Study Report

Traditional Infrastructure Assessment for West Central Texas

Prepared for

Development Corporation of Abilene, Inc.
674 East Highway 80
Abilene, Texas 79601
Attn: Lisa Hughes, Executive Director

Prepared by

Science Applications International Corporation
Technology Led Economic Development Practice
901 D Street, SW, Suite 201
Washington, DC 20024

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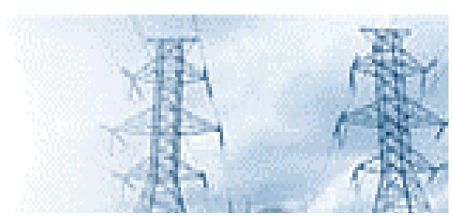

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Traditional Physical Infrastructure

A. Utility, Transportation, and Public Safety Infrastructure Objectives and Methodology

Infrastructure, as used in this study, encompasses all of the physical facilities and systems, services, and service providers (purveyors) needed to ensure the functioning and viability of a community (urban or rural) in terms of its economy, institutions, and the way of life of its citizens. Traditional infrastructure includes utility, transportation, and communications infrastructure and establishes the foundation for the community infrastructure as a whole. Utility services that are particularly critical to any urbanized area or town center include water supply, wastewater collection and treatment, electric power, and fuel energy. Due to their regional and national importance with regard to economic development and community viability, the discussions of water supply and electric power are preceded by introductory text where it is useful to introduce background or explanatory information to facilitate the reader's understanding of the broader context in which the infrastructure resource area is presented and analyzed. Transportation infrastructure includes the transportation facilities and networks including the highway, rail, and air transportation networks that link the urban community with surrounding communities and with distant points. For the purposes of this analysis, the traditional infrastructure assets have been evaluated and described at the level of detail commensurate with their importance to technology-oriented industrial interests, with other infrastructure components discussed at a summary level of detail. Emphasis in the analysis is placed on describing the infrastructure assets of Abilene and Brownwood as these are the largest urbanized areas in the study region and serve as loci for regional economic development. Where appropriate, infrastructure components are further discussed within the context of an appropriate region of influence that encompasses a specific geographic area in which there is some level of interrelationship among the infrastructure components under consideration. In addition, the realm of traditional infrastructure has been expanded for this study to encompass public safety and emergency response infrastructure resources that are particularly critical to urbanized centers especially those serving largely rural areas.

As part of this assessment, basic components of the utility, transportation, and public safety infrastructure associated with each urbanized center and sub-region were identified, evaluated, and assessed as summarized below:

- Utility infrastructure was assessed, described, and evaluated in terms of service area and availability as well as in terms of key performance measures such as available system capacity.
- Transportation infrastructure was evaluated in terms of the attributes of the highway, rail, and air transportation facilities and networks that serve each urbanized area and which link each sub-region.
- Public safety infrastructure was assessed, described, and evaluated in terms of the public safety services provided and the staffing levels of each provider as compared to staffing level benchmarks.

SAIC used publicly available sources of information (e.g., print media, websites) and contacted knowledgeable persons in the organizations responsible for providing utility services and for ensuring public health and safety as part of the data collection effort for assessing traditional infrastructure. In some cases, such as for utility infrastructure data, good engineering estimates were employed to more meaningfully compare the available data and to draw conclusions in terms of the adequacy of infrastructure components to support future development.

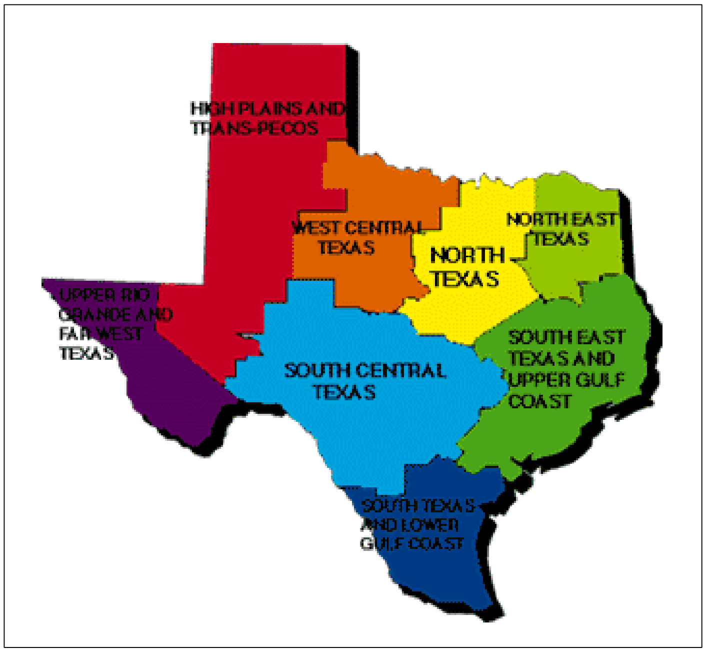
Note: For the analysis of electric power and natural gas, engineering details and locality-specific information such as current energy demands (loads) on and capacities of substations and electric lines, natural gas mains and service lines, and information on the service area routings of electric and natural gas lines could not be obtained from transmission and distribution utilities due to security restrictions and/or due to concerns about releasing information that is considered confidential and not for public release. While this information would have enabled a more thorough analysis, sufficient information was obtainable to enable a sufficiently detailed regional analysis of energy infrastructure in the study region, particularly for electric power.

B. Utility Infrastructure

B.1 Water Supply and Distribution

B.1.1 Background and General Overview

Periodic drought has become the accepted norm in many parts of Texas as well as in the "Big Country" of West Central Texas that approximately comprises the 19 counties in the subject study area's region of influence (**Figure 1**). The western half of West Central Texas roughly corresponds to the Low Rolling Plains region, while the eastern half is known as the North Central region as discussed for regional water planning purposes. Annual average precipitation ranges from less than 20 inches in the far western portion of the study area at Snyder (Scurry County) to about 26 inches at Brownwood (Brown County) (OEDD 2002a, 2002b). Abilene, at the heart of the study area, receives about 23.8 inches of precipitation annually (30-year average) (NWS 2002). Thus, the climate of the study region borders on semiarid, and the region and state as a whole have long recognized the need for long-term water resources planning. Consequently, the Texas State Legislature authorized the formation of the first "fresh water supply districts" in 1919 under the conservation amendment of 1917. These districts and similar entities (e.g., water improvement districts), either created by the legislature or under the Texas Water Code, exist for the purposes of providing and distributing water for domestic and commercial use. The districts, through their governing boards, can issue bonds for improvement projects, establish rates paid by water users, decide the terms on which water can be furnished, and make rules regarding water use and distribution. Revenues are used for operation and maintenance expenses or to help pay debts or interest on bonds. The board also has the power to acquire rights-of-way for the construction of pipelines, levees, sewer systems, bridges, and other structures through private and public land (TSHA 2002). The Texas Commission on Environmental Quality (TCEQ) (formerly the Texas Natural Resource Conservation Commission [TNRCC]) is



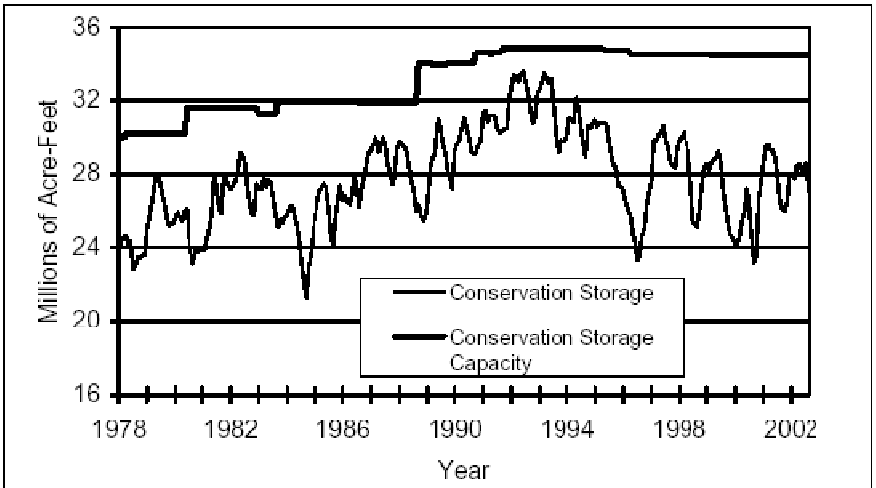
Source: Texas Environmental Center 2002.

Figure 1–West Central Texas.

responsible for the general oversight and regulation of districts, and water supply utilities, to include approval of bond issuance and the creation of new districts in accordance with Title 30 Texas Administrative Code Chapter 293. There are about 1,000 active water districts in Texas under TCEQ jurisdiction. A number of the urbanized centers included in this study are members of such water supply entities, as discussed later.

Following the droughts of the 1950's (corresponding to the State's Dust Bowl era), Texas embarked on statewide water planning. At the end of the drought in 1957, the State Legislature created the Texas Water Development Board (TWDB) and specially mandated statewide water planning culminating in a State Water Plan per Section 16.051 of the Texas Water Code. Following the drought of 1995–1996, the State Legislature passed Senate Bill 1 in 1997 that mandated that water planning be conducted on a regional basis, as directed by TWDB. The overall goal of the initiative was to ensure that long-range water needs would be met even during drought. It also designated groundwater conservation districts as the preferred entity to manage groundwater resources. The current installment of the state plan, *Water For Texas–2002,* is in part comprised of the 16 regional water plans developed and approved as part of the statewide planning process (TWDB 2002a: 4, 13, 17).

There is no amount of water resources planning that adequately substitutes for the lack of normal precipitation. Although not approaching the severity of the drought years of the 1950's, the droughts of 1996 and 1998 and extending to the present have seriously impacted parts of the 19-county study region (see **Figure 2**). Water supplies in the study region and the water supply entities that depend on them have been particularly affected. In parts of greater West Texas, the current period of drought dates back to 1993. These short-term, statewide droughts have produced widespread crop failure and forced over 300 cities and utilities to implement water conservation and management measures including rationing. The 1996 drought had the greater impact on water supplies when statewide reservoir levels dropped to 68% of conservation storage capacity[1], similar to the earlier drought of 1984 (Figure 2). Also, some aquifer levels were appreciably affected as well, including the extensive Edwards aquifer (Edwards-Trinity aquifer system) that underlies parts of the southern portion of the 19-county study region (TWDB 2002b). Abilene has experienced meteorological drought (below normal precipitation) in 6 of the last 10 years (through 2001)



Current data are based on elevation near end of month at 77 reservoirs that represent 98 percent of total conservation storage capacity in Texas reservoirs having a capacity of 5,000 acre-feet or more.

Source: TWDB 2002c.

Figure 2–Conservation Storage Data for Selected Major Texas Reservoirs.

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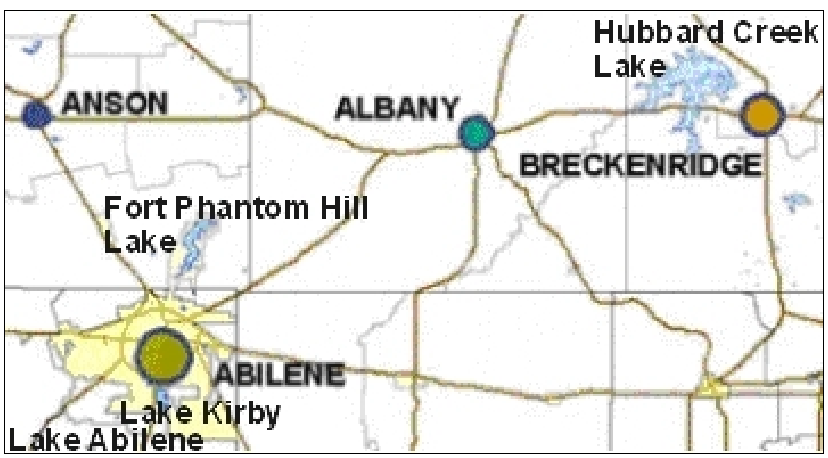
[1] Conservation storage capacity in a reservoir is the space available to store water above the level of invert of lowest outlet works and below the level of top of conservation pool or normal maximum operating level.

including every year during the period 1998–2001 and received only 16.67 inches of precipitation in 1999 (normal 23.8 inches). For comparison, during the drought of the 1950's, precipitation was below normal during the period 1951–1956. In 1956, Abilene recorded only 9.78 inches of precipitation for the year (NWS 2002). As a result of the 1990's period of drought, conservation storage in the nine major reservoirs (i.e., Greenbelt Reservoir, Lake Kemp, Millers Creek Reservoir, Fort Phantom Hill Lake, Lake Stamford, Lake J. B. Thomas, Lake Colorado City, Champion Creek Reservoir, and Hords Creek Lake) in the Low Rolling Plains region currently (September 2002) remains low, collectively averaging about 46% of their total conservation storage capacity. Similarly, the six major lakes and reservoirs farther to the south in the Edwards Plateau region collectively average 43% of their total conservation storage capacity, with E.V. Spence Reservoir and O.H. Ivie Reservoir at 10% and 39%, respectively. In contrast, Lake Brownwood in the southwest portion of the North Central region to the east stands at 86% of its conservation storage capacity with Hubbard Creek Lake, to the north, at 48% (TWDB 2002c). These reservoirs are further discussed within the context of the water supply and distribution infrastructure of the seven urbanized centers in the study area as follows.

B.1.1.1 Abilene Area

The City of Abilene Water Utilities Department is responsible for all water and wastewater operations in the city (wastewater is further discussed in *Wastewater Collection and Treatment* below). Abilene also supplies the nearby municipalities of Tye, Baird, Merkel, Clyde, and Hamlin as well as Eula Water Supply Corporation, Sun Water Supply Corporation, and Steamboat Mountain Water Supply Corporation (VanZandt 2002).

Abilene relies almost exclusively on surface water for its water supply, which is obtained from several reservoirs and lakes (City of Abilene Water Utilities 2002). Through its majority membership in the West Central Texas Municipal Water District (WCTMWD), the district-controlled Hubbard Creek Lake (Reservoir) serves as the city's single-largest water source. This lake is located about 50 miles northeast of Abilene and 5 miles west of Breckenridge, Texas and also serves as the principal water source for the district's three other member cities (Albany, Anson, and Breckenridge) (see **Figure 3**). The lake and the district further serve the water needs of the counties of Jones, Taylor, Shackelford, and Stephens (WCTMWD 2002). Nevertheless, Abilene is authorized to withdraw a daily maximum of 31 million gallons per day (MGD) from Hubbard Creek Lake with an average of about 15.5 MGD. Withdrawals from this lake are coordinated with those from the city's second primary source, Fort Phantom Hill Lake, which is located approximately 15 miles north of Abilene. Abilene is permitted to divert up to 30,690 acre-feet[2] of water annually from this city-owned lake or about 27 million gallons per day (MGD). Fort phantom Hill Lake is supported in part



Source: Modified from WCTMWD 2002.

Figure 3–Abilene Area Water Sources.

[2] One acre-foot of water is equivalent to 325,651 gallons.

by two permitted surface water diversions including one from Deadman Creek and the other from the Clear Fork of the Brazos River. Ultimately, raw water pumped from the two lakes is conveyed via underground pipelines to the city's two main treatment plants (i.e., Northeast Water Treatment Plant and the Grimes Water Treatment Plant). These plants each have a treatment capacity of 23.5 MGD. Abilene is also permitted to withdraw the equivalent of about 1.5 MGD from the city's Lake Abilene, adjacent to Abilene State Park, for municipal use that is treated at the Abilene Treatment Plant. This plant has a capacity of 1.5 MGD. Raw water treatment at each of the city's plants includes coagulation, sedimentation, filtration, and disinfection. A groundwater supply well located in Abilene State Park is used by the city to meet contracted industrial water requirements. Water is also used directly from the city's Lake Kirby for golf course irrigation with permitted usage up to about 1.0 MGD (City of Abilene Water Utilities 2002).

The city has continued to plan for the city's future water supply. Voters approved a referendum in 1985 authorizing the city along with several other municipalities to join the Colorado River Municipal Water District to construct O.H. Ivie Reservoir. The 19,200-acre reservoir is located about 50 miles southeast of Abilene on the southwest border of Coleman County (TPWD 2002). Construction was completed in 1990. Abilene has water rights equal to 16.54% of the safe yield of the reservoir and not to exceed 15,000 acre-feet per year (equivalent to about 13.4 MGD) (City of Abilene Water Utilities 2002). Water from O.H. Ivie is expected to support the city's water needs for the next 20 to 30 years. Meanwhile, the city is looking even longer term at securing future water supplies in conjunction with the WCTMWD by reserving up to 20,000 acre-feet per year of water from Possum Kingdom Lake. The lake, located about 75 miles northeast of Abilene and operated by the Brazos River Authority, could ensure the city's water needs indefinitely. The city plans to use reverse osmosis to treat water from Possum Kingdom lake as it can be three times more saline than water from O.H. Ivie (Segrist 2002a). Construction of the city's raw water delivery pipeline from O.H. Ivie is nearing completion, and construction of the city' associated treatment plant south of the city (off of U.S. Highway 83/84) will be completed in about 8 months. The new treatment plant will have a capacity of up to 8 MGD (VanZandt 2002).

In total, the city's three current treatment plants give Abilene a potable water production capacity of some 48.5 MGD with the new O.H. Ivie treatment plant adding 8 MGD of capacity. Historically, peak daily demands approached 46 MGD under pre-drought conditions and in the absence of water conservation measures. Since water conservation measures have been put into effect, summer peak demands have been in the 30 MGD range (VanZandt 2002). The City council adopted a Water Conservation Plan in July 2002 that calls for year-around water conservation even in the absence of water conservation alerts (City of Abilene Water Utilities 2002). As a result, Abilene's water system will soon have an available water supply capacity ranging from more than 10.5 MGD to as much as 26.5 MGD. On the high end, this surplus could potentially support large industrial demands throughout the city and would be equivalent to the demand of about 177,000 residential users[3]. Information on the largest industrial water user in the city was not available.

Water is distributed via some 900 miles of water main with over 36,000-metered connections and over 17 million gallons of storage (comprised of three ground and six elevated storage tanks). The distribution system is completely looped to ensure reliability, quality, and adequate pressure with mains ranging from 2-inches to 45-inches in diameter. The system is laid out along four pressure planes and includes five pumping stations with pressures averaging 50 pounds per square inch (PSI) but can range from 35 to 100 PSI (City of Abilene Water Utilities 2002; VanZandt 2002). The oldest water mains (dated circa 1929) exist in the older, downtown areas and are constructed of cast iron pipe. Since about 1981, the city has been installing PVC pipe for both water and sewer lines. To date, the city has also replaced about 120

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[3] Assumes residential usage of 150 gallons per person per day. This value reflects extensive use of residential lawn sprinkler systems in West Central Texas. Therefore, this value may be higher or lower than actual usage.

miles of water main with PVC pipe and has an ongoing operation and maintenance program to ensure the reliability of its distribution system. The goal of this program is to replace about 6 miles of cast iron water pipe with PVC annually. Efforts have been focused on the older, downtown areas where the original water mains remain and where the most leaks occur (about 700 annually). At present, there are no areas of the city where the capacity of the distribution system is stressed, but projections for growth in the vicinity of Abilene Regional Airport on the southeast side of the city could be difficult to meet with the current infrastructure that is in place (VanZandt 2002).

The quality of water delivered by the City of Abilene is generally good for most purposes with a total dissolved solids (TDS) concentrations averaging 605 parts per million (ppm) (City of Abilene Water Utilities 2002). Generally, water with a TDS concentration of less than 1,000 ppm is considered fresh, although taste is noticeably affected at concentrations above 500 ppm (the secondary drinking water standard). Higher TDS concentrations can cause problems in some industrial applications such as contributing to excessive scale buildup and corrosion in heating loops and on other metal surfaces.

As part of the city's water conservation effort, the city has adopted an inverted water rate structure whereby users pay higher rates as consumption increases for residential and commercial use. However, for industrial use, the rate is flat at $1.32 per 1,000-gallons plus a charge of $0.65 per 1,000-gallons to cover O.H. Ivie water costs (City of Abilene Water Utilities 2002).

B.1.1.2 Breckenridge Area

As previously mentioned in **Section B.1.1.1** above, the City of Breckenridge is a member of the WCTMWD. As such, the city's and the district's principal water source is Hubbard Creek Lake (see **Figure 3**), which impounds about 317,350 acre-feet of water. Additionally, the city also obtains water from its own 950-acre Lake Daniel, located about 10 miles south of the city (Ernest 2002; TPWD 2002). Water treated and distributed by the city is normally a 50/50 mixture of Hubbard Creek Lake and Lake Daniel water to optimize water quality. However, at present, Lake Daniel is only at 1% of its storage capacity (Ernest 2002). Also as previously discussed, the city through the WCTMWD is working to secure future water supplies via Possum Kingdom Lake. In addition to providing water supply within the city limits, Breckenridge also serves a number of connections outside the municipal limits in Stephens County and also provides water to the Stephens County Rural Water Supply Corporation and to High Mesa Water Company (Latham 2002). Stephens Country Water Supply Corporation is the source of water for most users in Stephens County (Ernest 2002). Groundwater is not a viable water supply source in the area due to salinity.

The city has a dedicated 18-inch, asbestos-concrete pipeline that carries raw water from the WCTMWD. It was constructed in 1962. In addition, the city maintains a 7-mile long pipeline from Lake Daniel that ranges from 20- to 14-inches in diameter. It was constructed in 1975 and has a hydraulic capacity of approximately 2.5 MGD. Breckenridge's water treatment plant is a conventional plant with a daily capacity of 3.1 MGD and was built in 1975. The city's summer average and peak water demands are 1.2 MGD and 1.9 MGD, respectively. The city's distribution system has a hydraulic capacity estimated at 4.7 MGD, which would allow for the city's treatment plant to be expanded (Ernest 2002). Regardless, considering the situation with Lake Daniel, the city has an available water supply capacity of approximately 1.2 MGD. This current surplus could potentially support a small to moderate increase in industrial demand throughout the city and is equivalent to the demand of about 8,000 additional residential users (see **Footnote 3**). The city's largest water user is R.E. Dyes Machine Shop with demands of about 0.010 MGD. Breckenridge has implemented water conservation measures that include alternate-day watering and prohibition on some types of outdoor water use such as washing vehicles (Ernest 2002).

Breckenridge's water distribution system consists of about 75 miles of looped water main with 2,577-metered connections at present. The city's storage capacity is 1.65 million gallons. Service pressures range from 40 to 95 PSI. Water distribution mains range from 2-inches to 30-inches (trunk lines) in diameter and are constructed of various piping materials. The year of construction of the city's water mains range from 1919 to 1994; however, the city does have in place an ongoing replacement/upgrade program for the city's original water mains (Ernest 2002; OEDD 2002c). Newer water distribution infrastructure includes an 8-inch asbestos-concrete water main that serves the Breckenridge Industrial Park. The line has a hydraulic capacity of approximately 1.7 MGD with demands of about 10% of capacity at present (Ernest 2002).

For water service, the City of Breckenridge has adopted an inverted water rate structure whereby users pay higher rates as consumption increases for residential and commercial (and industrial) use. For the first 3,000 gallons, a flat rate of $14.75 for the first 3,000 gallons of metered consumption applies plus an escalating rate that tops out at $2.75 per 1,000-gallons for consumption greater than 22,000 gallons. Special contracted rates are available in special circumstances. For example, the Texas Department of Criminal Justice Facility (Walker Sayle treatment unit) pays a flat rate of $4.60 per 1,000 gallons (Latham 2002).

B.1.1.3 Brownwood Area

The City of Brownwood Utilities Department, within the Department of Public Works, is responsible for all water and wastewater operations in the city. Brownwood obtains treated water from the Brown County Water Improvement District No. 1 (BCWID#1) whose water supply source is Lake Brownwood. The lake is located about 10 miles north of the City of Brownwood and 70 miles southeast of Abilene on the watersheds of Pecan Bayou and Jim Ned Creek (tributaries of the Colorado River). The 7,300-acre lake has a conservation storage capacity of approximately 119,000 acre-feet resulting in a daily safe yield of 24.1 MGD (City of Brownwood UD 2002a; TPWD 2002). Note that the Texas Water Development Board cites the lake's conservation storage capacity as 143,400 acre-feet (TWDB 2002c).

Lake Brownwood serves as the regional water supply source. In addition to providing the City of Brownwood with its entire water supply, the district also provides treated water directly to the City of Bangs, Brookesmith Water Supply Corporation (which serves some 1,300 rural connections) and supplies untreated water to the City of Early adjacent to Brownwood, the City of Santa Anna, Brookesmith Water Supply Corporation (i.e., serving about 870 connections in the Lake Brownwood area), and other users including water for irrigation usage (City of Brownwood UD 2002a). The district indicates that Lake Brownwood will be sufficient to meet the water supply needs of Brownwood and other district customers for the indefinite future. The City of Brownwood, in turn, also provides treated water directly to one other secondary customer (the Zephyr Water Supply Corporation) (Harris 2002).

The city has a dedicated 30-inch HDPE pipeline from the district to the city's distribution system which can deliver more than 13 MGD of treated water to the city (Harris 2002). The district's water treatment plant has a capacity of 18 MGD. Summer average and peak treatment demands on the district plant are about 7 and 9 MGD, respectively. Individually, the City of Brownwood is the largest district customer with average summer demands of 5 MGD and a peak demand of 6.5 MGD. Consequently, the City of Brownwood has an available water supply capacity of 2.5 MGD at present considering both the district's treatment plant capacity and district-wide demands. This current surplus could support a moderate increase in industrial demand throughout the city and is equivalent to the demand of about 17,000 additional residential users[4]. The city's largest water user has historically been Kohler Co. with annual use up to about 81 million gallons (or about 0.22 MGD). With build-out of the Camp Bowie Industrial Park, the city is planning for peak daily demands of up to 13 MGD by the year 2020 and which would require increasing the district's potable water treatment capacity, although peak daily demands to date have been less than forecasted (City of Brownwood UD 1999).

Brownwood's water distribution system consists of about 150 miles of looped water main with 7,396-metered connections at present (City of Brownwood UD 2002a; Harris 2002). The city has three primary storage tanks (i.e., two 1.0 million gallon elevated tanks and one 2.5 million gallon ground tank) providing 4.5 million gallons of water storage. The ground storage tank is located at the Roanoke Site on the eastern side of the city. Two elevated storage tanks include the 3M Tank located off of Highway 377 across from the 3M Manufacturing Plant in the southwest part of Brownwood and the Indian Creek Tank located near the intersection of Indian Creek and Highway 45 in the southeastern part of the city. There is also a 125,000-gallon elevated tank (Walnut Storage Tank) that is located in the northern part of the city on Walnut Street. In addition, the city utilizes one of Brown County's 1.0-million gallon storage tanks. In addition to "high service" pumping facilities operated by BCWID#1, the City of Brownwood operates three booster-pumping facilities, one at the ground storage tank at Roanoke Avenue, one at the airport, and another at the Camp Bowie Industrial Park. The water distribution system currently operates on a single pressure plane (City of Brownwood UD 1999; Harris 2002). Service pressures range from 50 to 90 PSI (OEDD 2002b). Most distribution piping ranges in size from 6-inches to 30-inches, with all piping greater than 18-inches located near the district's storage tanks (City of Brownwood UD 1999). Most distribution piping is 6-inch and 8-inch diameter (Harris 2002).

The oldest parts of the water distribution system are in the downtown area, which encompasses the area between Main Street, the Santa Fe Railroad and Adams Branch of the Pecan Bayou. This area includes Howard Payne University and the Brown County Courthouse. Most of the piping in this area consists of unlined cast iron pipe (dated circa early 1900's) (City of Brownwood UD 1999). Newer water mains have been constructed with a variety of piping materials including HDPE, AC, MOPVC, PVC, and concrete-encased steel, with water main upgrades being completed with PVC on an ongoing basis. For example, a new water distribution system has been completed to support development in the Camp Bowie Industrial Park located in the southwest corner of the city (Harris 2002). Since the early 1990's, the city has embarked on a program to ensure the continuing ability of the city's utility infrastructure to meet future needs and regulatory requirements. This includes an ongoing two-phase water system upgrade program. Highlights of Phase I include: installation of new water storage tanks, rehabilitation of the existing ground storage tank, installation of new pumping facilities, and installation of a new waterline to Brownwood Regional Airport. Phase II projects will include installation of a supervisory control and data acquisition system (SCADA) for operation of the city's water system, replacement of the water lines in the downtown area, replacement of the 3M ground storage tank, and construction of a 24-inch water service main to the Camp Bowie Industrial Park, among other projects (City of Brownwood UD 2002b). Phase I should be complete by December 2003, with extension of the new service water main (consisting of a 10-inch PVC line) to the airport completed by the end of November 2002. This line will have a demand of about 5-10% of capacity when put into service (Harris 2002). Phase II is currently in the planning stages (Harris 2002).

The quality of water delivered by the City of Brownwood is considered good to excellent. The city's annual water quality report indicated a TDS concentration of 524 ppm for 2001 (City of Brownwood UD 2002b). Generally, water with a TDS concentration of less than 1,000 ppm is considered fresh, although

[4] Assumes residential usage of 150 gallons per person per day. This value reflects extensive use of residential lawn sprinkler systems. Therefore, this value may be higher or lower than actual usage. Brownwood has calculated an actual per capita usage rate of about 169 gallons per person per day (City of Brownwood UD1999).

taste is noticeably affected at concentrations above 500 ppm (the secondary drinking water standard). Higher TDS concentrations can cause problems in some industrial applications such as contributing to excessive scale buildup and corrosion in heating loops and on other metal surfaces.

In addition to a monthly meter service fee, the City of Brownwood charges a flat water rate of $1.69 per 100 cubic feet (i.e., about 750 gallons) or equivalent to about $2.70 per 1,000 gallons (City of Brownwood UD 2002a).

B.1.1.4 Eastland Area

The City of Eastland obtains its water supply from the Eastland County Water Supply District whose water supply source is Lake Leon (Eastland County EDC 2002; OEDD 2002d). The 1,590-acre lake is located about 10 east of Eastland (TPWD 2002). Heavy rains in July 2002 reportedly filled the reservoir to capacity (Hoang 2002). In addition to the City of Eastland and Eastland County, the district supplies water to the City of Ranger and other municipalities (Eastland County EDC 2002).

Eastland's water system reportedly has a capacity of 6 MGD with peak water demands of 2.7 MGD. Thus, City of Eastland has an available water supply capacity of approximately 3.3 MGD (Eastland County EDC 2002; OEDD 2002d). This current available capacity could potentially support moderate increases in industrial demand throughout the city and is equivalent to the demand of about 22,000 additional residential users (see **Footnote 3**).

Eastland's water distribution system consists of mains ranging from 4- to 14-inches in diameter and provides pressure up to 90 PSI. The system is only partially looped. The city's storage capacity is approximately 2.7 million gallons (Eastland County EDC 2002; OEDD 2002d).

B.1.1.5 Haskell Area

The City of Haskell obtains treated water from the North Central Texas Municipal Water District whose water supply source is Millers Creek Reservoir (Watson 2002a). The 2,300-acre lake is located about 25 miles northeast of Haskell (TPWD 2002). The lake has a conservation storage capacity of 27,890 acre-feet (TWDB 2002c). The district and Millers Creek Reservoir also supply water to the districts other member cities including Knox City, Munday, and Goree. Groundwater is the primary source of potable water in the rural areas of the county, although the City of Haskell does supply water to some residences just outside the city limits (Watson 2002a).

Haskell receives water from the district via a 25-mile long, 13-inch diameter asbestos-concrete pipeline, which was constructed in 1978 (Watson 2002a). Delivery capacity of the pipeline is estimated at 1.5 MGD. Average daily water demands in the city are 0.5 MGD with peak summer demands in the 0.7 MGD range (Watson 2002a). Thus, the City of Haskell has an available water supply capacity of approximately 0.8 MGD. This current surplus could support a slight increase in industrial demand throughout the city and is equivalent to the demand of about 5,300 additional residential users (see **Footnote 3**). Currently, the Rolling Plains Regional Jail Facility is the city's largest water user. At full capacity, the facility's water demand is estimated at 0.083 MGD (Watson 2002a). Prior to constructing the pipeline, the city maintained its own well field which could provide backup water supply if needed. At present, Haskell does not have any drought restrictions in place (Watson 2002a).

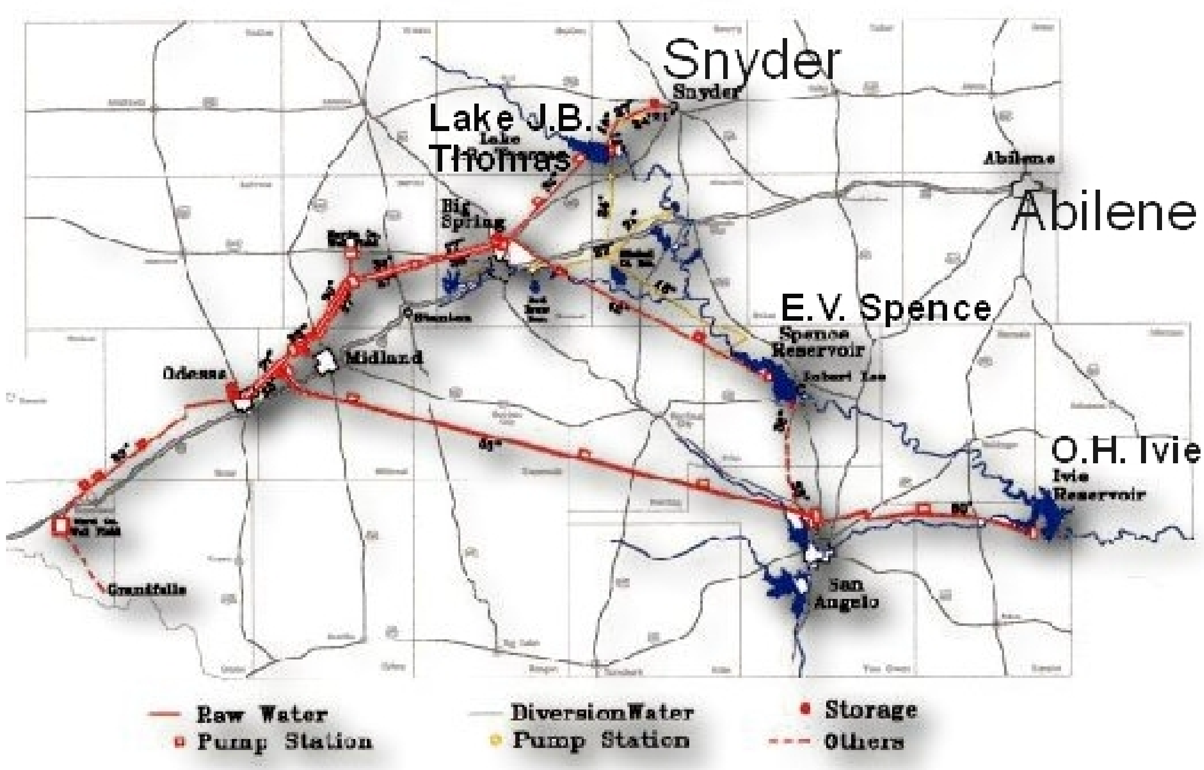
Haskell's water distribution system consists of about 70 miles of mostly looped water main serving some 1,600-metered connections at present. The city's storage capacity is 1.5 million gallons. Service pressures average 50 to 55 PSI. Water distribution mains are mostly 4-, 6-, and 8-inch diameter and constructed of iron pipe (dated circa 1930). New infrastructure includes 8-inch, looped PVC water main constructed in 2001 to supply the jail facility. Although the city does not have an ongoing replacement/upgrade program for the city's original water mains, the city is applying for a Federal grant to replace both its aging water mains and sanitary sewers (Watson 2002a).

For water service, the City of Haskell charges a flat water rate (regardless of use) of $14.15 for the first 3,000 gallons used per month plus a rate of $2.80 per 1,000 gallons thereafter (Watson 2002a).

B.1.1.6 Snyder Area

The City of Snyder obtains raw water from the Colorado River Municipal Water District (CRMWD) of which it is a member city. Other member cities include Odessa and Big Spring. In addition, CRMWD supplies specified quantities on a contract basis to a number of other customer cities in West Texas including Midland, San Angelo, Stanton, Robert Lee, Grandfalls, Pyote, and Abilene (through the West Central Texas Municipal Water District). The district principally relies on three surface water sources for supply including Lake J. B. Thomas, the E. V. Spence Reservoir, and the O. H. Ivie Reservoir (see **Figure 4**). These sources have a potential capacity (when full) of 1.247 million acre-feet. Five well fields are also maintained to supplement surface water deliveries such as during the summer months. CRMWD also diverts and supplies highly mineralized water that would otherwise reach the E. V. Spence Reservoir to a number of oil companies for secondary oil field recovery. The districts transmission assets include more than 600 miles of water pipeline ranging from 18- to 60-inches in diameter and 21 pump stations (CRMWD 2002).

The City of Snyder receives raw water via a 24-inch pipeline that terminates at the city's two treatment plants. The pipeline has a hydraulic capacity estimated at 9 MGD (House 2002a). A CRMWD-owned



Source: Modified from City of Snyder 2002.

Figure 4–CRMWD System Map.

well field consisting of 8 wells located within the Snyder city limits can supplement the city's water supply. It can produce up to 1.2 MGD and is tied directly into the city's distribution system. As a result, this production capacity is supplemental to the capacity of the incoming water delivery pipeline. Snyder's collocated treatment plants include a 4 MGD-capacity plant constructed in 1951 and a 5 MGD-capacity plant constructed in 1997. The latter plant is of modular design allowing its treatment capacity to be doubled if needed (City of Snyder 2002; House 2002a). Snyder's average daily and peak water demands are 3.1 MGD and 7.2 MGD, respectively (House 2002a). Thus, the city has an available water supply capacity of approximately 1.8 MGD. This current surplus could support a slight to moderate increase in industrial demand throughout the city and is equivalent to the demand of about 12,300 additional residential users (see **Footnote 3**). The city's largest water customer is the Texas Department of Criminal Justice facility with a demand of about 0.25 MGD. In addition to serving residents within the city, Snyder provides water to the municipalities of Rotan, Union/Fluvanna, and Ira totaling an average of about 0.47 MGD (House 2002a).

Snyder's water distribution system consists of about 91 miles of looped water main serving some 4,413-metered connections at present. The city's storage capacity is 1.05 million gallons (House 2002a). Service pressures range from 70 to 80 PSI. Water distribution mains are mostly 6- and 8-inch diameter and constructed of cast iron and galvanized steel (dated circa 1960). Chief among the city's newer water supply infrastructure, the city's SnTx Park I industrial park has 12-inch PVC water mains installed in 1994. Otherwise, the city has an ongoing water main replacement program focusing on the city's galvanized and cast iron water mains and replacing them with C900 plastic pipe. Plans are to replace about 40% of the mains with PVC pipe (House 2002a).

The quality of water delivered by the City of Snyder is good to very good compared to other municipalities. Based on 2001 and 2002 monitoring data, the TDS concentration of the city's distribution water averages 365 ppm (House 2002b). Generally, water with a TDS concentration of less than 1,000 ppm is considered fresh, although taste is noticeably affected at concentrations above 500 ppm (the secondary drinking water standard). Higher TDS concentrations can cause problems in some industrial applications such as contributing to excessive scale buildup and corrosion in heating loops and on other metal surfaces.

For water service, the City of Snyder charges a flat water rate (regardless of use) of $10.06 for the first 2000 gallons plus a rate of $2.91 per thousand gallons thereafter (House 2002a).

B.1.1.7 Sweetwater Area

Groundwater currently supplies the City of Sweetwater with nearly 100% of its water supply (Campbell 2002). Historically, the city relied exclusively on city-owned surface water reservoirs. Oak Creek Lake, at 2,375 acres, located approximately 20 miles south of Sweetwater in Coke County was Sweetwater's principal source. The city also obtains water from the 630-acre Lake Sweetwater, located about 5 southeast of the city, and the smaller Lake Trammel located 10 miles south of Sweetwater (Ellsworth 2000; Segrist 2002b; TPWD 2002). Until about the spring of 2001, Lake Sweetwater was supplying the city with about 10% of its needs with groundwater providing the rest. By that time, Oak Creek Reservoir had become unusable due to low volume and poor water quality (Pyburn 2001a). Currently, water levels in Oak Creek Lake, Lake Sweetwater, and Lake Trammel are at 8-, 22-, and 38-percent of their storage capacities, respectively. When usable, however, the transmission pipeline system from the city's reservoirs can supply up to 10 MGD (Campbell 2002).

Sweetwater's well field is currently comprised of 34 municipal supply wells and 14 raw water wells and associated storage and pipeline facilities. The wells tap the Santa Rosa aquifer that is part of the Edwards-Trinity aquifer system (Campbell 2002). The well field initially came online in January 2001

(Pyburn 2001b). The well field is located south of the town of Roscoe and about 10 miles southwest of Sweetwater. Production capacity is about 6 MGD. Water is conveyed via an 18-inch diameter pipeline to the city's water treatment facilities. The city's current plant is a conventional, sedimentation-type treatment facility with a capacity of 7 MGD (SEED 2002). The city is currently building a new state-of-the-art ultrafiltration water treatment facility with construction to be completed in about 14 months (in late 2003). The facility will have a capacity of 8 MGD (Campbell 2002). The original plant was reportedly constructed circa 1920's (Pyburn 2002a). Nevertheless, Sweetwater's average daily and peak water demands are currently about 3.0 MGD and 6.0 MGD, respectively (Campbell 2002). However, since the city instituted water restrictions, the city has been able to reduce its average daily demand during the summer months from 5 MGD to about 3 MGD (Pyburn 2001b). Nevertheless, factoring in unexpected peaks and discounting the reliability of surface water at present, the city has little firm water supply surplus at present. The city's largest water customer is TXU's Sweetwater generating station with a demand of about 0.35 MGD (Campbell 2002). In addition to serving residents within the city, the city provides water to the municipalities of Roby and Trent totaling an average of about 0.267 MGD. The city also is the source of water for most users outside the city in Nolan and Fisher counties (Campbell 2002).

Sweetwater's water distribution system consists of about 185 miles of mostly looped water main including raw water piping serving 4,779-metered connections at present. The city's storage capacity is 3.73 million gallons. Service pressures average 60 PSI. Water distribution mains are mostly 2-inch and 6-inch diameter ductile iron pipe (dated circa 1920's) (OEDD 2002e; Campbell 2002). All industrial parcels in the city have access to 10-inch water main or larger (SEED 2002). The city embarked on a program in early 2002 with a grant from the Texas Community Development program to replace the city's oldest water mains (Pyburn 2002b). The city's goal is to replace about 3,000 linear feet of 6-inch main and 8,000-feet of 2-inch main annually with C900 plastic pipe (Campbell 2002).

The quality of groundwater delivered by the City of Sweetwater is considered excellent. In 2002, the city's groundwater was ranked the best for cities with more than 10,000 people by the Central West Texas Region of the Texas Water Utilities Association (Pyburn 2002a). The TDS concentration of the city's groundwater averages 232 ppm, while the combined TDS concentration from the city's three surface water sources averages 900 ppm (Campbell 2002). Generally, water with a TDS concentration of less than 1,000 ppm is considered fresh, although taste is noticeably affected at concentrations above 500 ppm (the secondary drinking water standard). Higher TDS concentrations can cause problems in some industrial applications such as contributing to excessive scale buildup and corrosion in heating loops and on other metal surfaces.

For water service, the City of Sweetwater charges a flat water rate (regardless of use) of $32.29 for the first 2,000 gallons. For 3,000 to 25,000 gallons of consumption, the rate is $3.70 per 1,000 gallons. For consumption above 26,000 gallons, the rate is $3.98 per 1,000 gallons. The rates reflect a 5% increase as of October 1, 2002 (City of Sweetwater Water Department 2002).

B.1.1.8 Study Region Summary Conclusions for Water Supply

Water supply planning on a broad geographic basis and through regional initiatives such as districts or by investing in municipal-owned reservoir systems has long been practiced and provided communities with a hedge on drought to ensure a dependable water supply. Further, the availability of a dependable water supply (in terms of quantity and quality) even in drought has also been recognized as an essential component to economic development within the region in terms of new business recruitment and to maintain the viability of its urbanized centers. In general, the urbanized areas in the study region have been proactive in investing in the necessary water supply and distribution infrastructure essential to their well being. The cities of Abilene and Brownwood stand out with regard to having modern infrastructure in place, with Snyder and Sweetwater also having taken proactive steps to modernize their water supply infrastructure and to ensure future supply. Generally, the seven urbanized areas currently have adequate water supplies and the necessary delivery infrastructure to reliably meet current needs and to provide for at least some service expansion with the exception of Sweetwater. Nevertheless, the recent droughts have had the effect of forcing some municipalities, including some within the18 county study region (notably Sweetwater), to invest heavily to develop new, non-traditional water sources to meet current and potential future water demands.

The bounding-case benchmark for assessing traditional infrastructure capacity relative to high-technology manufacturing is semiconductor manufacturing. Water supply is a critical siting parameter. A large semiconductor manufacturing plant can require up to 6.7 MGD of water (PPRC 2000). Even from potable sources that are high quality to begin with, a large portion of this demand must be further treated before being used in the semiconductor manufacturing process in order to approach the purity of deionized water. For example, Samsung's Austin, Texas semiconductor plant has been heralded for its efforts to conserve up to 450 million gallons of water per year, but still requires more than 3 MGD (Samsung 2002). In fact, only Abilene would realistically have the available source and production (treatment) capacity to reliably meet such a demand, but would still likely require the development of the necessary delivery (distribution) infrastructure to the point of use. Still, such a large user would tax water supply infrastructure and would be expected to increase the urgency to secure additional water supplies for the future. Other high-technology industries such as a prospective biotech research and development (R&D) or an information technology (IT) services or infrastructure company would not be expected to have a large water demand above that required to meet the sanitary needs of their respective workforce. A general range for this demand is approximately 25 to 50 gallons per person per day. Other building specific uses would include makeup water for heating, ventilation, and air conditioning (HVAC) systems (e.g., boilers and chillers), charging of sprinkler systems, landscape irrigation, etc. Some biotech interests may require additional water for processes that require washing of equipment or substrates as part of manufacturing activities.

B.2 Wastewater Management

B.2.1 Abilene Area

Sanitary wastewater (sewage) from within the Abilene city limits and from the City of Tye is collected by the city's sanitary sewer system consisting of approximately 650 miles of sewer line (City of Abilene Water Utilities 2002; VanZandt 2002). Sanitary sewer lines were originally constructed of cast iron (dated circa 1929) and, like Abilene's water distribution system discussed previously, construction since 1981 has been with PVC pipe. As part of the city's sanitary sewer rehabilitation and upgrade project, about 40 miles of the city's original pipe have been replaced with PVC while another 10 miles of pipe have been rehabilitated through a fiberglass relining process. The city's goal is to replace/reline about 4 miles of sewer line annually (VanZandt 2002).

Sanitary wastewater collected by the sewer system is conveyed via gravity-flow and with the help of 10 lift stations to the city's Buck Creek Pump Station (City of Abilene Water Utilities 2002). The station is located just on the northeast side of the city on East Lake Road. The station has a rated pumping capacity of 24 MGD, although the city has recently issued contracts to upgrade the station's currently rated pumping capacity to 32 MGD (Chaney 2002). This facility also has an emergency storage basin with a capacity of 23 million gallons. From the station, wastewater is pumped approximately 7 miles northeast to the Abilene Water Reclamation Plant (Hamby Treatment Plant) that is located just outside the town of Hamby. The facility currently has a permitted treatment capacity of 18 MGD with a hydraulic capacity of about 22 MGD based on an expansion performed in 1994-1995. The city is therefore trying to obtain a discharge modification from TCEQ for 22 MGD. Currently, the facility treats an average daily flow of about 11.5 MGD with a daily peak flow of about 14 MGD. These demands have been the norm since drought restrictions were imposed. Previously, the daily peak treatment demand was 15.9 MGD (Chaney 2002). This gives the city an available treatment capacity of approximately 4 MGD at present, which is equivalent to the demand of about 80,000 new during residential users or about 160,000 additional employees[5].

The wastewater treatment plant is an activated sludge plant and includes final effluent disinfection and disinfectant removal (City of Abilene Water Utilities 2002). To protect the treatment process and final effluent quality, the city has an Industrial Pre-Treatment program that requires industrial users to pretreat their wastewater before it can enter the city's sanitary sewer system (City of Abilene Water Utilities 2002). Treated effluent is discharged to Freewater Creek which leads to Deadman Creek and in accordance with a TCEQ Texas Pollutant Discharge Elimination System (TPDES) permit (Chaney 2002).

The city's storm sewer system is separate from the sanitary sewer system (Chaney 2002). The storm sewer system is primarily a surface, open channel system, rather than an underground system, consisting of about 67 miles of creeks and other open channel drainages with storm runoff conveyed by the city's curb and gutter system. The city maintains 15 storm water detention ponds to capture street runoff (Abila 2002).

B.2.2 Breckenridge Area

Sanitary wastewater is collected by the city's sanitary sewer system consisting of approximately 65 miles of sewer line. The sanitary sewer system consists of various piping materials with segments ranging in age from 1929 to 1994. Breckenridge's industrial park is specifically served by an 8-inch clay pipe and PVC pipe sanitary sewer system (Ernest 2002).

Sanitary wastewater collected by the sewer system is conveyed to the city's wastewater treatment facility generally via gravity flow, although the system does have four lift stations that are emergency powered. The city's wastewater treatment plant is an aeration-circulation (oxidation ditch) plant that was last upgraded in 1995. It has a permitted capacity of 0.95 MGD with a peak treatment demand of 0.6 MGD (Ernest 2002; OEDD 2002c). Consequently, the facility has an available treatment capacity of about 0.3 MGD at present, which is equivalent to the demand of about 6,000 new during residential users or about 12,000 additional employees (see **Footnote 5**).

Treated effluent is discharged to Gonzales Creek in accordance with a TCEQ TPDES permit. The city's storm sewer system is minimal with only a few inlets in the downtown area. Instead, street curbing and gutters carry drainage that is ultimately conveyed by overland flow to surface drainages (Ernest 2002).

B.2.3 Brownwood Area

Sanitary wastewater from within Brownwood's city limits and from the City of Early is collected by the city's sanitary sewer system consisting of approximately 110 miles of sewer line. The system serves 7,333 connections at present (Harris 2002). Like the city's water distribution system, the City of Brownwood has an ongoing program to upgrade the sanitary sewer system as part of the downtown master plan project and other initiatives such as the Camp Bowie Industrial Park project.

[5] Assumes residential sanitary wastewater generation rate of 50 gallons per person per day and a conservative rate of 25 gallons per person per day for a workforce.

Sanitary wastewater collected by the sewer system is conveyed to the Brownwood Wastewater Treatment Plant via a series of lift stations. The plant is located at 3400 Hanover Street in the southern part of the city (City of Brownwood UD 2002a). It is a modern, activated sludge treatment plant constructed in the fall of 1993. The facility currently has a permitted treatment capacity of 4.54 MGD with total average treatment demands of 2.3 MGD and peak demands of 3.0 MGD. Wastewater collected from the City of Early contributes an average flow of 0.12 MGD with a peak of about 0.25 MGD to the plant (Harris 2002). Thus, the facility has an available treatment capacity at peak demand of approximately 1.5 MGD at present, which is equivalent to the demand of about 30,000 new during residential users or about 60,000 additional employees (see **Footnote 5**).

Brownwood has an Industrial Pretreatment Ordinance to protect the treatment process and final effluent quality (City of Brownwood UD 2002a). Treated effluent is discharged to Willis Creek in the southern part of the city in accordance with a TCEQ TPDES permit (Harris 2002).

A separate storm sewer system consisting of a combination of storm sewers and open channels totaling about 50 miles exists to convey street drainage and general storm water runoff (Harris 2002). A major flood control project was completed in 1993 after damaging floods occurred in 1990 and 1991. The $5.2 million Federally funded project involved the widening and channelization of Adams Creek that runs for about 4 miles through the northern portion of the city, including the downtown area. The project is credited with reducing flooding in the city after heavy rains in July of 2002 (Ellsworth 2002a). The project was identified as part of the last comprehensive plan update in 1990 (Freese and Nichols undated). The city is also considering a second, similar project for Willis Creek in the southern part of the city that would be partly paid for by the U.S. Army Corps of Engineers (Ellsworth 2002a).

B.2.4 Eastland Area

Sanitary wastewater collected by the city's sewer system is conveyed to the city's wastewater treatment facility. The city's treatment plant is an oxidation-type plant with a permitted capacity of 1.0 MGD. Peak treatment demand is reportedly 0.47 MGD (Eastland County EDC 2002; OEDD 2002d). Consequently, the facility has an available treatment capacity of about 0.5 MGD at present, which is equivalent to the demand of about 10,000 new during residential users or about 20,000 additional employees (see **Footnote 5**). No other specific information is available.

B.2.5 Haskell Area

Sanitary wastewater is collected by the city's sanitary sewer system consisting of approximately 35 miles of sewer line. The sanitary sewer system primarily consists of clay pipe with most sewers in the 4 to 6-inch size range and of the same vintage as the city's water mains. As previously mentioned, the city is planning to embark on a sanitary sewer replacement/upgrade project with the assistance of a Federal grant.

Sanitary wastewater collected by the sewer system is conveyed to the city's wastewater treatment facility via gravity flow. The city's treatment plant is a race track/oxidation ditch system with a permitted capacity of 0.75 MGD. However, the system has a hydraulic capacity of 1.0 MGD (Watson 2002a; DCOH 2002). Average daily and peak treatment demands are approximately 0.43 MGD and 0.57 MGD, respectively (Watson 2002a). Consequently, the facility has an available treatment capacity of about 0.2 MGD at present, which is equivalent to the demand of about 4,000 new residential users or about 8,000 additional employees (see **Footnote 5**).

Treated effluent is discharged to Bryce Springs Creek, which flows to Lake Stamford, in accordance with a TCEQ TPDES permit. The City of Haskell does not have a sanitary sewer industrial user ordinance or a storm sewer system (Watson 2002a).

B.2.6 Snyder Area

Sanitary wastewater is collected by the city's sanitary sewer system consisting of approximately 87 miles of sewer line that serves 4,094 connections. The sanitary sewer system primarily consists of clay pipe and of the same vintage as the city's water mains. Currently, the city does not have a sanitary sewer replacement/upgrade project in place. However, the city's industrial park (SynTx Park 1) has a new sanitary sewer collection system constructed of 12-inch PVC pipe (House 2002a).

Sanitary wastewater collected by the sewer system is conveyed to the city's wastewater treatment facility with the assistance of four lift stations equipped with emergency backup power (House 2002a). Snyder's treatment plant is a modern, activated sludge facility that operates in extended air mode and is equipped with an ultraviolet disinfection system. It was constructed in 1992. The facility has a permitted capacity of 2.3 MGD and is of modular construction permitting its hydraulic capacity to be doubled. Average daily and peak treatment demands are approximately 1.1 MGD and 1.89 MGD, respectively (City of Snyder 2002; House 2002a). Consequently, the facility has an available treatment capacity of about 0.4 MGD at present, which is equivalent to the demand of about 8,000 new residential users or about 16,000 additional employees (see **Footnote 5**).

Treated effluent can either be discharged to a receiving stream or to a public golf course and other public property within the city limits for irrigation in accordance with a TCEQ TPDES permit. The city has an industrial waste ordinance in place that applies standards to industrial effluents disposed of via the city's sewer system. The city's storm sewer system consists of about 2 miles of storm sewer (City of Snyder 2002; House 2002a).

B.2.7 Sweetwater Area

Sanitary wastewater is collected by the city's sanitary sewer system consisting of approximately 116 miles of sewer line consisting mostly of clay pipe. Currently, the city does not have a sanitary sewer replacement/upgrade project in place (Campbell 2002).

Sanitary wastewater collected by the sewer system is conveyed to the city's wastewater treatment facility with the assistance of two lift stations (Campbell 2002). Sweetwater is currently bringing online a new wastewater treatment plant as a replacement to its aging activated sludge plant. The new plant is a $6-million extended aeration facility (Campbell 2002; Pyburn 2001a). The new facility has a permitted capacity of 2.2 MGD. Current treatment demands are approximately 1.2 MGD (Campbell 2002). Consequently, the facility has an available treatment capacity of about 1.0 MGD at present, which is equivalent to the demand of about 20,000 new during residential users or about 40,000 additional employees (see **Footnote 5**).

Treated effluent is discharged to a city-owned farm in accordance with a TCEQ TPDES permit. Storm water is conveyed through a separate storm sewer system (Campbell 2002).

B.3 Study Region Summary Conclusions for Wastewater Management

Wastewater treatment is generally not seen as a limiting economic development factor in the urbanized centers studied. All have adequate wastewater collection and treatment infrastructure at present with several cities having recently made investments in their wastewater infrastructure and/or have ongoing wastewater upgrade projects (i.e., Abilene, Brownwood, Snyder, Sweetwater). As discussed for water supply under **Section B.1.1.8**, neither a prospective R&D biotech nor an IT company would be expected to generate large quantities of wastewater with the volume generally equivalent to the water demand required to meet the sanitary needs of the respective facility's workforce. However, some biotech manufacturing facilities or high-technology manufacturing (e.g., semiconductor manufacturing) facilities may have additional manufacturing-related water demands and may generate relatively large volumes of industrial wastewater potentially requiring pretreatment or monitoring for compliance with a city's sanitary sewer significant industrial user provisions, as applicable. Nonetheless, the treated wastewater could potentially be used for irrigation purposes ("greywater" irrigation) or put to other beneficial use.

C. Electric Power and Natural Gas

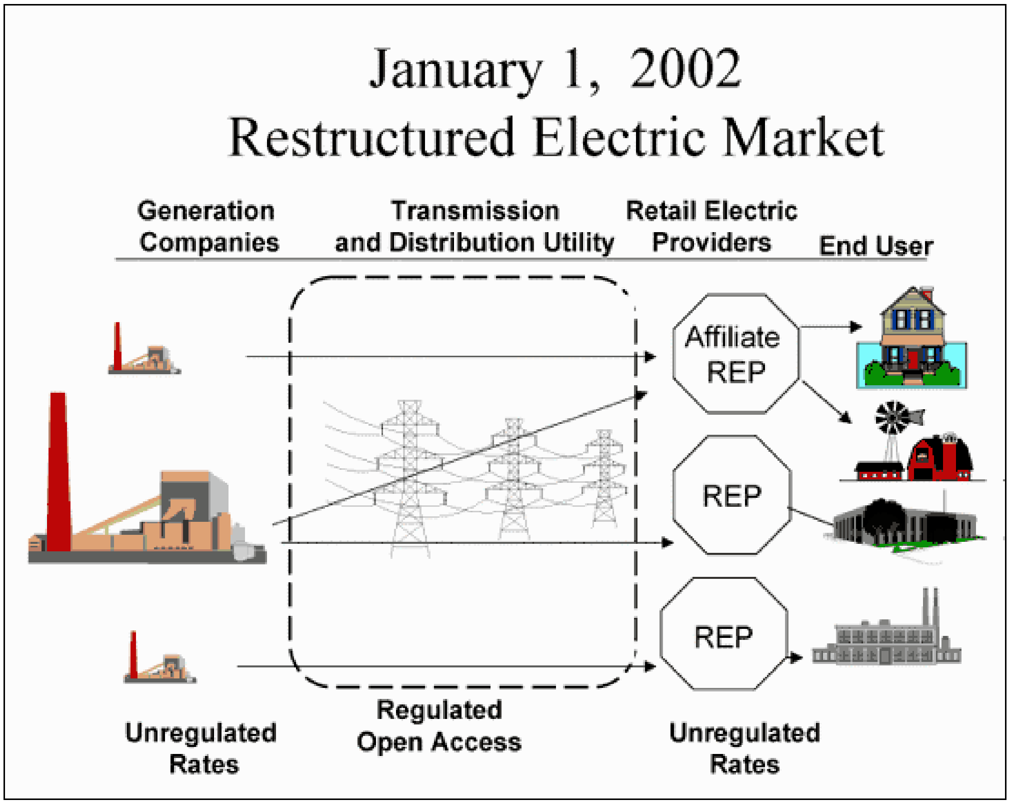
C.1 Background and General Overview

The new era of electric utility deregulation or "restructuring" in the United States followed passage of the federal Energy Policy Act (EPACT) of 1992 by Congress to encourage wholesale electric power competition across the country. Earlier, the Public Utility Regulatory Policies Act (PURPA) of 1978 (see 18 Code of Federal Regulations Part 292.201 et seq.) also laid much of the groundwork for energy deregulation in the country, and has had a major effect on Texas' energy utilities. This is because PURPA, for the first time, enabled non-utility (private) companies to own and operate electric generating plants (i.e., independent power producers [IPPs]) and specifically promoted renewable energy and cogeneration energy production.

Nevertheless, EPACT provided the Federal Energy Regulatory Commission (FERC) with added authority to act to ensure competition in the industry. However, even before formal electric industry deregulation actions, FERC was actively restructuring the natural gas industry to stimulate competition. For example, FERC Order 636, issued April 9, 1992, required pipeline companies to open access to capacity to any and all transporters and to "unbundle" transportation services so as to allow customers to select supply and transportation services from any competitor in whatever quantity and combination so desired. This set a precedent for FERC to follow with regard to electric restructuring. Following passage of EPACT, FERC Orders 888 and 889, in part, required utilities to separate electric power trading and transmission operations (DOE 2002a: 6.3, 6.4, 6.8).

The State of Texas has not taken legislative action to restructure the natural gas industry but is pursuing legislation. However, thanks to previous FERC action, unbundled gas service is available for large commercial and industrial customers in all states, including Texas (PNNL 2002a). However, retail competition in the sale of electricity began in Texas on January 1, 2002 following the signing of Senate Bill 7 into law by Gov. George W. Bush on June 18, 1999. Briefly, the new law is designed to give customers greater control and is intended to lower the price of electricity over time by allowing market forces to work where possible (PUCT 2002a). The law required each investor-owned utility under the jurisdiction of the Electric Reliability Council of Texas (ERCOT) to file a business separation plan with the PUCT by January 10, 2000 and, by January 1, 2002, to separate into three separate functions: power generation; transmission and distribution (electric power delivery); and retail electric provider (REP) services (sales), as illustrated in **Figure 5**. Each function must hereafter be operated as a separate company (PNNL 2002b; PUCT 2002a). This latter aspect is unique to Texas' restructuring program.

The most notable and immediate change in the deregulated market is that most customers of investor-owned electric utilities have the right to choose among competing REPs to sell them electricity. Included are customers of TXU Electric (Oncor) and American Electric Power–West Texas Utilities (AEP-WTU) that have service areas within the 19-county study region. Customers who did not choose a new REP were automatically transferred to their utility's "affiliated" REP (i.e., a separate affiliate of the former



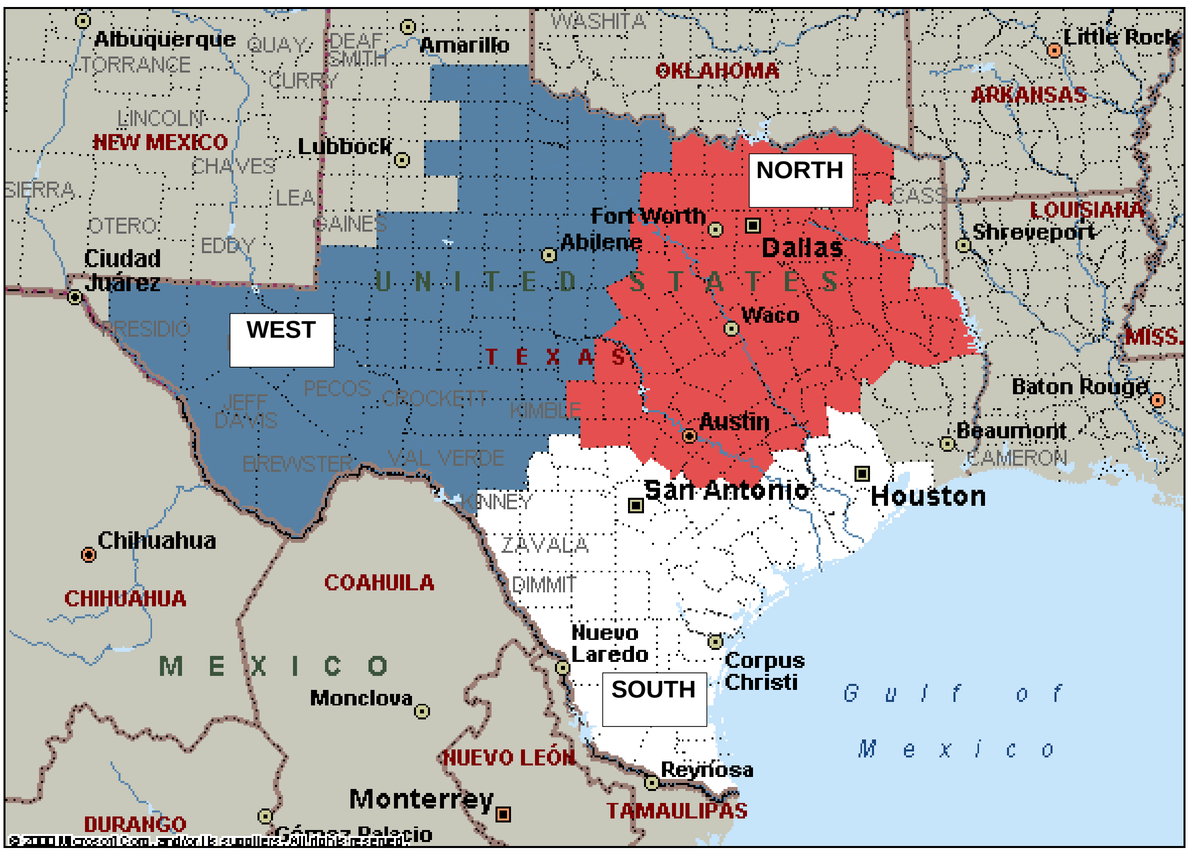
Source: PUCT 2002a.

Figure 5–Electric Market Restructuring in Texas.

bundled electric utility). All REPs must obtain certificates from the PUCT to participate in Texas' deregulated market (PUCT 2002a). Senate Bill 7 mandated a three-year rate freeze that ended on January 1, 2002. It also required utilities to enact an automatic rate discount of 6% for residential and small commercial customers. This is the utility's bundled rate that is 6% less than its affiliated transmission and distribution utility rates for its residential and small commercial customers. This rate is called the "price to beat" and will be maintained for three years or until 40% of an area's consumption is provided by more than one electric utility. There is no prescribed discount for large commercial and industrial customers (PNNL 2002b). Consumers who choose their former utility's affiliate REP, rather than selecting another REP, will pay for electricity at the regulated "price to beat" but can still choose another REP at any time (PUCT 2002a). As for pricing considerations, the residential prices to beat of affiliate REPs (e.g., WTU Retail Energy, the affiliate REP of AEP-WTU) range from $0.0599 to $0.0888 per kilowatt-hour (kWh) (PUCT 2002b).

In general, REPs buy wholesale energy from competing power generation companies and pay a fee to the local transmission and distribution company to deliver the power to retail customers. The local transmission and distribution ("wires") company, an affiliate of the former bundled electric utility, continues to be regulated by the Public Utility Commission of Texas (PUCT) with the company remaining responsible for service reliability (e.g., outages) and for maintaining distribution infrastructure (e.g., poles, wires, service connections). Metering services for residential customers will continue to be provided by the local wires company until the later of September 1, 2005, or the date on which at least 40 percent of those residential customers have chosen competitive REPs. For commercial and industrial customers, metering services are scheduled to go competitive beginning on January 1, 2004 (PUCT 2002a).

While the state's 76 member-owned electric cooperatives (“co-ops”) and 85 municipally-owned utilities participate in the competitive wholesale market, they are not required by Senate Bill 7 to open their systems to retail competition but can choose to open their service areas to competition (PUCT 2002a). Within this restructured framework, the PUCT, which traditionally approved electric rates that utilities could charge, is responsible for implementing a competitive retail market, providing adequate protections for customers, and for overseeing ERCOT (PUCT 2002a). ERCOT is an independent, not-for-profit organization responsible for ensuring the reliability and security of electric power transmission across most of Texas’ interconnected power grid, which encompasses the entire 19-county study region (see **Figure 6**). ERCOT is also responsible for overseeing transactions related to the State’s restructured electric power market including power scheduling and troubleshooting. ERCOT comprises one of the 10 electric reliability regions in North America (part of the North American Electric Reliability Council [NERC]) with the ERCOT region comprising about 85% of the electric load in Texas. Further, ERCOT is the only reliability region in North America that is located completely within the borders of a single state, and it is one of two reliability regions that is also an Independent System Operator (ISO) (ERCOT 2002a).



Source: ERCOT 2002b: 27.

Figure 6–ERCOT Electric Reliability Region and Planning Area Regions.

C.2 Study Region Analysis

Assessment of the availability of electric power to support population and economic growth in a region is conducted through knowledge of peak electric demand (peak load) and available supply (generation capacity), but also the ability to distribute the electricity generated. In West Texas, peak load occurs in late summer (summer peaking) coinciding with the peak of the cooling season. The difference between demand and capacity is the reserve capacity. While the electric utility industry has not established a firm benchmark percentage for a capacity margin that is considered adequate to guarantee electricity at all times and under varying conditions, the capacity margin of the Texas Grid (corresponding with ERCOT) is the highest in the country (DOE 2002b) (see **Table 1**).

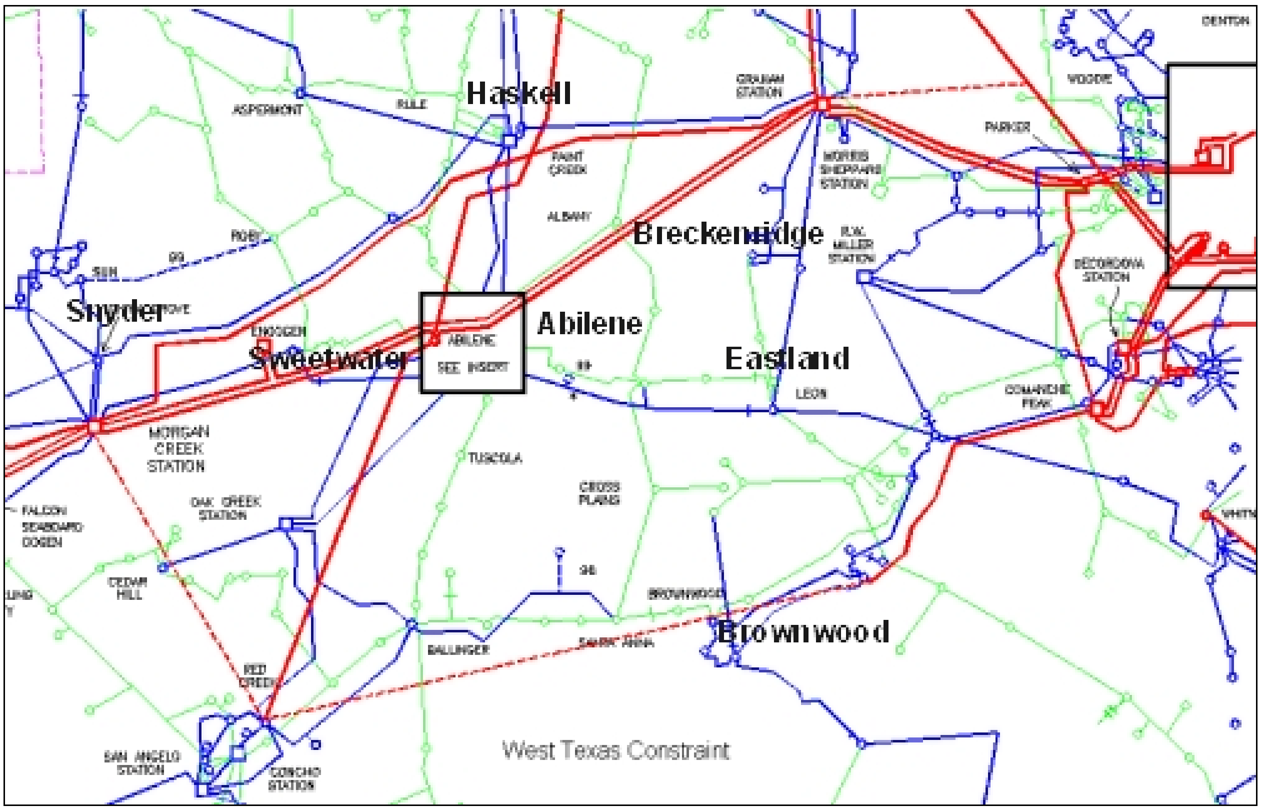
Table 1. U.S. Summer Capacity Margins, 2001

	Eastern Grid	Texas Grid	Western Grid	U.S. Total
Demand (MW)	501,405	**53,414**	114,830	669,649
Supply (MW)	582,223	**69,769**	141,068	793,060
Capacity Margins (%)	13.9	**23.4**	18.6	15.6

Notes: MW=Megawatts.
Source: DOE 2002b.

Subsequent to deregulation, investor-owned utilities across the country are no longer responsible for long-range capacity planning as generating assets have been divested. As a result, capacity may not keep up with demand. For instance, capacity margins averaged between 25 and 30 percent in the period 1978–1992. Since 1992, margins have declined to less than 15 percent nationally as electricity demand has increased. However, this decline is expected to reverse after 2001 (DOE 2002b). This might be expected as market factors favor development of many new generating projects (i.e., IPPs) that are more energy efficient than older generating facilities. Accordingly, this contributed to the decision by electric utility AEP in September 2002 to consider mothballing up to 16 of its generating stations in Texas including the Fort Phantom Plant on Fort Phantom Hill Lake, the long-idle Abilene Plant on U.S. Highway 80 in Abilene, the Oak Creek Plant in Coke County, and the Paint Creek Plant on Lake Stamford in Jones County. AEP specifically stated that the gas-fired power plants were inefficient compared to modern plants and not necessary to maintain the ERCOT transmission grid. A total of 44 new power plants have been built in Texas since 1999 (Ellsworth, 2002b). On October 15, 2002, AEP announced that seven of the sixteen plants would continue to operate through at least the end of 2002 under "reliability must run" status based on agreements made between AEP and ERCOT; the remaining plants would be closed (AEP 2002a). Nevertheless, increased demand and generation capacity has a corresponding strain on the electric transmission and distribution systems. The above has been borne out in Texas, and within the West Texas planning region of ERCOT in particular. Electric use has continued to grow consistent with a transformation to a high-technology economy. Between 1994 and 2002, ERCOT peak demand has grown 27.8% (12,115 MW) (ERCOT 2002b: 8, 41). Based on the total capacity expected to be available to ERCOT, summer peak capacity margins are projected to range from 34.6% in 2003 and forecasted to peak at 39.80% in 2005 before falling to 36.7% in 2007 (data not available beyond 2007). This estimate assumes that all proposed generation projects (excluding wind projects) are developed and includes switchable capacity from the adjoining Southwest Power Pool and other available system imports. When only ERCOT generation capacity is considered, summer peak capacity margins range from 20.7% in 2003 and fall to 12.7% in 2007 (ERCOT 2002c). Thus, this variability reflects uncertainty in electric energy forecasting under deregulation and other factors that may or may not be within the control of the system operator. Nevertheless, some 6,500 MW of new capacity is proposed to be added to the ERCOT system between the years 2002 and 2005, with most in the North Texas ERCOT planning region and the far West Texas region (ERCOT 2002b: 50). For the West Texas planning region which encompasses the study area, ERCOT has received more than 40 new generation interconnection requests totaling more than

10,000 MW. The majority of these are for renewable energy projects (ERCOT 2002b: 34). West Texas generation capacity currently exceeds peak load by about 3,000 MW. On problem is with transmission line constraints in the area as exports from West Texas are limited by thermal loading limits of several 345-kilovolt (KV) and 138-KV lines (see **Figure 7**). This situation has been further impacted by new IPP and renewable energy project loadings (ERCOT 2001: 46). One identified problem area is the Brownwood/Comanche/Dublin area where an outage on either the Seldon to Dublin 138-KV line or the Comanche Peak-Comanche Switch 345-KV line would leave the area without electric service. However, this constraint will be resolved with completion of the Red Creek to Comanche 345-KV line (see **Figure 7**). Additionally, electric transmission providers are implementing a number of other projects to relieve contraints in the West Texas Region (ERCOT 2002b: 34).



Notes: Not all transmission infrastructure is shown.

Red=345-KV; Blue=138-KV; Green=69-KV line. ¦?=Generating Station; o =Substations.

Source: ERCOT 1999.

Figure 7–Regional Transmission System.

On a county-by-county basis within the 19-county study region, electric demand varies greatly as does the associated transmission and distribution infrastructure necessary to meet the demand in a given locality (see **Table 2**). Existing demand in an area is generally, although not always, a general indicator of the associated distribution system capacity. For the purposes of this analysis, such data collectively provides an approximate gauge of the level of additional demand that can be supported in lieu of constructing additional distribution infrastructure as well as the possible need for additional transmission infrastructure to bring more electric power into an area. As can be seen, electric load is not directly proportional to population served, although it is a fairly good indicator, especially in areas where electrical demands are summer peaking.

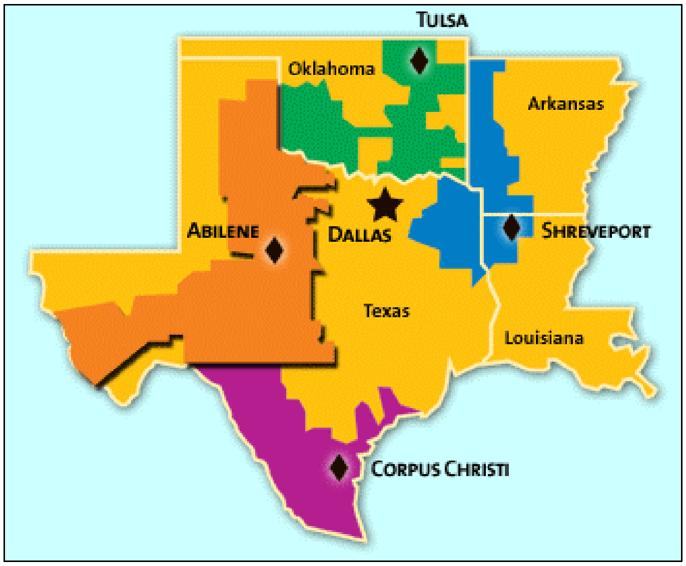
Table 2. Summer 2000 Electric Load by County.

County (City)	Noncoincident Load (MW)	Population (County/City)
Brown (Brownwood)	114	37,674/18,813
Callahan	41	12,905
Coleman	33	9,235
Comanche	57	14,026
Eastland (Eastland)	59	18,297/3,769
Fisher	32	4,344
Jones	64	20,785
Kent	57	859
Knox	23	4,253
Haskell (Haskell)	37	6,093/3,106
Mitchell	20	9,698
Nolan (Sweetwater)	63	15,802/11,415
Runnels	34	11,495
Scurry (Snyder)	144	16,361/10,783
Shackelford	21	3,302
Stephens (Breckenridge)	63	9,674/5,868
Stonewall	9	1,693
Taylor (Abilene)	412	126,555/115,930
Throckmorton	10	1,850
Total	1,293	324,901/169,684

Source: ERCOT 2002d; U.S. Bureau of the Census 2002a, 2002b.

C.2.1 Abilene Area

AEP West Texas Utilities (AEP-WTU), a subsidiary of investor-owned American Electric Power (AEP) headquartered in Columbus, Ohio, is the electric energy delivery company (transmission and distribution utility) that serves the City of Abilene. In total, AEP serves more than 4.9 million customers in 11 states with a system comprised of 38,000 circuit miles of transmission lines and more than 186,000 miles of distribution lines (see **Figure 8**). AEP also owns over 80 power plants with more than 38,000 megawatts of generating capacity in the U.S. In particular, AEP-WTU is headquartered in Abilene and serves 184,000 customers in an area that spans 52 counties and 53,000 square miles of West Texas (AEP 2002b).



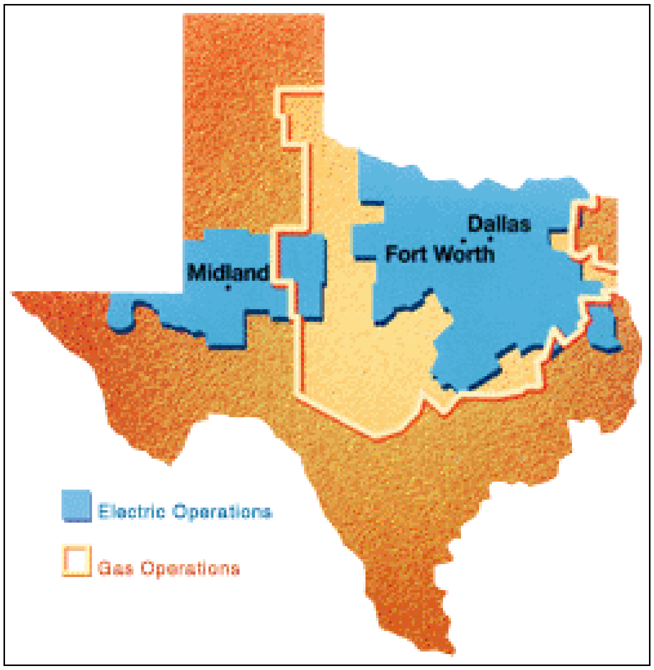
Source: AEP 2002b.

Figure 8–AEP Service Territories.

Twenty-seven electric substations serve the City of Abilene and adjoining areas (including Dyess Air Force Base) with 13 of the stations located on 138-KV transmission line routings, including the two stations serving the Abilene Industrial Park, and the remaining 14 on 69-KV routings (Plaisance 2002). Most of the distribution system in the city is overhead, except at the industrial park where it is strictly underground, and looped enabling the service load to be accommodated from more than one substation or from multiple feed circuits in the event of an outage. The distribution system's service voltage is rated at 12.5/7.2 KV (AIF 2002; Plaisance 2002). Currently, there are no major substation upgrades planned with the last major project involving construction of the Abilene Industrial Park's distribution system. Two substation transformers serve the park presently, with the capacity to accommodate two additional units to provide for additional load (Plaisance 2002).

Natural gas delivery service in Abilene is provided by Oncor (Oncor provides both natural gas and electric power to five of the other six urbanized areas in the study region) (see **Figure 9**). Oncor, a TXU company, is TXU's energy delivery entity and is the corporate successor to TXU Electric and Gas. TXU Gas provides customer service and billing for Oncor gas customers. In total, Oncor delivers electricity and natural gas to REPs throughout Texas and operates 13,000 miles of electric transmission line, 91,000 miles of electric distribution line, and 30,000 miles of gas distribution and pipeline (Oncor 2002; TXU 2002).

Gas delivery into the Abilene is facilitated by one 10-inch and one 16-inch gas pipeline from the west; one 12-inch line from the north; one 16-inch and one 12-inch line from the east; and one 12-inch line into Dyess Air Force Base. Oncor operates approximately 539 miles of natural gas distribution line in the Abilene area. The distribution network provides intermediate service pressure to most areas of the city (i.e., 15 to 20 PSI), with most lower pressure distribution (i.e., 4 to 6 PSI) in the downtown areas. Oncor performs distribution line replacements as needed to control delivery loss. Oncor provides delivery service to 34,590 customers in the city and to another 37,500 customers in Taylor County. Specific natural gas and demand information for Oncor's Abilene service area is not available (Schweikhard 2002).



Source: Oncor 2002.

Figure 9–Oncor Service Territories.

Taylor Electric Cooperative, Inc., a member-owned electric cooperative, provides electric service to the rural areas of Taylor County as well as Callahan, Jones, Nolan, Shackelford, Fisher, Coke, and Eastland counties. Taylor Electric is currently constructing a 10-MVA substation off of Highway 36 and FM 1750 to provide additional capacity for customers south of Abilene. It is expected to be online in early 2003. The cooperative does not currently own generation capacity but purchases power primarily from AEP (McKee 2002; Taylor Electric Cooperative 2002).

C.2.2 Breckenridge Area

Oncor provides electric energy delivery service to the City of Breckenridge. The City of Breckenridge and immediate vicinity is served by two substations on 138-KV transmission line routings while the rest of Stephens County is served by two additional substations on 138-KV lines and by one substation on a 69-KV line (ERCOT 2002e). In meetings with city representatives in July 2002, the provision of electric power via two directions was identified as an important element of the high reliability of electric service in the area. Three electric cooperatives also serve portions of the county including Fort Belknap Electric Cooperative in the northern and northwestern portion of the county, United Cooperative Services in the northern and western portions, and Comanche Electric Cooperative in the southern portion of the county (TEC 2002). Comanche Electric Cooperative serves several of the 19 counties in the study region including Shackelford, Stephens, Callahan, Eastland, Brown, Comanche, as well as Mills. Comanche purchases its power from the Brazos Electric Power Cooperative and maintains 5,000 miles of distribution line and 15,276 billed meters in its seven-county service area (Comanche EC 2002).

Southern Union Gas, a division of Southern Union Company, is the natural gas purveyor in Breckenridge. In Texas, this gas utility serves approximately 535,000 customers, including the cities of Austin, El Paso, Brownsville, Galveston, and Port Arthur (Southern Union Gas 2002).

C.2.3 Brownwood Area

Oncor provides electric energy and natural gas delivery service to the City of Brownwood. Two substations both on 138-KV transmission line routings proximally serve the city and immediate vicinity, while service throughout the rest of Brown County includes three additional substations on 138-KV routings and 3 substations on 69-KV lines (ERCOT 2002e). All Oncor substations in the county are reportedly SCADA-controlled and can be reset remotely. Throughout most of the city, particularly in the downtown, electric distribution is via overhead lines with service voltage rated at 12.5/7.2 KV. The distribution system is such that parts of the system can be isolated and served from different substation distribution circuits. Dual electric service is available from Oncor. The 3M manufacturing facility located in the Camp Bowie Industrial Park in the southwestern part of the city is supplied by two circuits from one substation. This is a requirement for manufacturing facilities with operations with low tolerance for electric load fluctuations and outages.

Comanche Electric Cooperative serves most of the rural areas of Brown County as further described in **Section C.2.2**.

As for natural gas, most of the city has generally low-pressure (i.e., about ¼ PSI) gas service, although some areas have 5 to 10 PSI service. High-pressure service is available in the Camp Bowie Industrial Park. Oncor also has an ongoing gas line replacement project in the city (Heine 2002).

C.2.4 Eastland Region

Oncor provides electric energy and natural gas delivery service to the City of Eastland (OEDD 2002d). The city and immediate vicinity is primarily served by a single substation on a 69-KV transmission line routing while service throughout the rest of Eastland County is provided by eight additional substations on 69-KV routings and 2 substations on 138-KV lines (ERCOT 2002e). Oncor's energy delivery assets are further described in **Section C.2.1**.

Comanche Electric Cooperative serves most of the rural areas in Eastland County while United Cooperative Services serves the eastern part of the county, with Taylor Electric Cooperative serving a small area in the western part of the county (TEC 2002). No other specific information is available regarding electric power and natural gas service in Eastland.

C.2.5 Haskell Area

AEP-WTU is the electric energy delivery company that serves the City of Haskell while Oncor (TXU Gas) provides natural gas delivery service to the city (OEDD 2002f). The City of Haskell and immediate vicinity is served by a single substation on a 69-KV transmission line routing while service throughout the rest of Haskell County is provided by nine substations on 69-KV lines (ERCOT 2002e). Big Country Electric Cooperative serves most of the rural areas in Haskell County and also provides electric service to the counties of Garza, Borden, Scurry, Kent, Fisher, Nolan, Mitchell, Stonewall, Jones, Shackelford, and Throckmorton. It maintains 5,100 miles of power distribution line. The cooperative does not currently own generation capacity but purchases power from AEP-WTU (64%) and from Golden Spread Electric Cooperative, Inc. (36%) (Buckner 2002; Big Country EC 2002). Big Country currently serves 1,888 customers in Haskell County. The cooperative also serves 1,873 in Fisher County, 2,689 in Jones County, 194 in Kent County, 1 in Mitchell County, 45 in Nolan County, 2,652 in Scurry County, 633 in Shackelford County, 371 in Stonewall County, and 62 customers in Throckmorton County (Buckner 2002). Substation assets in the general area include the Nugent substation located 12 miles north of Abilene (actually in Taylor County) (3.75 MVA transformer); the Haskell substation located 3 miles south of Haskell on U.S. Highway 83/277 (3.75 MVA transformer); and the Longworth substation located 6 miles south of Roby and east of Route 70 in Fisher County (3.75 MVA transformer) (Alexander 2002; ERCOT 2002e). Electric distribution is almost exclusively via overhead lines with most service voltage primarily rated at 12.5 KV, although some distribution circuits are rated at 29.4 KV (Alexander 2002).

The northern part of Haskell County is also served by Tri-County Electric Cooperative (TEC 2002).

C.2.6 Snyder Area

Oncor provides electric energy and natural gas delivery service to the City of Snyder (OEDD 2002a). The City of Snyder and immediate vicinity is primarily served by a single substation on a 138-KV transmission line routing and secondarily by a substation to the northeast located on a 69-KV routing. Service throughout the rest of Scurry County is provided by nine additional substations on 138-KV routings and 12 substations on 69-KV lines (ERCOT 2002e). Oncor's energy delivery assets are further described in **Section C.2.1**. The proliferation of electric substations in the county is at least partly attributable to the large number of reservoir dam projects in the county. No other specific information is available from Oncor regarding electric power and natural gas service in Snyder.

Big Country Electric Cooperative serves most of the rural areas in Scurry County (see **Section C.2.5**). Big Country's substation assets in the general area of Snyder include the Plainview substation located 5 miles east of Snyder on U.S. Highway 180 (3.75 MVA transformer); the Union substation located about 5 miles west of Snyder on Farm road 1607 (10 MVA transformer); and the Fluvanna substation located 4 miles west of Dermott on Farm road 2126 (3.75 MVA). Electric distribution is almost exclusively via overhead lines with most service voltage primarily rated at 12.5 KV (Alexander 2002). Snyder's industrial park (SnTx Park I) located at the intersection of U.S. Highways 84 and 180 and the Texas Department of Criminal Justice's Price Daniel Unit complex are in a dually certified electrical service area with TXU (Oncor) and Big County serving the site (DCOS 2002). The Texas Department of Criminal Justice facility does not have natural gas service, but the city extended an 8-inch gas distribution line to the city's industrial park at its own expense, according to city representatives.

In meetings with city representatives in July 2002, the perceived high cost of electricity in the region $0.04 to $0.045 per kWh was cited as an impediment to new business development as industry is attracted by prices in the $0.02 per kWh. However, this seems in contradiction to the generally low cost of electricity in Texas and throughout the south-central United States compared to other parts of the country.

C.2.7 Sweetwater Area

Oncor provides electric energy and natural gas delivery service to the City of Sweetwater (OEDD 2002e). The City of Sweetwater and immediate vicinity is served by a single substation on a 138-KV transmission line routing while service throughout the rest of Nolan County is provided by four substations on 69-KV lines (ERCOT 2002e). No other specific information is available from Oncor regarding electric power and natural gas service in Snyder.

Most of the rural areas of the county are served by Taylor Electric Cooperative (see **Section C.2.1**) with Big County Electric Cooperative (see **Section C.2.5**) also serving a small portion of the northern part of the county. Concho Valley Electric Cooperative serves the southwestern portion of the county (TEC 2002). Concho Valley serves over 4,600 members encompassing over 10,400 connected meters and maintains a distribution network of 3,730 miles of lines in 10 counties including Mitchell, Nolan, and Runnels counties in the 19-county study region (Concho Valley EC 2002).

C.3 Study Region Summary Conclusions for Electric Power and Natural Gas

As evident in **Table 2** (see **Section C.2** above), electric load is not directly proportional to population served, although it is a fairly good indicator, especially in areas where electrical demands are summer peaking. Note that the largest loads are generally in the counties with the largest populations and urbanized areas, and which generally correspond with the largest concentrations of industrial activity. Electric utilities typically do not "oversize" electric distribution infrastructure due to upfront cost. For example, installed transformer capacity is normally only adequate to supply the defined peak load (and reasonably foreseeable future load) in the area that it serves, along with some reserve for unexpected peaks in demand. Although, this is not to say that additional distribution capacity cannot be constructed at a particular substation.

As noted in **Section A**, the utility-affiliated electric transmission and distribution companies (notably Oncor [i.e., affiliated transmission and distribution utility for TXU]) were unable to provide electric capacity and loading (demand) information for particular substations or for distribution circuits emanating from them due to security and other concerns relative to the dissemination of information considered proprietary and not for public release. The same constraints were encountered with regard to natural gas distribution data. The electric cooperatives, which serve the areas outside the urbanized areas, were generally more willing to provide data in this regard. AEP-WTU was able to provide peak demand and available electrical capacity data for its distribution system serving the Abilene region as a whole. Nevertheless, even with these constraints on the available information, key conclusions can be drawn. As stated above, current peak demand in a region is a good indicator of electrical distribution capacity. The bounding-case benchmark selected in this study for assessing traditional infrastructure capacity relative to high-technology manufacturing is semiconductor manufacturing. Peak load demands for a large semiconductor manufacturing plant can range up to 50 MW (PPRC 2000). A recent survey of semiconductor manufacturers in the Austin, Texas area indicated peak load demands of 10 to 45 MW (Pope 2002). Comparing such an electric load to the county loads in **Table 2**, such a demand would eclipse that in most of the counties in the study region. Based on the available data, it is likely that only the Abilene area in Taylor County could support such a facility given current infrastructure. Using available data from AEP-WTU, the "Abilene area" has an available electrical capacity of about 274 megavolt-amperes (MVA), or about 219 MW (Plaisance 2002). Still, satisfying the electric needs of a semiconductor manufacturing facility would likely require construction of a large, dedicated electric distribution substation. While a particular transmission line routing (e.g., 138-KV line) might be able to support such a substation, an assessment would be required on the part of the transmission and distribution utility company to determine how much transmission capacity would be available to a new user. As such, the cost associated with providing the additional infrastructure would likely have to be borne by the user for the local wires company to provide the service required. Thus, infrastructure cost and not electric availability and reliability becomes the limiting factor to support new, large electric demands. Of course, electric energy cost, availability, and reliability are all critical to any prospective company having load sensitive activities including biotech companies where R&D or manufacturing activities are electric load sensitive or IT entities that have networks, service centers, and data warehousing facilities that are equally if not more sensitive to electric load fluctuations and outages.

Natural gas is generally not a limiting factor to economic development. The region is a summer peaking energy use region owing to the hot summers and high electrical demand for cooling. All seven urbanized areas are served by natural gas with extensive trunk line transmission capacity in the region. Most, if not all, IPP and cogeneration plants being developed in or that are in operation in Texas are gas-fired. Nonetheless, providing the necessary natural gas delivery capacity to a particular location could be problematic if small-diameter or low-pressure gas lines only serve the desired location. As an example, this would be a siting consideration for a biotech facility that might have a high gas demand (e.g., to support manufacturing activities) or an entity wishing to locate a facility with a large space-heating requirement. Both Abilene and Brownwood have ensured that their industrial parks are served by large, high-pressure gas mains.

Contingency planning could be undertaken to account for possible shortcomings in electric power and natural gas service by querying prospective companies as to their infrastructure needs that could then be compiled into a user profile. Combined with theoretical siting criteria, the user profiles could then be provided to the utility for a more definitive assessment of the utility's ability to meet the demand with current infrastructure at a specified site.

D. Transportation Infrastructure

D.1 Abilene Area

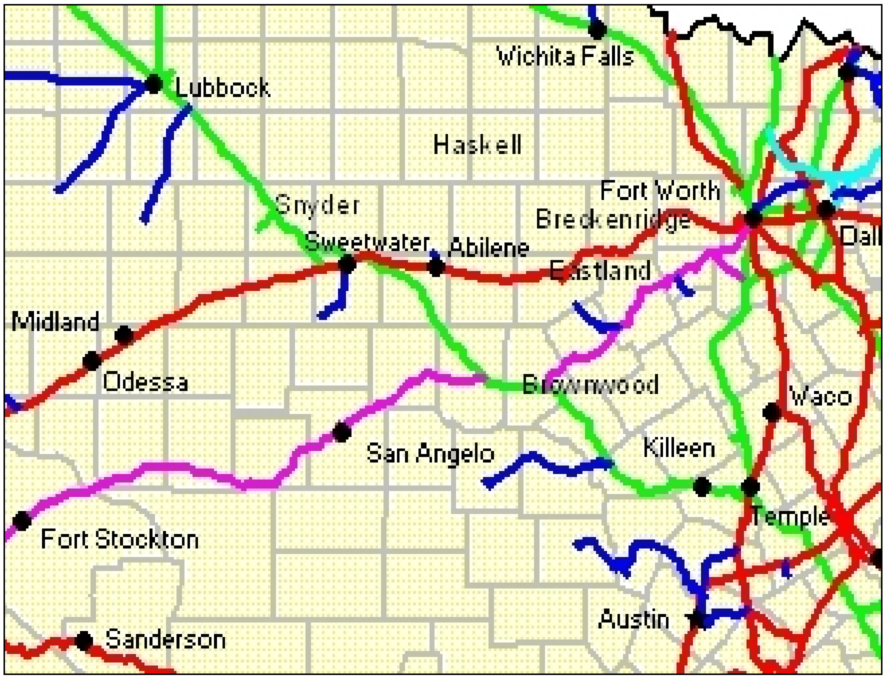
Major Highway and Rail Access. The City of Abilene lies at the center of the Interstate 20 corridor of West Central Texas with the center of the Dallas-Fort Worth metroplex approximately 170 miles to the east, Austin 213 miles to the southeast, and Amarillo 266 miles to the northwest. The city also lies at the crossroads of U.S. Highway 83/277 from the north and U.S. Highway 83/84 and U.S. Highway 277 from the south (TDOT 2001).

Abilene is served by the Union Pacific Railroad (see **Figure 10**).

Air Transportation. The City of Abilene operates Abilene Regional Airport with American Airlines (operated by American Eagle) providing major commercial airline service between the city and Dallas-Fort Worth (City of Abilene 2002). The airport is located approximately 3 miles southeast of Abilene and has a Federal Aviation Administration (FAA) control tower as well as an instrument landing system (ILS). Abilene Regional Airport has three asphalt runways with lengths of 3,678 feet, 7,198 feet, and 7,202 feet, respectively. The airport offers nearly all standard categories of service with additional services including air freight, air ambulance, avionics service, charter flights, and aircraft sales. There are 84 aircraft based at the airport, and aircraft operations average 230 per day with 38% of the volume attributed to military operations (AirNav 2002a).

D.2 Breckenridge Area

Major Highway and Rail Access. The City of Breckenridge is located on the cross roads of U.S. Highway 183 from the south and U.S. Highway 180 coming from the east. The city is 23 miles north of Interstate 20 and approximately 57 miles northeast of Abilene (TDOT 2001). Breckenridge does not have railroad access.



Source: Modified from Texas RRC 2002.

Burlington Northern/Santa Fe; **Union Pacific**; **South Orient**; **Kansas City Southern; Other Railroads**.

Figure 10–Regional Rail Service.

Air Transportation. Stephens County Airport serves the city. It is located approximately 2 miles south of Breckenridge. This general aviation airport does not have an FAA tower. The airport has three asphalt runways with lengths of 2,399 feet, 2,400 feet, and 4,998 feet, respectively. The airport offers nearly all standard categories of service with additional services including agricultural operations (aerial spraying) and flight instruction. There are 54 aircraft based at the airport, and aircraft operations average 43 per day (AirNav 2002b). In meetings with city representatives in July 2002, the airport was heralded as an important community asset as a number of oil companies have corporate aircraft based there. Also, the airport is used to fly in hunters with hunting comprising an important recreational activity in the area.

D.3 Brownwood Area

Major Highway and Rail Access. The City of Brownwood is located at the junction of U.S. Highways 377 and U.S. Highway 84/183 from the south and U.S. Highway 67/377 coming east from the metroplex. Brownwood is 49 miles south of Interstate 20. The city is 27 miles southwest of Fort Worth, 187 miles north of San Antonio, 232 miles southeast of Lubbock, 140 miles northwest of Austin, and 77 miles southwest of Abilene (TDOT 2001).

Brownwood is served by the Burlington Northern and Santa Fe Railroad (see **Figure 10**) as well as the Fort Worth and Western railroad (OEDD 2002b). The city proper has extensive railroad infrastructure including a Burlington Northern Santa Fe rail yard with rail transportation used heavily by local employers including Superior Essox, Vulcan Materials, and Kohler Company according to city representatives. Further, rail and highway access were cited by city representatives as factors contributing to the city's success in industrial recruitment and retention.

Air Transportation. The city is served by Brownwood Regional Airport, which is located on U.S. Highway 183, five miles north of Brownwood. This airport does not have an FAA tower. Although 85% of airport operations are general aviation-related, the airport offers commercial airline service to Dallas-Fort Worth. The cost associated with providing commercial service to Brownwood is subsidized by the Federal government under the U.S. Department of Transportation's (DOT) Essential Air Service (EAS) program. This program provides for Federal assistance to eligible small or isolated communities where interstate air service is deemed vital. Mesa Airlines was selected by the U.S. DOT to pickup this service beginning October 1, 2002 with the service comprised of three roundtrip flights between Abilene and Dallas-Fort Worth (Meas Airlines 2002). This service was previously provided by Big Sky Airlines. Brownwood Regional Airport has two asphalt runways with lengths of 4,596 feet and 5,599 feet, respectively. The airport offers nearly all standard categories of service with additional services including air freight, air cargo, flight instruction, aircraft rental, and aircraft sales. There are 46 aircraft based at the airport, and aircraft operations average 36 per day (AirNav 2002c). A new terminal was completed in 2001, and in 2001, the Texas Department of Transportation listed the airport as the most improved in the state in part due to the extensive facility upgrades completed by the city (City of Brownwood AD 2002). A number of the based aircraft are reportedly corporate jets, with major Brownwood-based employers like Kohler Company making extensive use of the airport according to city representatives. In addition, FedEx and UPS operate out of the airport. Military operations include C-130 aircraft from Dyess Air Force Base as well as U.S. Army helicopter (i.e., AH-64 Apache) itinerant operations.

D.4 Eastland Region

Major Highway and Rail Access. The City of Eastland is located on State Highway 6 and just north of Interstate 20. The city is about 54 miles east of Abilene and approximately 95 miles west of Fort Worth (TDOT 2001). Eastland is served by the Union Pacific Railroad (see **Figure 10**).

Air Transportation. The city is served by Eastland Municipal Airport, which is located one mile north of Eastland. This general aviation airport does not have an FAA tower. The airport has one asphalt runway with a length of 4,050 feet. Airport services are generally limited to fuel and aircraft parking. There are 15 aircraft based at the airport, and aircraft operations average 15 per day (AirNav 2002d).

D.5 Haskell Area

Major Highway and Rail Access. The City of Haskell is located on the busiest intersection between Abilene and Wichita Falls with over 10,000 vehicles passing through Haskell via the north-south running U.S. Highway 277 and the east-west running U.S. Highway 380. The city is 150 miles east-southeast of Lubbock, 95 miles southwest of Wichita Falls, 190 miles west of Dallas, and 55 miles north of Abilene (DCOH 2002; TDOT 2001). Haskell does not have railroad access.

Air Transportation. The city is served by Haskell Municipal Airport, which is located two miles north of Haskell. This general aviation airport does not have an FAA tower. The airport has one asphalt runway with a length of 3,427 feet. Airport services are generally limited to fuel and hangar facilities, although agricultural operations (aerial spraying) are conducted from the airport. There are 7 aircraft based at the airport, and aircraft operations average 21 per day (AirNav 2002e).

D.6 Snyder Area

Major Highway and Rail Access. The City of Snyder is located along the east-west running U.S. Highway 180 and U.S. Highway 84, which provides access to Interstate 20 approximately 30 miles to the south. The city is approximately 80 miles southeast of Lubbock and 70 miles west of Abilene (DCOS 2002; TDOT 2001). Snyder is served by the Burlington Northern and Santa Fe Railroad (see **Figure 10**).

Air Transportation. The city is served by Winston Field Airport, which is located two miles southwest of Snyder. This general aviation airport does not have an FAA tower. The airport has two asphalt runways with lengths of 4,200 feet and 5,599 feet, respectively. Airport services are generally limited to fuel as well as hangars and tie downs for aircraft, although agricultural operations (aerial spraying) are conducted from the airport. There are 28 aircraft based at the airport, and aircraft operations average 21 per day (AirNav 2002f). Based on discussions held with city representatives in July 2002, it was learned that operations at the airport include a few corporate jets used by oil companies. In addition, a new Air Force support facility for Dyess Air Force Base is reportedly located at the airport.

D.7 Sweetwater Area

Major Highway and Rail Access. The City of Sweetwater is located on State Route 70 and Interstate 20. The city is 123 miles southeast of Lubbock and 42 miles west of Abilene (SEED 2002; TDOT 2001). Sweetwater is served by both the Burlington Northern and Santa Fe and Union Pacific railroads (see **Figure 10**).

Air Transportation. The city is served by Avenger Field Airport, which is located three miles west of Sweetwater. This general aviation airport does not have an FAA tower. The airport has two asphalt runways with lengths of 5,658 feet and 5,835 feet. The airport offers nearly all standard categories of service such as major airframe and powerplant service with additional services including aerial spraying and aircraft rental. There are 15 aircraft based at the airport, and aircraft operations average 12 per day (AirNav 2002g).

D.8 Study Region Summary Conclusions for Transportation

Superb highway access is critical to high-technology manufacturing as products must be shipped to distribution points and parts and other material received from secondary suppliers and distributors. All seven urbanized areas have reasonably good highway access, although Abilene, Eastland, and Sweetwater are optimally located along or near Interstate 20. Abilene, Brownwood, Snyder, and Sweetwater also have rail access. Only Abilene and Brownwood have commercial airline service from their regional airports to Dallas-Fort Worth.

E. Public Safety Infrastructure

E.1 Abilene Area

Police Protection. The Abilene Police Department operates exclusively out of its headquarters facility located at 450 Pecan Street in Abilene. Current staffing levels include 179 sworn officers (Zemcik 2002). The department has an authorized strength of 180 sworn officers plus 50 civilian positions (City of Abilene Police Department 2002). This equates to a police officer-to-population ratio of 1.5 per 1,000 persons served (based on a city population of 115,930 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This is less than the 2000 State average of about 2.1 police officers per 1,000 persons served (U.S. Census Bureau 2002c). However, this is only a statistical comparison and may aptly reflect the fact that Abilene requires fewer officers due to a crime rate that is one of the lowest in the State (City of Abilene Police Department 2002).

Fire Protection and First Response Services. The Abilene Fire Department is a public department that operates out of its new Central Fire Station located at 250 Grape Street in addition to seven other stations strategically located throughout the city. The city also uses a "deactivated" fire station to house an equipment maintenance facility, a physical fitness center, and the Office of Emergency Management. In addition to firefighting, capabilities include water recovery, rescue, and hazardous materials response. As in most urban areas, the Fire Department is normally the first on scene for medical emergencies as dispatched by 911. This is the case in Abilene with firefighters who are also certified Emergency Medical Technicians (EMTs) available for dispatch. For example, in 2001, the Abilene Fire Department responded to 8,265 medical emergencies (City of Abilene Fire Department 2002). Current staffing includes 171 professional firefighters, although the department is authorized for 173 firefighters plus the Fire Chief (Gallion 2002). Regardless, this equates to a firefighter-to-population ratio of 1.5 per 1,000 persons served (based on a city population of 115,930 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This exceeds the 2000 State average of about 0.9 firefighters per 1,000 persons served (U.S. Census Bureau 2002c). Note that this State average figure includes professional firefighters employed by state and local governments and does not account for volunteer firefighters. Regardless, the relatively higher staffing level as compared to the municipal population served may reflect the need for additional personnel to respond to calls located outside the city limits, particularly in Taylor County and along the Interstate 20 corridor. In addition, the Abilene Fire Department has a mutual aid agreement in place with Taylor County and with Dyess Air Force Base (Gallion 2002).

Rural/Metro Corporation provides ambulance service within the City of Abilene. Rural/Metro operates a total of 10 ambulance units in Abilene with a minimum of three ambulances staffed 24-hours a day to respond to calls (Rural/Metro 2002). Air ambulance service is also available in the immediate region. Also, through Hendrick Health System (operator of Abilene Regional Medical Center), Southwest Air Ambulance Service was to begin providing air ambulance service within a 150-mile radius of Abilene by November 2002, with one medevac helicopter based at Abilene Regional Airport (Bethel 2002). Note that all public safety services in the city are 911 dispatched.

E.2 Breckenridge Area

Police Protection. The Breckenridge Police Department is collocated with the Fire Department at 120 West Elm Street in Breckenridge. Current staffing levels include 12 sworn officers (Wimberley 2002). This equates to a police officer-to-population ratio of 2.0 per 1,000 persons served (based on a city population of 5,868 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This is roughly equivalent to the 2000 State average of about 2.1 police officers per 1,000 persons served (U.S. Census Bureau 2002c).

Fire Protection and First Response Services. The Breckenridge Fire Department is a public department that is collocated with the Police Department as discussed above. Current staffing includes 10 professional firefighters (Wimberley 2002). This equates to a firefighter-to-population ratio of 1.7 per 1,000 persons served (based on a city population of 5,868 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This greatly exceeds the 2000 State average of about 0.9 firefighters per 1,000 persons served (U.S. Census Bureau 2002c). Note that this State average figure includes professional firefighters employed by state and local governments and does not account for volunteer firefighters. Similar to the case for Abilene, the relatively higher firefighter staffing level as compared to the municipal population served may reflect the need for additional personnel to respond to calls located outside the city limits.

The department has mutual aid agreements in place with all surrounding counties. Air ambulance service is provided by Stamford Hospital in Stamford (Jones County). Note that all public safety services in the city are 911 dispatched (Wimberley 2002).

E.3 Brownwood Area

Police Protection. The Brownwood Police Department operates out of its facility housed in the Joint Law Enforcement Center located at 1050 West Commerce in Brownwood. The department also serves as the 911-dispatch center for all of Brown County and also houses the Brown County Sheriff's Department (City of Brownwood PD 2002). Current staffing levels include 33 sworn officers and 19 staff including communcation/911 personnel (City of Brownwood PD 2002; Hatcher 2002). This equates to a police officer-to-population ratio of 1.8 per 1,000 persons served (based on a city population of 18,813 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This is slightly less than the 2000 State average of about 2.1 police officers per 1,000 persons served (U.S. Census Bureau 2002c).

Fire Protection and First Response Services. The Brownwood Fire Department is a public department that operates out of its main station at 809 Main Street and from a substation at 1511 Indian Creek Drive (City of Brownwood FD 2002; Rigler 2002). In addition to firefighting, capabilities include water and rope rescue, motor vehicle extraction/rescue, and hazardous materials response. The department responds to over 1,000 calls annually with the majority being motor vehicle accidents (City of Brownwood FD 2002). For emergency medical first response, the department has at least one EMT on each duty shift (Reiger 2002). Current staffing includes 30 professional firefighters (Hatcher 2002; Reiger 2002). This equates to a firefighter-to-population ratio of 1.6 per 1,000 persons (based on a city population of 18,813 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This exceeds the 2000 State average of about 0.9 firefighters per 1,000 persons served (U.S. Census Bureau 2002c). Note that this State average figure includes professional firefighters employed by state and local governments and does not account for volunteer firefighters. Similar to the case for Abilene, the relatively higher firefighter staffing level as compared to the municipal population served may reflect the need for additional personnel to respond to calls located outside the city limits.

In addition to first response provided by the Brownwood Fire Department, *Promed EMS* provides ambulance service to the city and to Brown County. Staffing includes a total of 25 EMTs with four ambulance units. Two units are on duty 24-hours a day (Hatcher 2002).

Further, the department has mutual aid agreements in place with all surrounding counties. Air ambulance service is provided by Brownwood Regional Medical Center that has a medevac helicopter based there (Reiger 2002).

E.4 Eastland Region

Police Protection. The Eastland Police Department is located adjacent to City Hall at 416 South Seaman Street in Eastland. Current staffing levels include 8 sworn officers (Eastland County EDC 2002). This equates to a police officer-to-population ratio of 2.1 per 1,000 persons served (based on a city population of 3,769 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This is equal to the 2000 State average of about 2.1 police officers per 1,000 persons served (U.S. Census Bureau 2002c).

Fire Protection and First Response Services. The Eastland Fire Department is a part paid and part volunteer department with its base of operations located at 414 South Seaman Street in Eastland. Current staffing includes four professional and 25 volunteer firefighters. The department has 12 emergency medical services-certified volunteer firefighters (Brinkley 2002). Nonetheless, Eastland's paid firefighter staffing level equates to a paid firefighter-to-population ratio of 1.1 per 1,000 persons served (based on a city population of 3,769 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). Even excluding volunteers, this is still greater than the 2000 State average of about 0.9 firefighters per 1,000 persons served (U.S. Census Bureau 2002c). Note that this State average figure includes professional firefighters employed by state and local governments and does not account for volunteer firefighters. Similar to the case for Abilene, the relatively higher firefighter staffing level as compared to the municipal population served may reflect the need for additional personnel to respond to calls located outside the city limits.

The department has mutual aid agreements in place with all surrounding counties. Air ambulance service is provided from both Abilene and Brownwood as well as from Fort Worth. Note that all public safety services in the city are 911 dispatched (Brinkley 2002).

E.5 Haskell Area

Police Protection. The Haskell Police Department is located at 301 South First Street in Haskell, which is in proximity to the Fire Department Current staffing levels include 4 sworn officers (Watson 2002b). This equates to a police officer-to-population ratio of 1.3 per 1,000 persons served (based on a city population of 3,106 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This is below the 2000 State average of about 2.1 police officers per 1,000 persons served (U.S. Census Bureau 2002c).

Fire Protection and First Response Services. The Haskell Fire Department is an all-volunteer department comprised of 29 volunteer firefighters including three paramedics (Watson 2002b). Haskell also has mutual aid agreements in place with surrounding counties. Air ambulance service is provided by Stamford Hospital in Stamford (Jones County). Note that all public safety services in the city are 911 dispatched (Watson 2002b).

E.6 Snyder Area

Police Protection. The Snyder Police Department operates out of the Law Enforcement Center in Snyder. This facility also houses the Scurry County Sheriff's Office and jail as well as the Texas Rangers (City of Snyder 2002). Current staffing levels include 16 sworn officers with a staff of 20 total including the Chief of Police (City of Snyder 2002). This equates to a police officer-to-population ratio of 1.5 per 1,000 persons served (based on a city population of 10,783 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This is lower than the 2000 State average of about 2.1 police officers per 1,000 persons served (U.S. Census Bureau 2002c).

Fire Protection and First Response Services. The Snyder Fire Department is a part paid and part volunteer department that operates out of the Central Fire Station. Historically, the city used a total of three stations. Current staffing includes 9 full-time professional and 44 volunteer firefighters (Westmoreland 2002). This equates to a paid firefighter-to-population ratio of 0.8 per 1,000 persons served (based on a city population of 10,783 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This approximates the 2000 State average of about 0.9 firefighters per 1,000 persons served (U.S. Census Bureau 2002c). Note that this State average figure includes professional firefighters employed by state and local governments and does not account for volunteer firefighters. .

Snyder EMS provides emergency medical response from one station located at 3902 College Avenue. Staffing includes 9 full-time EMTs and 16 part-time EMTs. Four ambulance units are maintained plus a first responder vehicle. Two ambulances are staffed 24-hours a day (Westmoreland 2002).

The department is developing mutual aid agreements with all surrounding counties. The department already covers half of Borden County in addition to taking calls in Scurry County. About 65% of all calls are for locations outside the city. Air ambulance service is primarily from San Angelo. Emergency 911 service (enhanced service) is provided by the county (Westmoreland 2002).

E.7 Sweetwater Area

Police Protection. The Sweetwater Police Department is located at 200 East 4th Street in Sweetwater. Current staffing levels include 20 sworn officers (City of Sweetwater Personnel Department 2002). This equates to a police officer-to-population ratio of 1.8 per 1,000 persons served (based on a city population of 11,415 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This is slightly lower than the 2000 State average of about 2.1 police officers per 1,000 persons served (U.S. Census Bureau 2002c).

Fire Protection and First Response Services. The Sweetwater Fire Department is a public department that operates from 900 East Broadway in Sweetwater. In addition to firefighting, capabilities include a dive team for underwater rescue and recovery, life support services, motor vehicle extraction/rescue, and hazardous materials response. The department also runs four first response vehicles with 14 paramedics (SEED 2002). Current staffing includes 27 professional firefighters (Baker 2002). This equates to a firefighter-to-population ratio of 2.4 per 1,000 persons served (based on a city population of 11,415 as recorded by the 2000 Census) (U.S. Census Bureau 2002a). This greatly exceeds the 2000 State average of about 0.9 firefighters per 1,000 persons served (U.S. Census Bureau 2002c). Note that this State average figure includes professional firefighters employed by state and local governments and does not account for volunteer firefighters. Similar to the case for Abilene, the relatively higher firefighter staffing level as compared to the municipal population served may reflect the need for additional personnel to respond to calls located outside the city limits.

The department has mutual response agreements in place with all surrounding counties. Air ambulance service is provided from Stamford Hospital in Stamford (Jones County), San Angelo, and from Abilene. Note that all public safety services in the city are 911 dispatched (Baker 2002).

E.8 Study Region Summary Conclusions for Public Safety

Paid fire and police protection force levels are generally adequate in the seven urbanized areas, especially considering the populations that are served in the more rural cities. With the exception of Haskell that has an all volunteer fire department, all urbanized areas have paid professional police forces and fire departments, although Eastland and Snyder have combination paid and volunteer fire departments. Fire protection staffing in each of the urbanized areas, as measured as a ratio of paid firefighters compared to the population served, generally exceeds the State average ratio of firefighters to population served. One exception is Snyder. Police protection force levels (measured in terms of sworn officers) are on par with or below the State average, but this may be attributable to the generally lower crime rate and the fact that each associated county also have sheriff's departments. The higher staffing levels for fire protection may be attributable to the fact that each of the seven urbanized areas either have mutual aid agreements with neighboring jurisdictions and/or generally respond to accidents, fires, and other incidents in the more rural areas of the encompassing counties and adjacent counties.

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