of nearly 26,000 ac-ft over the 1990-2050 planning period. Water savings associated with municipal, industrial, and irrigated agricultural water conservation practices and programs are projected to reduce the basin's annual water use by about 23,000 ac-ft by the year 2020, and more than 42,000 ac-ft annually by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. In order to ensure that the springs at San Marcos and New Braunfels continue to flow, alternative water supplies must be developed for the San Antonio area. One reservoir, Sandies Creek (previously known as Lindenau), is recommended in the basin and should be developed to meet these additional needs. The project is recommended for development before 2030 and is discussed in detail below. Some of the supplies developed from Sandies Creek can be used to meet those needs in the lower part of the basin which are presently supplied by Canyon Reservoir, freeing supplies in Canyon Reservoir to be used in the New Braunfels - San Marcos area. The following is recommended to increase the supplies in the basin:

Canyon Subordination. It is recommended that the other hydropower permits below Canyon Lake be subordinated to the water supply needs from the reservoir. This subordination will increase the supplies available from Canyon by about 35,000 ac-ft, depending on the level of environmental criteria that will have to be met. The hydropower subordination will be needed before 2010.

Sandies Creek. This project is recommended for development before 2030. The project would consist of a large off-channel storage reservoir located on Sandies Creek and facilities to divert flows of the Guadalupe River during certain conditions into the reservoir. The storage lake would be located in DeWitt and Gonzales counties northwest of the City of Cuero. The diversion facilities could be located in Gonzales County near the City of Gonzales. The project was recommended over other sites and projects due to lesser environmental impacts, the amount of water supplies developed, the ability to use other planned facilities, and the projected cost to develop the site.

A supply of more than 97,600 ac-ft per year from this project could be developed by assuming that only the amount of water actually projected to be used by downstream water rights holders would be passed to them. If full downstream water rights were considered and a corresponding volume of water was passed to meet them, then the supply available from the project would be 80,000 ac-ft per year. The amount of flows estimated to be passed through this reservoir for environmental maintenance is 3,175 ac-ft per year. This project would inundate 29,322 acres, including an estimated 2,388 acres of mixed riparian forest.

San Antonio River Basin

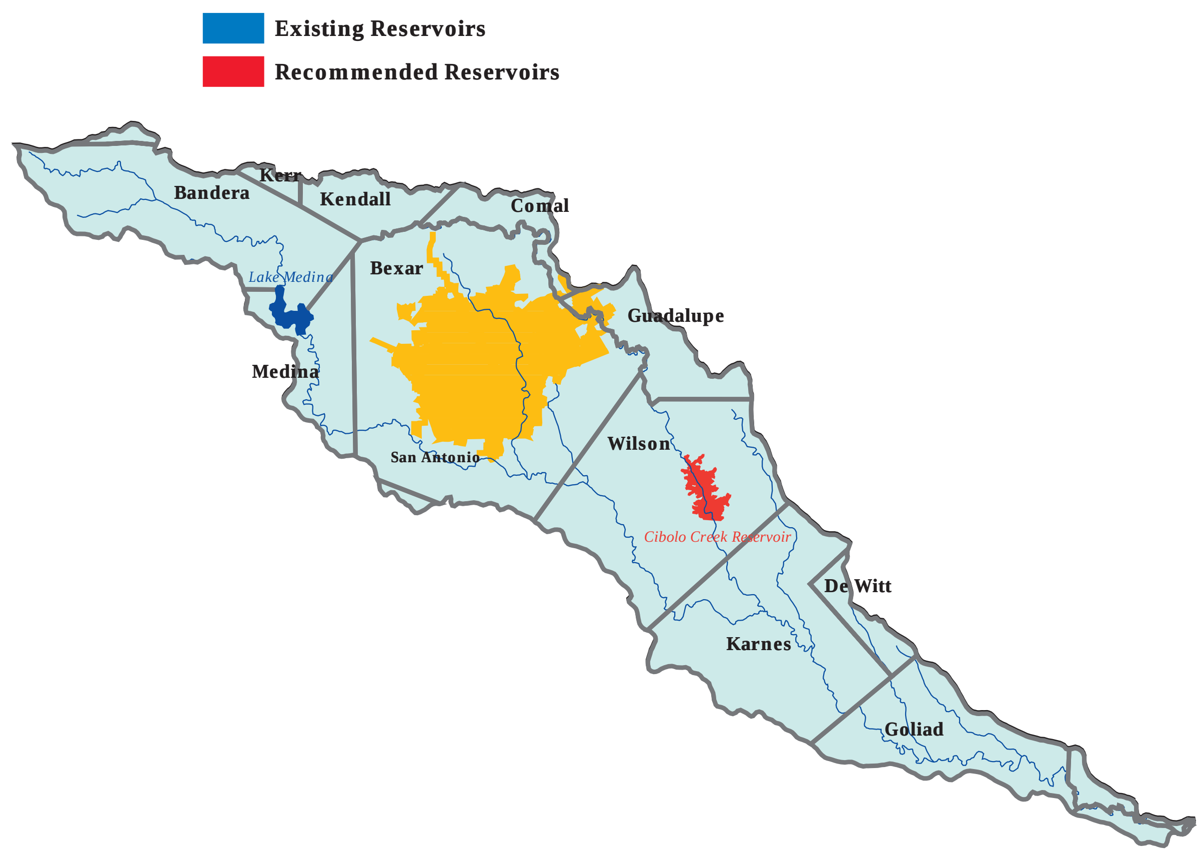

Figure 3-58

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	327,534	576,600
Manufacturing	17,105	32,092
Steam Electric	36,000	56,000
Mining	5,213	5,900
Irrigation	69,908	54,048
Irrigation Adjustment	(4,555)	(11,798)
Livestock	5,960	5,960
Total in-Basin Demands	457,165	718,802
IN-BASIN SUPPLIES		
Groundwater	343,011	318,541
Surface Water	147,854	296,097
Total In-Basin Supplies	490,865	614,638
TRANSFERS		
Import Supplies	3,300	102,234
Export Demands	25,000	26,640
NEW SUPPLIES	0	28,570
NET AVAILABILITY	12,000	0

Reservoir NameStatus		Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Medina	Built	1,064.2	5,575	254,000	39,200
Cibolo	*Recommended*	*416.0*	*16,700*	*409,676*	*28,570*
Diversion to Cibolo	*Recommended*				*93,500*

3.3.1.13 San Antonio River Basin

Basin Description. The San Antonio River Basin is bounded on the north and east by the Guadalupe River Basin, and on the west and south by the Nueces River Basin and the San Antonio-Nueces Coastal Basin (see Figure 3-58). Total drainage area of the basin is 4,180 square miles. Government, manufacturing, tourism, services, agriculture, agribusiness, and wholesale and retail trades are the prominent sectors of the basin economy. In 1990, the population of the basin totaled 1.271 million which represents an increase of 216,499 above the 1980 basin population. By the year 2050, the basin population is projected to increase to about 3.331 million residents. Major population centers and their latest population estimates include all or portions of the cities of San Antonio (1,065,384), Universal City (14,444), Schertz (12,788), Live Oak (10,637), Leon Valley (10,035), Converse (10,397), Kirby (8,904), Alamo Heights (7,213), Floresville (6,210), Kenedy (3,618), Karnes City (3,060), and Goliad (2,158).

Current Water Uses. Ground-water resources supply about 88 percent of the water used for all purposes in the basin with surface water resources supplying the remaining 12 percent. In 1990, water used for municipal, industrial, and agricultural purposes totaled 358,470 acre-feet (ac-ft). Municipal water use accounts for 67 percent of all water use in the basin with water used for irrigated agriculture accounting for about 20 percent. Ground-water resources supply about 99 percent of the water for municipal use in the basin and about 80 percent of the water used for irrigated agriculture.

Current Water Supplies. Currently the San Antonio Basin is supplied by pumpage of groundwater from the Edwards-Balcones, Edwards-Trinity (Plateau), Trinity, Carrizo-Wilcox, Queen City, Sparta, and Gulf Coast aquifers. The Edwards Aquifer provides almost all of the water for the San Antonio area. Dependence on the Edwards-Balcones Aquifer in the upper portion of the basin and the effects of pumpage on ground-water reservoir levels, dependable supplies, and springflow in the Guadalupe Basin are considered major problems and are receiving considerable scrutiny from both local users and local, State, and Federal government agencies. Senate Bill 1477, creating the Edwards Aquifer Authority, also calls for withdrawal limits of 450,000 ac-ft per year through 2007, at which time the limit is reduced to 400,000 ac-ft until December 31, 2012. After 2012 the authority, through various management practices, shall ensure the maintenance of continuous minimum springflows at Comal and San Marcos springs to protect the endangered and threatened species to the extent required by federal law. The Trinity Aquifer provides a minor amount of variable quality water to the upper part of the basin. Water level declines are common during dry periods.

Existing reservoirs in the basin provide water for irrigation (Lake Medina), cooling for steam-electric power generation (Braunig and Calaveras Reservoirs), and flood protection (Olmos Reservoir).

Basin Water Districts/Authorities. There is one major surface water district/authority serving the San Antonio River Basin.

San Antonio River Authority (SARA). SARA is the only major surface water supplier for the San Antonio River Basin. The SARA's primary purpose is to provide flood protection and wastewater treatment services in the San Antonio River Basin. The Authority provides laboratory services and is the lead agency in the Clean Rivers program. The Authority has provided project management services and has been a contributor in the multi-year, multi-regional planning study of the San Antonio region. The Authority could be the local sponsor for the recommended Cibolo Reservoir .

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, water quality in the San Antonio River was historically relatively poor, particularly during periods of low-flow. In recent years, advanced waste treatment has been instituted at the three major City of San Antonio wastewater treatment plants, Dos Rios, Leon Creek, and Salado Creek. A former facility, the Rilling Road wastewater treatment plant, has been eliminated. As a result, dissolved oxygen levels in the San Antonio River have increased substantially, and aquatic life has been enhanced.

Certain water quality concerns remain in the basin. Nutrient concentrations are elevated in nine segments. Elevated fecal coliform bacteria levels occur in four segments, preventing attainment of the contact recreation use. These contaminants are derived mainly from municipal wastewater discharges. The aquatic life use is not supported in three segments due to elevated toxic chemical concentrations in water (in one case also due to depressed dissolved oxygen levels). Elevated concentrations of metals and/or pesticides occur in sediment in five segments. Primary sources of toxic chemicals include municipal and industrial wastewater discharges and urban runoff from San Antonio.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-59.

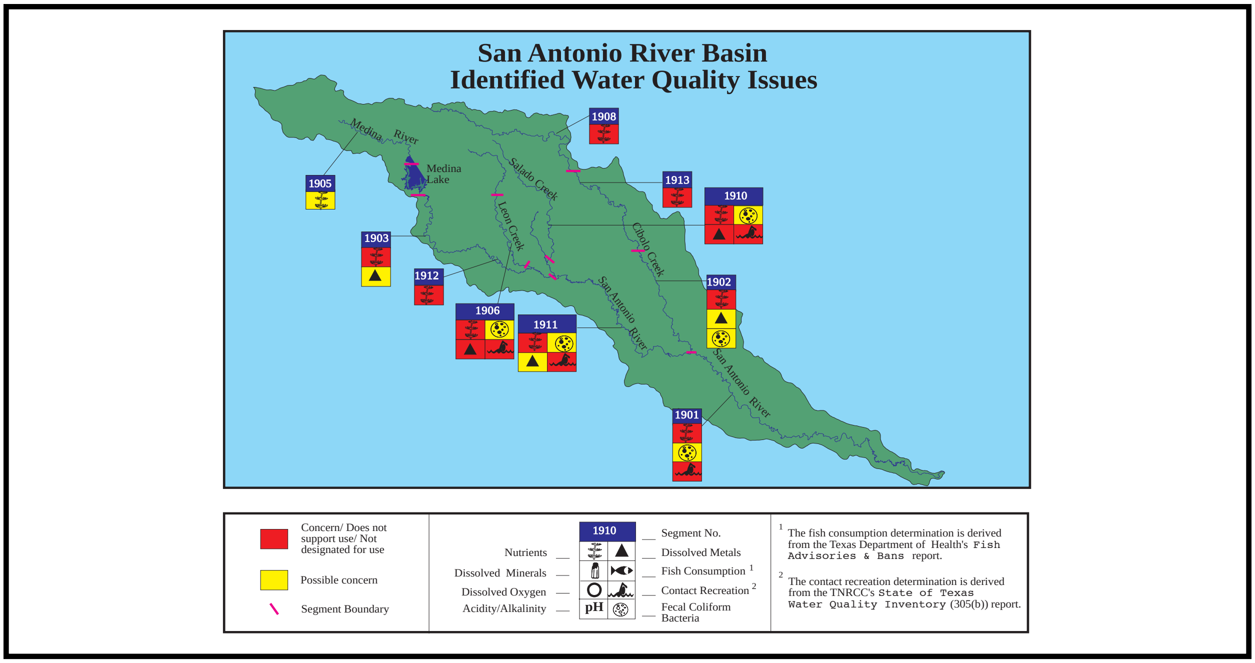

Figure 3-59
Ambient Water Quality Summary for the San Antonio River Basin

Future Water Uses. Total water use in the basin is projected to increase to about 719,000 ac-ft by the year 2050, representing an increase of about 360,000 ac-ft over the 1990-2050 planning horizon. The impetus for this significant increase in total water use is the anticipated increase in municipal water use of almost 337,000 ac-ft over the planning horizon. Water savings associated with municipal, industrial, and irrigated agricultural water conservation practices and programs are projected to reduce annual water use by almost 93,000 ac-ft by the year 2020, and more than 152,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. With the ground-water withdrawal limits as imposed by SB 1477, additional surface water supplies in the San Antonio and Guadalupe River basins will need to be developed for use in the San Antonio area, even with the Board's advanced water conservation savings projections. Long-term water needs in the area will be difficult to meet unless several options are successfully pursued. In order to meet the needs in the San Antonio area, the Board recommends that the Cibolo Reservoir project be developed before 2010. However, final decisions on actual projects and timing will be made locally.

Cibolo Reservoir. This project would be located near the City of Stockdale in Wilson County, and would consist of a reservoir on Cibolo Creek and diversion facilities on the San Antonio River. The diversion facilities, located near Floresville, would divert flows from the San Antonio River including wastewater return flows from the San Antonio area into the main reservoir. These diversions would be considered a new appropriation and would likely be subject to the consensus environmental planning criteria in the permitting process. It is estimated that over 122,000 ac-ft of supplies could be developed by this project. The estimate includes the supplies that could be developed with diversions of wastewater return flows from San Antonio and river flows from the San Antonio River, estimated to be 93,530 ac-ft/year by 2050. The project would pass flows (based on inflows, not storage) averaging about 25,000 ac-ft/year to meet environmental flow needs under the consensus environmental planning criteria. The project would inundate 9,896 acres, including 1,615 acres of mixed riparian forest.

Medina Lake is recommended for conversion from a purely irrigation supply source to a source of both municipal and irrigation water. By converting to both municipal and irrigation usage, the lake could be used to supply some of the municipal water needs in western Bexar County.

Nueces River Basin

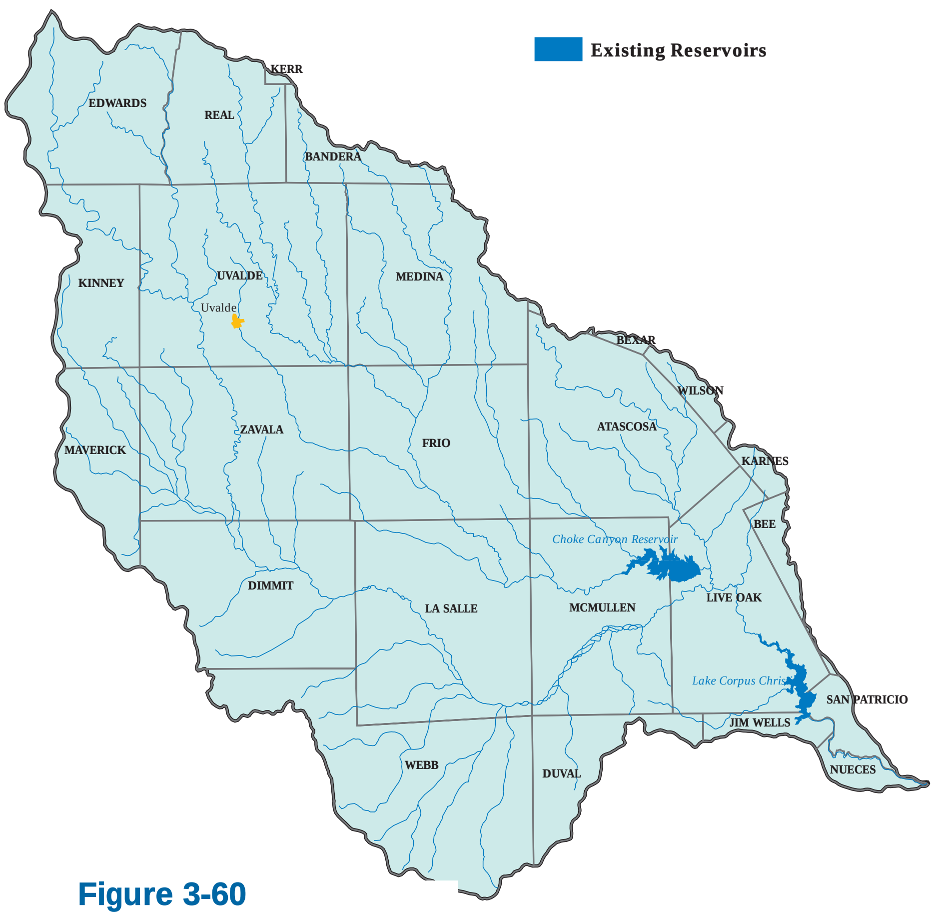

Figure 3-60

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	42,101	56,051
Manufacturing	4,738	7,140
Steam Electric	15,400	25,400
Mining	10,774	8,449
Irrigation	517,608	419,827
Irrigation Adjustment	(253,227)	(321,138)
Livestock	13,174	13,174
Total in-Basin Demands	350,568	208,903
IN-BASIN SUPPLIES		
Groundwater	297,624	148,072
Surface Water	221,883	209,561
Total In-Basin Supplies	519,507	357,633
TRANSFERS		
Import Supplies	0	5,259
Export Demands	151,657	150,201
NEW SUPPLIES	0	0
NET AVAILABILITY	17,282	3,788

Reservoir NameStatus		Conservation Pool			
		Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Choke Canyon	Built	220.5	25,733	689,314	178,000
Corpus Christi	Built	94.0	19,251	237,473	

3.3.1.14 Nueces River Basin

Basin Description. The Nueces River Basin is bounded on the north and east by the Colorado, San Antonio, and Guadalupe river basins and the San Antonio-Nueces Coastal Basin, and on the west and south by the Rio Grande River Basin and the Nueces-Rio Grande Coastal Basin (see Figure 3-60). Total drainage area of the basin is 16,950 square miles. Agriculture, agribusiness, mineral production, and wholesale and retail trades are the predominant sectors of the basin economy. In 1990, the population of the basin was 165,549 which represents an 8 percent increase above the 1980 basin population. The basin population is projected to increase to about 298,000 by the year 2050. Major population centers and their latest population estimates include all or portions of the cities of Corpus Christi (273,620), Uvalde (15,773), Crystal City (8,279), Pearsall (7,713), Pleasanton (8,472), Hondo (6,819), Carrizo Springs (5,755), Mathis (5,642), Devine (4,794), and Cotulla (4,230).

Current Water Use. Ground-water resources supply about 76 percent of the water used for all purposes in the basin with surface water resources supplying the remaining 24 percent. In 1990, total water use in the basin was 615,752 acre-feet (ac-ft) which represents an increase of about 89,000 ac-ft above the 1980 total basin water use. The largest water use category in the basin is irrigated agriculture which accounts for nearly 90 percent of all the water used, while municipal water use accounts for about 5 percent. In 1990, 138,834 ac-ft of water was exported to the Nueces-Rio Grande Coastal Basin from the Nueces River Basin for municipal and industrial purposes.

Current Water Supplies. The Edwards-Balcones, Edwards-Trinity, Carrizo-Wilcox, Sparta, and Queen City aquifers provide most of the water supplies for the basin. Surface water resources in the basin include several small lakes on the Nueces River in Zavala and Dimmit counties owned by Zavala-Dimmit Counties WID#1, and lakes Choke Canyon and Corpus Christi owned by the City of Corpus Christi and the Nueces River Authority. The City of Corpus Christi owns Lake Corpus Christi and part of Choke Canyon Reservoir. The two sources are operated as a water supply system, called the Choke Canyon-Lake Corpus Christi System. The system presently can supply approximately 178,000 ac-ft per year. The City provides water to the South Texas Water Authority (STWA), Alice Water Authority, Beeville, Port Aransas, Rockport, Mathis, Three Rivers, San Patricio County MWD No.1, Lamar Peninsula, and the industrial complexes on the Corpus Christi Ship Channel.

Basin Water Districts/Authorities. There is only one river authority that manages and provides surface water for non-irrigation purposes in the basin. The Zavala-Dimmit WSC#1 provides water for irrigation purposes only. The City of Corpus Christi is the largest water right holder in the basin.

Nueces River Authority (NRA). Established in 1935, NRA provides management of the surface water resources for all of the region except Wilson and Karnes counties. The Authority is a sponsor of Choke Canyon Reservoir which was built to provide water to Corpus Christi and other cities outside of the region. The Authority has participated in a number of local planning studies and in one regional study for water supply and water quality. The Authority also serves as the lead agency in the Clean Rivers program.

Zavala-Dimmit Counties WID#1. The district provides irrigation water for 14,000 acres in Zavala and Dimmit counties from a series of small lakes on the Nueces River.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, water quality in the upper portion of the basin in the less-inhabited reaches is good, except for relatively high nitrate-nitrogen levels occurring naturally in the spring-fed streams. A substantial part of the flow of the Nueces River and its tributaries enters the fractured and cavernous limestone formation of the Edwards Aquifer (Balcones Fault Zone). As a result, stream flows in the Nueces River Basin downstream from the recharge zone consist almost entirely of stormwater. During low-flow conditions, chloride, sulfate, and total dissolved solids levels increase due to natural and man-made activities. The Atascosa River experiences elevated fecal coliform bacteria, inorganic nitrogen, and phosphorus levels downstream of the City of Pleasanton.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-61.

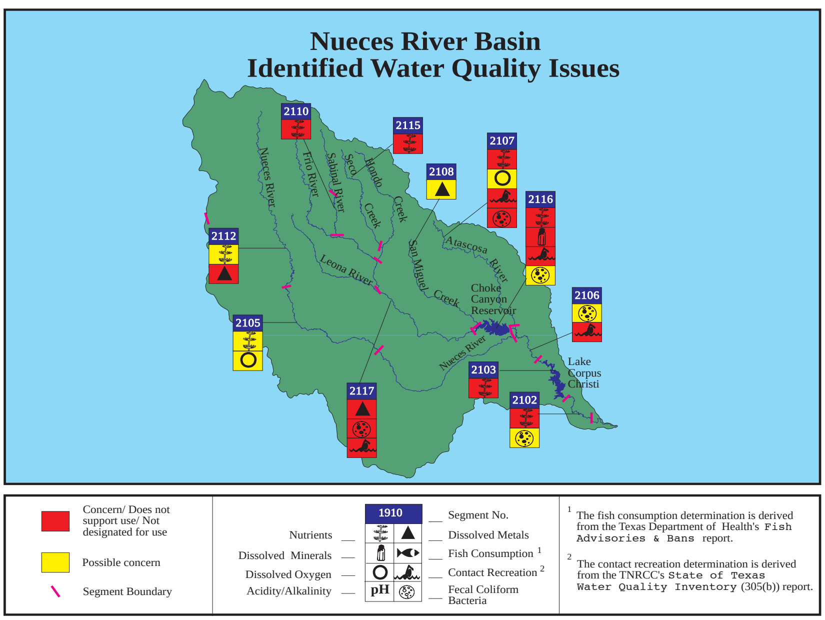

Figure 3-61
Ambient Water Quality Summary for the Nueces River Basin

Future Water Use. Total water use in the basin is projected to decline over the 1990-2050 planning period with a projected total water use of about 209,000 ac-ft by the year 2050. This decline is due to a projected reduction in water requirements for irrigated agriculture of about 82 percent over the planning period. This substantial reduction in irrigation water requirements is due to estimated declines in ground-water availability resulting in insufficient quantities of groundwater to meet current and projected future levels of irrigation water use. In addition, voluntary transfers of water between uses was assumed, as was increased implementation of water-efficient irrigation technology, leading to increased irrigation water savings. Most of the reduction in irrigation water use due to declining ground-water availability is anticipated to occur in the Winter Garden area and Edwards Aquifer area of the Nueces River Basin. Based on dry weather planning assumptions, municipal water use in the year 2050 is projected to increase more than 23,000 ac-ft above 1990 levels. Water savings associated with municipal and industrial water conservation practices and programs are projected to reduce the basin's total annual water use by about 10,000 ac-ft by the year 2020, and nearly 15,000 ac-ft annually by the year 2050. These savings are actually a reduction in increased water use in some sectors that would occur without conservation practices.

Future Water Supplies. The basin will continue to depend on the Edwards (BFZ) and the Carrizo Wilcox aquifers to meet the basin's future water needs. Little reuse is anticipated to occur in the basin due to the credits received by Corpus Christi for wastewater return flows that meet the freshwater inflow requirements of Nueces Bay. However, the City is investigating the diversion of wastewater to the upper reaches of Nueces Bay to increase the productivity of the bay system and reduce the amount of fresh water passed through to the bay. Imports from the Lavaca and probably the Colorado Basin will be used to meet future needs in the area. Construction of the pipeline from Lake Texana in the Lavaca Basin to Corpus Christi has begun.

Rio Grande Basin

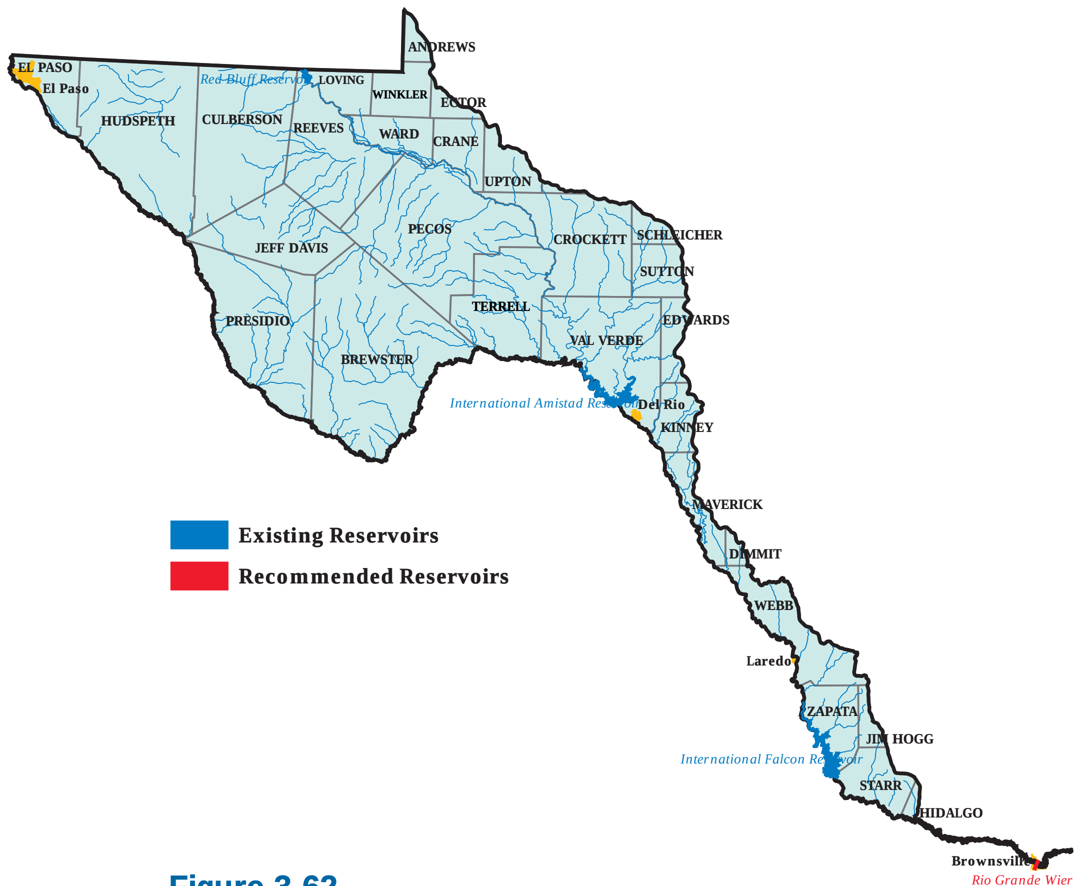

Figure 3-62

Basin Balance Item	Yr 2000	Yr 2050
IN-BASIN DEMANDS		
Municipal	274,536	471,612
Manufacturing	15,009	20,745
Steam Electric	14,800	14,800
Mining	11,461	9,429
Irrigation	700,619	604,744
Irrigation Adjustment	(30,899)	(120,336)
Livestock	13,882	13,882
Total in-Basin Demands	999,408	1,014,876
IN-BASIN SUPPLIES		
Groundwater	495,637	357,484
Surface Water	1,631,953	1,680,983
Total In-Basin Supplies	2,127,590	2,038,467
TRANSFERS		
Import Supplies	70	90
Export Demands	1,126,713	1,103,681
NEW SUPPLIES	0	80,000
NET AVAILABILITY	1,539	0

Reservoir NameStatus		Conservation Pool Elev. (ft. msl)	Area (acres)	Capacity (ac-ft)	Supply (ac-ft)
Intl. Amistad	Built	1,117.0	64,900	3,505,400	1,364,000
Intl. Falcon	Built	301.1	87,210	2,767,400	
Rio Grande Weir	*Recommended*	*26.0*	*600*	*6,000*	*40,000*

3.3.1.15 Rio Grande Basin

Basin Description: The Rio Grande Basin is bounded on the east by the Colorado and Nueces river basins and the Nueces-Rio Grande Coastal Basin, on the north by the State of New Mexico, and on the south by Mexico (see Figure 3-62). The Rio Grande originates in southern Colorado, flows southerly across New Mexico, and enters Texas just above the City of El Paso. The Rio Grande forms the international boundary between the United States and Mexico. Total drainage area of the basin in Texas is 48,259 square miles. The basin economy is predominately comprised of agriculture, agribusiness, manufacturing, tourism, wholesale and retail trade, and government. In 1990, the basin population was 951,623 and represents a net gain in population of 170,663 between 1980 and 1990. Population of the basin is projected to increase to about 2.63 million by the year 2050. Major population centers in the basin and their latest population estimates include all or portions of the cities of El Paso (577,911), Laredo (157,559), Del Rio (34,201), Eagle Pass (24,572), Pecos (11,831), Rio Grande City (11,562), Fort Stockton (8,984), Monahans (7,845), Kermit (6,540), and Alpine (5,930).

Current Water Uses. Surface water resources supply about 66 percent of all water used in the basin with ground-water resources supplying the remaining 34 percent. In 1990, water used for municipal, industrial, and agricultural purposes totaled approximately 1.005 million acre-feet (ac-ft). The 1990 total basin water use represents a decline of nearly 184,000 ac-ft from the 1980 basin water use. This reduction in total water use was due in part to a decline in water requirements for irrigated agriculture of about 172,000 ac-ft. During the decade of the 1980s, municipal and industrial water use increased by more than 35,000 ac-ft or about 19 percent. Irrigated agriculture is the largest water use category, accounting for nearly 75 percent of all water used in the basin. In 1990, 1.214 million ac-ft was exported to the Nueces-Rio Grande Coastal Basin from the Rio Grande Basin for municipal, industrial, and agricultural irrigation purposes.

Current Water Supplies. Groundwater from the Hueco-Mesilla Aquifer supplies water needs of the upper basin with some amounts supplied from surface water of the Rio Grande. Other important aquifers in the basin are the Bone Spring-Victorio Peak, Cenozoic Pecos Alluvium, Edwards-Trinity (Plateau), and West Texas Bolsons. In the El Paso area, water is provided by the Rio Grande Project of New Mexico-Texas with water from Elephant Butte Reservoir in New Mexico under terms of the Rio Grande Compact. A discussion of the Rio Grande Compact appears in the "Upper Rio Grande Region" section.

Basin Authorities/Districts. Water management agencies in the basin generally are limited to irrigation districts. Examples are the Red Bluff Water Power and Control District (which is the "master district" for seven irrigation districts taking water from Red Bluff Reservoir in the upper basin), Brownsville Irrigation and Drainage District, Delta Lake Irrigation District #1, and numerous others. Each irrigation district as well as each municipality is constrained by its surface water rights according to the basin's adjudication (note: the Texas Natural Resource Conservation Commission is currently in the process of adjudicating water rights within the Upper Rio Grande Basin, which is the last area of the state remaining to be adjudicated).

The actual geography and hydrology of this narrow basin limits the amount of available surface water. It was the relative scarcity of surface water and an universal reliance on the Rio Grande as the only long watercourse present in this area which brought about historical conflicts between various Texas users, ultimately resulting in adjudication of the lower basin as a resolution of the conflicts there. The treaty with Mexico resolves historical and potential future conflict between Mexico and the United States over the limited amounts of water available to each nation from the Rio Grande.

Watermaster Office of the Texas Natural Resource Conservation Commission. The Watermaster Office of the state's regulatory agency (TNRCC) administers the allocation of the United States' share (Texas' share) of international waters of the Rio Grande. In the portion of the basin downstream of Amistad International Reservoir near the City of Del Rio, the allocation involves water stored in international reservoirs Falcon and Amistad. The allocation must follow the international treaty entered into by the United States and Mexico, as well as following the Texas court decision which adjudicated the Lower Rio Grande Basin. Both municipalities and irrigators have water rights to the Falcon-Amistad Reservoir system; the Watermaster allocates the proper amounts to the various water right holders and also facilitates marketing of water rights. In the upper portion of the basin, the Watermaster's duties involve overseeing Texas' share of water in the Rio Grande and its Texas tributaries from Amistad Dam to Fort Quitman, excluding drainage basins of the Pecos River and Devils River.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, the basin's size and wide range of geologic and climatic conditions is responsible for a wide range of water quality conditions in the Rio Grande/Rio Bravo (Rio Bravo is the Mexican name) system. Most of the flow of the Rio Grande/Rio Bravo is diverted for irrigation and municipal uses at the American Canal in Texas and the Acequia-Madre Canal in Mexico before it reaches El Paso. Downstream of El Paso, most of the flow consists of treated municipal wastewater from El Paso and irrigation return flow. The Rio Grande River flow is intermittent to Presidio where inflow from Mexico's Rio Conchos enters the Rio Grande/Rio Bravo. The presence of metals and pesticides have been identified sporadically throughout the Rio Grande Basin. Elevated fecal coliform levels occur in the river downstream of major US-Mexico border cities due to municipal wastewater treatment facilities in Texas and untreated wastewater in Mexico. Levels of chloride, sulfate, and total dissolved solids are increasing in the Rio Grande downstream of Falcon Reservoir due to repeated use of water for irrigation. Elevated nutrient levels are also common in the Rio Grande.

Major tributaries to the Rio Grande/Rio Bravo are the Devils River and Pecos River in Texas, and the Rio Conchos, Rio Salado, Rio San Juan, Rio Alamo, and Rio San Rodrigo in Mexico. The Devils River has no known water quality problems. The Pecos River drains a substantial part of New Mexico and far West Texas. The saline waters of the Pecos River entering Texas are stored in Red Bluff Reservoir. Downstream of the reservoir, the salinity in the Pecos River continues to increase.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns on a river basin basis, as illustrated in Figure 3-63.

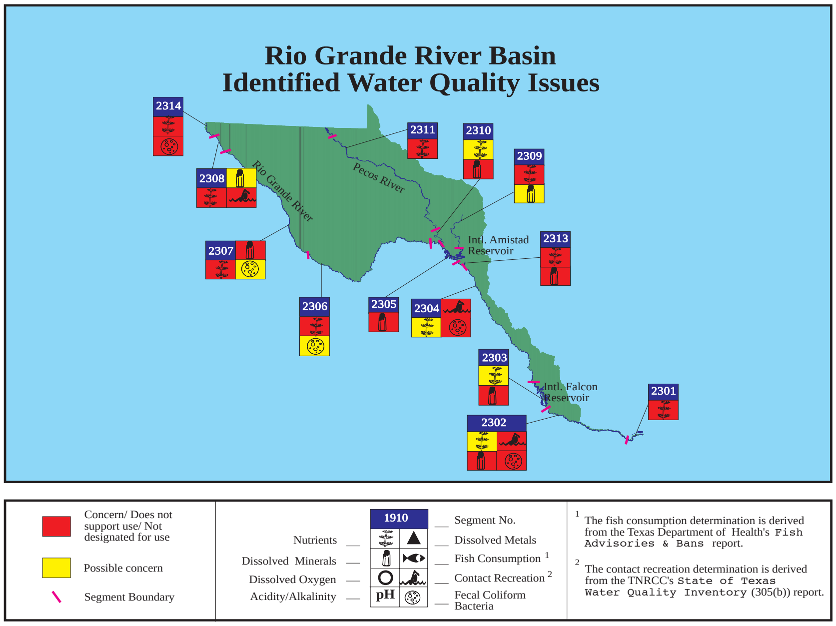

Figure 3-63
Ambient Water Quality Summary for the Rio Grande Basin

Future Water Uses. Total water use in the basin is projected to remain relatively stable over the 1990-2050 planning horizon with a total basin water use of about 1.003 million ac-ft by the year 2050. This stable water use pattern is the result of a projected decline in water requirements for irrigated agriculture of about 36 percent below current levels. The anticipated reduction in irrigation water use is due to estimated declines in ground-water availability resulting in insufficient quantities of groundwater to meet current and projected future levels of irrigation, and also due to assumed voluntary transfers of water among users. Most of this reduction in irrigation water requirements associated with declines in ground-water availability is anticipated to occur in the upper portion of the Rio Grande Basin. Based on dry weather planning assumptions and a projected additional 1.6 million people living in the basin by the year 2050, municipal water use is projected to more than double over the planning horizon. Water savings associated with improvements in water conservation practices and programs are projected to reduce total annual water use in the basin by nearly 99,000 ac-ft by the year 2020, and more than 163,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. In El Paso County due to increasing municipal demands and a shift from irrigation to municipal use (mainly due from land conversion from rural to urban), there may be an irrigation deficit in the year 2050, but no municipal deficit provided that the City of El Paso expands its current reuse of municipal wastewater. The City should continue to receive water delivered by New Mexico under the Rio Grande Compact, and will also benefit from the New Mexico Channel Improvements project by about year 2030. The City would also utilize desalination technology to desalt groundwater for a portion of its future supply.

Rio Grande Weir. In the lower basin, a new channel dam (Site "A" just downstream of Brownsville) is recommended for development. The recommended project consists of a weir in the Rio Grande approximately eight miles downstream from the Gateway Bridge in Brownsville. The project would capture available United States flows in the lower basin that normally would discharge to the Gulf of Mexico. The project could supply the Brownsville area with additional supplies which would be needed sometime after the year 2010. The ultimate availability of water provided by the channel dam will be determined during the permitting process, and is somewhat dependant on negotiations with Mexico regarding amendments to the existing international treaty. Concerns about aquatic and terrestrial habitat in the riparian corridor along the Rio Grande, including the Channel Dam site, water quality, "no charge" pumping, flooding, and off-channel storage options would have to be fully evaluated in the permitting process. This project would inundate 422 acres of mixed riparian forest.

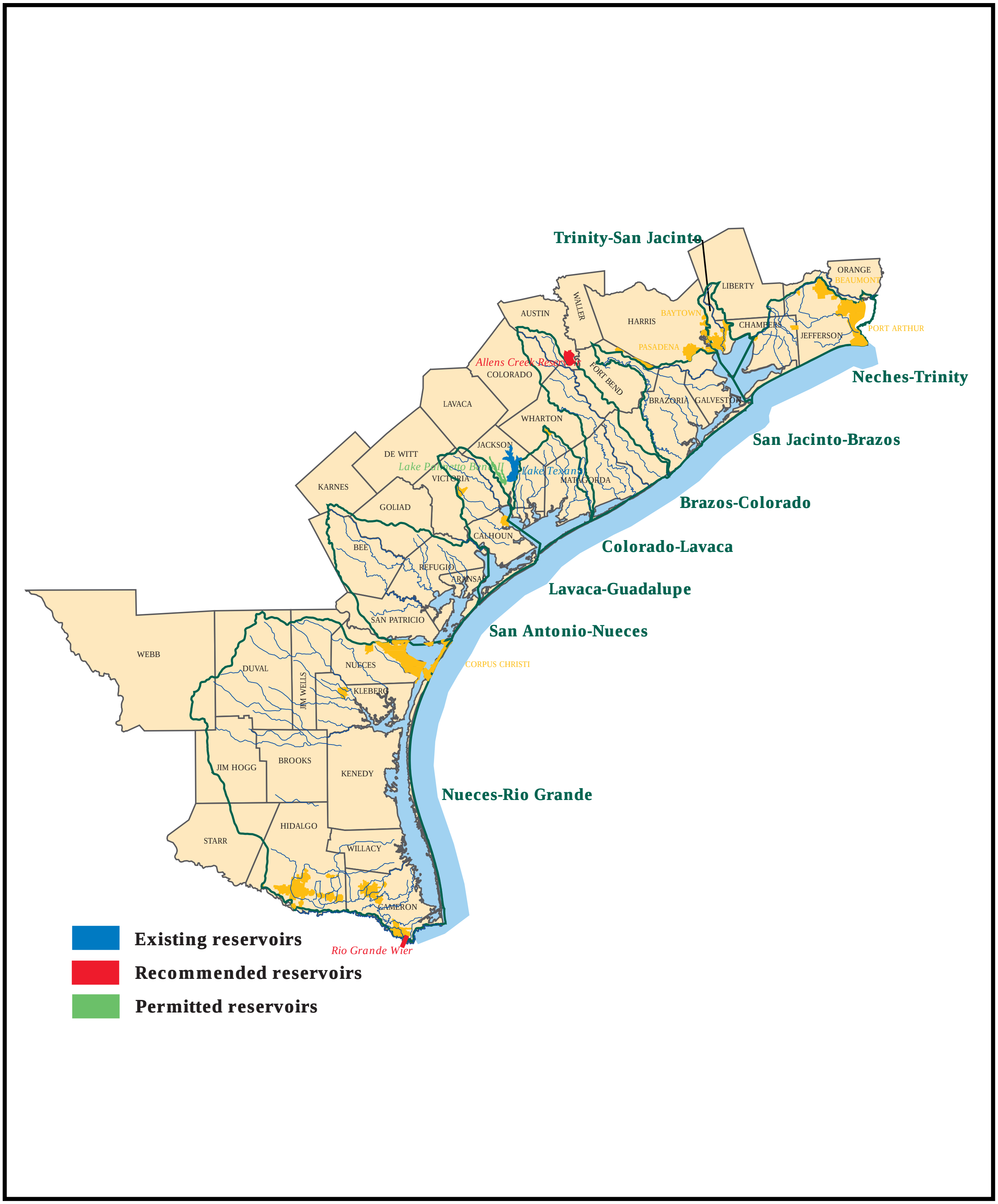

Figure 3-64
Coastal Basins of Texas

3.3.2 Coastal Basins

There are eight designated coastal basins in Texas (see Figure 3-64). None of the coastal basins have large surface water projects located in their areas. Generally, because of potential subsidence problems and salt water intrusion, ground-water usage is small; thus, these basins generally rely on the adjoining river basins to provide surface water to meet their needs. In fact, the largest reported exported amounts of water from the river basins are to adjoining coastal basins. Because there are a large number of different types of water supply districts and authorities located in the coastal basins, only a few of the major districts/authorities will be described.Those districts not described are mainly districts that supply irrigation water. The current and anticipated water (supply and demand) balances of the coastal basins are shown in Table 3-5.

Table 3-5
Current and Projected Water Balances of the Coastal Basins of Texas

Item	Neches-Trinity		Trinity-San Jacinto		San Jacinto-Brazos		Brazos-Colorado	
	Year 2000	Year 2050	Year 2000	Year 2050	Year 2000	Year 2050	Year 2000	Year 2050
IN-BASIN DEMANDS								
Municipal	33,979	34,460	20,163	28,661	145,593	261,594	15,624	26,076
Manufacturing	80,120	112,445	78,456	107,449	184,246	291,515	21,347	28,028
Steam Electric	0	0	1,100	5,000	3,000	4,000	0	0
Mining	480	69	9,590	10,805	571	532	3,544	3,543
Irrigation	218,056	163,278	31,774	27,229	148,714	107,893	258,451	212,888
Irrigation Adjustment	0	0	0	0	0	0	(14,743)	(9,349)
Livestock	1,005	1,002	265	226	1,094	1,094	1,827	1,827
Total In-basin Demands	333,640	311,257	141,309	179,370	483,218	666,628	286,052	263,014
IN-BASIN SUPPLIES								
Groundwater	8,924	9,024	19,537	11,371	65,638	71,687	75,439	80,000
Surface Water	18,380	18,341	6,160	20,628	39,978	70,085	24,132	28,651
Total In-basin Supplies	27,304	27,365	25,697	31,999	105,616	141,772	102,180	108,651
TRANSFERS								
Import Supplies	306,336	283,892	115,612	147,371	377,602	524,856	186,481	154,363
Export Demands	0	0	0	0	0	0	0	0
ADDITIONAL NEW SUPPLIES	0	0	0	0	0	0	0	0
NET AVAILABILITY	0	0	0	0	0	0	0	0

Item	Colorado-Lavaca		Lavaca-Guadalupe		San Antonio-Nueces		Nueces-Rio Grande	
	Year 2000	Year 2050	Year 2000	Year 2050	Year 2000	Year 2050	Year 2000	Year 2050
IN-BASIN DEMANDS								
Municipal	4,008	4,878	7,726	10,051	17,511	23,342	272,103	455,942
Manufacturing	16,673	30,678	46,069	84,738	14,251	40,022	49,964	75,466
Steam Electric	100	100	0	0	0	0	3,450	5,300
Mining	329	249	779	1,177	367	84	6,285	3,226
Irrigation	139,277	115,539	46,140	22,866	4,053	2,259	1,169,980	974,890
Irrigation Adjustment	0	0	(3,629)	(12,899)	0	0	(204,617)	(183,492)
Livestock	955	955	1,155	1,155	2,222	2,222	7,774	7,774
Total In-basin Demands	161,342	152,399	98,240	107,088	38,404	67,929	1,304,939	1,339,106
IN-BASIN SUPPLIES								
Groundwater	80,816	67,445	27,163	15,389	11,087	9,468	49,051	47,481
Surface Water	5,813	6,028	1,356	6,934	862	862	3,973	21,961
Total In-basin Supplies	86,629	73,473	28,519	22,323	11,949	10,330	53,024	69,442
TRANSFERS								
Import Supplies	74,713	78,926	69,721	84,765	26,455	57,599	1,251,915	1,269,664
Export Demands	0	0	0	0	0	0	0	0
ADDITIONAL NEW SUPPLIES	0	0	0	0	0	0	0	0
NET AVAILABILITY	0	0	0	0	0	0	0	0

3.3.2.1 Neches-Trinity Coastal Basin

Basin Description. The Neches-Trinity Coastal Basin is bounded on the north by the Neches and Trinity river basins, on the east by Sabine Lake, and on the west by Galveston and Trinity bays. Total drainage area of the Neches-Trinity Coastal Basin is 769 square miles. The economy of the area is based on manufacturing, oil production, agriculture, agribusiness, commercial shipping and fishing, and trades. Over the 1980-1990 decade, population of the basin declined from 203,727 in 1980 to 194,452 in 1990. By the year 2050, the basin population is anticipated to increase to about 249,000 residents. Major basin population centers and their latest population estimates include all or portions of the cities of Beaumont (115,797), Port Arthur (58,559), Nederland (16,803), and Groves (16,739).

Current Water Uses. In 1990, annual water use in the basin totaled 397,174 acre-feet (ac-ft). By far, the largest water use category in the basin is agricultural irrigation which accounted for about 74 percent of all water used within the basin.

Current Water Supplies. There are no major water-supply reservoirs in the basin. The J. D. Murphree impoundments, owned by the Texas Parks and Wildlife Department, are used for wildlife management purposes. Surface water is supplied to the basin primarily from the Trinity and Neches river basins. The Gulf Coast Aquifer supplies only about 6,100 ac-ft per year of groundwater to the basin, or 2 percent of the basin's water supply. The major water suppliers within the basin are the Lower Neches Valley Authority (LNVA), Devers Canal Rice Producers Association and Chambers-Liberty Navigation District.

Current Water Quality. According to the TNRCC's 1996 <u>The State of Texas Water Quality Inventory</u>, depressed dissolved oxygen concentrations occur in Taylor Bayou, and elevated levels of fecal coliform bacteria and nutrients occur in Taylor and Hillebrandt bayous. Taylor Bayou is a naturally sensitive body of water due to hydrological modifications by channelization and a salt-water barrier, extremely sluggish conditions, and low atmospheric reaeration capabilities. These conditions are further aggravated by point source discharges from the cities of Beaumont and Port Arthur. Toxic substances in sediment exceed screening levels in Taylor Bayou and the Sabine-Neches Canal.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns for the coastal basin and some of the associated bays and estuaries, as illustrated in Figure 3-65.

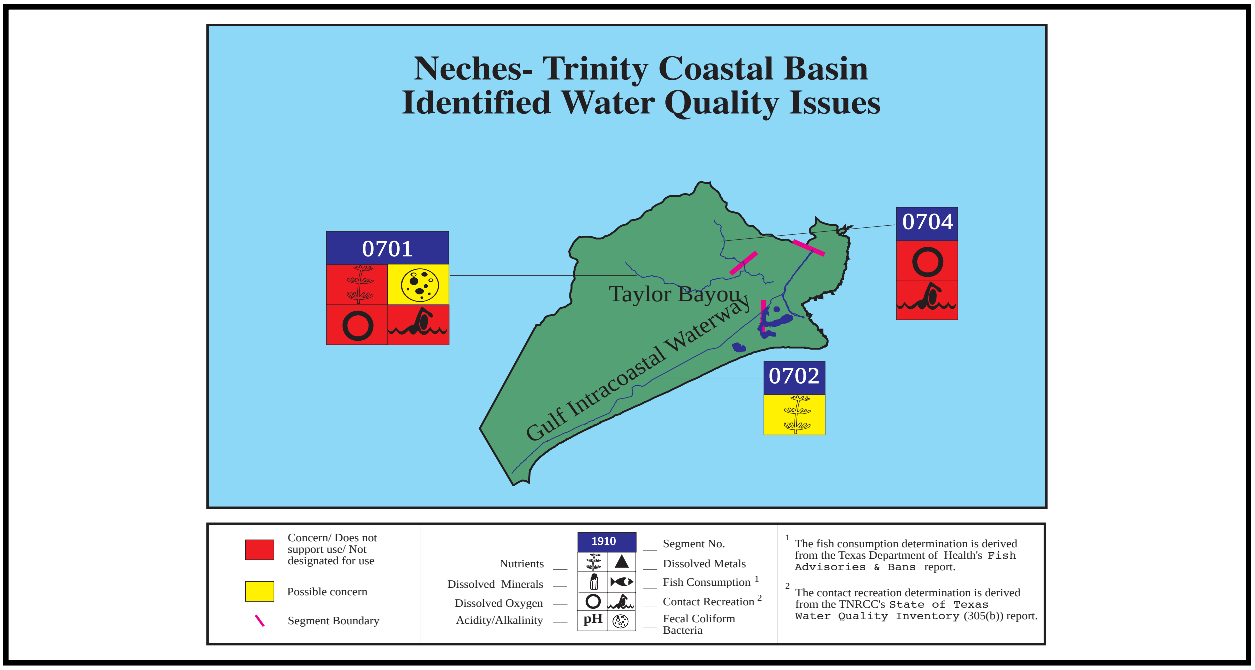

Figure 3-65
Ambient Water Quality Summary for the Neches-Trinity Coastal Basin

Future Water Uses. Total water use in the basin is projected to decline from about 397,000 ac-ft in 1990 to about 312,000 ac-ft in 2050. The primary reason for this anticipated decline is a projected decline in water requirements for irrigated agriculture. Continued improvements in municipal, manufacturing, and irrigation conservation practices and programs are anticipated to reduce total annual water use by about 19,000 ac-ft by the year 2020, and more than 31,000 ac-ft by the year 2050 over planning scenarios with no conservation.

Future Water Supplies. Any additional needs for surface water will be met from importation of supplies from the Neches and Trinity river basins. There are adequate supplies available in these basins to meet the future needs of the Neches-Trinity Coastal Basin.

3.3.2.2 Trinity-San Jacinto Coastal Basin

Basin Description. The Trinity-San Jacinto Coastal Basin is bounded on the east by the Trinity River Basin and the Neches-Trinity Coastal Basin, on the west and north by the San Jacinto River Basin and the San Jacinto-Brazos Coastal Basin, and on the south by Trinity and Galveston bays. The drainage area of the Trinity-San Jacinto Coastal Basin is 247 square miles and drains into the Galveston and Trinity bay systems. The basin-wide economy is based on manufacturing, agriculture, trades, services, commercial fishing, and tourism. The basin population totaled 95,809 in 1990 and represents an increase of nearly 20 percent above the 1980 population. By the year 2050, the basin population is projected to increase to about 206,000 residents. Major population centers in the basin and their latest population estimates include all or portions of the cities of Baytown (68,505), Highlands (7,832), Barrett (3,335), Crosby (2,138), and Mont Belvieu (1,544).

Current Water Uses. In 1990, annual water use in the basin totaled 128,496 acre-feet (ac-ft). Irrigation and manufacturing are the largest water use categories with a current use of 37,690 and 71,746 ac-ft, respectively. Annual municipal water use is 14,000 ac-ft.

Current Water Supplies. Cedar Bayou Reservoir, which supplies saline water from Cedar Bayou for steam-electric power generation, is the only water supply reservoir in the basin. Almost 9,700 ac-ft per year of groundwater is currently being supplied by the Gulf Coast Aquifer to basin users. All other basin needs are supplied by surface water from the San Jacinto River Authority (SJRA) with diversions from the San Jacinto River and Lake Conroe, and from the Trinity River Basin through the Coastal Water Authority (CWA). A detailed discussion of the operational area and activities of the SJRA and CWA is provided in the section for the San Jacinto River Basin.

Current Water Quality. According to the TNRCC's 1996 <u>The State of Texas Water Quality Inventory</u>, elevated levels of fecal coliform bacteria and nutrients occur in the basin. Depressed dissolved oxygen concentrations occur in Cedar Bayou above tidal. Sluggish flow and municipal and industrial wastewater discharges contribute to the problems.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns for the coastal basin and some of the associated bays and estuaries, as illustrated in Figure 3-66.

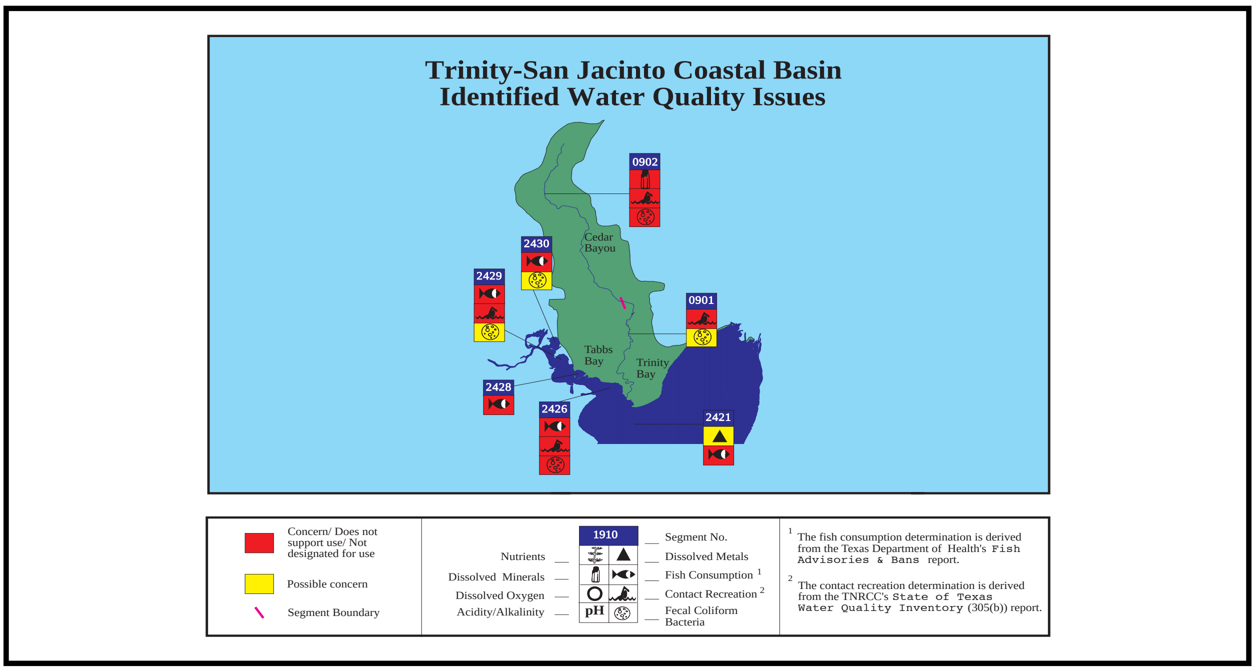

Figure 3-66
Ambient Water Quality Summary for the Trinity-San Jacinto Coastal Basin

Future Water Uses. Total water use in the basin is projected to increase to about 180,000 ac-ft by the year 2050. Manufacturing water use is anticipated to remain the largest water using sector in the basin. Irrigation water requirements are projected to decline slightly over this same period of time. Water savings associated with improvements in municipal and industrial water conservation practices and programs are projected to reduce annual water use by about 17,000 ac-ft by the year 2020, and about 30,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. Future needs of the basin will be supplied by additional use of groundwater and additional imports from the Trinity River Basin. SJRA plans to use 56,000 ac-ft of water per year from the Trinity Basin to meet future needs in the Authority's water service area. The Authority obtained these rights by buying part of the bankrupt Devers Canal system, with financial assistance from TWDB. This will free additional Lake Conroe water to meet future needs of Montgomery County. Other needs in the basin will continue to be met with Lake Livingston water through the Coastal Water Authority (CWA) system.

3.3.2.3 San Jacinto-Brazos Coastal Basin

Basin Description. The San Jacinto-Brazos Coastal Basin is bounded on the north by the San Jacinto River Basin, on the east by Galveston Bay and the Trinity-San Jacinto Coastal Basin, and on the west by the Brazos River Basin. The total drainage area of the San Jacinto-Brazos Coastal Basin is 1,440 square miles, the majority of the area consisting of small, tidally influenced streams draining into Galveston Bay or West Bay. The economy of the coastal basin is based on manufacturing, agriculture, trades, services, commercial shipping and fishing, and tourism. In 1990, the basin population was 705,379 which represents an increase of 168,581 residents above the 1980 population. By the year 2050, the basin population is projected to increase to about 1.874 million residents. Major population centers in the basin and their latest population estimates include all or portions of the cities of Houston (1,741,257), Pasadena (129,483), Galveston (62,947), Missouri City (49,170), Texas City (41,408), League City (40,235), and Deer Park (29,917).

Current Water Uses. In 1990, water used for municipal, industrial, and agricultural purposes totaled about 405,000 acre-feet (ac-ft). The largest water using category in the basin is manufacturing with a current use of about 162,000 ac-ft. Other major water use categories include irrigation and municipal use of about 131,000 and 107,000 ac-ft, respectively.

Current Water Supplies. There are no major surface water reservoirs with conservation (water supply) storage in the basin. The only major water supply available within the basin is groundwater from the Gulf Coast Aquifer with about 70,000 ac-ft per year in current use. All other supplies are imported from the Brazos, Trinity, or the San Jacinto river basins. The Brazos River Authority (BRA) provides water to water suppliers in the basin from reservoirs in the Brazos River Basin. A more thorough discussion of the BRA is provided in the section for the Brazos River Basin. The major suppliers of water from the Brazos River Basin for use in the San Jacinto-Brazos Coastal Basin are Dow Chemical Company, Chocolate Bayou Company, and Galveston County Water Authority which use Brazos River diversions backed-up by water supplies in reservoir storage from the Brazos River Authority. The City of Houston provides treated water to a number of cities in the basin that have or are converting from groundwater to surface water in compliance with the Harris-Galveston Coastal Subsidence District mandate.

Basin Authorities/Districts. There are two main water districts and one authority that manage the water resources of the basin.

Harris-Galveston Coastal Subsidence District. The District manages the amount of groundwater that can be withdrawn within the Harris and Galveston counties' portions of the basin. The district has divided the counties into regulatory areas that have different levels of ground-water usage and different time frames for implementation. Those parts of Harris and Galveston counties that are in the basin are in two different regulatory areas. Most of Galveston County and the eastern part of Harris County are in regulatory area 1 which requires that ground-water withdrawals must comprise no more than 10% of the total water used. The remaining parts of the two counties are in regulatory area 2 which requires that ground-water withdrawals comprise no more that 20% of total water use.

Fort Bend Subsidence District. The District covers all of Fort Bend County and has yet to develop a groundwater-to-surface-water conversion plan. The District coordinates with the Harris-Galveston District, and has hired that district to manage its operations. It is anticipated that the conversion plans for the Fort Bend District will be similar to those of the Harris-Galveston District.

Galveston County Water Authority. The Authority provides water to the industrial complexes and municipalities in Galveston County. It owns two canal systems and the water rights for these systems once owned by Brazos River Authority.

Current Water Quality. According to the TNRCC's 1996 <u>The State of Texas Water Quality Inventory</u>, most of the streams in the basin are heavily urbanized and receive treated domestic and industrial wastewater as well as agricultural and urban runoff. Nutrient levels, especially phosphorus, are consistently elevated in the tidal areas and occasionally elevated in areas above tidal. The elevated nutrient levels directly affect dissolved oxygen and chlorophyll a in both Oyster Creek segments and Armand Bayou. Fecal coliform levels are frequently elevated throughout the basin and cause nonsupport of the contact recreation use.

Due to elevated organic toxic substances in tissue, the Texas Department of Health has issued a fish and shellfish no-consumption advisory for Clear Creek. The former Brio Refinery is the suspected source of the contaminants. Sediments in Clear Creek upstream of tidal and the Old Brazos River Channel tidal segment contain metals in elevated levels.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns for the coastal basin and some of the associated bays and estuaries, as illustrated in Figure 3-67.

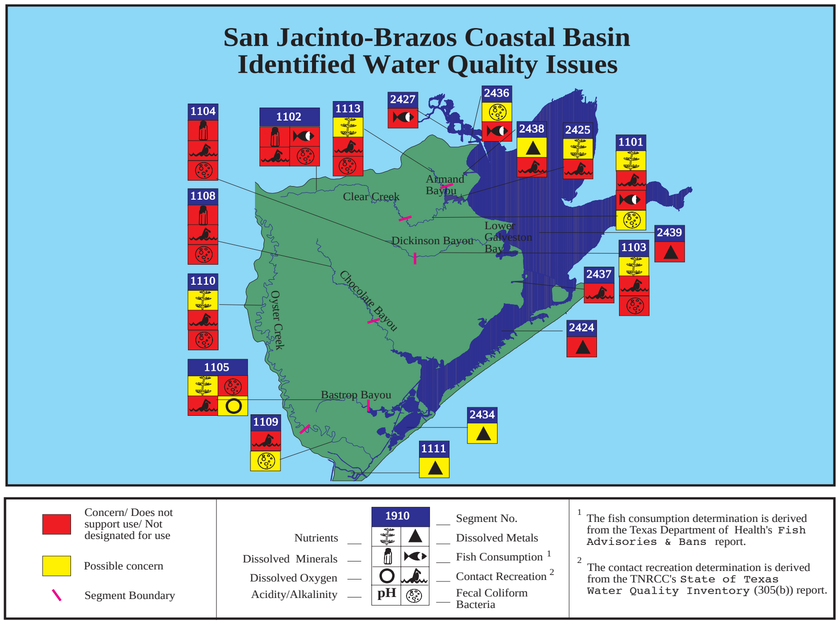

Figure 3-67
Ambient Water Quality Summary for the San Jacinto-Brazos Coastal Basin

Future Water Uses. Total water use in the basin is projected to increase to about 667,000 ac-ft by the year 2050. Municipal water requirements, under dry conditions in the planning assumptions, are anticipated to double over the planning horizon, and municipal water use is expected to become the second largest water use category within the basin. Water savings associated with municipal and manufacturing water conservation practices and programs are projected to reduce annual water use by 68,000 ac-ft by the year 2020 and 133,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. Because of anticipated subsidence problems outside of Harris and Galveston counties, it was assumed that other areas in the basin would approach the subsidence problem in a manner similar to the Harris-Galveston Coastal Subsidence District (HGCSD). Subsidence problem areas were converted to surface water over a 20-year period. The conversion was phased-in similar to the HGCSD conversion, but 10 years later in time. The conversion to surface water will require the development of additional surface water supplies in the Brazos River Basin. The Allens Creek project is recommended to meet these conversion needs (for details on the Allens Creek project, see the section on the Brazos River Basin in this chapter). Additional water conveyance facilities from the Trinity and Sabine river basins will be needed to meet the needs in the Harris County part of the basin.

3.3.2.4 Brazos-Colorado Coastal Basin

Basin Description. The Brazos-Colorado Coastal Basin is bounded on the east by the Brazos River Basin, on the west by the Colorado River Basin, and on the south by the Gulf of Mexico. Total drainage area for the Brazos-Colorado Coastal Basin is 1,850 square miles. The basin economy is based on manufacturing, agriculture, agribusiness, and trades. The basin population increased slightly over the 1980-1990 decade, experiencing an increase of about nine percent. Population of the basin is projected to increase to more than 196,000 residents by the year 2050. Major population centers in the basin and their latest population estimates include all or portions of the cities of Bay City (18,462), Freeport (13,041), Wharton (9,855), West Columbia (4,999), Eagle Lake (3,774), Sweeney (3,457), Brazoria (2,934), Needville (2,788), and Jones Creek (2,171).

Current Water Uses. In 1990, water used for all purposes in the basin totaled 355,460 acre-feet (ac-ft). Irrigated agriculture is the largest water using category in the basin, accounting for more than 89 percent of all water used.

Current Water Supplies. Presently, the basin obtains the majority of its water supply from the Gulf Coast Aquifer. Imports from the Colorado Basin and supplies from creeks and rivers within the coastal basin make up the remainder of the water supplies for the Brazos-Colorado Coastal Basin.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, elevated fecal coliform levels cause nonsupport of the contact recreation use in the tidal portions of the San Bernard River and Caney Creek. Elevated nutrient levels also occur in the San Bernard River and Caney Creek segments.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns for the coastal basin and some of the associated bays and estuaries, as illustrated in Figure 3-68.

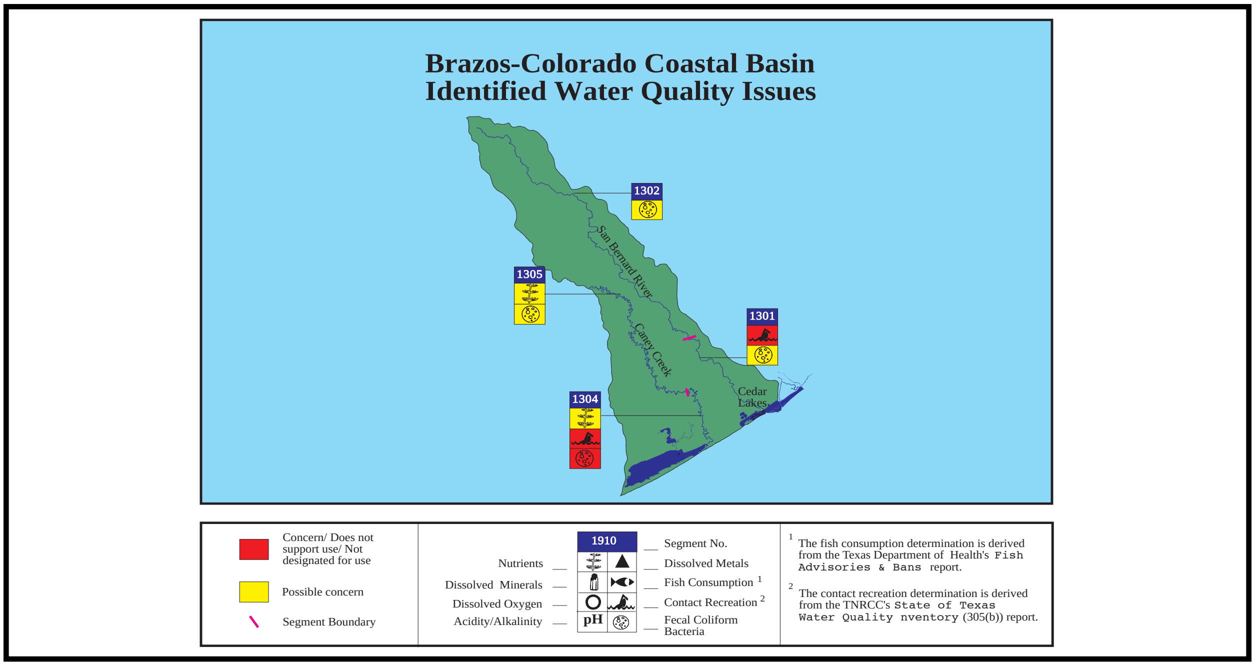

Figure 3-68
Ambient Water Quality Summary for the Brazos-Colorado Coastal Basin

Future Water Uses. Total water use in the basin is projected to decline over the planning horizon with an anticipated annual water use of about 263,000 ac-ft by the year 2050. This anticipated decline reflects an expected decline in water requirements for irrigated agriculture of about 114,000 ac-ft. Annual water savings associated with municipal and manufacturing water conservation practices and programs are projected to reach 7,000 ac-ft by the year 2020 and 13,000 ac-ft by the year 2050 over planning scenarios with no conservation.

Future Water Supplies. It is anticipated that the coastal basin will continue to be supplied by imports from the adjacent Colorado River Basin and that ground-water usage will remain at about its current level.

3.3.2.5 Colorado-Lavaca Coastal Basin

Basin Description. The Colorado-Lavaca Coastal Basin is bounded on the east by the Colorado River Basin and on the west by the Lavaca-Guadalupe Coastal Basin and the Lavaca River Basin. Drainage area for the Colorado-Lavaca Coastal Basin is 939 square miles. Manufacturing, agriculture, retail and wholesale trades, agribusiness, commercial fishing, and tourism are the major sectors of the basin economy. From 1980 to 1990, the basin population declined by about seven percent. The basin population is projected to increase slightly over the planning period with a year 2050 population of about 38,000 residents. Major population centers in the basin and their latest population estimates include all or portions of the cities of El Campo (10,788), Palacios (4,442), and Point Comfort (1,079).

Current Water Uses. In 1990, water used for municipal, industrial, and agricultural purposes within the basin totaled nearly 176,000 acre-feet (ac-ft). Irrigated agriculture is the largest water using category in the basin accounting for nearly 94 percent of all water used in the basin. The fastest growing category is manufacturing water use which increased its annual water requirements threefold over the 1980-1990 period.

Current Water Supplies. Presently, the coastal basin obtains about 86,000 ac-ft of groundwater per year from the Gulf Coast Aquifer. Water supplies also include imports of surface water from the Colorado and Lavaca river basins. Imports from the Colorado River Basin are mostly used for irrigation purposes, while supplies from the Lavaca Basin meet local industrial needs. Water from the Colorado River is also used to maintain the cooling capacity of the South Texas nuclear power facility. Municipal water needs in the coastal basin are met by the Gulf Coast Aquifer. However, the major use of the aquifer is for irrigation. Problems in the basin include over-drafting of the aquifer and concerns regarding bay and estuary freshwater inflow needs.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, Tres Palacios Creek, tidal and above tidal, is experiencing elevated fecal coliform bacteria, high nutrient concentrations, and low dissolved oxygen levels. Elevated fecal coliform levels contribute to nonsupport of the contact recreation use. This basin is primarily affected by agricultural runoff.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns for the coastal basin and some of the associated bays and estuaries, as illustrated in Figure 3-69.

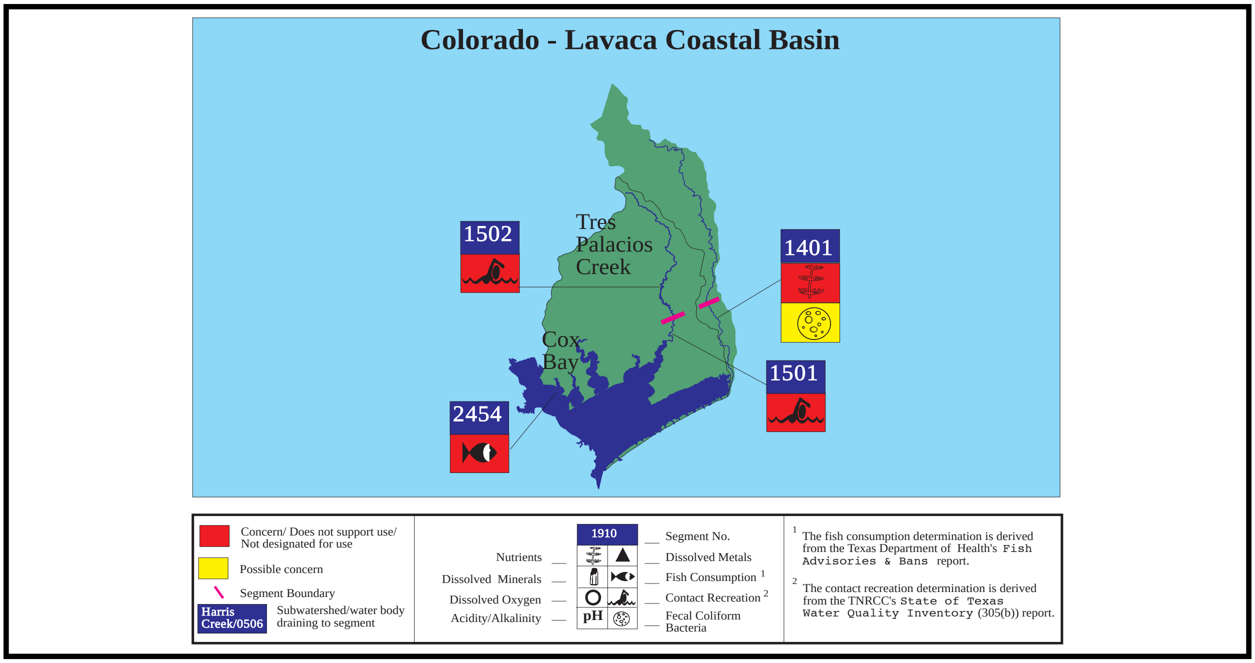

Figure 3-69
Ambient Water Quality Summary for the Colorado-Lavaca Coastal Basin

Future Water Uses. Total water use is projected to decline slightly over the planning horizon with a year 2050 water requirement of about 152,000 ac-ft. A projected decline of about 49,000 ac-ft of water requirements for irrigated agriculture is the primary reason for the anticipated decline in total water use in the basin. Annual savings associated with municipal and manufacturing water conservation practices and programs are projected to reach 5,400 ac-ft by the year 2020, and 7,500 ac-ft by the year 2050 over planning scenarios with no conservation.

Future Water Supplies. Ground-water withdrawals should be reduced to the safe yield of the Gulf Coast Aquifer, providing supplies of about 67,200 ac-ft a year by 2050. Surface water imports from the Colorado River Basin will continue to meet irrigation and industrial cooling needs of the basin. Imports from the Lavaca Basin will increase with the expansion of industrial plants and conversion of some cities to surface water.

3.3.2.6 Lavaca-Guadalupe Coastal Basin

Basin Description. The Lavaca-Guadalupe Coastal Basin is bounded on the east by the Lavaca River Basin and the Colorado-Lavaca Coastal Basin, and on the west by the Guadalupe River Basin and San Antonio-Nueces Coastal Basin. The drainage area of the Lavaca-Guadalupe Coastal Basin is 998 square miles. Agriculture, agribusiness, manufacturing, commercial fishing, and wholesale and retail trade are the predominate sectors of the basin economy. The basin population increased slightly over the 1980-1990 decade with an increase of about three percent. Population of the basin is projected to increase to about 66,000 residents by the year 2050. Major population centers in the basin and their latest population estimates include all or portions of the cities of Victoria (60,942), Port Lavaca (11,553), Bloomington (1,938) and Seadrift (1,485).

Current Water Uses. In 1990, annual water use in the Lavaca-Guadalupe Coastal Basin totaled 87,489 acre-feet (ac-ft). By far, the largest water using category in the basin is irrigated agriculture which accounts for about 70 percent of all water used.

Current Water Supplies. All current Lavaca-Guadalupe Coastal Basin water needs are met from the Gulf Coast Aquifer or with surface water imports from the Guadalupe Basin by the Guadalupe-Blanco River Authority (GBRA). A detailed discussion of the GBRA can be found in the section for the Guadalupe River Basin in this chapter. Port Lavaca and the industrial complex on the Victoria Barge Canal are also supplied by the GBRA.

Current Water Quality. The TNRCC routinely monitors the one segment (Victoria Barge Canal) in this basin, which has no known water quality problems. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, all water quality standards and uses are supported. Phosphorus and chlorophyll a levels are occasionally elevated. At certain times during the year, the canal is very biologically productive, but other parameters do not indicate water quality instability.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns for the coastal basin and some of the associated bays and estuaries, as illustrated in Figure 3-70.

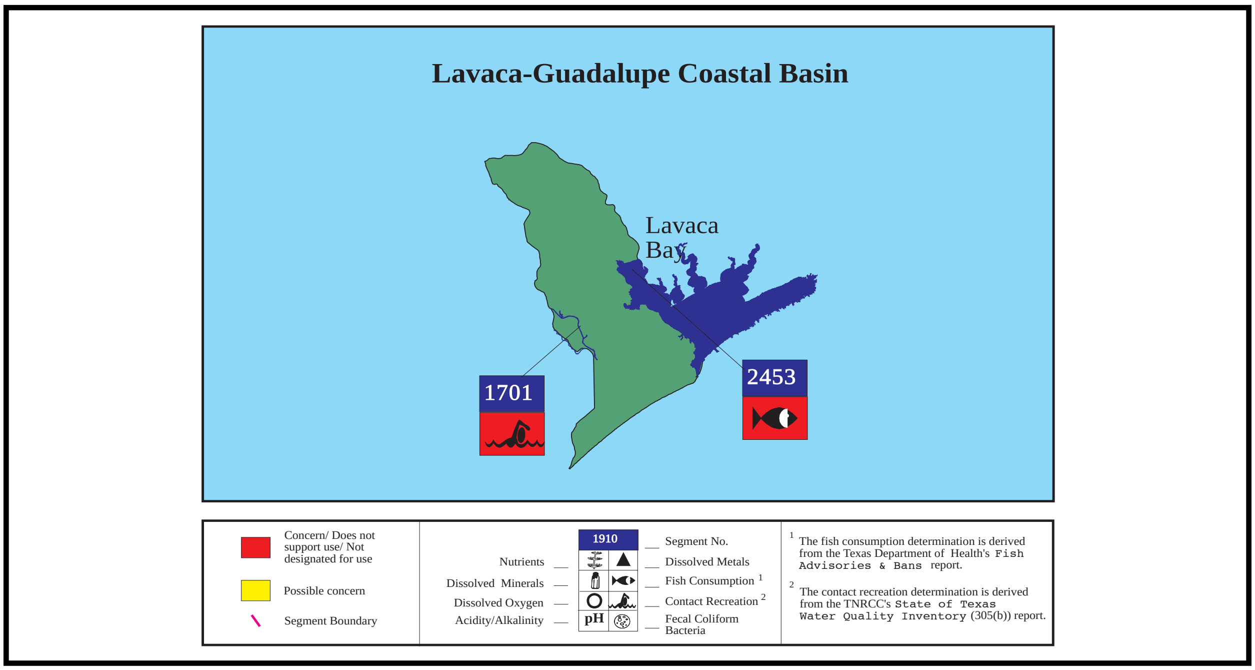

Figure 3-70
Ambient Water Quality Summary for the Lavaca-Guadalupe Coastal Basin

Future Water Uses. Total water use in the basin is projected to increase over the 1990-2050 planning period with an anticipated total water use of about 107,000 ac-ft by the year 2050. Water requirements for irrigated agriculture are expected to decline over this same time frame while manufacturing water requirements are projected to increase. Annual water savings associated with municipal and manufacturing water conservation practices and programs are anticipated to reach 14,000 ac-ft by the year 2020, and nearly 20,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. The basin will continue to be supplied by imports from the GBRA; however, the supplies will likely be from the recommended Sandies Creek Reservoir in the lower Guadalupe Basin instead of from Canyon Lake (for details on the Sandies Creek project, see the Guadalupe River Basin section in the chapter). Groundwater will continue to supply over 20 percent of the needs of the coastal basin.

3.3.2.7 San Antonio-Nueces Coastal Basin

Basin Description. The San Antonio-Nueces Coastal Basin is bounded on the north and east by the San Antonio River Basin and the Lavaca-Guadalupe Coastal Basin, and on the south and west by the Nueces River Basin and the Nueces-Rio Grande Coastal Basin. The drainage area of the San Antonio-Nueces Coastal Basin is 2,652 square miles, and it drains into Copano Bay and Aransas Bay. The economy of the basin is based on agriculture, agribusiness, retail and wholesale trades, mineral production, manufacturing, commercial fishing, and tourism. The basin population increased slightly over the 1980-1990 period with a population of 100,679 residents in 1990. By the year 2050, population of the basin is projected to increase to about 198,000 residents. Major population centers in the basin and their latest population estimates include all or portions of the cities of Beeville (14,077), Portland (13,658), Aransas Pass (7,760), Ingleside (6,915), Sinton (5,828), Rockport (5,923), Refugio (3,083), Taft (3,660), and Odem (2,616).

Current Water Uses. Water used for municipal, industrial, and agricultural purposes in the basin totaled about 29,000 acre-feet (ac-ft) in 1990. The largest water use category is municipal which accounts for about 50 percent of all water used in the basin.

Current Water Supplies. The coastal basin is supplied by groundwater from the Gulf Coast Aquifer and importation of surface water from the Nueces Basin. The major supplier in the basin is San Patricio Municipal Water Authority. The Authority purchases water from the City of Corpus Christi.

Current Water Quality. According to the TNRCC's 1996 <u>The State of Texas Water Quality Inventory</u>, water quality in the Mission River is impaired by elevated levels of fecal coliform, but the river otherwise has good water quality. The Aransas River exhibits good water quality in the tidal stretch, but elevated levels of fecal coliform, chloride, sulfate, and total dissolved solids are common above tidal.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns for the coastal basin and some of the associated bays and estuaries, as illustrated in Figure 3-71.

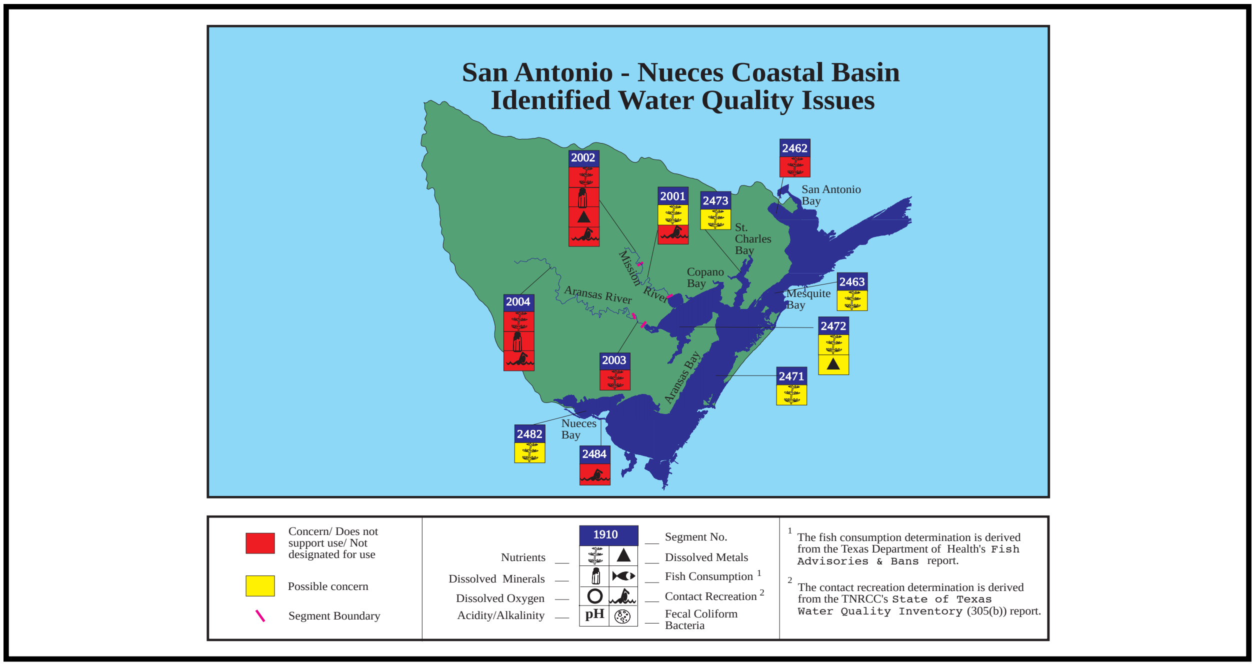

Figure 3-71
Ambient Water Quality Summary for the San Antonio-Nueces Coastal Basin

Future Water Uses. By the year 2050, the total water use in the basin is projected to increase to about 68,000 ac-ft. The impetus for this increase in water use is the projected increase in manufacturing water requirements which indicates that manufacturing will replace municipal water use as the largest water using category in the basin by the year 2020. Water savings associated with municipal and manufacturing water conservation practices and programs are projected to reduce annual water use in the basin by about 8,100 ac-ft by the year 2020 and nearly 16,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. The San Antonio-Nueces Coastal Basin will continue to rely on imports from the Nueces River Basin to provide most of the supplies for the basin. However, additional contractual commitments for future water supplies will need to be secured from the City of Corpus Christi.

3.3.2.8 Nueces-Rio Grande Coastal Basin

Basin Description. The Nueces-Rio Grande Coastal Basin is bounded on the north by the Nueces River Basin and on the west and south by the Rio Grande Basin. The drainage area of the Nueces-Rio Grande Coastal Basin is 10,442 square miles and the area drains to the Laguna Madre Estuary system. There are no perennial streams within the drainage area. The economy of the coastal basin is based on agriculture, agribusiness, manufacturing, retail and wholesale trades, mineral production, commercial shipping, commercial fishing, and tourism. The basin population increased form 853,383 in 1980 to 1.022 million in 1990. By the year 2050, the coastal basin population is projected to increase to about 2.739 million residents. Major population centers of the basin and their latest population estimates include all or portions of the cities of

Corpus Christi (273,620), Brownsville (127,682), McAllen (98,847), Harlingen (53,609), Pharr (39,268), Mission (37,303), Edinburg (35,722), Kingsville (26,383), Weslaco (27,064), and San Benito (22,430).

Current Water Uses. In 1990, annual water use in the Nueces-Rio Grande Coastal Basin totaled about 1.387 million acre-feet (ac-ft). Irrigation water use is the largest category in the coastal basin, accounting for nearly 81 percent of all water used.

Current Water Supplies. The northern part of the coastal basin is supplied water from Lakes Corpus Christi and Choke Canyon in the Nueces River Basin. The southern part of the coastal basin is supplied by lakes Falcon and Amistad in the Rio Grande Basin. Total imports of water into the coastal basin are over 1.1 million ac-ft per year. The Gulf Coast Aquifer provides nearly 50,000 ac-ft of groundwater per year to the basin. Water-related problems in the coastal basin include inadequate wastewater and water facilities in economically distressed areas, flooding, pesticide residue in Arroyo Colorado, and concerns associated with freshwater inflows to bays and estuaries.

Current Water Quality. According to the TNRCC's 1996 The State of Texas Water Quality Inventory, the Arroyo Colorado, the major drainage way in the Lower Rio Grande Valley, receives much of the municipal, industrial, and agricultural wastewater generated in the area. Flow in the Arroyo is sustained by irrigation return flows and municipal wastewater discharges. In the above-tidal segment, which is effluent-dominated, fecal coliform bacteria levels are elevated, preventing attainment of the contact recreation use. In the tidal segment, the aquatic life use is not supported because of depressed dissolved oxygen concentrations. Nutrient and chlorophyll a concentrations exceed screening levels in both segments.

In the above-tidal portion of Petronila Creek, orthophosphorus concentrations are elevated. In addition, chloride, sulfate, and total dissolved solids concentrations exceed segment criteria, as a result of leaching from deposits left by past oil field activity.

Elevated concentrations of various metals and/or pesticides occur in sediment in the Arroyo Colorado above tidal and Petronila Creek above tidal. Pesticide residues derived from agricultural runoff have been a long-standing problem in the Arroyo Colorado.

The Texas Department of Health has issued a restricted-consumption advisory for the Arroyo Colorado above tidal, which recommends that fish consumption be limited to one meal per month due to elevated levels of chlordane, toxaphene, and DDT in fish tissue. The advisory covers portions of Willacy, Cameron, and Hidalgo counties. An aquatic life closure has been issued for Donna Reservoir due to elevated levels of PCBs in fish tissue.

Additionally, the TNRCC's 1996 Clean Rivers Program has summarized water quality concerns and possible water quality concerns for the coastal basin and some of the associated bays and estuaries, as illustrated in Figure 3-72.

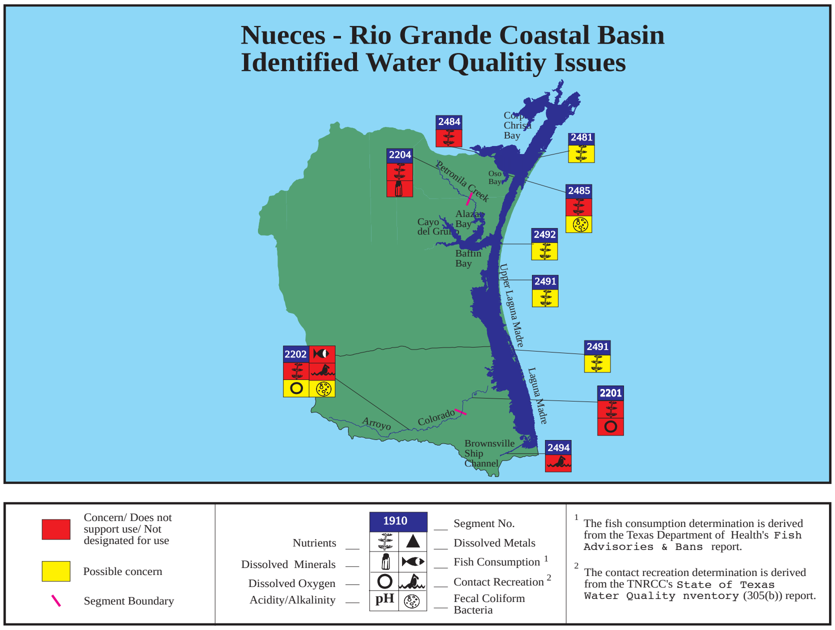

Figure 3-72
Ambient Water Quality Summary for the Nueces-Rio Grande Coastal Basin

Future Water Uses. Total water use in the basin is projected to decline slightly to about 1.339 million ac-ft by the year 2050. Water requirements for irrigated agriculture are projected to decline over the 1990-2050 planning period; however, irrigated agriculture is anticipated to remain the largest water use category in the basin. The expected reduction in irrigation water use is due primarily to assumed voluntary transfers of water within the basin. Annual water savings associated with municipal, manufacturing, and irrigation water conservation practices and programs are projected to reach more than 208,000 ac-ft by the year 2020, and about 349,000 ac-ft by the year 2050. These savings are actually a reduction in increased water use that would occur without conservation practices.

Future Water Supplies. The Nueces-Rio Grande Coastal Basin will continue to rely on imports from the Nueces and Rio Grande basins to meet most of its needs. Imported water supplies will grow to about 1.2 million ac-ft by 2050. This will require the construction of the "Site A" Channel Weir below Brownsville to provide water supplies for Brownsville and Harlingen. The northern part of the coastal basin, including the Corpus Christi area, should develop a water reuse program, although it could provide only limited amounts of additional water due to required freshwater pass-throughs to the estuary from lakes Corpus Christi and Choke Canyon. Given the potential limitation on reuse, questions concerning the reliability of firm yield estimates for Corpus Christi's surface water reservoirs, and required freshwater pass-throughs, additional supplies imported from Lake Texana in the Lavaca River Basin and later deliveries of water from the Colorado Basin are recommended to help meet the future needs of the northern portion of the coastal basin.