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Volume IV Appendix 5c of 16

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

SUPERCONDUCTING SUPER COLLIDER

Volume IV
Appendix 5c

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VOLUME IV

APPENDIX 5c

AFFECTED ENVIRONMENTS
AT ALTERNATIVE SITES

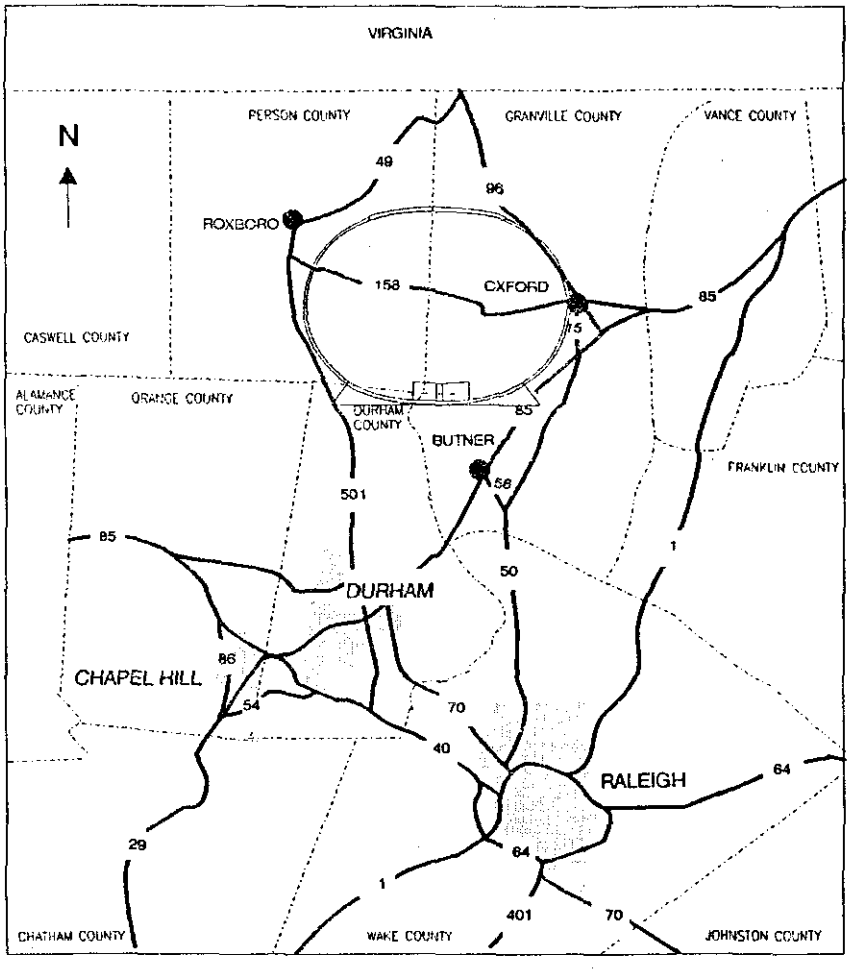
5.5 NORTH CAROLINA

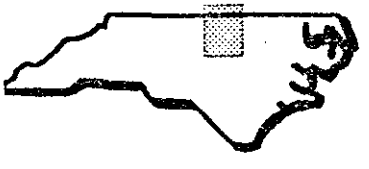
5.6 TENNESSEE

5.7 TEXAS

Affected Environments at Site Alternatives

N O R T H C A R O L I N A





North Carolina - **The proposed site is located in the north central portion of North Carolina, approximately 10 miles north of Durham. It includes portions of Person, Granville and Durham Counties. The entire tunnel would be constructed by tunneling techniques in the interlayered metamorphosed volcanic and sedimentary rocks below the water table.**

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5.5 NORTH CAROLINA

5.5.1 Earth Resources

5.5.1.1 Physiography and Topography

The proposed North Carolina SSC site lies in the Piedmont Upland section of the Piedmont physiographic province, in an area characterized by moderate relief developed on a submaturely dissected peneplain (Fenneman 1938). Topography at the site and the vicinity is predominantly a flat to slightly rolling little dissected upland surface that locally grades to rolling topography at prominent drainages (Figure 5.5.1-1). An area of Triassic Lowlands lies southeast of the site.

Elevations in the site vicinity range from 250 ft, where the Flat River flows to the south (U.S.G.S. 19746), to 830 ft in the hills immediately northwest of the ring (U.S.G.S. 1982). Elevations in the site proper range from 380 ft at Knap of Reeds Creek (U.S.G.S. 1977) to 740 ft on the northwestern edge of the ring (U.S.G.S. 1982). Relief on the flatter upland portion of the site area is low, comprising mostly 50- to 80-ft-high swells that are 0.25 to 0.5 mi across (U.S.G.S. 1981a, b and c).

Drainage in the site area has a well-integrated dendritic pattern; bedrock geology appears to exert little control on the drainage pattern. The southwestern half of the site is drained by tributaries of the Flat River (U.S.G.S. 1974a, 1977, 1981b). The eastern portion is drained by tributaries and main stem of the Tar River (U.S.G.S. 1974a, 1981c). Other creeks (Mayo Creek and Grassy Creek) drain the far northern portions (U.S.G.S. 1980 and 1981a). Tributary creeks at the site are generally only slightly incised; main stems of the Tar and Flat rivers have incised to 60 to 110 ft below the adjacent uplands.

5.5.1.2 Stratigraphy

A stratigraphic column of the rock units within and surrounding the North Carolina site is depicted in Figure 5.5.1-2. Lithologic descriptions of these units are given in Table 5.5.1-1. All lithologic descriptions in the table refer to rocks metamorphosed to greenschist grade, unless otherwise specified. Rock names represent protoliths, in keeping with local geologic practice; metamorphic mineralogy is listed in the "Other Characteristics" column. The site rocks are part of a large tectonostratigraphic belt commonly referred to as the Carolina Slate Belt, which extends from southern Virginia to northern Georgia along the trend of the Appalachians. Information in this section was obtained from various sources, including Harris and Glover (1988), Glover and Sinha (1973), Hadley (1973), Burt et al. (1978), Bates and Jackson (1980), Ragland et al. (1968), McConnel and Glover (1982), Briggs et al. (1978), and Stuckey and Conrad (1958). The time scale used to approximate the age of rock units is the "Decade of North American Geology 1983 Geologic Time Scale" (Palmer 1983).

Figure 5.5.1-1

TOPOGRAPHIC SETTING OF THE NORTH CAROLINA SITE

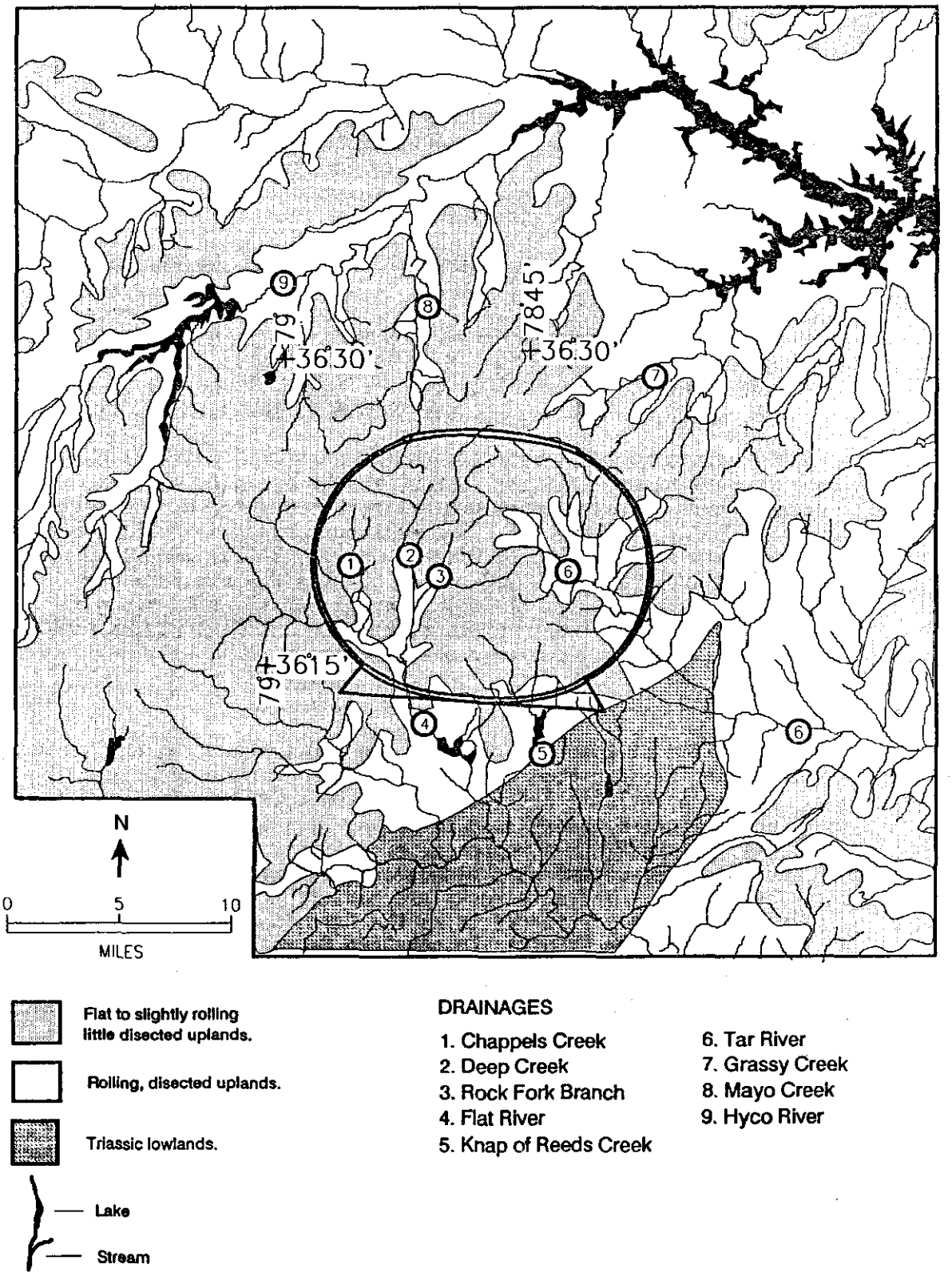
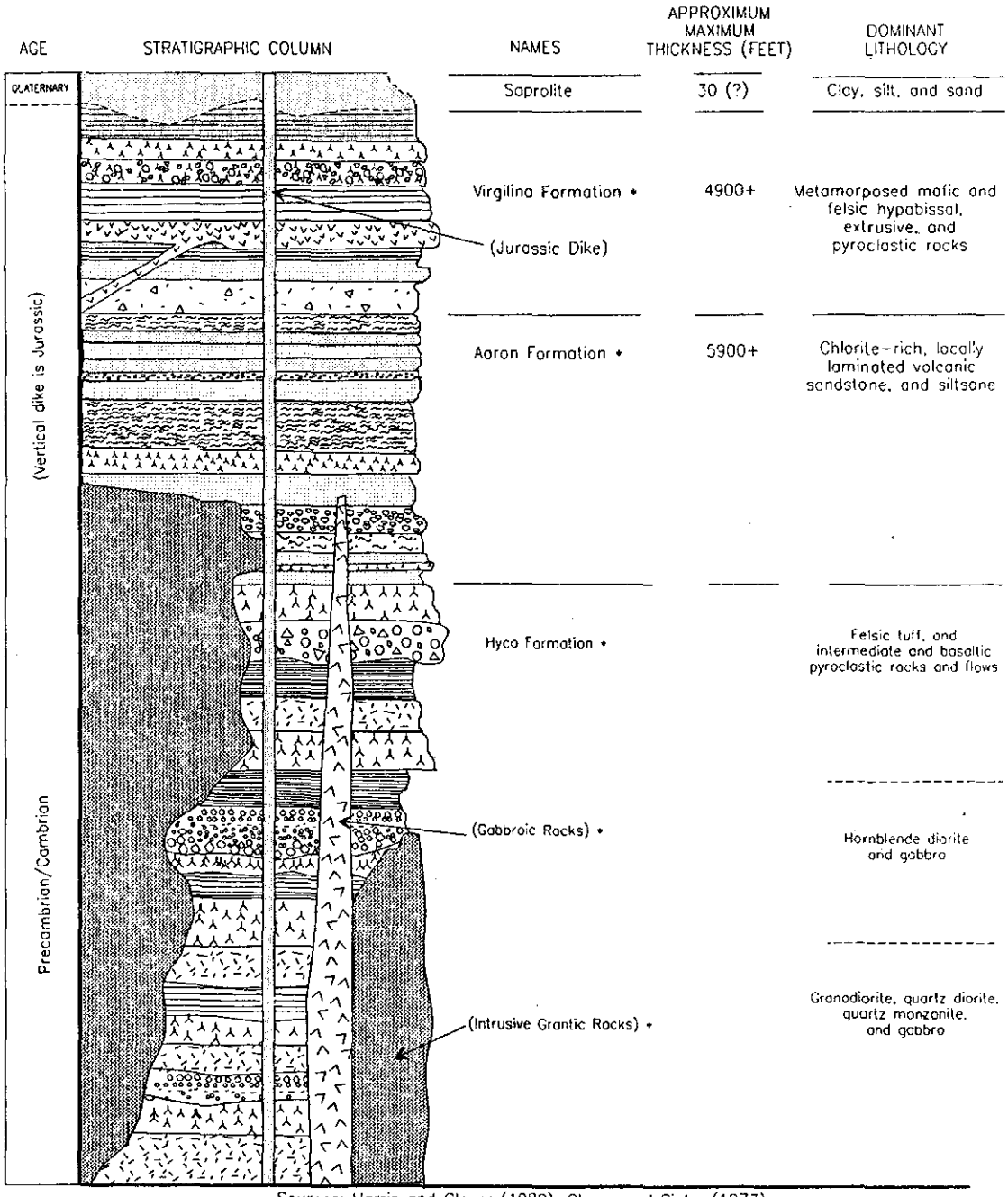


Figure 5.5.1-2

STRATIGRAPHIC COLUMN-NORTH CAROLINA SITE



Sources: Harris and Glover (1988), Glover and Sinha (1973), and Stucky and Conrad (1958)

• Unit penetrated by collider tunnel

Table 5.5.1-1

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Saprolite	Residual overburden formed by in situ chemical weathering of underlying rock.	Transitional between soil and weathered rock.
Jurassic Diabase Dikes	Dark gray to black, massive, crystalline, unmetamorphosed diabase.	
Virgilina Formation	Predominantly mafic and felsic metavolcanics. Mafic rocks are mostly pyroclastic debris (lapilli tuff) that fall within the basalt range. These are commonly highly scoriaceous and may include thin-bedded tuff interlayered with the lapilli tuff and tuff breccia. Other mafic rocks include mafic sills, lavas, dikes, and minor interbeds of felsic volcanic rock, tuffaceous epiclastic sandstone, and mudstone. Felsic rocks include porphyritic dikes and lava domes with plagioclase and quartz phenocrysts as well as bedded tuff and fine lapilli tuff that are mineralogically similar. Both mafic and felsic rocks are overlain by a thin-bedded mudstone unit.	Mafic component increases northward. Mafic metamorphic assemblage is chlorite-actinolite-epidote (albite-quartz-hematite). Felsic groundmass is epidote-chlorite-sericite. Metallic sulfide vein mineralization has proven eco-nomic within the Virgilina Synclinorium.

Table 5.5.1-1 (Cont)

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Aaron Formation	Chlorite-rich, locally laminated volcanic sandstone, siltstone, some conglomerate, and minor pyroclastic units. Sandstone is poorly to moderately well sorted and contains quartz, feldspar and volcanic detritus. Siltstone is thin-bedded and generally more alluminous than the sandstone.	Metamorphic phases are interstitial sericite and chlorite, which are most abundant in the siltstone.
Hyco Formation	Buff, gray, and red, coarse, felsic tuff and lapilli tuff in the dacite to rhyodacite range, light gray-green, intermediate pyroclastic rocks and lavas, and medium- to dark-green pyroxene andesite, and basaltic pyroclastic deposits and lava. Dacitic tuffs have plagioclase and quartz phenocrysts, are commonly massively bedded, and are locally brecciated. They occur as vitric, vitric crystal, crystal, and lapilli tuffs. Disseminated pyrite occurs locally.	Felsic rocks now composed of quartz-plagioclase-muscovite-potassium feldspar-chlorite-(hematite or magnetite) ± biotite. Intermediate rocks have a greater chlorite and epidote content, with pseudomorphs of chlorite and actinolite after hornblende. Intermediate rocks are plagioclase-quartz-chlorite-epidote-muscovite-(hematite or magnetite). Mafic rocks are chlorite-actinolite-epidote-plagioclase-quartz-(hematite or magnetite).

Table 5.5.1-1 (Cont)

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Intrusive Granitic Rocks	Collectively includes granodiorite, porphyritic granodiorite, granite, quartz diorite, and quartz monzonite (adamel-lite), with minor mafic phases. The granodiorite is medium- to coarse-grained, subporphyritic, with large crystals of partially albitized plagioclase in a groundmass of anhedral quartz and perthite, with minor plagioclase. The porphyritic granodiorite contains 5- to 6-mm plagioclase phenocrysts in a medium-grained groundmass of plagioclase, quartz, and potassium feldspar; relative abundances vary locally into the quartz monzonite range. The quartz diorite includes quartz and plagioclase phenocrysts in a fine-grained ground-mass of quartz, plagioclase, epidote, and potassium feldspar.	Intrusive granitic rocks (as defined here) include the Roxboro metagranite pluton, the Oxford pluton, the Moriah pluton, and the Butner stock. Rock types described are probably related to multiple magmatic events associated with the consolidation of numerous plutons, and are probably genetically related to the mineralogically similar extrusive rocks. Metamorphic effects in these rocks are slight and generally consist of alteration of the groundmass to include matted chlorite and epidote.
Gabbroic Rocks	Generally coarse-grained hornblende diorite or gabbro. May contain large albitized plagioclase phenocrysts.	Typically, most hornblende is replaced by chlorite, actinolite, stilpnome-lane, and hematite.

Sources: Ragland et al. 1968; Burt et al. 1978; Glover and Sinha 1973; Briggs et al. 1978; McConnel and Glover 1982; Hadley 1973; Harris and Glover 1988; Stuckey and Conrad 1958; Bates and Jackson 1980;

According to an interpretation by Harris and Glover (1988) the now metamorphosed volcanic rocks of the Slate Belt were erupted in a magmatic island arc. The oldest units (Hyco formation) were deposited between 620 and 700 million years ago in a mixed subaerial and subaqueous environment. As this initial volcanic stage waned, the region was uplifted and eroded, generating the epiclastic (submarine fan) sediments of the Aaron formation. A renewal of volcanism 600 to 620 million years ago resulted in the rocks of the Virgilina formation. Throughout this time period, felsic and mafic magmas related to the concomitant volcanism intruded in much of the volcanic pile. These rocks have since been metamorphosed and deformed by a variety of tectonic events that culminated between 440 and 480 million years ago with the permanent suturing of the island arc to the North American continent (Harris and Glover 1988).

5.5.1.3 Geologic Structure

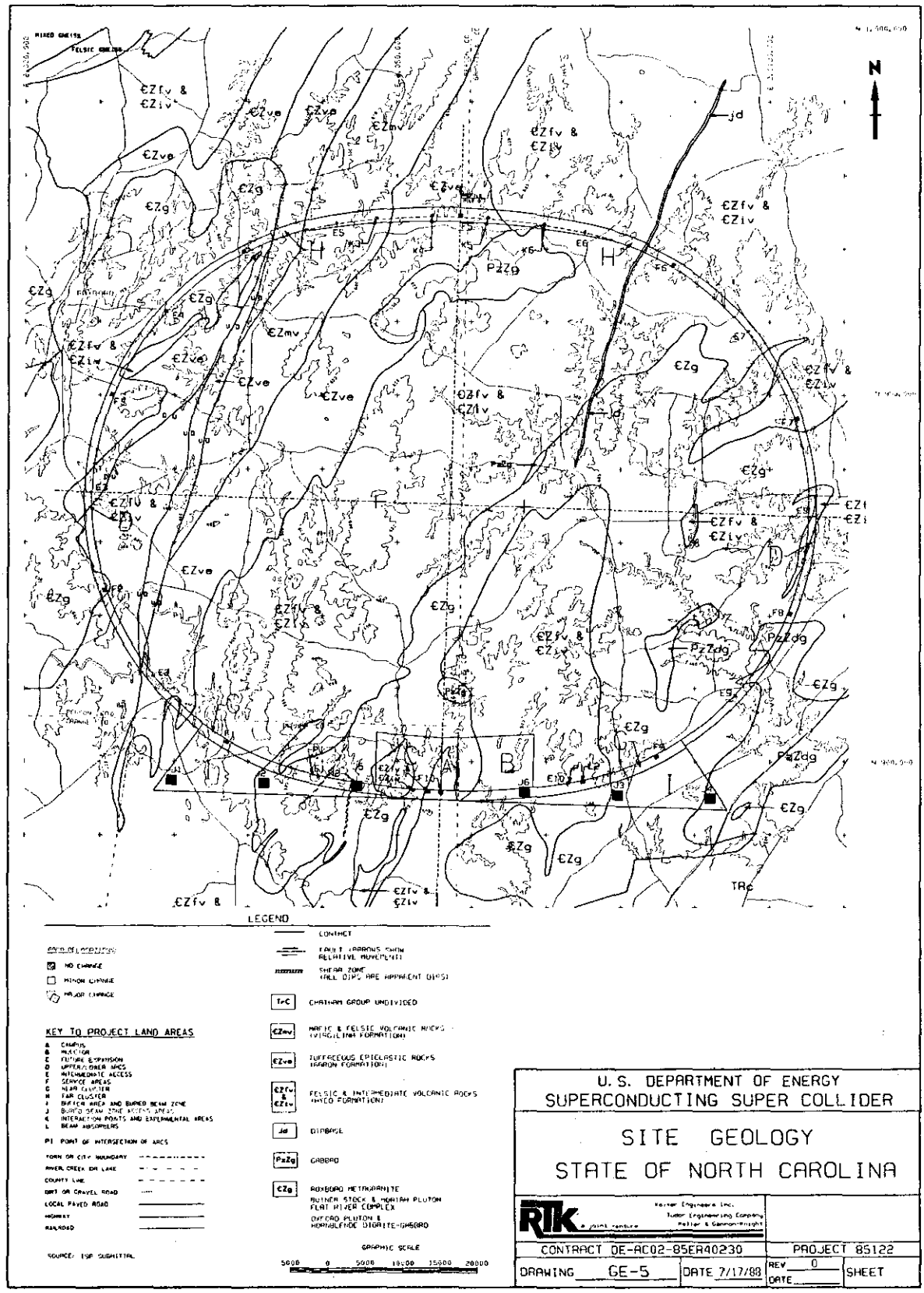
Figure 5.5.1-3 is a geologic map of the vicinity of the North Carolina site. Figure 5.5.1-4 is a cross section along the proposed ring. Rock units described in these figures are principally metamorphosed sedimentary, intrusive, and volcanic rocks of the Carolina Slate Belt that were folded by a regional compressive event to form the Virgilina Synclinorium during the late Precambrian period more than 570 million years ago. The synclinal axis trends northeast and crosses the western portion of the proposed ring. Subsequent intrusive, metamorphic, and deformational events, including the Taconic event in the Ordovician period (435 to 500 million years ago), have produced additional structural and mineralogic imprints that have contributed to the geologic complexity of the region.

Information on mapped faults in the area is presented in Table 5.5.1-2. Detailed mapping of the Virgilina area by Glover and Sinha (1973) delineated several faults and folds in the vicinity of the "nose" of the synclinal structure. Although these faults are displayed in Figure 5.5.1-3, more recent mapping revealed no field evidence for them (Reid 1986). Additional faults mapped by McConnel and Glover (1982) within the Aaron and Hyco formations in the same area were not confirmed during SSC-related studies. Other faults in the vicinity include those bounding the Triassic (195-million to 225-million-year-old) basin southeast of the ring. In addition to the faults listed in Table 5.5.1-2, two shear zones were mapped across the southern portion of the ring (see Figure 5.5.1-3). These zones appear highly silicified at the surface, although unhealed brecciation is also evident locally. The nature of these structures at tunnel depth is uncertain.

A weak cleavage, generally paralleling the regional fabric of the North Carolina Piedmont at North 20° to 50° East, is present in most rocks. The cleavage is most noticeable in weathered rock and is commonly imperceptible at depth. Numerous joint trends are evident in the different units; major trends occur at North 20° to 90° West, North 0° to 30° East, and North 40° to 70° East with nearly vertical dips. Joint spacings generally range from less than an inch between joints of a particular set, to almost 5 ft (Reid 1988a).

Figure 5.5.1-3

GEOLOGIC MAP OF THE VICINITY OF THE NORTH CAROLINA SITE



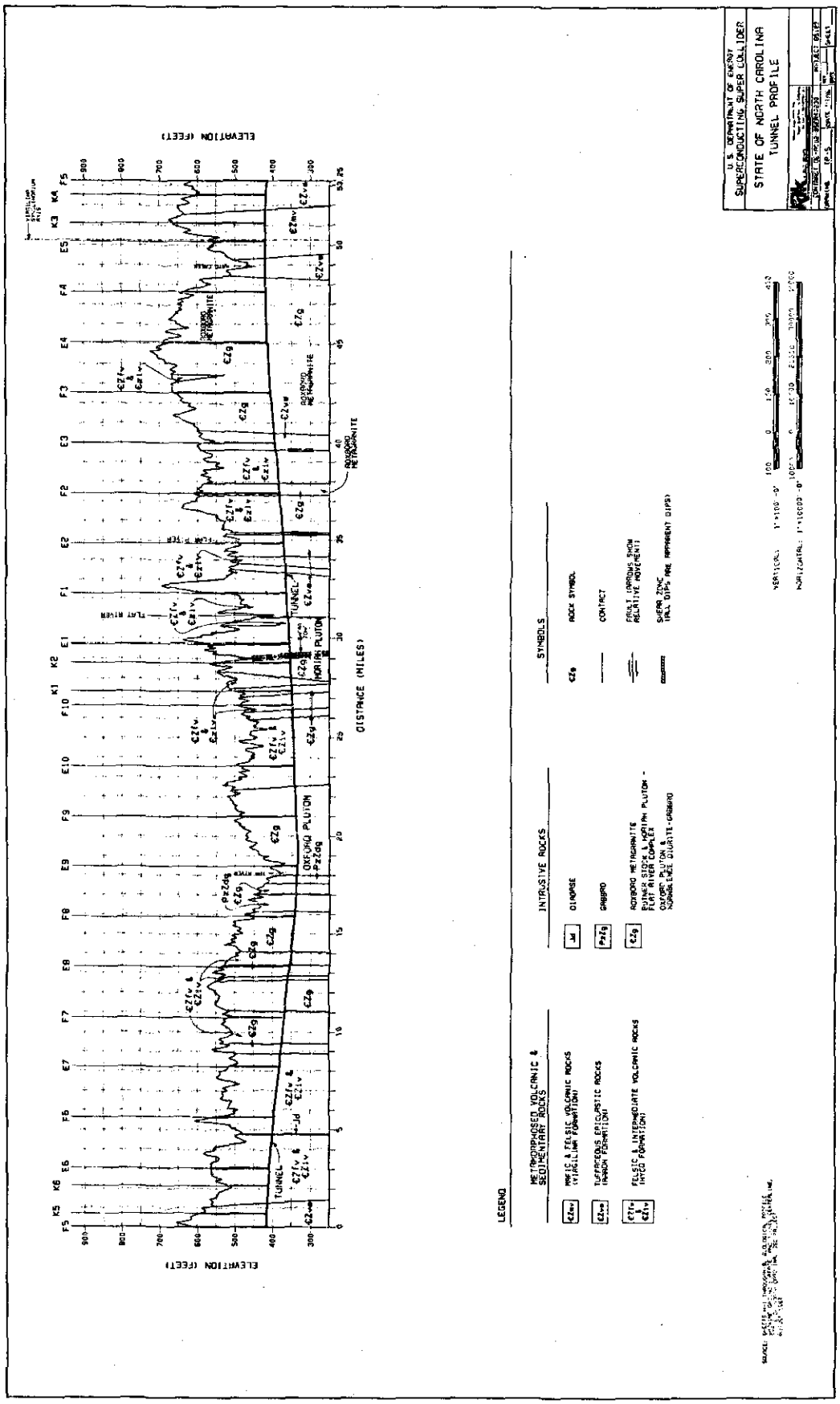


Figure 5.5.1-4

CROSS SECTION ALONG THE PROPOSED COLLIDER RING

Table 5.5.1-2

SUMMARY OF FAULT CHARACTERISTICS

Fault	Location	Strike	Dip	Thickness	Displacement/Age
Two faults surrounding linear outcrop of Aaron Fm.	Two faults cross near E2 and one crosses near F4	N-NE	--	--	Precambrian-Cambrian
Normal fault	3 mi SE of southeastern ring	NE	SE	--	Triassic
Normal fault	5 mi SE of southeastern ring	N-S	W	--	Triassic

Source: Reid 1988c.

5.5.1.4 Geoengineering Conditions

The geoengineering materials at the SSC site in North Carolina include:

- o Soils
  - Clay
  - Silty clay or clayey silt
  - Sandy silt and silty sand
- o Rocks
  - Felsic and intermediate volcanic rocks
  - Epiclastic rocks
  - Mafic and intermediate rocks
  - Felsic intrusive rocks
  - Hornblende-diorite gabbro

The overburden soils are mostly of the residual type developed by in-place weathering of underlying geologic formations. Alluvial soils are encountered in stream valleys. Clay, silt, and sand are the main constituents of soils at the surface of the site. Table 5.5.1-3 represents the geotechnical characteristics of soils. The soils are classified as MHG (elastic inorganic silts) CL (inorganic clays of low to medium plasticity), ML (low plasticity inorganic silts, sands), and SM (low permeability, low compressibility), based on Unified Soil Classification System. A typical soil profile includes clay, silty clay (CL), or clayey silt (ML or MH) at the surface grading to sandy silt (ML-SM), and silty sand (SM) with increasing depth. The proposed campus area may contain local, shallow zones of clay with moderate shrink swell potential. Bearing-capacity of the soil ranges from 20 lb/inch^2 to 35 lb/inch^2. The unconfined strength of soil typically averages about 18 lb/inch^2 within a 30 ft thickness above the underlying rock (Law Engineering 1987). The most compressible soils are located close to the surface and typically are above the water table. Some of the partially weathered rock behaves like a preconsolidated soil (Sower and Richardson 1983) because of residual mineral bonds between unweathered or partially weathered grains.

For rocks, the borehole velocity logs were used to estimate the in situ rockmass properties. For the proposed site, the apparant modulus ratios range from 170 to 620 and average close to 350 (in the range for typical metamorphic rocks). The unconfined compressive strength of the rocks along the collider ring ranges from 5,000 lb/inch^2 to 15,000 lb/inch^2 with corresponding total hardness values ranging from 35 to 228. Table 5.5.1-4 presents the geotechnical characteristics of rocks.

Table 5.5.1-3

GEOTECHNICAL CHARACTERISTICS OF SOILS

Deposit*	Soil Description USCS	Dry Density lb/ft^3	Moisture Content %	Liquid Limit/ Plasticity Index	Unconfined Strength lb/inch^2	Shear Strength lb/inch^2	Friction Angle	Calculated Avg. Bearing Capacity lb/inch^2
Residual	CH, ML	93.0	22	50/26	19.5	ND	20° - 35°	20-35
Residual/Alluvial	MH, ML, MH/ML	79.7	33	53/18	18.0	ND	20° - 35°	20-35

*Undisturbed soil samples were taken at two locations, depths 7.5-9.5 ft and 4.0-6.0 ft. One sample from each location was tested.

Notes: ML = Low plasticity inorganic silts, sands

MH = Elastic inorganic silts

CH = Inorganic clays of high plasticity

ND= No data

Source: Reid 1988 c.

Table 5.5.1-4

GEOTECHNICAL CHARACTERISTICS OF ROCKS

t	Seismic Velocity Ratio Vs/Vp	Unconfined Compressive Strength lb/inch^2	Tensile Strength lb/inch2	Young's Modulus lb/inch^2 x 10^6	Poisson's Ratio	Bulk Density lb/ft^3	Total Hardness	Cherchar Abrasivity Index	P-Wave Velocity ft/s[a]
sic and ermediate canic rocks	ND	(6,000-11,600)	ND	Average apparent modulus of 3.9 x 10^6 lb/inch^2 estimated from modulus ratio of about 350	ND	(165-173)	34-56	4.4 (2.4-5.9)	17,000
clastic	ND	(5,500-11,900)	ND		ND	(146-179)	35-37	3.2 (1.8-4.2)	19,000
ic and ermediate canic rocks	ND	(3,600-15,800)	ND		ND	(170-177)	50-56	3.5 (2.9-4.6)	20,000
sic intrusive ks	ND	(13,800-17,600)	ND		ND	(154-181)	125-228	5.5 (4.2-6.6)	19,000
nblende rite-Gabbro	ND	15,700[b]	ND		ND	177[b]	56[b]	4.8[b]	16,500

es: Data are presented as averages with range in parentheses.

a. Unweathered rock
b. One sample tested

rce: Reid 1988c; GeoConSol, Inc; Colorado School Mines 1987.

At various locations along the collider ring, drill hole cores, and exposures in quarries and highway cuts reveal the following:

- Soil thickness varies from 15 ft to 50 ft
- Soil with plastic clay occurs locally within the upper 2 to 4 ft with the water table often within 10 to 15 ft of the surface.
- Depth to hard soil or partially weathered rock is about 20 ft in areas underlain by volcanic rocks and 20 to 40 ft in areas underlain by intrusive rocks.
- Rock quality at tunnel depth ranges from good to excellent, based on Deere's rock quality designation scheme.
- Some of the major vertical fractures observed are healed with quartz and epidote, or with calcite.
- A distinctly fractured zone was noticed in one boring.
- There are three major subvertical joint sets (Section 5.5.1.3).

5.5.1.5 Geologic Hazards

Patterns of historical seismicity in the southeastern U.S. indicate four zones in which earthquakes are more common than elsewhere in the region (Bollinger 1973). These zones are the Central Virginia Seismic Zone (CVSZ), the Southern Appalachian Seismic Zone (SASZ), the South Carolina-Georgia Seismic Zone (SCGSZ), and the Northern Virginia-Maryland Seismic Zone (NVMSZ). The North Carolina site is in a part of the Piedmont with a low level of historical seismicity, bounded by the CVSZ, SASZ, and SCGSZ. Historically, there have been about 50 earthquakes within 100 mi of the site (Bollinger 1973). The majority of earthquakes within a 100 mi radius of the site occurred 25 mi north of the site within the CVSZ.

The site is along the boundary between UBC seismic zones 1 and 2 (International Conference of Building Officials 1988); therefore it could experience minor to moderate damage corresponding to Modified Mercalli intensities up to about VII. The nearest earthquake occurred about 3 mi east of the site in the 1890s and had Modified Mercalli intensities of II and III. Algermissen et al. (1982) estimated accelerations with a 90% probability of not being exceeded in 50 years in the site area to be 0.05g. There are no potentially active faults in proximity of the North Carolina SSC site (Howard et al. 1978). The geologic materials in the site area, rock overlain by residual saprolite, have a low susceptibility for liquefaction.

No other geologic hazards are anticipated at this site. No hydrocarbons are extracted in the region (Section 5.5.1.6), and the site rocks are

not gassy. Groundwater withdrawal will not cause subsidence since the metamorphic bedrock is relatively incompressible. There is no volcanic activity in the area. Since site topography is sufficiently subdued, landslides are not expected to be a problem.

5.5.1.6 Economic Geologic Resources

Locations of known prospects and mines in the vicinity of the proposed North Carolina site are shown in Figure 5.5.1-5. These were obtained from the U.S. Bureau of Mines (USBM) (1988), and the U.S.G.S. (Reid 1988b) Aggregate resources are available from numerous facilities that supply crushed rock to the region; raw materials are plentiful. Cement is not produced in the immediate vicinity of the site; however, cement supplied from neighboring states is available. Copper, gold, and silver have been produced from several mines in the area; most of these are no longer economical. Small deposits of kyanite, mica, talc, pyrophyllite, and iron, of small economic importance, are also present near the site.

A. Earthen Construction Materials

Material suitable for use as high-quality aggregate is abundant in the vicinity of the site. Aggregate production in this area includes the output of nine existing quarries, and could be expanded to include inactive quarries and permitted but as yet undeveloped resources. Aggregate sources are generally crushed rock, including diabase, gabbro, and metavolcanic rocks (Reid 1988b).

Cement is available from plants in Virginia, Tennessee, Georgia, and South Carolina, where calcareous rock of adequate grade is found. The lack of local cement production has not hindered construction in the past; cement is commonly supplied through rail shipments from these neighboring states (Reid 1988b).

B. Energy Resources

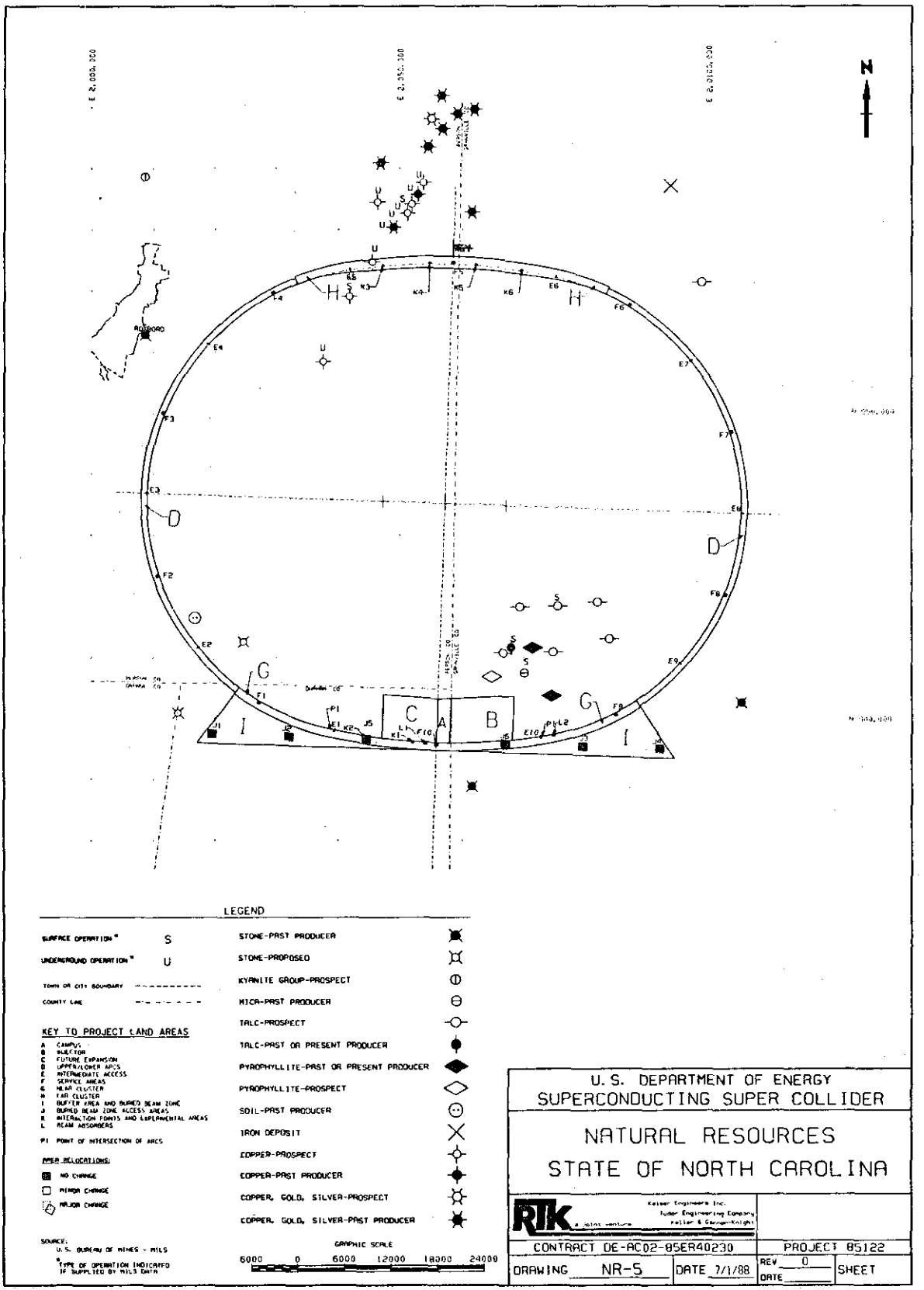
A search of oil and gas well records by Petroleum Information Corporation (1988) revealed no information regarding oil or gas exploration or production in the vicinity of the proposed site. Likewise, evidence of uranium or other energy resources was not found in files maintained by the USBM (1988).

C. Metallic Resources

Various types of metallic deposits associated with the rocks of the Slate Belt have been prospected and mined, including chromite, copper, gold, iron, lead, zinc, silver, molybdenum, and tungsten. However, very few of these deposits have proven economic, and North Carolina has not been a large-volume producer of metallic minerals (Carpenter 1976).

Figure 5.5.1-5

**LOCATIONS OF KNOWN PROSPECTS
AND MINES IN THE NORTH CAROLINA SITE AREA**



Chromium deposits of the Slate Belt are generally confined to ultramafic rocks. Two deposits prospected are located near Wilton in Granville County and in the Adam Mountain area in Wake County, southeast of the site (Carpenter 1976). No ultramafic rocks have been identified in the immediate vicinity of the site.

Copper mineralization commonly occurs as veins containing chalcopyrite, bornite, chalcocite, and malachite along shear zones and fractures in felsic metavolcanic rocks. Copper districts include the Virgilina, Gold Hill, and Cid districts, and areas in southwestern Chatham County and Guilford County (Carpenter 1976). The Virgilina district extends from Person County to Dan River in Virginia, intersecting the northern portion of the proposed ring and passing through the town of Virgilina on the North Carolina-Virginia border. Ore deposits averaged about 2% copper and small amounts of silver (Reid 1988b).

Prospects and past producers of copper in the vicinity of the ring are shown in Figure 5.5.1-5. These are concentrated along the axis of the Virgilina Synclinorium where quartz veins containing discontinuous copper mineralization are concentrated.

Two inactive copper mines, or prospects, are located inside the ring alignment, a third is on or very near the ring, and another fifteen are within 5 mi of the ring. Despite all previous exploration efforts, only a few deposits north of the site are considered potentially economic (Reid 1988b).

Gold is typically encountered free and in sulfides associated with the copper mineralization of the Virgilina district. Gold deposits are also found scattered throughout Orange County where felsic pyroclastic rocks are in contact with intrusions (Carpenter 1976). Lead, zinc, and silver have also been produced as byproducts of copper production in the area. Molybdenite is found in minor quantities throughout North Carolina; molybdenum associated with the copper and gold deposits of the Slate Belt is typically uneconomic (Carpenter 1976).

Scheelite, wolframite, and huebnerite associated with pyrite, chalcopyrite, barite, siderite, sphalerite, galena, and gold and silver have been mined for tungsten in Vance and Cabarrus counties. The Vance County mines were important producers between 1951 and 1958, but activity has been sporadic since then (Carpenter 1976). Iron oxides, including hematite, magnetite, and goethite have been mined in the Slate Belt, with most of the production concentrated in Chatham and Orange counties. There are three iron deposits near the site, one is inside the ring alignment (Reid 1988b).

D. Other Resources

Pyrophyllite and talc are present at at least ten localities inside the ring alignment (see Figure 5.5.1-5). Major pyrophyllite deposits occur on Bowlings Mountain about 3 mi northwest of Stem (Stuckey 1967). These

and other deposits contain reserves that could be mined in the future (Reid 1988b). However, pyrophyllite has never been considered a significant resource; total U.S. production in 1986 was valued at 1.75 million dollars (Reid 1988b).

Other resources identified on Figure 5.5.1-5 include an undeveloped kyanite prospect and an inactive mica mine.

5.5.2 Water Resources

5.5.2.1 Surface Water Hydrology, Quality, and Use

A. Surface Water Runoff and Flooding

The proposed North Carolina project location straddles the Neuse, Tar, and Roanoke rivers. All three flow generally southeast toward the Atlantic; the Neuse and Tar rivers empty into Pamlico Sound, and the Roanoke, into Albemarle Sound. Figure 5.5.2-1 shows the size and limits of these watersheds and the location of the SSC. The Tar River, which has its headwaters within the ring, is the only large river that intersects the ring location (Figure 5.5.2-2). Mayo Creek, which also has its headwaters within the ring, flows north into Mayo Reservoir, then into Kerr Reservoir, and finally into the Roanoke River. The Flat River, which has its headwaters west of the project location, flows east across the ring near E2, then south over the ring near J2, into Lake Michie, and finally into the Neuse River (Figure 5.5.2-2).

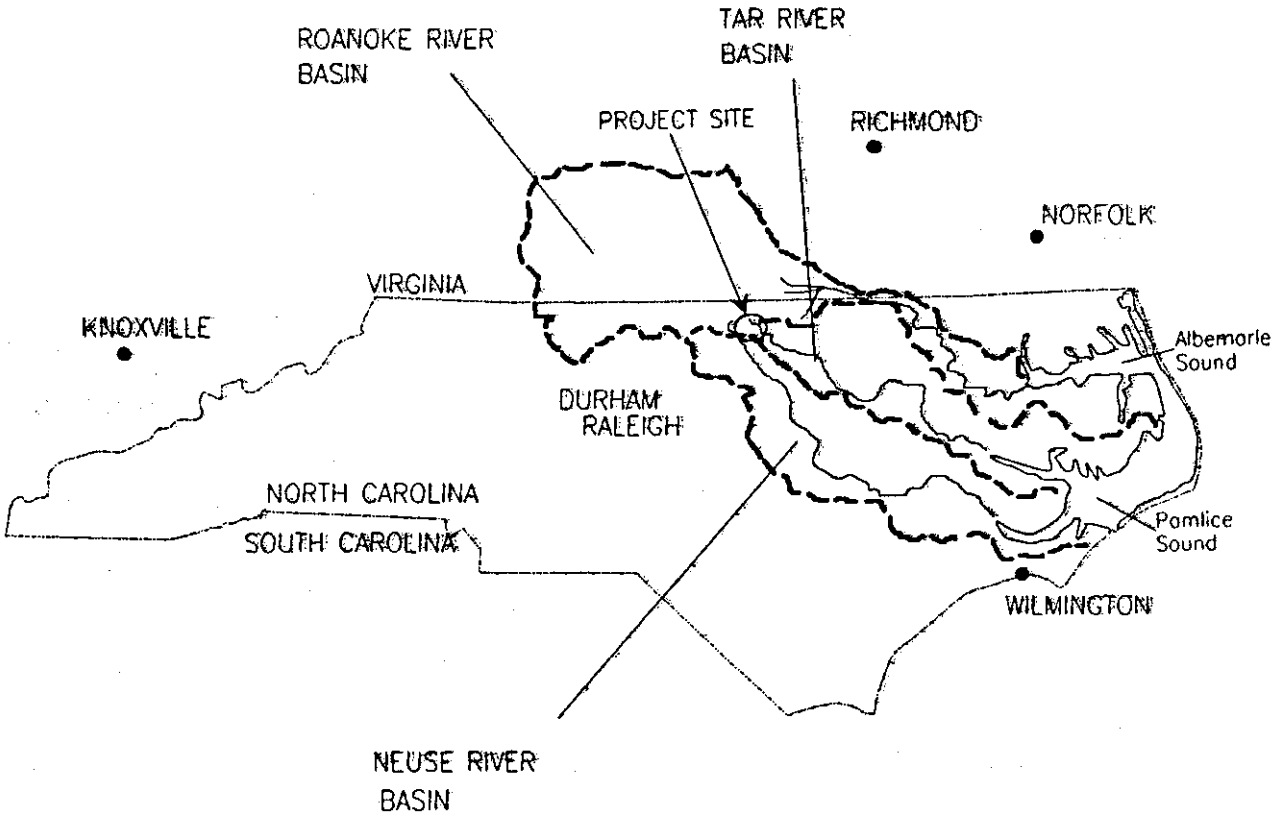
There are four active U.S.G.S. gauging stations in the project vicinity with records ranging in length from 4 to 61 years. General flow values for these stations are presented in Table 5.5.2-1. No active, unregulated U.S.G.S. stations on the Roanoke or its tributaries exist in the project vicinity, only one is available for the Tar River systems, and three are on the Neuse River or tributaries.

Six major stream channels cross the proposed ring location, four in the Neuse River drainage, one in the Roanoke River drainage, and one in the Tar River. The drainage areas, channel, and floodplain dimensions are given in Table 5.5.2-2. These watersheds are relatively small, ranging in size from Mayo Creek, with an area of 12 mi^2, to the Flat and the Tar Rivers with 141 and 123 mi^2, respectively. All of these channels are confined within moderately narrow valleys except for Mayo Creek, the smallest stream, which has one of the broadest valleys. The potential for flooding on these streams is limited because of these narrow valleys.

The Federal Emergency Managemenent Agency has developed Flood Insurance Rate Maps (FIRMs) for Durham County's unincorporated areas, including the lands traversed by the SSC ring. The Durham County FIRM covers the Flat River crossing at the ring. In Granville and Person counties, only Flood Hazard Boundary Maps (FHBMs) have been prepared. These maps cover the North and South Flat Rivers, Mayo Creek, the Tar River, and Knap of Reeds Creek. Where available, floodplain widths from the FEMA maps were incorporated into the values in Table 5.5.2-2. Only Durham County currently participates in the National Flood Insurance Program; thus, it alone has the rate maps published. Even these rate maps show flood zones without elevations, indicating that no detailed analysis of flooding has been performed. Flooding in North Carolina is generally caused

Figure 5.5.2-1

MAJOR WATERSHEDS IN NORTH CAROLINA



Source: North Carolina Department of Water and Air Resources.

Figure 5.5.2-2

HYDROLOGIC FEATURES - NORTH CAROLINA SSC SITE

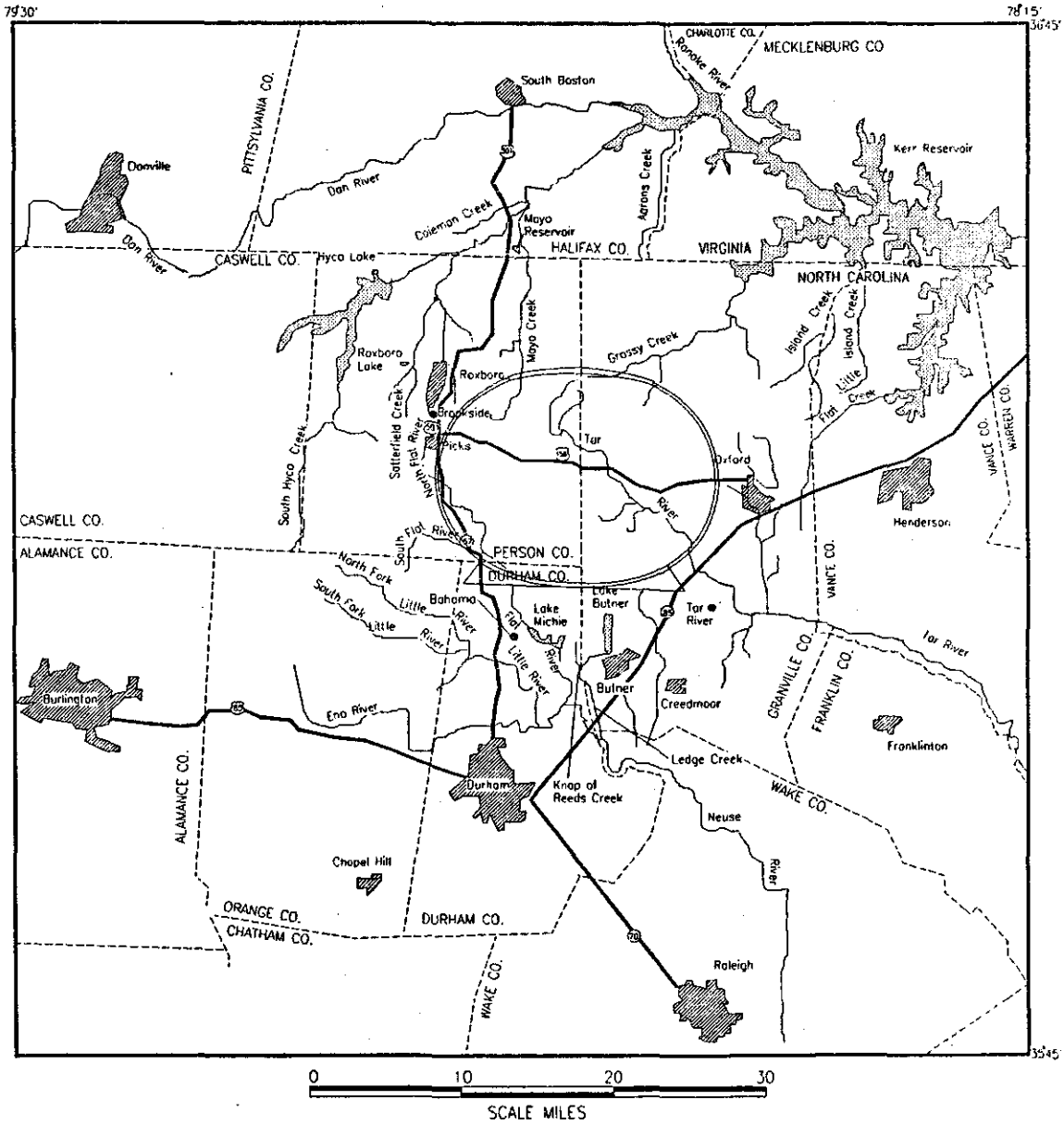


Table 5.5.2-1

GAUGE DATA IN PROJECT VICINITY

U.S.G.S. Gauge	Drainage Area mi^2	Instantaneous Maximum Flow*	Date	Minimum Flow*	Average Flow*	Flow Duration* Q5%	Q25%	Q50%	Q75%	Q95%
1. Little River near Orange Factory (No. 02085220)	80.4	9,070	10/25/71	0.01	74.0	-	-	-	-	-
2. Flat River at Bahama (No. 02085500)	149.0	20 000	7/26/38	0.27	144.0	-	-	-	-	-
3. Knap of Reeds Creek near Butner (No. 02086624)	43.0	3,210	3/6/84	1.19	52.5	-	-	-	-	-
4. Tar River near Tar River, NC (No. 02081500)	167.0	14,200	4/27/78	0.02	158.0	-	-	-	-	-

* All flow values in cubic feet per second (ft^3/s).

Source: Barker et al. 1986.

Table 5.5.2-2

CHANNEL AND FLOODPLAIN CHARACTERISTICS AT THE COLLIDER RING NORTH CAROLINA SSC SITE

Drainage Channel	Drainage Area mi^2	Bankfull Channel Width ft	Bankfull Channel Depth ft	Floodplain Width ft
Flat River near J2	141	60	5	150
S. Flat River near E2	56	40	10	200
N. Flat River near F2	20	20	6	90
Knap of Reeds Creek near F10	11	30	5	300
Mayo Creek near F4	12	10	3	400
Tar River near E9	123	50	6	400

Note: Drainage areas were measured from U.S.G.S. topographic maps, and channel widths and depths, were estimated during site visits in 1988.

Source: Federal Emergency Management Agengy 1978a, 1978b, and 1979.

by either thunderstorms during the warm season or tropical storms (and hurricanes) during the late summer or early fall. However, flooding is not restricted to only these time periods, but can occur throughout the year (Gunter, et al., 1987). An indication of this random nature of flooding is given in Table 5.5.2-1 where the four U.S.G.S. gauging stations closest to the SSC have maximum flows occurring in four different months. Historic flooding in the state is highly variable with six major floods occurring statewide over the past 75 years (Gunter et al. 1987). Little historic flooding data is available for the proposed SSC location because the site is located in smaller watersheds, and because it is rural, no heavily improved areas are affected when flooding does occur.

B. Surface Water Quality

North Carolina has recently revised its administrative code concerning classification of surface waters and establishment of water quality standards (North Carolina 1988). Five fresh water classifications are now used; three are water supply classifications (WS-I, WS-II, and WS-III), while the other two relate to uses suitable for secondary recreation and fish propagation (Class C), and suitable for swimming and primary recreation in addition to all of Class C uses (Class B). The streams in the vicinity of the proposed SSC project location are classified as follows.

Roanoke Basin	
Mayo Creek	C
Neuse Basin	
North Flat River	WS III (potential WS II)
South Flat River	WS III (potential WS II)
Flat River (L. Michie and upstream)	WS III (potential WS II)
Flat River (downstream from L. Michie)	WS III
Knap of Reeds Creek (L. Butner and upstream)	WS III (potential WS I)
Ledge and Holman creeks (L. Rogers and upstream)	WS III (potential WS I)
Tar Basin	
Tar River	WS III (possible WS I)
Jackson Creek	C
Owen Creek	C

Twenty-five sampling stations were used to gather water quality data in the general area of the SSC (see Figure 5.5.2-2) over the past 20 years. Ten are in the Neuse River basin, eight are within the Roanoke River basin, and seven are on the Tar River or its tributaries. Only seven of the 25 stations are currently active. Data from six representative stations are included in Table 5.5.2-3 as an indication of current water quality, even though two of these locations have no data after 1980. The data indicate that both the average concentrations of lead and mercury and the turbidity levels at these stations exceed standards.

Table 5.5.2-3

SURFACE WATER QUALITY DATA IN PROJECT VICINITY

Parameter		Standard	Maximum	Minimum	Average
Stream: Mayo Creek at SR 1547 STORET Station No.N4515000 Period of Record - 1985 to Present					
Fecal Coliform	#/100 ml	≤ 1,000	-	-	-
pH		6.0-9.0	7.4	5.7	6.9
Temperature	°C	-	1	24	13
Dissolved Oxygen	mg/l	≥ 5.0	12.9	7.2	10.1
Dissolved Solids	mg/l	-	-	-	-
Turbidity	NTU	≤ 50	75	15	39
Chloride	mg/l	-	-	-	-
Sulfate	mg/l	-	-	-	-
Nitrate(N)	mg/l	-	0.41	0.10	0.26
Lead	µg/l	≤ 25			≤ 50
Mercury	µg/l	≤ 0.2	0.4	0.2	0.1
Stream: Grassy Creek at SR 1325 STORET Station No. N4600000 Period of Record - 1973-1980					
Fecal Coliform	#/100 ml	1,000	-	-	-
pH		6.0-9.0	7.6	5.7	6.9
Temperature	°C	-	26	3	14
Dissolved Oxygen	mg/l	≥ 5.0	11.5	6.3	9.2
Dissolved Solids	mg/l		-	-	-
Turbidity	NTUq	≤ 50.0	600	0.5	46
Chloride	mg/l	-	-	-	-
Sulfate	mg/l	-	-	-	-
Nitrate(N)	mg/l	-	0.70	0.05	0.17
Lead	µg/l	≤ 25.0	100		54
Mercury	µg/l	≤ 0.2	-	-	< 0.5

Table 5.5.2-3 (Cont)

SURFACE WATER QUALITY DATA
IN PROJECT VICINITY

Parameter		Standard	Maximum	Minimum	Average
Stream: 14 Flat River at SR 1614 STORET Station No. J1070000 Period of Record - 1981-1987					
Fecal coliform	#/100 ml		-	-	-
pH		6.0-9.0	7.9	6.4	7.0
Temperature	°C	-	27	0	14
Dissolved oxygen	mg/l	≥ 5.0	15.8	4.5	9.2
Dissolved solids	mg/l	≤ 500.0	-	-	-
Turbidity	NTU	≤ 50.0	800	5	65
Chloride	mg/l	≤ 250.0	-	-	-
Sulfate	mg/l	< 250.0	-	-	-
Nitrate(N)	mg/l	≤ 10.0	0.77	0.01	0.31
Lead	µg/l	≤ 25.0	120		<32
Mercury	µg/l	≤ 0.2	0.2		0.1
Stream: 15 Lake Michie at Dam STORET Station No. J1090000 Period of Record - 1974-1980					
Fecal coliform	#/100 ml		-	-	-
pH		6.0-9.0	8.0	4.6	6.7
Temperature	°C	-	28	2	17
Dissolved oxygen	mg/l	≥ 5.0	13.5	2.2	8.2
Dissolved solids	mg/l	≤ 500.0	-	-	-
Turbidity	NTU	≤ 50.0	200	5	29
Chloride	mg/l	≤ 250.0	-	-	-
Sulfate	mg/l	≤ 250.0	-	-	-
Nitrate(N)	mg/l	≤ 10.0	0.59	-	0.21
Lead	µg/l	≤ 25.0	-	-	100
Mercury	µg/l	≤ 0.2	0.7	-	< 0.2

Table 5.5.2-3 (Cont)

SURFACE WATER QUALITY DATA IN PROJECT VICINITY

Parameter		Standard	Maximum	Minimum	Average
Stream: Knap of Reeds Creek at Butner STORET Station No. J1210000 Period of Record - 1969-1978					
Fecal coliform	#/100 ml		-	-	-
pH		6.0-9.0	7.6	6.0	6.6
Temperature	°C	-	28	12	22
Dissolved oxygen	mg/l	≥ 5.0	10.4	3.2	6.9
Dissolved solids	mg/l	≤ 500.0	-	-	-
Turbidity	NTU	≤ 50.0	-	-	-
Chloride	mg/l	≤ 250.0	-	-	-
Sulfate	mg/l	≤ 250.0	-	-	-
Nitrate(N)	mg/l	≤ 10.0	0.28	0.14	0.21
Lead	µg/l	≤ 25.0	-	-	< 100
Mercury	µg/l	≤ 0.2	-	-	< 0.5
Stream: Tar River at NC Highway 96 STORET Station No. 0100000 Period of Record - 1968-1987					
Fecal coliform	#/100 ml		-	-	-
pH		6.0-9.0	7.8	5.8	6.7
Temperature	°C	-	29	0	16
Dissolved oxygen	mg/l	≥ 5.0	13.7	3.8	8.4
Dissolved solids	mg/l	≤ 500.0	-	-	-
Turbidity	NTU	≤ 50.0	555	4.5	43
Chloride	mg/l	≤ 250.0	-	-	-
Sulfate	mg/l	≤ 250.0	-	-	-
Nitrate(N)	mg/l	≤ 10.0	2	-	0.26
Lead	µg/l	≤ 25.0	200	-	31
Mercury	µg/l	≤ 0.2	0.7	-	0.1

However, judging water quality in terms of the standards for the specific surface water classifications, these streams or rivers have generally fair to good water quality.

Suspended sediment yields from Piedmont watersheds in North Carolina were measured by the U.S.G.S. from 1970 to 1979. The range of suspended sediment loads carried by five streams near the proposed collider ring is from 70 to 417 ton/mi^2 per year, but four of the five streams had yields less than 200 ton/mi^2 per year. (Simmons 1988).

NPDES permits have been approved for fifteen locations in the three major basins surrounding the proposed SSC location. Thirteen of these permits are for wastewater treatment plants or for smaller package plants. The constituents governed are commonly BOD, DO, ammonia, pH, and fecal coliform for the wastewater treatment permits, and metals, chlorine, and grease for the other two permits.

C. Surface Water Use

The area surrounding the proposed SSC location is not heavily developed and depends on distributed, rural water supply systems. Durham, Butner, Creedmoor, Roxboro, and Oxford are serviced by municipal water supply systems. These systems use water from a variety of sources within the Neuse and Roanoke river basins, and Oxford uses a Tar River source as emergency back-up supply. Additional water uses include commercial and industrial water supply, and cooling water. The continued reliability of the surface water sources, especially under drought conditions, is a significant water resources issue in the area. Table 5.5.2-4 gives known water uses for different sources within the project area, and includes projected water use where available. Information was not always available on specific uses or ultimate delivery site. For example, Lake Butner supplies water for six different general users, including residential, commercial, and industrial uses. (Lake Butner was officially renamed Lake Holt in 1984, but is still commonly referred to as Lake Butner. That convention will continue here.) Actual amounts of water supplied to each user were available only for half of these and no information on residential or commercial and industrial uses within Butner or Durham was available.

Table 5.5.2-4

SURFACE WATER USE IN PROJECT VICINITY

Water Source	Use	Quantity Current acre-ft	Quantity Projected acre-ft
Neuse River Basin			
1. Lake Butner-Knap of Reeds Creek			
Butner	Residential	--	--
Durham	Residential	--	--
Durham/OWASA	Residential	975	--
Cozart Sanitary District	Comm/Indus	4	--
Lyons Station Sanitary District	Comm/Indus	220	--
Umstead State Hospital	Residential	--	--
Total		1,845	3,555
2. Lake Michie-Flat River			
Durham	Residential	20,775	43,770
3. Lake Rogers-Ledge Creek			
Creedmoor	Residential	250	525
4. Irrigators, general			
15 ponds, wells, streams	Irrigation	1,395	--
Roanoke River Basin			
1. Isaac Walton Lake-Satterfield Creek			
Roxboro	Residential	4,770	6,610
2. Kerr Reservoir-Roanoke River			
Oxford	Residential	1,306	--
Oxford	Comm/Indus	327	--
Corps of Engineers	Cooling	?	--
3. Mayo Reservoir-Mayo Creek			
CP & L Electric Generating Plant	Cooling	?	--
4. Irrigators & General 20 ponds	Irrigation	727	--
Tar River Basin			
1. Irrigators & General 75 Ponds & Wells	Irrigation	4,016	--

Sources: North Carolina Department of Natural Resources and Community Development 1988a and 1988b; Carolina Power and Light Company 1977.

5.5.2.2 Groundwater Hydrology, Quality, and Use

A. Groundwater Hydrology

The proposed SSC site is underlain predominantly by metamorphic rocks with Triassic sedimentary rocks occurring southeast of the project area. Most of the precipitation in the area becomes surface runoff and only 10 to 15% of the total precipitation percolates to the water table. The rocks underlying the site generally occur as two zones. The uppermost zone is formed by weathering of the underlying bedrock and is referred to as saprolite. The second zone underlying the saprolite consists of partially weathered and unweathered bedrock that is composed of various metamorphic, sedimentary, or intrusive rocks (Putnam and Lindskov 1973). Wells in the area are completed in the bedrock zone.

The thickness of the saprolite affects the yield of wells in the bedrock because the saprolite acts as a reservoir for downward-moving water. Where fractured rocks are pumped, water seeps downward from the saprolite so that the thicker the saprolite layer, the larger the volume of water available for withdrawal. Thickness of the saprolite ranges from a few feet near rock outcrops to 100 ft. Average thickness on hills and ridges is about 30 ft, while in stream valleys it is generally less than 20 ft thick (Putnam and Lindskov 1973). The saprolite is usually porous, but not necessarily very permeable, so that a thick layer of saprolite has a large storage and recharge potential but does not yield water to wells readily. A thick layer of saprolite may be an indication that the underlying rock has joints, fractures, or pores that contain water (May and Thomas 1968). Hydraulic conductivities reported for the saprolite in the area range from 10^{-4} to 10^{-6} cm/s (Sowers and Richardson 1983).

The relative yield of wells expressed in gallons per minute per foot of well varies according to the topographic location, depth, and rock unit penetrated by the well. Wells on hills generally have slightly lower relative yields than those located in draws. Similarly, the relative yield of wells decreases with depth. The relative well yield is also a function of the rock unit penetrated. The igneous and metamorphic rocks, predominantly gneisses, schists, and granite, are usually the most productive of the bedrock zones. The metavolcanic rocks are composed primarily of tuffs, breccias, phyllites, argillites, and graywacke. The size and interconnection of fractures in these rocks are usually less than the igneous and metamorphic rocks and as a result, the water-bearing characteristics of the metavolcanics are not as favorable for well development. The Triassic sedimentary rocks consist of sandstone, siltstone, shale, and conglomerate that have a variable lithology and generally low conductivity, making them the least favorable for groundwater development (May and Thomas 1968).

Table 5.5.2-5 is a summary of the water-bearing properties of the bedrock types in the SSC site vicinity. As shown on the table, the Triassic rocks tend to be less productive, with an estimated sustained

Table 5.5.2-5

SUMMARY OF WATER-BEARING PROPERTIES OF THE BEDROCK IN THE VICINITY OF THE NORTH CAROLINA SSC SITE

Rock Type	Range of Sustained Yields ac-ft/yr/mi^2	Range of Average Relative Well Yields gal/min/ft of well
Triassic	20 - 65	0.04 - 0.06
Metavolcanic and metasedimentary	145 - 335	0.06 - 0.25
Gneiss and schist	225 - 280	0.06 - 0.15
Igneous intrusive	280 - 335	0.05 - 0.19
Argillite and graywacke	NA	0.07 - 0.25

NA = Not Available

Sources: North Carolina Department of Natural Resources and Community Development, 1983 and 1986; May and Thomas, 1968; Bain and Thomas, 1966.

yield that ranges from 20 to 65 acre-ft/yr/mi^2. This is considerably lower than the estimated sustained yield for the three other rock types shown on the table. The range of average relative well yields also demonstrates this difference in the water-bearing properties of the various rock types. Again, the Triassic rocks exhibit lower relative well yields than the other rock types, with highest average relative well yields of 0.06 gal/min/ft of well compared with a high of 0.25 gal/min/ft of well for the argillite-graywacke sequence.

The hydraulic conductivity of the metavolcanic and metasedimentary rocks at the SSC site has been estimated to range from 1.5×10^{-3} to 7.6×10^{-5} cm/s based on tests of wells drilled for the project. The hydraulic conductivity of the intrusive rocks at the site ranges from 5.1×10^{-5} to 2.5×10^{-6} cm/s (Law Engineering 1987).

1. Person County

The oldest rocks in Person County are the metamorphic bedrocks that consist of gneisses and schists, covered by thick saprolite. The metavolcanic rocks consist of tuffs and flows that are slightly metamorphosed. The metavolcanic rocks are overlain by a predominantly sedimentary unit designated as argillite-graywacke. These rocks are overlain by tuffs and flows. All the bedrock units are intruded by granite, granodiorite, diorite, and gabbro plutonic masses (Bain and Thomas 1966).

The average depth of wells in the bedrock units range from about 67 ft to 134 ft. Average reported water level is about 24 ft below land surface. Seasonal fluctuations in the water table can be as high as 12 ft within one year. The relative yield of wells in gal/min/ft of well ranges from 0.06 in the gneisses and metavolcanics to 0.09 in the granite and granodiorite. Well yields are generally less than 10 gal/min, but a few wells in the county are reported to yield 25 to 30 gal/min (Bain and Thomas 1966). Sustained groundwater yields range from 290 acre-ft/yr/mi^2 in areas underlain by granitic rock to 145 acre-ft/yr/mi^2 in areas underlain by other rock types (North Carolina Department of Natural Resources and Community Development 1986).

2. Durham County

In the northern part of Durham County, groundwater yields are sufficient to supply many users, whereas in the southern part of the county, it is difficult to obtain sufficient water even for domestic use. Geologic variations account for these differences in water-bearing properties. The northern portion of the county is underlain by metamorphosed sedimentary and volcanic rocks and igneous intrusive rocks. The southern portion is underlain by Triassic rocks that are intruded by diabase dikes (Bain and Thomas 1966). The Triassic rocks are composed of sandstones, shales, and coarse fanglomerate rocks, which are poor aquifers because of the impervious nature of the soils, poor sorting of the materials, and irregular bedding within the rock unit. The safe sustained yield of this geologic unit is estimated to be 65 acre-ft/yr/mi^2 and

individual well yields are usually less than 10 gal/min. Where the dikes are numerous, well yields as high as 50 gal/min have been obtained. The average pumping yield of wells in the Triassic Unit is 16.5 gal/min (North Carolina Department of Natural Resources and Community Development 1983). The average well yield for wells completed in the Triassic sediments is about 0.06 gal/min/ft of well (Bain and Thomas 1966).

Those wells in the northern part of the county that tap the metavolcanics and metasedimentary rocks have an average yield of 42 gal/min. These rocks are capable of yielding between 225 and 280 acre-ft/yr/mi^2. Average specific capacity of wells in the northern part of the county is 0.25 gal/ min/ft of drawdown. Average yield of wells completed in the metavolcanics is 0.11 gal/min/ft of well (Bain and Thomas 1966). The average depth to water in wells in the metavolcanics and metasedimentary rocks in the northern part of the county is 21 ft. Average depth of wells in these sediments is 370 ft with the range being between 180 and 500 ft (North Carolina Department of Natural Resources and Community Development 1983).

3. Granville County

Metavolcanic rocks underlie most of the county and include minor beds of metasedimentary rocks. Rocks of volcanic origin include tuffs, breccias, flows, and basalt, with a few beds of conglomerate and quartzite. Argillite and graywacke rocks underlie a small area in the extreme northwestern corner. Intrusions of granodiorite also occur. Triassic rocks intruded by diabase dikes occur in the southern portion (May and Thomas 1968).

The average yield of wells is about 10 gal/min with the range being 0 gal/min in the Triassic rocks to 60 gal/min in the granodiorite. Average yield of wells per foot of well in all rock types is 0.11 gal/min/ft of well with the highest yields occurring in the argillite-graywacke unit (May and Thomas 1968). No estimate of the sustained groundwater yield of the various rock units was available but it would be expected that these would be similar to those reported for the same rock types in adjacent counties.

Average depth of wells is 94 ft and ranges from 70 to 141 ft. Average water level in the area is 23 ft below the surface and ranges from flowing to 72 ft below the surface. Depth of wells ranges from 28 to 487 ft with the average being about 65 ft (May and Thomas 1968).

Two springs are used as water supply sources. The yields of these springs ranges from 2 to 7 gal/min. The source rock for both springs is the metavolcanic sequence (May and Thomas 1968).

B. Groundwater Quality

The chemical quality of groundwater in the project does not show consistent relation to the rock units. Table 5.5.2-6 provides a summary of the groundwater quality in Durham, Person, and Granville counties by the

Table 5.5.2-6

GROUNDWATER QUALITY IN DURHAM, PERSON, AND GRANVILLE COUNTIES - NORTH CAROLINA

	Range of Chemical Constituents mg/l				
Source	Total Dissolved Solids	Chloride	Sulfate	Iron	Hardness* $CaCO_3$
National drinking water standards	500	250	250	0.3	None
Triassic rocks	200-806	16-337	4-24	0-0.33	37-524
Metavolcanics/ metasedimentary rocks	25-407	0.3-134	2.2-121	0.02-3.2	9-292
Granite and granodiorite	64-449	1-73	1-26	0.06-2.8	14-357
Gneiss and schist	68-406	0.2-128	2.2-67	0.03-0.4	12-291
Argillite - graywacke	81-456	3-139	2.6-10	0.05-1.4	72-354
Diorite	250	16	32	0.06	179

*Typical classifications of the hardness of water are as follows: 0-60 mg/l = soft to slightly hard; 60-120 mg/l = moderately hard; 120-180 mg/l = hard; >180 mg/l = very hard.

Sources: Bain and Thomas 1966; Driscoll 1986; May and Thomas 1968; U.S. Environmental Protection Agency 1977.

bedrock units. Groundwater in the area is of the sodium, calcium, and magnesium bicarbonate type. Total disolved solids in groundwater ranges from a low of 25 mg/l in the metavolcanic/metasedimentary rocks to a high of 806 mg/l in the Triassic rocks.

C. Groundwater Use

Groundwater in the vicinity of the SSC project is used principally for individual residences, commercial establishments, irrigation, and industries that are not connected to existing public water supply systems. Table 5.5.2-7 is a summary of the existing data available on groundwater use in Durham, Granville, and Person counties. The information on rural, irrigation, and industrial use is for 1986 and was provided by the North Carolina Department of Natural Resources and Community Development. As shown on the table, a limited amount of groundwater is used in the project area. There are no public water supplies in the three counties that are derived from the groundwater (Mann 1978). There is only one industrial user that is located in Durham County presently using groundwater as a supply source.

Table 5.5.2-7

GROUNDWATER USE IN DURHAM, GRANVILLE, AND PERSON COUNTIES - NORTH CAROLINA (Acre-ft/yr)

County	Public Supplies	Rural	Irrigation	Industrial
Durham	0	80	110	0.2
Granville	0	750	0	0
Person	0	500	0	0

Sources: Mann, 1978; North Carolina Department of Natural Resources and Community Development 1988a and 1988b.

5.5.3 Climate and Meteorology

5.5.3.1 General Description

The climate in North Carolina mainly varies as a function of elevation and proximity to the Atlantic Ocean. The climate in the Piedmont region is moderated by the Appalachian Range, which prevents cold fronts spreading southeastward across the United States from crossing into North Carolina. Another influence on the climate is the proximity of the state to the meeting location of the cold Labrador Current and the warm Gulf Stream. Low pressure systems develop here that cause rain in North Carolina and in other states to the north (National Oceanic and Atmospheric Administration 1974).

5.5.3.2 Temperature

Summer temperatures rarely exceed 100°F because cloud development inhibits solar insolation while temperatures are still in the 90°s (National Oceanic and Atmospheric Administration 1974). Temperatures range from an average low temperature of 32°F in December to an average high temperature of 90°F in June, July, and August. The extreme high temperature recorded was 105°F, which occurred in July; the extreme low temperature recorded was -2°F, which occurred in February. The temperature drops below freezing on an average of 65 days per year. Frost penetration reaches an average of 2 inches and an extreme of 8 inches in depth (U.S. Weather Bureau 1941). Normal and extreme temperature and heating degree-day data are shown in Table 5.5.3-1.

5.5.3.3 Precipitation

The seasonal variation in rainfall in North Carolina does not produce wet and dry seasons. Rain in the summer is produced mostly by thunderstorms and convective showers, and is more variable than other seasons. Winter rain occurs in conjunction with migratory low-pressure storms, appears in greater frequency, and is more evenly distributed than summer precipitation (National Oceanic and Atmospheric Administration 1974).

The North Carolina South Piedmont climatic region receives a mean of 46.12 inches of rain per year. The peak month for precipitation is July, with a mean of 5.77 inches. The month with the least precipitation is November, with a mean of 2.76 inches. The region receives an average of 4 inches of snow per year. Mean precipitation and snowfall data are shown in Table 5.5.3-2. Also, 1-, 2-, 5-, 10-, 25-, 50-, and 100-yr return period extreme rainfall data are shown in Table 5.5.3-3.

Table 5.5.3-1

NORMAL AND EXTREME TEMPERATURE DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average maximum temperature, °F	55	57	65	72	80	90	90	90	86	75	65	55
Average minimum temperature, °F	35	32	40	48	57	65	68	68	62	50	38	32
Highest	80	82	94	95	99	104	105	103	104	98	88	79
Lowest	2	-2	11	23	32	44	49	49	37	19	14	0
Heating degree-days	690	580	480	160	20	0	0	0	10	120	440	690

Source: U.S. Environmental Science Services Administration 1968.

Table 5.5.3-2

MEAN PRECIPITATION AND SNOWFALL DATA

NORTH CAROLINA SOUTH PIEDMONT CLIMATIC REGION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly precipitation, inches	3.65	3.40	4.30	3.65	3.29	3.82	5.77	5.05	3.91	2.82	2.76	3.70
Mean monthly snowfall, inches	1.2	1.5	0.5	0	0	0	0	0	0	0	0	0.8

Source: U.S. Environmental Science Services Administration 1968.

Table 5.5.3-3

MAXIMUM 1-HOUR AND 6-HOUR RAINFALL
BY RETURN PERIOD

Return Period Yrs	Rainfall (inches) 1-Hour	6-Hour
1	1.4	2.2
2	1.6	2.5
5	2.1	3.3
10	2.4	3.8
25	2.8	4.2
50	3.1	5.0
100	3.4	5.5

Source: U.S. Weather Bureau 1961.

5.5.3.4 Wind

The prevailing wind direction is towards the northeast at an annual average speed of 8 mi/h. The monthly average speeds are uniform, and vary from 7 mi/h to 10 mi/h. The fastest recorded wind speed was 57 mi/h, which occurred in January, June, and December. Average wind speed and direction data are shown, by month, in Table 5.5.3-4.

5.5.3.5 Humidity

The yearly mean relative humidity in the region of the SSC site is 70%. The monthly average relative humidity reaches a peak of 80% in August and September, and reaches its lowest value in April at 65%. Mean and maximum dewpoint and mean relative humidity data are shown in Table 5.5.3-5.

5.5.3.6 Severe Weather

Severe weather in the region of the SSC site can be best understood through discussion of tornadoes, extreme winds, thunderstorms, and hail. Atlantic coast hurricanes do not penetrate as far inland as the site location, although North Carolina does experience, approximately once in every ten years, hurricanes that strike with enough force to cause damage inland (National Oceanic and Atmospheric Administration 1974).

Tornadoes in the region of the site are relatively rare since North Carolina is outside the principal U.S. tornado area. The yearly probability of a point being struck by a tornado is 4.41×10^{-4}, which corresponds to a return period of 2,300 years (Thom 1963).

Table 5.5.3-4

MONTHLY AVERAGE WIND SPEED AND DIRECTION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average wind speed, mi/h	9	9	9	10	8	7	7	7	7	8	8	7
Wind blowing toward:	NE	SW	NE	N	NE	NE	NE	N	SW	SW	NE	NE

Source: U.S. Environmental Science Services Administration 1968.

Table 5.5.3-5

DEWPOINT AND RELATIVE HUMIDITY DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean dewpoint temperature, °F	32	32	36	46	56	64	67	67	61	50	39	32
Maximum 12 h 1000 mB dewpoint, °F	66	66	68	70	74	76	78	78	76	74	70	67
Mean relative humidity, %	70	70	70	65	70	70	75	80	80	70	70	72

Source: U.S. Environmental Science Services Administration 1968.

For the years 1950-1986, 107 tornadoes were observed within a 50-nautical mile radius of Roxboro. These events caused 2 deaths and 32 injuries (National Severe Storms Forecast Center 1988).

Extreme expected winds in the region are shown in Table 5.5.3-6 by wind speed and return period.

Table 5.5.3-6

EXTREME WIND SPEED AND RETURN PERIOD DATA

Return Period Yrs	Wind Speed mi/h
10	59
25	69
50	78
100	90

Source: Thom 1968.

Thunderstorms occur in the region on an average of 62 times per year, with peak activity in May, June, July, and August (National Climatic Center 1981). Hail greater than 0.75 inches in diameter is observed, on the average, 0.54 times per year (U.S. Weather Bureau 1969).

5.5.4 Air Quality

5.5.4.1 Conditions Affecting Air Quality

A. Topographical

The North Carolina site is rural, located in gently rolling hills and hollows, and is mostly wooded. This area is influenced somewhat by the Smokey Mountains approximately 130 mi to the west. There are, however, no major adverse topographical influences on wind dispersion in this terrain.

B. Meteorological

The ability of the atmosphere to disperse a pollutant is categorized in part by its stability classification. The stability classification was described in detail in Appendix 5, Section 5.1.4. The site's relative frequency of occurrence of the six stability classes is shown in Table 5.5.4-1. Class A has the highest degree of dispersion.

Table 5.5.4-1

FREQUENCY OF OCCURRENCE OF ATMOSPHERIC STABILITY CLASSES

Class	Definition	% Occurrence
A	Extremely unstable	1
B	Unstable	7
C	Slightly unstable	13
D	Neutral	42
E	Slightly stable	14
F	Stable and extremely stable	23

Source: National Climatic Data Center 1/82 - 12/86.

G. C. Holzworth's number of forecast days for high air pollution potential is higher than the national average, falling between 10 and 20 (Holzworth 1972). Holzworth's methodology was discussed in greater detail in Appendix 5, Section 5.1.4. The influence of winds on dispersion conditions on an annual basis is demonstrated in Table 5.5.4-2.

Table 5.5.4-2

ANNUAL FREQUENCY OF WIND SPEED AND DIRECTION NORTH CAROLINA SSC SITE

	Speed - knots						
Direction	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	Greater than 21	Total
N	011166	.030734	.034205	.012079	.001073	.000046	.089302
NNE	.010376	.025117	.025049	.009270	.000206	.000023	.070040
NE	.010529	.026784	.020596	.003562	.000000	.000000	.061470
ENE	.007080	.020301	.014111	.001918	.000000	.000000	.043911
E	.011659	.030369	.014408	.001667	.000000	.000000	.058103
ESE	.016045	.029981	.011988	.001827	.000160	.000023	.060023
SE	.013458	.022445	.010298	.001850	.000251	.000000	.048302
SSE	.009794	.020984	.012376	.002763	.000069	.000023	.046008
S	.019679	.050051	.033063	.007056	.000206	.000023	.110077
SSW	.012862	.038109	.028999	.007558	.000434	.000023	.087985
SW	.010228	.027469	.025300	.009019	.000959	.000023	.072998
WSW	.006336	.019957	020756	.009270	.001142	.000046	.057507
W	.005442	.017879	.019020	.008129	.001256	.000137	.051862
WNW	.004977	.013244	013883	.009681	.001416	.000114	.043315
NW	.005353	.015687	.015664	010344	.001735	.000206	.048988
NNW	.005835	.016486	017171	.009933	.000617	.000069	.050109
Total	.160817	.406097	.316885	.105925	.009522	.000754	

Source: National Climatic Data Center 1/82-12/86.

Selected ambient air quality monitoring stations are plotted in Figure 5.5.4-1. The table is an annual summary of the frequency of wind speed and direction for the Raleigh first-order National Weather Service Station (NCDC 1988).

5.5.4.2 Air Quality

A. Applicable Standards

The National Ambient Air Quality Standards (NAAQS) (40 CFR 50) function as the applicable regulatory levels in the state of North Carolina. The standards are shown in Table 5.5.4-3.

B. Background Concentrations

A portfolio of values was assembled to quantify ambient air pollutant concentrations. Air pollutant concentrations with the values shown for averaging periods of less than 1 yr are the highest measure in the region. These values are delineated, along with the applicable standards for each pollutant, in Table 5.5.4-3.

C. Compliance Status

None of the counties potentially impacted by the North Carolina SSC site in either North Carolina or Virginia is in a nonattainment area for the six criteria pollutants listed in Table 5.5.4-2 (U.S. EPA 1985).

D. Proximity to Sensitive Areas

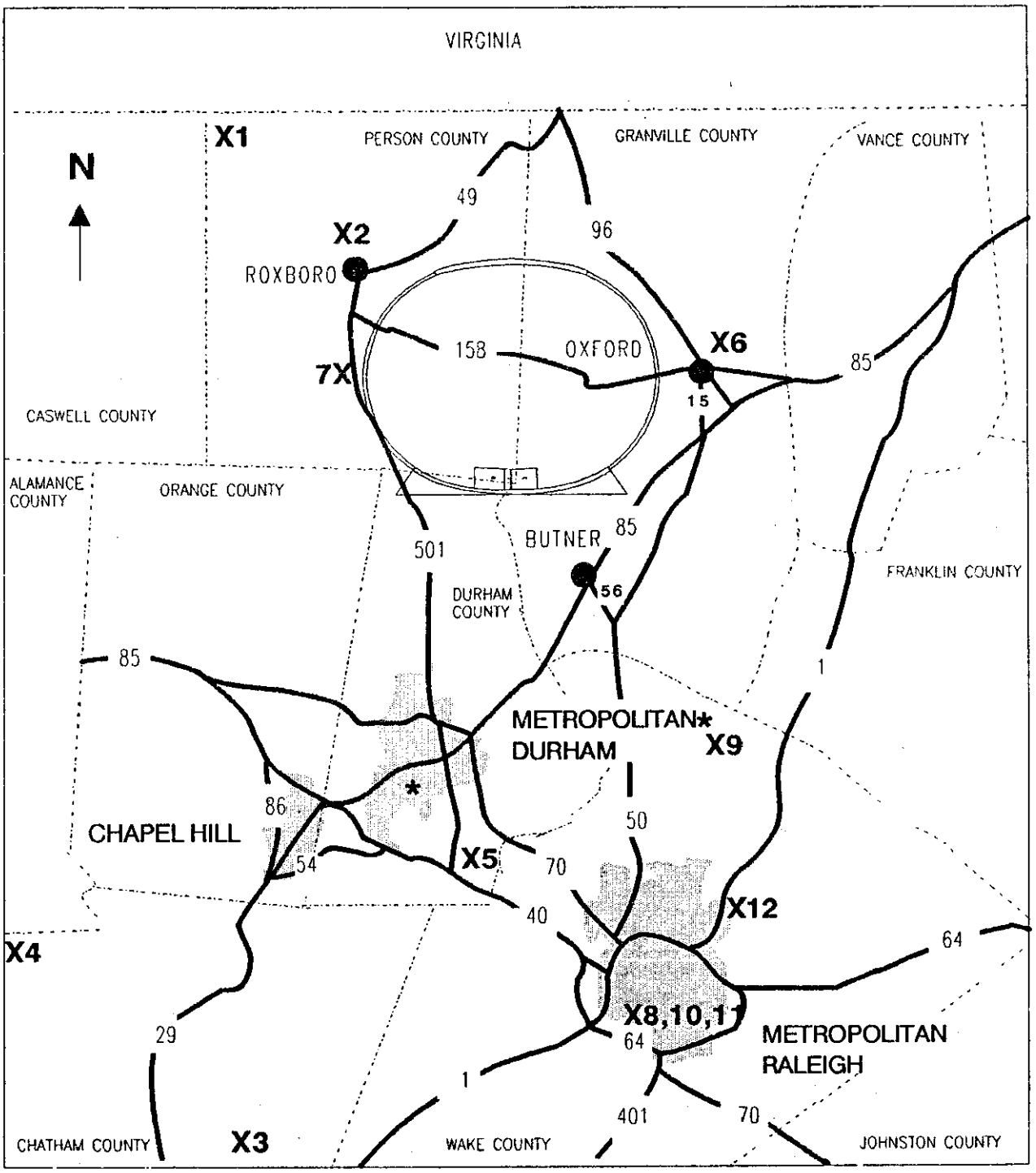
The proposed North Carolina SSC site is located in a Prevention of Significant Air Quality Deterioration (PSD) Class II area, that allows for moderate growth in air pollutant emissions. The closest PSD Class I area, which permits minimal air quality deterioration is Linville Gorge Wilderness approximately 125 mi west of the site.

5.5.4.3 Regional Air Pollution Sources

Air pollutant sources in the site vicinity include a Carolina Power and Light coal-fired electricity-generating station and a cogeneration facility. The permitted emissions for these two PSD sources are shown in Table 5.5.4-4 along with emissions of other air pollutant sources. These sources are plotted in Figure 5.5.4-1.

Figure 5.5.4-1

**AMBIENT AIR QUALITY MONITORING STATIONS
AND REGIONAL AIR POLLUTION SOURCES
NORTH CAROLINA SITE**



X = Regional Air Pollutant Source

* = Ambient Air Monitoring Station

Table 5.5.4-3

AMBIENT AIR POLLUTANT ALLOWABLE CONCENTRATIONS AND BACKGROUND LEVELS

Pollutant Averaging Time	NAAQS Standard $\mu g/m^3$	Background Concentration $\mu g/m^3$	Point Measured at
TSP-24-hr	260	81*	Durham, 1985
TSP-Annual geo. mean	75	47	Durham, 1985
SO_2-3-hr	1300	293*	Greensboro, 1985
SO_2-24-hr	365	90*	Greensboro, 1985
SO_2-Annual	80	15	Greensboro, 1985
NO_2-Annual	100	28	Winston-Salem, 1985
CO-1-hr	40,000	26,000*	Durham, 1985
CO-8-hr	10,000	15,000*	Durham, 1985
O_3-1-hr	235	228*	Wake Forest, 1985
Pb-Calendar Quarter	1.5	0.4*	Greensboro, 1985

* Highest representative regional value given.

Source: Ambient Air Quality Data Report 1985 State of North Carolina, 1986.

Table 5.5.4-4

REGIONAL AIR POLLUTANT SOURCES
NORTH CAROLINA SSC SITE

Source Name	Location	Permitted or Actual Emissions (tons/yr)				
		SO_2	TSP	NO_x	CO	VO_c
1. Carolina Power and Light	Mayo	41,407	3,452	24,158	188	22
2. Cogentrix Carolina Leasing	Roxboro	4,349	80	1,594	1,594	7.3
3. Allied Signal	Moncure	-	244	<1	<1	<1
4. Collins & Alvman	Silver City	-	128			
5. General Electric	Research Triangle Park	6	6	<1	<1	10
6. Certainteed	Oxford	74	36	<1	<1	<1
7. Martin Marietta	Timberlake	<1	44	<1	<1	<1
8. Ajinomoto	Raleigh	799	66	12	<1	<1
9. Burlington	Wake Forest	<1	37	<1	<1	<1
10. Mallinckodt	Raleigh	296	20	<1	<1	<1
11. Martin Marietta	Raleigh	<1	34	<1	<1	<1
12. Wake Stone	Knightdale	<1	31	<1	<1	<1

Source: North Carolina Division of Environmental Management 1988.

5.5.5 Noise and Vibration

This section describes background noise and vibration conditions at the proposed North Carolina SSC site.

5.5.5.1 Ambient Noise Levels

A. Applicable Standards

Applicable noise abatement criteria have been promulgated by Durham County (for Research Triangle Park), the Federal Highway Administration (FHWA), and the Department of Housing and Urban Development (HUD). Durham County has promulgated noise emission regulations for Research Triangle Park facilities. Noise levels from any facility are not to exceed the octave-db levels listed in Table 5.5.5-1, as adjusted by considerations delineated in Table 5.5.5-2. (North Carolina Department of Transportation). FHWA and HUD noise abatement criteria are in Section 5.1.5.

Table 5.5.5-1

MAXIMUM PERMISSIBLE SOUND-PRESSURE LEVELS FOR NOISE RADIATED CONTINUOUSLY FROM A FACILITY (DURHAM COUNTY)

Frequency band (Hz)	Decibel level
20 - 75	69
75 - 150	54
150 - 300	47
300 - 600	41
600 - 1,200	37
1,200 - 2,400	34
2,400 - 4,800	31
4,800 - 10,000	28
10,000 - 20,000	26
20,000 - 30,000	25
30,000 - 40,000	24
40,000 - 50,000	23

Source: North Carolina Department of Transportation 1988.

Table 5.5.5-2

CORRECTIONS TO MAXIMUM PERMISSIBLE SOUND-PRESSURE LEVELS FOR NON-CONTINUOUS NOISE (DURHAM COUNTY)

Type of Operation or Character of Noise	Correction (decibels)
Noise source operates less than 20% of any 1-h period	+5*
Noise source operates less than 5% of any 1-h period	+10*
Noise source operates less than 1% of any 1-h period	+15*
Noise of impulsive character (hammering, etc.)	-5
Noise of periodic character (hum, screech, etc.)	-5

* Apply one of these corrections only.

Source: North Carolina Department of Transportation

B. Background Levels

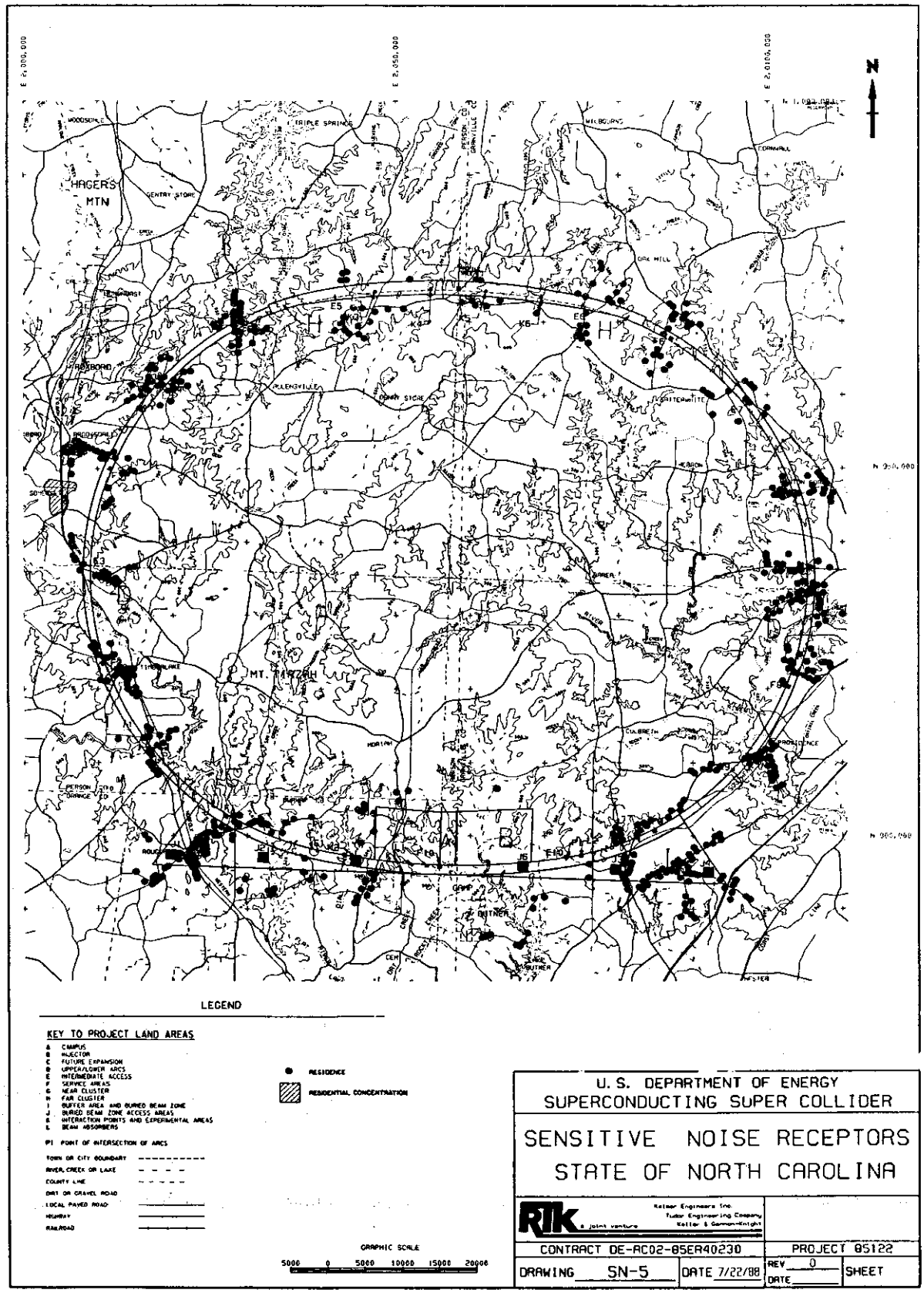
Existing noise levels are typical of agricultural areas, and range from a low of 34 dBA to 72 dBA, measured at a point 50 ft away from Interstate 85 (UNC-Chapel Hill 1988). The day-night sound level is expected to average 40 dBA. (EPA 1982)

C. Proximity to Sensitive Areas

Sensitive receptors in the region of the site include churches, hospitals, schools, and residences. Both hospitals in the project vicinity, Granville Hospital in Oxford and Person County Hospital in Roxboro, are more than 2 mi from the ring. Other sensitive receptors include Helena School and North Granville School, which are located between 1/2 and 1 mi away from the ring. Ten rural churches are located within 1 mi of the ring. Sensitive receptors in the project vicinity are shown in Figure 5.5.5-1.

Figure 5.5.5-1

**SENSITIVE NOISE RECEPTORS
NORTH CAROLINA SSC SITE**



5.5.5.2 Other Noise Sources

Primary sources of noise in the region include road traffic and farm equipment. Hourly L_{eq}'s measured at various points ranged from 72 dBA at I-85 to 54 dBA at State Route 1607 and at State Route 1004 (UNC Chapel Hill 1988).

5.5.5.3 Ambient Vibration Levels

Ambient vibration levels are highly dependent on proximity to man-made sources. Naturally occurring vibrations that result from weather phenomena exciting vibrations that travel long distances in the earth are low frequency (1 Hz or less). Large, distant earthquakes will also produce vibrations at the site.

5.5.5.4 Other Vibration Sources

Major man-made vibration sources in the region include roads, railroad lines, and quarries. Principal roads include Interstate Highway 85 and U.S. Route 501. Interstate Highway 85 passes within 1.8 mi of the collider ring and within 7 mi of an interaction point K1. U.S. Route 501 crosses the ring, and passes within 3.3 mi of interaction point K2.

Railroad lines in the project vicinity include the Southern and the Norfolk and Western. The Southern railroad line crosses the ring, and passes within 5.4 mi of an interaction point K1. The Norfolk and Western railroad line passes within 0.6 mi of the collider ring and within 6.4 mi of interaction point K3.

Quarries in the vicinity include the Butner quarry, which is located within 6.5 mi of the collider ring, and within 7.3 mi of K1. A Nello Teer quarry has been permitted for a site located 4,000 ft from J1.

Monitored vibrations in the vicinity of the collider ring are shown in Table 5.5.5-3. Roads and railroads in the project vicinity are shown in Figure 5.5.5-2.

Table 5.5.5-3

REGIONAL VIBRATIONS
NORTH CAROLINA SSC SITE

Measurement Point Location	Vibrations[1] Vertical Displacement, in	Vertical Freq, Hz	Horizontal N-S Disp, in	Horizontal N-S Freq, Hz	Horizontal E-W Disp, in	Horizontal E-W Freq, Hz
Interaction area K1 (surface)	N/A	N/A	2×10^{-6}	1-10	2×10^{-6}	1-10
Interaction area K2 (surface)	1×10^{-6}	1-10	3×10^{-6}	1-10	4×10^{-6}	1-10
Interaction area K3 (surface)	1×10^{-6}	1-20	2×10^{-6}	1-10	2×10^{-6}	1-10
Interaction area K4 (surface)	1×10^{-6}	1-10	1×10^{-6}	1-10	1×10^{-6}	1-10
Interaction area K5 (surface)	2×10^{-6}	1-10	3×10^{-6}	1-10	2×10^{-6}	1-10
Interaction area K6 (surface)	2×10^{-6}	1-10	2×10^{-6}	1-10	2×10^{-6}	1-10

Notes:

1. Maximum peak-to-peak ground motion

N/A: Not Available

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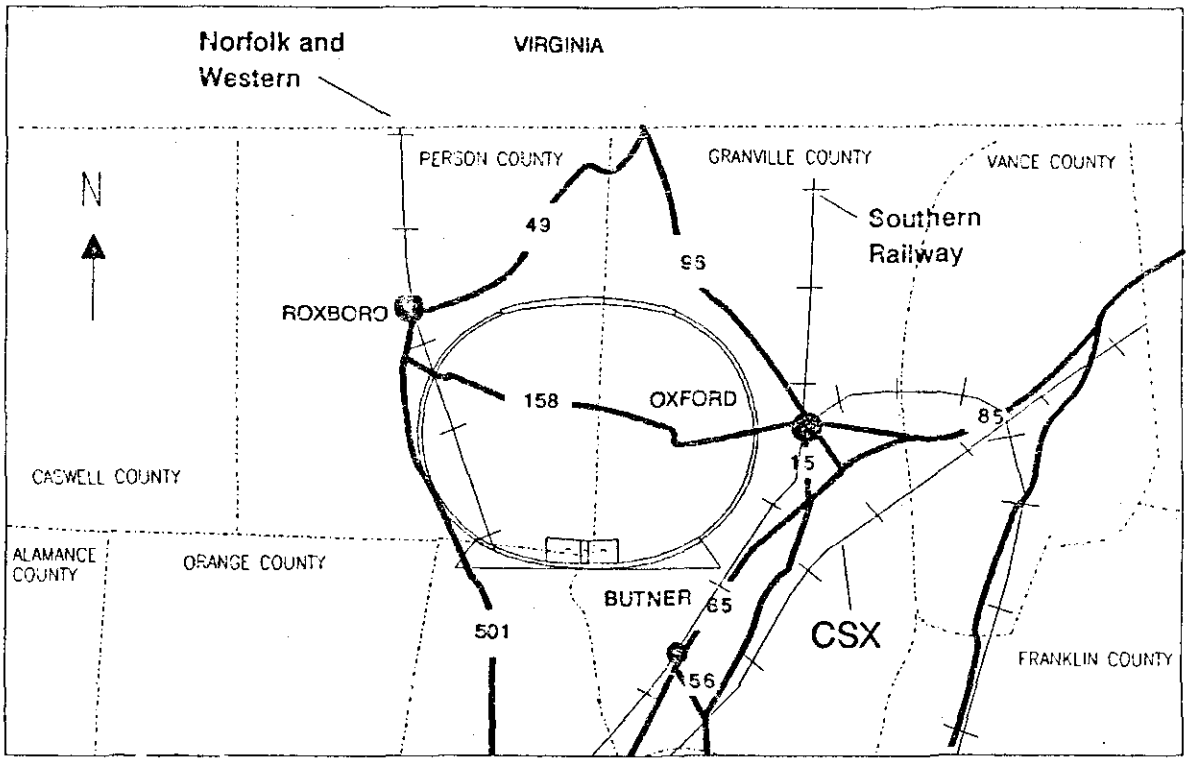
Figure 5.5.5-2

**REGIONAL VIBRATION SOURCES
NORTH CAROLINA SSC SITE**



5.5.6 Environmental Radiation

5.5.6.1 Natural Radioactivity

A. Radon

Indoor radon levels reported by the University of Pittsburgh Radon Project are presented in Table 5.5.6-1. Radon levels in residences in Durham County averaged 1.57 pCi/l (Cohen 1988). Data compiled by the Radiation Protection Section of the Department of Human Resources, State of North Carolina, indicated indoor radon levels from 0.2 to 7.80 pCi/l with an average of 1.56 pCi/l for homes in Durham, Granville, and Person counties (NC 1988a).

Radon levels in three ground water wells in the vicinity of the proposed SSC site ranged from 352 to 2,988 pCi/l with an average of 1,413 pCi/l (NC 1988a). The average radon levels in public water supplies from a ground water survey of all locations performed in 1974 by the State of North Carolina was 2,933 pCi/l. An additional survey by the EPA at 166 locations yielded an average of 544.9 pCi/l of Rn-222 (NC 1988a).

The Ra-226 concentrations in core samples from the proposed tunnel depth ranged from 0.05 to 0.75 pCi/g with an average of 0.33 pCi/g (NC 1988a).

There are no identified uranium deposits in the proposed site (Councill 1955) (AEC 1969).

B. Soil/Rock

Two soil samples collected near the proposed SSC ring were analyzed for U-238, Th-232 and K-40 concentrations (NC 1988a). The concentrations, as reported in pCi/g, were less than 0.03 and 0.38 for U-238, 0.81 and 0.59 for Th-232, and 4.7 and 7.2 for K-40.

Natural Uranium Resource Evaluation (NURE) aerial gamma-ray surveys for Bismuth-214 do not indicate elevated radiation levels over the site and areas up to 10 mi away (NURE 1979). Typical measurements are 10-20 counts/sec/div, which indicate the uranium content in the surface soil is approximately 1 pCi/g or less (Bennett 1988).

Eight core samples from six locations ranging in depth from 8.8 ft to 238.6 ft were analyzed using gamma spectroscopy (NC 1988b) for radium/radium daughters. Two of these samples were at shallow depths--8.8 ft and 13.4 ft--and yielded results of 1.08 pCi/g and 0.55 pCi/g, respectively. The other six cores were from 116.9 ft to 238.6 ft and ranged from 0.05 pCi/g to 0.75 pCi/g with an average of 0.33 pCi/g.

Twenty-one core samples from locations around the ring near the proposed tunnel depth (38 to 251 ft) were analyzed (X-ray Assay Laboratory 1988). The following ranges and averages are calculated from the reported data:

Table 5.5.6-1

RADON LEVELS

Location	Number of Samples	Geometric Mean pCi/l	Average pCi/l	Percentage of Homes with Radon Levels <4 pCi/l	4-20 pCi/l	>20 pCi/l
United States						
Living space	49,659	1.76	4.01	80	18	2
Basement	23,984	3.37	7.87	59	34	7
North Carolina						
Living space	418	1.96	3.30	78	20	2
Basement	60	2.80	3.85	68	32	0
Durham County						
Living space	13	1.16	1.57	100	0	0
Basement	4	2.61	2.85	100	0	0
Granville County	NA					
Person County	NA					

NA = Not available

Source: Cohen 1988.

U-238 0.4 to 5.2 ppm, average 1.5 ppm; Th-232 0.6 to 11.4 ppm, average 3.8 ppm; K-40 0.03 to 4.24% by weight average 1.80% by weight; and Rb-87 less than 10 to 112 ppm, average 51 ppm.

The eight cores that represent seven different geologic classifications are noted in Table 5.5.6-2.

Table 5.5.6-2

RADIUM ACTIVITIES IN THE VARIOUS GEOLOGIC CLASSIFICATIONS

Sample Depth	Geologic Classification	Radium and Its Decay Products pCi/g
238.6 ft	Moderately hard to hard, gray/green mafic metavolcanic	0.05
163.6 ft	Hard gray/purple metamorphosed epiclastics	0.47
165 ft	Hard to very hard, light gray to dark greenish gray felsic to mafic metavolcanic (epiclastics) sheared	0.11
13.4 ft	Moderately hard to hard, grayish/yellow/green intermediate metavolcanic	0.55
8.8 ft	Moderately hard, mottled gray/white/black/pink granodiorite	1.08
197.1 ft	Hard, mottled gray/white/black/pink granodiorite	0.75
116.9 ft	Soft mafic green/white metavolcanic	0.24
126.6 ft	Hard to very hard, light bluish gray/greenish black quartz diorite	0.33

Source: (NC 1988b)

C. Water

Three groundwater wells in the vicinity of the proposed SSC were sampled and analyzed for alpha and beta activities, and radon concentrations (State of North Carolina 1987). The sample depth was between 12 and 19 feet. Two of the wells were lower in radioactivity averaging 0.4 pCi/l alpha, 1.4 pCi/l beta, and 626 pCi/l radon. The other well exhibited radioactivity levels of 8.5, 4.6, and 2,988 pCi/l, respectively.

The public water supplies from 35 different locations in Granville, Person, and Durham counties were sampled between 1979 and 1986. Thirty-two samples were analyzed (State of North Carolina 1986). The radioactivity ranged from lower limit of detection (LLD) to 13.21 pCi/l gross alpha and 10.16 pCi/l gross beta. The average from the 31 locations (the highest concentration from the location that was sampled twice was used in deriving the average) was 1.88 pCi/l alpha and 2.43 pCi/l beta. Four locations were in excess of 5 pCi/l alpha. They were located 4, 10, 12, and 13 mi from the ring. Five additional samples, which were not quarterly composites, had ranges from less than the LLD to 3.39 pCi/l alpha and 2.84 pCi/l beta.

The cities of Durham and Creedmoor and John Umstead Hospital use Michie, Rogers, and Hoet lakes, respectively, for water supplies. Analysis of the three samples collected between 1983 and 1985 showed alpha activities ranging from 0.16 pCi/l to 1.52 pCi/l, with an average of 0.84 pCi/g, and beta activities from less than 0.2 pCi/l to 1.52 pCi/l beta with an average of 0.86 pCi/g (NC 1988b).

D. Measured Considerations

Borehole and water radioactivity levels were based on the limited number of samples. These may or may not be representative of the radioactivity expected at the site.

5.5.6.2 Man-Made Radiation

Based on the profile of state and local radiation control programs for FY 1985 (CRCPD 1987), the State of North Carolina issued 245 medical licenses, 209 industrial licenses, and 34 academic licenses authorizing the use of radioactive materials in the state. Forty-four licenses authorized the use of radioactive materials other than the above named categories. Authorization was also awarded to one licensee in use of source materials. Radioactive materials were used in medical institutions, private clinics, eye applicator, mobile nuclear medicine, teletherapy, veterinary, and in-vitro laboratory analysis by the medical licensees. For the industrial licensees, the radioactive materials were used for well logging, gauging, measurement systems other than gauge, industrial radiography, irradiation, radioactive material distribution or manufacture of the equipment containing radioactive materials, research and development. Some licensees were authorized to perform

leak tests for radioactive sealed sources for their clients. Nuclear reactors and federal facilities, excluding DOE facilities, are currently regulated by the Nuclear Regulatory Commission (NRC). In North Carolina, 17 radioactive material licensees are under the NRC's jurisdiction.

The proposed SSC site is in a rural area that does not contain any of the licensed operations listed above. The site does not encompass any government facilities possessing radioactive materials nor are there any milling or mining activities what would contribute to the natural background levels.

5.5.6.3 Background Radiation

Sixty-one measurements were made in 1987-88 by the Radiation Protection Section of the North Carolina Department of Human Resources on background radiation at locations around the proposed collider ring using thermoluminescent dosimeters and high-pressure ionization chamber at 1 m above the surface. The measured values ranges from 37 to 116 mrem/yr (North Carolina 1987-88).

5.5.7 Nonradioactive Environmental Hazards

5.5.7.1 Hazardous/Toxic Materials

A number of underground storage tanks (UST) exist in the the general vicinity of the proposed ring location, according to the state's UST registry. It is estimated from a computer search by zipcode that approximately 50 or fewer tanks are located within 1,000 ft of the SSC corridor. Most of the tanks appearing on the state list are fuel tanks associated with retail or farming operations (Motzno 1988).

No RCRA-permitted TSD sites are located within the SSC envelope. However, several RCRA generators are situated within 5 mi of the proposed site. Three CERCLA sites exist within 1.5 mi of the ring; Alumark Corp.(0.6 mi W), Eaton Corp.(1.1 mi W), and Channel Master Co.(1.5 mi E) (Rhodes 1988). The Alumark site has no indication of on-site hazardous waste disposal or release. The facility has released cyanides and cadmium to the municipal wastewater treatment system (Crosby 1985). Elevated levels of chromium, nickel, and copper were detected in the soils at the Eaton Corporation site. Chlorinated solvents have been detected in groundwater in on-site monitoring wells. The contaminants originated in wastewater surface impoundments and on-site sludge burial grounds (Atwood 1986). The Channel Master site has groundwater contamination from halogenated hydrocarbons. The company is completing the removal of sludge, contaminated soil, and metal plating wastes in lagoons (Butler 1987).

Camp Butner was used during World War II as a firing range for Army trainees and continues to be used by the NC National Guard as a small arms firing range. Since the SSC campus and beam absorber areas would be located at the northern end of the firing range, there is a slight chance that unexploded ordinance could be found unexpectedly in this area (NCNG 1987).

5.5.7.2 Biological Hazards

No biological hazards are known to exist within the proposed SSC site area.

5.5.8 Existing Waste Management Facilities

5.5.8.1 Sewage Facilities

Figure 5.5.8-1 shows the approximate location of the existing sewage treatment plants near the North Carolina SSC site. Table 5.5.8-1 shows the locations of the publicly owned wastewater treatment plants, approximate distance from SSC site, design flow, actual flow, and available capacities of the plants.

Table 5.5.8-1

EXISTING SEWAGE TREATMENT PLANTS

Plant	Approximate Distance from SSC site	Design Flow million gal/d	Actual Maximum Flow million gal/d	Available Capacity million gal/d
Oxford-North	8	0.63	1.45	0
Oxford-South	7	0.75	>0.75	0
Oxford-South No.1	7	1.25	1.66	0
Butner	4	3.5	2.4	1.1
Creedmoor	5	0.24	0.18	0.06
Butner-Creedmoor (Proposed)		3.5	2.6	0.9
Durham-Eno River	15	1.5*	1.8	0
Durham-Northside		[10*	2.3	0
Roxboro	12	5	5.8	0

*Under expansion.

Source: Water Quality Planning Branch - Division of Environmental Management.

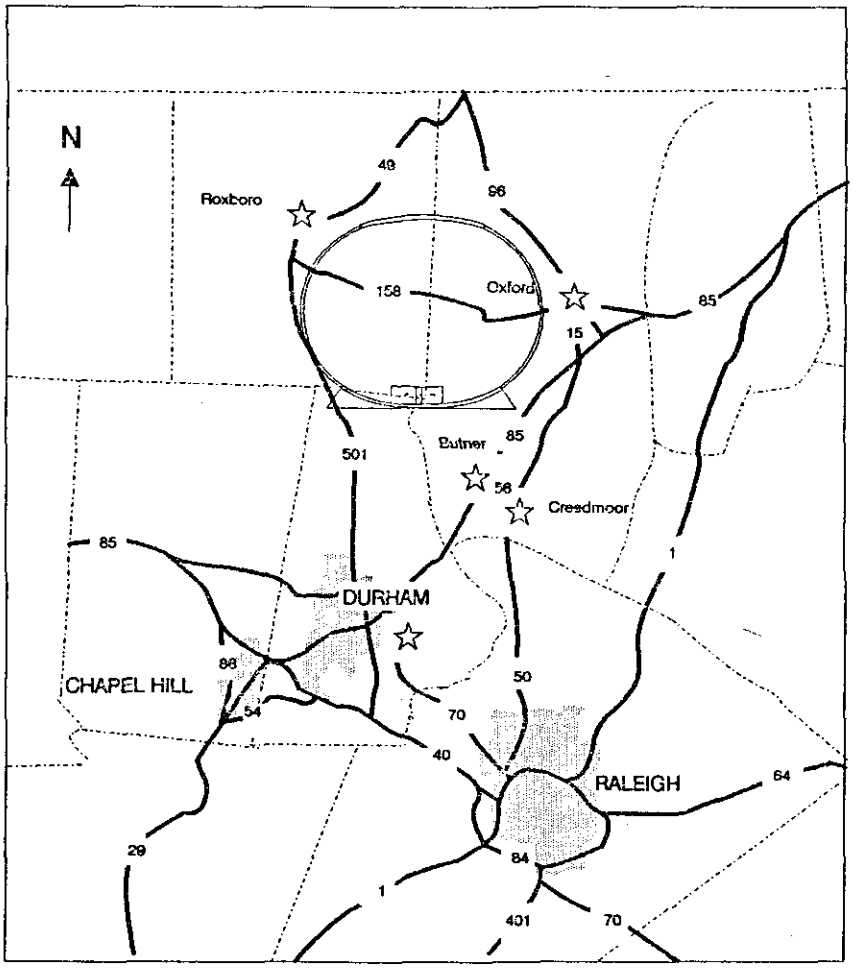
The data in Table 5.5.8-1 show that the existing Butner wastewater treatment plant has an excess capacity of 1 million gal/d.

The City of Durham has planned for permanent expansion of the Eno Wastewater Treatment Plant to raise its capacity from its present 1.5 million gal/d to 10 million gal/day by 1990. An interim expansion is currently planned to raise capacity to 2.5 million gal/d (Durham 1987).

The Butner Wastewater Treatment Plant is undergoing a reconstruction to upgrade the quality of its effluent. Upon completion in 1988, this plant will have an excess capacity of approximately 1 million gal/d.

Figure 5.5.8-1

EXISTING SEWAGE TREATMENT FACILITIES
NORTH CAROLINA SSC SITE



☆ Approximate Location of Existing Sewage Treatment Facilities in the North Carolina SSC Area

5.5.8.2 Solid Waste Facilities

Figure 5.5.8-2 shows the approximate location of the five landfills in the region of influence.

Table 5.5.8-2 shows the existing sanitary landfills in the region, approximate distance from the SSC site, acreage, acres per year used, and the remaining capacities of the landfills. Table 5.5.8-2 also shows that the existing landfills are reaching their capacity.

Table 5.5.8-2

EXISTING SANITARY LANDFILL CAPACITIES

Landfill	Approximate Distance from SSC Site	Total Acreage	Use Rate Acres per year Years used	Remaining Capacity in Acres	Years
City of Durham	20	130	5	25	5
Granville County Butner Landfill	8	66	5	24	2-5
Granville County Oxford Landfill	20	42	1	5	2-5
Person County	25	40	2	20	5-10

Source: North Carolina State, Solid Waste Branch.

Sanitary landfills in North Carolina would accept nonhazardous oil and grease wastes, including diesel fuels.

5.5.8.3 Hazardous Waste Disposal Facilities

Currently, there are no facilities in North Carolina permitted to dispose of hazardous waste. The closest facility is Gennstar in Pinewood, South Carolina.

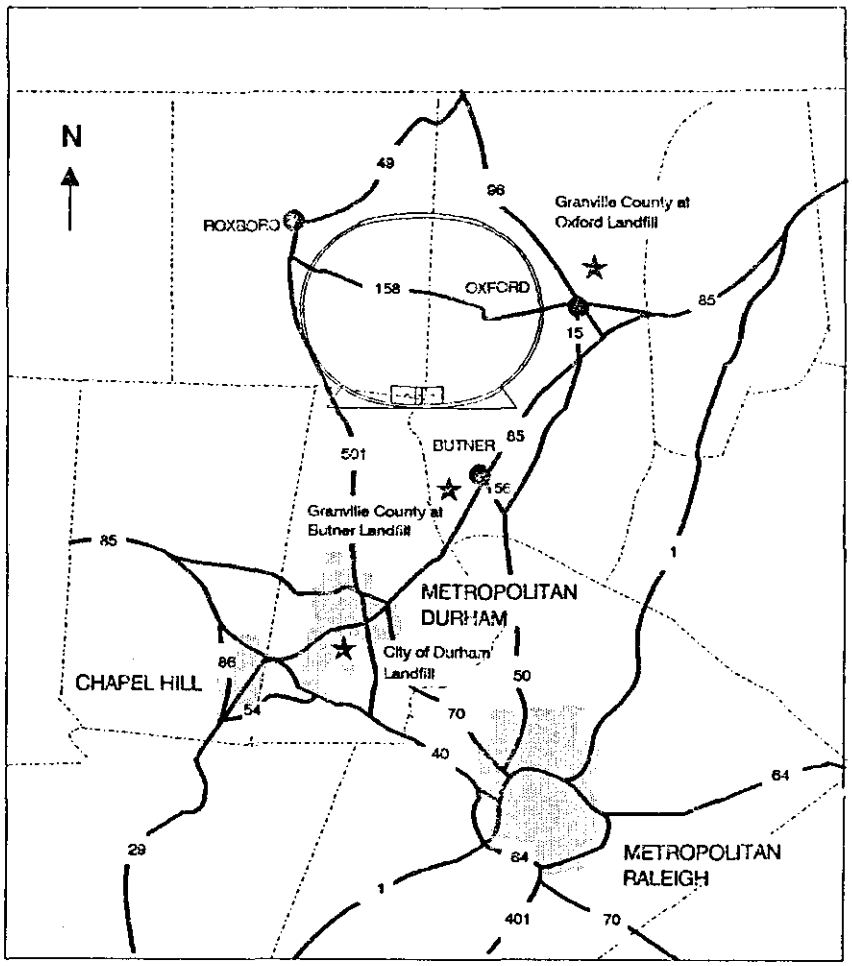
5.5.8.4 Low-level Radioactive/Mixed-Waste Disposal Facilities

There are no commercial low-level radioactive/mixed waste disposal facilities currently operating in North Carolina.

In North Carolina, 2,318 m^3 (11,014 Ci) of low-level radioactive waste were generated by utility (74.5%), industrial facilities (19.4%), academic (5.3%), medical institutions (0.7%), and government (0.2%), as reported by the commercial disposal site operators. The commercial nuclear power reactor generated spent resins/filter sludges/evaporator bottom (30.18%), dry compressible waste/contaminated equipment (69.21%),

Figure 5.5.8-2

**EXISTING SANITARY LANDFILLS
NORTH CAROLINA SSC SITE**



★ Approximate Location of Existing Sanitary Landfills in the North Carolina SSC Area

irradiated components (0.13%), and other waste (0.48%). Most of the LLRW is class A waste (98.4%). Class B and Class C LLRW accounted for 1.4% and 0.2% respectively (EG&G 1987).

5.5.9 Ecological Resources

5.5.9.1 Regional Ecological Characteristics

A. Definition of Drainage Basin and Boundaries of Ecological Resources Potentially Impacted

The proposed North Carolina SSC site is located in the midst of three river systems within the Piedmont upland region of the Piedmont physiographic province. The three rivers, the Neuse, the Tar, and the Roanoke all flow eastward toward the Atlantic Ocean. Figure 5.5.9-1 shows the extent of the three watersheds and the relationship of the approximate ring template to the watersheds.

The area of the proposed site includes several headwaters, first and second order streams, and small reservoirs used for surface water storage. These include:

- Neuse watershed, including the Flat River, Deep Creek, Lake Michie, Lake Butner, and Knap of Reeds Creek, is a 168 mi^2 watershed in the western portion of the site. Deep Creek flows into Flat River almost due west of the proposed campus, and the River then flows into Lake Michie south of the site; first order streams flow south through the proposed campus and drain into Lake Butner, which subsequently flows through Knap of Reeds Creek south to the confluence with Flat River.

- Tar watershed, including Cib Creek, Shelton Creek, Jackson Creek as well as a diverse dendritic pattern of first order streams flowing southeast into the Tar River, is approximately two-thirds of the proposed site area but smaller in total size than the Neuse watershed, having an area of 122 mi^2.

- Roanoke watershed, including Mill Creek and Mayo Creek, drains from the northwest portion of the site north into the Mayo Reservoir, which flows into the Roanoke River.

B. Relationship of Ecological Resources with Other Resources

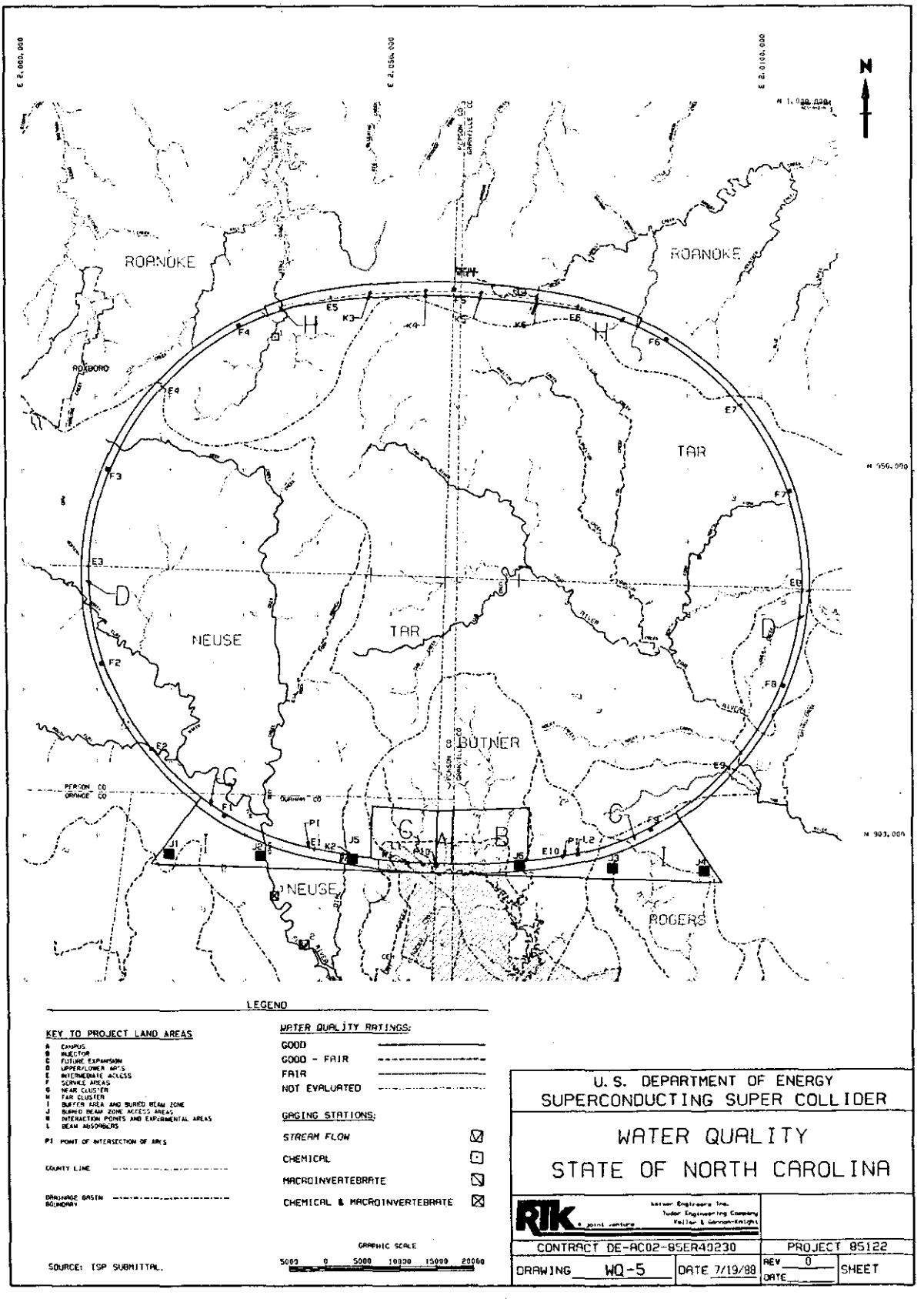
Because the site is located at the headwaters of three watersheds, and because the soils are sensitive to erosion and the streams and rivers to sediment loading, the resource most interconnected with the ecology is water. The relationship is twofold: 1) soil stability/erosion control, and 2) nutrient accumulation and nutrient cycling mechanisms that allow reclamation following disturbance.

C. Classification of Ecosystem Types and Their Distribution

The proposed North Carolina site occupies an area of diverse mesic terrestrial and aquatic ecosystems. Wetland communities are largely confined to streamsides and emergent growth areas around reservoirs and ponds. The majority of the terrestrial systems are upland communities

Figure 5.5.9-1

RELATIONSHIP OF THE SSC RING TO WATERSHEDS OF THE NORTH CAROLINA SITE



in some stage of oak-hickory succession. Most are second growth; few are mature deciduous forests. There is a high proportion of cleared land, regrowth area, and planted coniferous woodlands, largely loblolly pine.

There are several relatively rare plant communities; the most notable are the Upland Depression Swamp Forests.

5.5.9.2 Terrestrial Ecosystem Characteristics

There are seven distinct terrestrial ecosystems in the site area. These are:

- Deciduous forests
- Coniferous forests
- Mixed deciduous/coniferous forests
- Reforestation areas
- Forested wetlands
- Shrub wetlands
- Emergent wetlands.

A. Plant Community Composition

1. Deciduous Forest

Six distinct plant communities have been indentified within the deciduous forest ecotype. Each is briefly described below.

a. Dry Oak-Hickory Forest

This plant community is typically located on ridges or upslope areas and at maturity has trees that reach a height of 50-70 ft tall. Growth and productivity of the community is greatly limited by the associated thin, acidic, infertile soils and relatively dry (xeric) conditions. This type is infrequent in the immediate area because of typically more moderate (mesic) conditions and less acidic soil in the general area. These associations are easily separated from the mesic oak-hickory stands by the presence of ericaceous species, such as gooseberry, blueberry, and azalea.

b. Mesic Oak-Hickory Forest

The mesic oak-hickory stands are the most common habitats in the immediate proximity of the proposed site and the most often disturbed. Consequently, most of these stands are in early to mid-successional stage, mixed with shortleaf and loblolly pines and younger oaks and hickory trees. The stand matures with trees approximately 80 ft tall, with hickory dominating in number and biomass. Typically dogwood and tulip trees are present in great numbers in the understory, while the more xeric species are minimally represented.

c. Chestnut Oak-Scarlet Oak Forest

The chestnut oak-scarlet oak stands are rare in the area and are found on tops and upper slopes of monadnocks. There are approximately five monadnocks in the immediate area of the SSC proposed ring. The surface of the soil in these areas is very rocky, and this plant community is somewhat resistant to invasion by other species. This community is typically present as mature forest stands, with chestnut oak providing approximately 90% of the canopy. Often ericaceous species form a solid knee-high mass throughout the stands.

d. Acidic Cliff Forests

The acidic cliff forest is an uncommon plant community in the area, characterized by stands of mountain laurel and rhododendron, with chestnut oak as the characteristic canopy species. These are extremely rare stands in the area along the Flat River at Red Mountain. A few similar habitats may be present on the acidic cliffs in the upper reaches of the Tar River. The most notable example of the association occurs immediately south of the proposed site along the Flat River immediately north of Lake Michie. The soil is acidic, rocky, and thin. Species diversity is extremely limited.

e. Alkaline Oak-Hickory Forest

This oak-hickory association occurs on neutral to alkaline soils. A mature stand straddles the Granville-Pearson county line. There are also stands of this association in the vicinity of Butner south of the site. While the canopy does not differ appreciably from the oak-hickory associations on acidic soils, the shrub and herb layers are significantly different. Red cedar and redbud predominate in the understory. Ericaceous plants are rare.

f. Mesic Mixed Hardwood Forest

Mesic mixed hardwood forest is the most productive and most rapidly growing of the associations in the area. These stands are generally downslope of the oak-hickory stands, and while the soils are slightly acidic, they are more developed and more moist. Extensive wildflower communities may be present. The mixed hardwood forest is common in the proposed SSC site area on lower slopes and sides of ravines. The dominant canopy species are tulip tree and American beech.

2. Coniferous Forests

All of the coniferous stands in the area are pine stands. Three species, Virginia, shortleaf, and loblolly are dominant in these stands. All coniferous stands are early successional stages that eventually will mature through stages as mixed pine/ hardwood to mixed hardwood communities in fully mature systems. Loblolly pine dominates these stands in the southeastern third of the proposed site. Shortleaf pine dominates

in the northeastern portion, and Virginia in the northwestern portion. Another coniferous species, present occasionally as an old field invader, although not as important as the three pine species, is eastern red cedar.

3. Mixed Deciduous/Coniferous Forests

The mixed deciduous/coniferous forests are successional stands, somewhat older than the coniferous stands described above and in transition to a pure hardwood species. Hardwood species may be present in the understory and subcanopy of these forests, including persimmon, black cherry, sassafras, sweetgum, and red maple.

4. Montmorillionite Forest

Montmorillion forest is an uncommon association found in small pockets of neutral to basic soils. The few examples present in the project area are young and of poor quality, e.g., a ridgetop near Goshen. These stands generally are dominated by mixed conifers even when fairly mature. All species represented are typical of dry shallow soils.

5. Reforestation Areas

Reforestation is an extremely common land pattern. This type of forest association may range from very early stages of succession following old field abandonment or timbering operations to regeneration of forest following selective cutting of woodlands on private lands.

6. Clearings

Cleared land is common around agricultural areas, developments, and following timbering. Germination of weed and/or old field species begins almost immediately as the soil is rapidly covered by such species as crabgrass (and other grass species), horseweed, and frost asters. Tall goldenrod joins these species in dominating 2- to 3-yr-old fields. By 5 years or more, following the initial clearing and in the absence of plowing or other major soil disturbance, broomsedge begins to dominate the old field and pine and red cedar seedlings germinate to begin the reforestation through natural succession.

7. Wetlands

There are wetland associations in the area of the proposed site, including two forest associations, a shrub association, and an emergent association. The forested wetlands in the area are generally limited to streams and river banks. These areas are quite narrow and the wetlands form linear associations along the channels. There are a few swamps in the Butner area near Knapp of Reeds Creek, but these are several miles south of the site. Shrub wetlands are very rare associations around beaver ponds, farm ponds, and reservoir shorelines. These are successional stages of the forested wetlands and are dominated by black willow. Emergent wetlands include both persistent and nonpersistent marshes, which are rare in the area of the proposed site. Nonpersistent wetlands

die back in the winter. These marshes rarely persist for more than 20 years because of the succession of shrubs and eventually forested wetlands in the absence of shoreline disturbance.

Piedmont/Mountain Alluvial Forest is the most common wetland in the area, generally present where the floodplain is absent or less than 100 yards wide. These are so narrow that fluvial ridges and levees are absent. These forests are marginally considered wetlands.

Piedmont/Mountain Bottomland Forests are very rare in the immediate area of the proposed SSC site. These stands are associated with actual floodplains. Only 5% of the forested wetlands in the area are bottomland forests.

Upland Depression Swamp Forests are very rare and in the area of the proposed site are limited to a few poorly drained flats on mafic rock west of Goshen. These swamps are upland sites with depressions in which water stands several months a year, especially winter and spring. These are usually less than an acre in size. Willow oak is the dominant woody species. The only willow oaks near the ring template are on Knapp of Reeds Creek near Butner.

8. Agricultural Communities

Agricultural land use in the proximity of the proposed SSC site is extensive. On a statewide basis, North Carolina ranks first in the nation in flue-cured tobacco, total tobacco, sweet potatoes, turkeys, and farm forest products. The state ranks second in pickling cucumbers, third in poultry and poultry products value of production, in peanuts, and in burley tobacco. The state ranks fourth in the nation in commercial chicken broiler production.

In the northern Piedmont region, agricultural production increases have lagged behind that of other portions of the state. Tobacco occupies approximately 15% of the cropland in the region, about twice that of the state in general. Tobacco accounts for about 6% of the crop-produced income in the Piedmont. Truck-to-market vegetables and fruit are the other high-income commodities produced.

Acreages of tobacco, corn, soybeans, sorghum, wheat, oats, barley, and hay have generally decreased in all three counties during the last 10 years.

Timber is still an important economic resource in the Piedmont. However, the acreage of commercial forest land has decreased in all three of the counties potentially hosting the SSC. Within the North Carolina Piedmont, the total land committed to commercial forest has decreased by more than 500,000 acres in the last 40 years. The lands once in commercial timber have been altered to: urban uses, 44%; agricultural uses,

38%; water and/or noncommercial forests, 18%. In the mid-1980s, commercial forests occupied 5.5 million acres or slightly more than 50% of the region.

B. Animal Community Composition

The fauna of the proposed site are typical of the North Carolina Piedmont. The amphibian and reptile populations are diverse. Approximately 60 species of amphibians and reptiles in the area are found both in the wetlands and in forested bottomland wetlands.

Birds and mammals generally use the woodlands for roosting and shelter and the agricultural lands, old fields, and woodland understory for food. The population dynamics of birds and mammals in the area are not well documented (Clark 1988). Based on the data available, there are about 135 species of breeding or wintering birds and 35 species of mammals present in habitats in the vicinity of the proposed site. Those that are economically or recreationally important are discussed below.

Species diversity of bird and mammals differs markedly among the different habitats. The greatest diversity is found in the swamps, marshes, and bottomland forests. The woodlands have lesser diversity than the wetlands, but greater diversity than the agricultural and old field areas. The least diversity is, of course, found in the urban areas.

The region is a portion of the Atlantic Flyway used by migrating waterfowl and as wintering grounds for dove, woodcock, snipe, and many shore and wading birds. The region provides hundreds of miles of streams as well as a diverse landscape of feeding, roosting, and nesting sites supporting these migratory populations. Many formerly migrating species have become permanent residents of the region, including Canadian goose, wood duck, dove, mallard, and other waterfowl and shore bird species. Both osprey and bald eagle have been sighted. The bald eagle is present in large numbers south of the proposed site and uses the large lakes outside of the SSC zone as feeding grounds.

C. Ecosystem Level Processes

The North Carolina Piedmont is a productive collage of old field successional habitats, forests and frequent streams. The nutrient cycles of these systems are highly coupled between soil, plants, and microorganisms, especially symbiotic microbes or mycorrhizae. These symbiotic relationships support rapid soil stabilization and rapid revegetation of cleared areas.

However, the long-term productivity of these systems is largely dependent upon soil maintenance. Consequently, erosive processes are detrimental to terrestrial system stability and reclamation efforts as well providing a significant source of aquatic system pollutants.

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5.5.9.3 Aquatic Ecosystems

Several water supply and recreational reservoirs have been constructed outside the boundary of the proposed SSC project on the three rivers whose headwaters lie within the site. Within the area, there are five reservoirs, four rivers, and nine streams of sufficient size to be a significant recreational and biotic resource.

There are two main aquatic community types in the SSC area, flowing water (rivers and creeks) and still water (lakes and ponds). Rivers and creeks are widespread, although there are no large, wide rivers in the region. Little vegetation occurs in flowing waters, but animal life is moderately abundant. Dozens of species of fishes, mainly small nongame species, are present. These rivers are inhabited by a diverse mollusk population and four species, rare in North Carolina, are present in the rivers and larger creeks.

Lakes and ponds in the area are all man made, except for beaver ponds. The nonflowing or still waters support several dozen fish species, some of which have been introduced as game species from other areas. Amphibians make good use of lakes and ponds, as do smaller numbers of reptiles, birds, and mammals. However, the lakes within 1 mi of the SSC ring are relatively small and are not used by waterfowl to any great extent.

5.5.9.4 Economically, Recreationally, and Culturally Important Species

The generally rural nature of much of the proposed SSC offers excellent hunting and fishing, with a high diversity of fish species and populations of game birds and mammals. Major fishing areas on or near the proposed SSC site include hundreds of farm ponds, five reservoirs, four rivers, and nine streams. Major game fish species are striped bass, largemouth bass, chain pickerel, Roanoke bass, black crappie, white crappie, white perch, white bass, and various sunfishes (bream).

Bird and mammal game species are found throughout the SSC site. These species include whitetail deer, raccoon, mink, river otter, red fox, gray fox, bobcat, eastern gray squirrel, beaver, muskrat, bobwhite, wood duck, and many other migratory waterfowl. The largest area available for public hunting within the proposed SSC site is the Butner Game Lands, of which approximately 10% lies on the proposed SSC near-cluster location. Management of these state-owned lands by the NC Wildlife Resources Commission as game lands is considered an interim use. Extensive game lands also surround Mayo Reservoir and Mayo Creek.

Recreational use of the major Corps of Engineers lake in the area, the falls of the Neuse Lake, and of Lake Mickie include active recreation such as boating, water sports, camping, and bird watching, among others. However, this resource will be uneffected by the SSC.

No other species of particular recreational, cultural, or economic significance are known to be present within the North Carolina SSC site area.

5.5.9.5. Threatened and Endangered Species

A. Federally Listed and Candidate Species

There are no known threatened or endangered species from the federal list in the area of the proposed North Carolina SSC site (Gantt, USFWS, 1988).

One plant species, Harperella (*Ptilimnium nodosum*), formerly known as stream mock bishop weed, is present in Granville County. This species is proposed for listing as an endangered species.

There are also five species that are in "status review" by the U.S.F.W.S. (U.S. Fish and Wildlife Service) under provisions of the Endangered Species Act of 1973, as amended. These are:

Carolina madtom, *Norurus furiosus*
Smooth coneflower, *Echinacea laevigata*
Barbara's buttons, *Marshallia grandiflora*
Nestronia, *Nestronia umbellula*
Lewis' heartleaf, *Hexastylis lewisii*

While these are not currently protected under the act, the length of time projected for construction of the SSC is of sufficient length to evaluate potential impacts on these species. No population data are available for these species in the area proposed for the SSC.

B. State-Protected Species

North Carolina has statutorily provided four categories of special status species to be addressed in all NEPA compliance documents. These categories are:

- Endangered -- May become extinct from state if not protected.
- Threatened -- May become endangered if not protected.
- Special Concern -- Rare species that control collection and sale, endangered and threatened species may also be of special concern.
- Primary Proposed -- Species with few populations in the state, small populations, occur only in rare habitats; although there is no current evidence of decline these may be threatened or endangered in the future.

Tables 5.5.9.2 and 5.5.9.3 list the state-protected species and their classifications. These species occur in the counties that would host the proposed SSC site. They are typically associated with terrestrial

or aquatic communities found at one or more locations along the alignment and are probably in the area of the proposed site. However, population data are not available.

5.5.9.6 Unique Ecosystems and Communities Potentially Affected

A. Statutorily Protected Areas

There are no statutorily protected natural ecosystems within the proposed SSC project area.

B. Remnant Communities, Virgin Stands, and Unique Assemblages

Natural areas, having unique or unusual resources, have been identified throughout North Carolina by the NC Natural Heritage Program. Several of these natural areas are in the vicinity of the proposed SSC site. Although these sites are defined primarily on the basis of their botanical resources, some of them provide habitat for locally or regionally rare animal species. These sites are listed in Table 5.5.9-4. Additional description of these areas is presented in Appendix 11 along with the discussion of site specific impacts.

C. Marginal Range Associations and Transition Zones

The proposed SSC site in North Carolina is located in the middle of the Piedmont physiographic province and no major transition zones are present. The proposed site area does involve the watersheds of three different river systems near their headwaters. These three rivers all flow to the Altlantic and are similar with respect to their floral and fauna components.

Table 5.5.9-2

NORTH CAROLINA PROTECTED PLANT SPECIES IN THE AREA OF THE NORTH CAROLINA PROPOSED SITE

Species Scientific Name	Common Name	Status
Ptilimnium nodosum	Bishop's weed	Threatened
Panax quinquefolius	Ginseng	Special concern
Hexastylis lewisii	Lewis' heartleaf	Primary proposed
Rhus michaux	Michaux's sumac	Endangered
Nestronia umbellula	Nestronia	Threatened
Echinacea pallida	Pale coneflower	Primary proposed
Silphium terebinthinaceum	Prairie dock	Primary proposed
Solidage ptarmicoides	Prairie goldenrod	Primary proposed
Helianthus schweinitzii	Schweintiz' Sunflower	Endangered
Portulaca smallii	Smooth coneflower	Threatened
Delphinium exaltatum	Tall larkspur	Endangered, Special concern

Sources: Sutter et al. 1987; NC DNRCD 1988.

Table 5.5.9-3

NORTH CAROLINA PROTECTED ANIMAL SPECIES IN THE AREA OF THE NORTH CAROLINA PROPOSED SITE

Species Scientific Name	Common Name	Status
Ambloplites cacifrons	Roanoke bass (fish)	Special concern
Elliptio lanceolata	yellow lance (mollusk)	Special concern
Fusconaia masoni	Atlanic pigtoe (mollusk)	Threatened
lanius ludovicianus migrans	loggerhead shrike (bird)	Threatened
Necturus lewisi	Neuse River dog (amphibian)	Special concern
Alasmidonta heterodon	ancient floater (mollusk)	Endangered
Villosa constricta	notched rainbow (mollusk)	Special concern

Source: NC DNRCD 1988.

Table 5.5.9-4

UNIQUE OR UNUSUAL NATURAL AREAS IN VICINITY OF SSC

Site Name	Significance
Goshen Gabbro forest	Statewide
Vernon Hill Church Road dry forest	Regional
Tar River - aquatic habitat	Regional
Flat River slopes above lake michie	Regional
Mayo Creek alopes	Local
Timberlake poorly-drained upland forest	Local
South Flat River rock outcrops	Local
Flat River slopes at Red Mountain	Local

5.5.10 Land Resources

5.5.10.1 Regional Setting

A. Jurisdictional Setting

The proposed North Carolina site is located approximately 15 mi northeast of Durham in primarily unincorporated portions of the following three counties: northeastern Durham, western Granville, and eastern Person counties. (See Figure 5.5.10-1.) The county seats of each jurisdiction and the year of respective establishment are as follows: Durham, Durham County (1881), Oxford, Granville County (1746), and Roxboro, Person County (1791) (Kane 1972). The area of each jurisdiction is listed below:

County	Area (mi^2)
Durham	299
Granville	542
Person	400
Total	1,241

The SSC project is situated in areas that are represented by the following federal, state, and local elected officials (State of North Carolina 1985):

- United States Senate
  Jesse Helms
  Terry Sanford
- United States House of Representatives
  Tim Valentine Jr., 2nd District
- State Senate
  Ralph A. Hunt, 13th District
  Kenneth C. Royall, Jr., 13th District
- State Assembly
  James W. Crawford, Jr., 22nd District
  William T. Watkins, 22nd District
  John T. Church, 22nd District
  George W. Miller, Jr., 69th District

B. Ownership Patterns

Land ownership in the three-county SSC project area is largely private, with notable exceptions in northeastern Durham County being: 1) the 5,000-acre Camp Butner that includes both the firing range and the game area, 2) the 2,401-acre North Carolina State University Hill Demonstration

Forest, and 3) the 811-acre City of Durham-owned Lake Michie (Cline 1988; Jeruis 1988). There are also some small scattered state and local government holdings in the area. Aside from these exceptions, a pattern of predominant private ownership is consistent with land ownership patterns of rural north-central North Carolina. The 38,445-acre Falls Lake complex, including the lake itself and associated recreation, wildlife, and CDE office and management areas, is located south of the SSC project study area in portions of Granville, Durham, and Wake counties (Cline 1988).

C. Historic Land Uses

The growth of northcentral North Carolina is linked intimately to its physical geographic/natural setting. The area is part of the Piedmont physiographic province (Fenneman 1938). The area is characterized by moderate relief, with topographic features ranging from predominantly flat surfaces to gently rolling terrain found at prominent drainages. Major rivers in the region include the Flat River and the Tar River, the latter has its headwaters located in the interior of the proposed SSC project collider arc region. Both rivers have a number of small tributaries that drain the area in finger-like patterns. Both prehistoric and historic settlement patterns are reflective of these features in that communities were established along these drainage pattern lines. For these reaches, settlement sizes for communities other than Durham were uniformly small and grew at roughly equal rates. Durham has been the primary urban center for the region, having grown along with the rise in tobacco fortunes. Agriculture has, of course, been the historic economic base of the region.

Recent major man-made imprints to the region have included the development of Camp Butner, interstate highway projects, and large waterworks projects that either altered historic settlement patterns and/or inundated areas historically used for farming.

D. Existing Land Use Plans, Policies, and Controls

Land use planning in northcentral North Carolina is conducted at the state, regional, and local levels of government; the local level includes not only county-level activities, but also municipalities. Land use planning at the state level is conducted primarily by the North Carolina Department of Resources and Community Development, with its various divisions, such as Community Assistance, Environmental Management, Forest Resources, Land Resources, Parks and Recreation, Water Resources, and Wildlife Resources Commission (North Carolina Department of Natural Resources and Community Development n.d.). The Division of Community Assistance is particularly important as it provides aid to North Carolina local governments in the areas of community development, land use, public management, and economic development planning. Such assistance is provided through the administration of the Community Development Block Grant Program, the Main Street Program, and direct technical land use planning consultation.

Land use planning at the regional level is conducted by Triangle J Council of Governments for a six-county area, including Durham County and the Kerr-Tar Regional Council of Governments for a five-county area, including Granville and Person counties (Triangle J Council of Governments n.d. and 1986; Kerr-Tar Regional Council of Governments 1987). Both organizations are designated as the "Lead Regional Organization" in their respective jurisdictions; they are established as voluntary associations of local governments that have no authority to pass laws, levy taxes, provide police protection, or other activities normally associated with government. The Triangle J Council of Governments is the older of the two organizations since it was the original Research Triangle Regional Planning Commission (RTRPC) established by the State Legislature in 1959. In 1970, the incumbent governor signed an executive order by which 17 multicounty planning regions were created throughout the state as a means by which to consolidate a variety of local special agencies into cohesive planning units. A year later, the State Legislature authorized these multicounty planning regions as official Regional Councils of Government (COGs). The Triangle J Regional COG is composed of its six-member counties and 30 municipal governments. Its current planning activities include: A-95 clearinghouse reviews, regional land use planning, local planning assistance, transportation planning, water quality planning, housing planning and research, aging programs, nutrition programs, emergency medical services, and solid waste and hazardous waste planning. The Kerr-Tar Regional COG is composed of its five-member counties and 15 municipal governments. Its current planning activities include: aging program planning and funding assistance, regional ombudsman assistance, community development block grant program planning, economic development, including the creation of a Small Business Administration-certified development company, emergency medical services funding, and job training partnership program planning.

Key Triange J Regional COG plans include: Water Resource Management (1977), Areawide Water Quality Management Plan (1977), Housing in Region J (1978), Land Classification Plan (1978), Regional Airport System Plan for Region J (1978), Solid Waste Management Alternatives (1979), Agriculture in Region J (1979), Areawide Housing Opportunity Plan (1979), Open Space and Recreation Planning Related to Water Quality Management (1980), Economic Analysis of Region J (1980), Inventory and Low-Level Radioactive Waste in Region J, North Carolina (1982), Project 2000: Focus on Tomorrow (1982), Regional Landfill Feasibility Study (1982), and Durham County Inventory of Critical Lands (1985) (Triangle J Council of Governments n.d.).

Key Kerr-Tar Regional COG plans include: The Region K Land Use Element (1978) and Population and Economic Characteristics Update (1987).

Under North Carolina state law, the establishment of comprehensive zoning and subdivision regulations is delegated to either the county level for all unincorporated lands or to incorporated municipalities, such as cities. Counties can issue zoning regulations for either their entire

jurisdictions at once as did Durham County (1987), or piecemeal by township, as did Person County for Roxboro and part of Flat River Townships (1983). Person County is currently reviewing a zoning ordinance that will be applicable countywide (Person County 1988). Both Durham and Person counties have subdivision regulations in effect. Granville County currently has no zoning regulations for the area as a whole or for selected townships, although it does enforce a subdivision ordinance (Granville County Planning Board 1987). Several municipalities located in the SSC project study area have prepared land use plans and have zoning ordinances and/or subdivision regulations in effect. The community of Butner has recently prepared a land use plan update (1987) and has a zoning ordinance and map in effect. The cities of Oxford and Roxboro both have zoning and subdivision regulations in effect.

E. Existing Land Use

Existing land use in northcentral North Carolina continues to build on the area's historically developed land use patterns. Agriculture is still the dominant economic activity in Granville and Person counties but not any longer in Durham County. It has been estimated that since 1950, Durham County has converted over 60% of its farmland to urban uses (Durham County 1987).

The reasons for this are varied, depending on factors such as declines in farm profitability, urban growth pressures, rising land values, changing community expectations, personal life cycle/style changes, and changing regulatory environment. Nevertheless, agriculture is a sector of the economy that Durham County has deemed important enough to include as a resource to be preserved as part of implementing their development plans. Such a policy is important to the area's tobacco farmers, for in 1982, almost 80% of the county's 350 farmers raised tobacco, most of whom did so on small farms on a part-time basis (Durham County 1987).

Durham, along with Chapel Hill and Raleigh, have developed over the last thirty years as the three nodes that anchor the 6,200-acre Research Triangle Park area. While the thrust to Durham's development has been to the southeast towards Raleigh, growth has also been occurring to the north and northwest, flanking transportation corridors, such as Interstate-85 and State Route 501 (Durham County 1987).

F. Future Planned Land Uses

The Durham County Critical Watershed Ordinance of May 28, 1985, is the cornerstone document for future planned land use in the county and the basis upon which the Durham County General Development Plan - 2005 was formulated (Durham County 1987). The watersheds listed for protection in the ordinance include Little River, Flat River, Eno River, Falls Lake, and Jordan Lake. The ordinance is designed to preserve and protect the public drinking water portions of these watersheds while, at the same time, allowing for economic development in the region. A number of performance standards were developed, as practical measures by which to

regulate development. Examples of some of these measures include: the creation of buffer zones along floodplains, large minimum lot sizes for both water quality critical areas and water quality basin areas, prohibition of industrial development in certain critical areas, and the creation of stormwater protection measures (see Section 5.5.2).

The Durham County Board of Commissioners identified in its Durham County General Development Plan - 2005 (1987) "Agriculture" and "Environment" as two areas for which land use planning goals and objectives need to be identified and incorporated into future planning actions. The county planning goal for agriculture is to maintain the long-term productivity of prime agricultural lands through land use patterns that minimize conflict between farming and nonfarm activities. The following three corresponding objectives have been identified to meet this goal: 1) protect prime agricultural lands from encroachment by residential and strip-commercial development; 2) foster the agricultural use of prime agricultural land; and 3) promote soil conservation practices in order to preserve topsoil and prevent excessive siltation and pollution of streams.

The county planning goal for the environment is to protect the natural environment and harmonize new development with it to ensure continuance of a healthy and pleasant place to live for current residents and future generations (Durham County 1987). The following five topics have been identified around which multiple objectives have been set to meet this goal: natural resources, water quality and quantity, recreation, urban design, and historic preservation. These objectives are listed, given their relevance to the SSC project and its associated development:

Natural Resources Objectives

- Identify the floodway, floodway fringe, and stream buffers in Durham County and restrict development in those areas.
- Protect wetlands by defining critical wetlands and appropriately guide development in those areas.
- Identify and preserve sites of scenic value, including rare species of flora and fauna.
- Be diligent in protecting Durham County from the adverse effects of the use, storage, and transport of hazardous materials, by considering the impact of industrial facilities at locations which might have transportation implications for areas defined as water quality critical areas in Durham County.

Water Quality and Quantity Objectives

- Protect the water quality of Lake Michie Reservoir and Little River Reservoir, Jordan Lake, and Falls Lake by regulating development in the watersheds.

- Discourage the development of industries which require a large quantity of treated water.
- Protect the quantity and quality of groundwater in areas of the county served by wells by strict regulation of type and density of development.

Recreation Objectives

- Promote urban patterns which provide recreation opportunities for residents of all ages and income groups.
- Protect recreation at reservoirs from encroachment by conflicting or degrading uses.
- Promote multiple use, when possible of school and governmental facilities.
- Acquire land for active and passive recreational use.

Urban Design Objectives

- Improve the appearance of major corridors in Durham County through development buffer control, landscaping, sign regulations, and other aesthetic considerations, such as scale, urban form, and building design.

Historic Preservation Objectives

- Strengthen the existing historic preservation program to ensure that Durham County's historic and cultural legacy will be maintained.

The Person County Board of Commissioners in its Person County Development Plan 1985-1995 identified the following six issues as focal points around which to develop land use policies, goals, and development objectives and by which to guide future planning actions: land use, housing and residential development, public utilities, economic development, recreation and open space, and transportation. These policy statements are listed, given their relevance to the SSC project and its associated development:

Land Use Policy

- All land uses should be 1) suitable for the desired use, environmentally, 2) not a contributor to adverse or incompatible uses, and 3) serviceable with basic public services and utilities, either on- or off-site.

Agricultural Lands Policy

- Encourage those developments which are not detrimental to the county's most productive farmlands.
- Utilize the services of the Soil Conservation Service and other agencies to help identify prime farmlands.

- Develop such land development regulations and/or provide public services in such a manner as to minimize the impact on the most productive farmlands.

Commercial Forest Lands Policy

- Encourage the preservation and enhancement of commercial timberlands, while recognizing that, at times, such lands will need to be made available for other development.
- All commercially timbered areas should be reforested, as a responsibility of the commercial timber cutters.

Areas With Constraints to Development Policy

- Encourage compliance with existing development restrictions in the watershed area due to the absence of centralized sewer service.

Housing and Residential Development Policy

- Encourage the development of high quality residential developments which are served with basic needed infrastructure, such as water, sewer, adequate street and/or road access, and adequate drainage.

- Support, where feasible, the application for funds to initiate programs of housing rehabilitation in identified areas.

Public Utilities and Community Facilities Policy

- Water and/or sewer service should be extended and/or developed on a priority basis to areas meeting either of the following two conditions: 1) have sufficient existing and projected population density and concentration to make such extension to development economically feasible, or 2) be of environmental or sanitary urgency or necessity due to special conditions adversely affecting or threatening the environmental integrity or the health and welfare of the populace.
- Continue to seek to provide a high level of support services, in the form of community facilities, to meet the requirements of the future population.

Economic Development Policy

- Continue to support actions and programs leading to expanded commercial and industrial opportunities in the county. This shall include extension of needed utilities, e.g., water and sewer, to support such expansion.
- Require a "prescreening" to the extent feasible, of all industries desiring to locate in the county.
- Support industrial skills training activities located in the county.

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Recreation and Open Space Policy

- Ensure that all new development be designed so as to maintain the natural aesthetic quality of open space in the county.
- The existing recreational system and use of school facilities should still be maintained in coordination with the local booster clubs.
- Support the expansion of public water access facilities at Hyco Lake.

Transportation Policy

- Continue to support proposed improvement projects to roads and bridges in the county conducted through financial assistance by the North Carolina Department of Transportation.
- Support the development and enforcement of Subdivision Regulations which contain specific design criteria for all new subdivision streets.

Future land use growth and development will occur not only in and around Durham, following its radiating transportation corridors, but also in the northern part of the county as the planned, 5,172-acre mixed use development of Treyburn comes on line (Durham County 1987). Zoning approval for the project was granted by the Durham County Board of Commissioners in April, 1986, with a 20-year development timetable planned. When completed, Treyburn is projected to provide up to 40,000 jobs in research, manufacturing, and commercial sectors and approximately 4,000 housing units. While the project is large in scale and well planned, it is not conceived as a stand-alone "new town." Treyburn will definitely draw on the City and County of Durham to provide needed infrastructure and other public services. A development of this magnitude is of concern to Person County planners, who may also feel certain development pressures as a result of project development (Person County 1987).

G. Community Values/Attitudes Towards Development

There is a strong environmental planning/management ethic that prevails at all levels of government. The need to preserve, conserve, and manage the state's natural resources for the betterment of current and future residents is evident in the structure and functioning of agencies, such as the North Carolina Department of Natural Resources and Community Development, the Region J and the Kerr-Tar Regional COGs, and the Durham and Person County Boards of Commissioners. This ethic is coupled with a strong desire to provide economic opportunities so that North Carolina can be assured of increasingly higher standards of living and a more satisfying quality of life.

5.5.10.2 Local Setting

A. Project Level

The proposed SSC project site is located in portions of northeastern Durham, western Granville, and eastern Person counties on lands that are largely unincorporated (see Figure 5.5.10-1). The SSC project study area contains no federal parklands, such as national parks, monuments, preserves, rivers, scenic or historic trails, historic sites, recreation areas, or parkways. There are also no federal or state designated wilderness areas or wild and scenic rivers located in the SSC project study area.

The project study area is largely rural in nature, either as agriculturally used lands or as forested areas, including the North Carolina State University Hill Demonstration Forest. Population centers are located near the outer edges of the eastern and western arc quadrants, along regionally important transportation corridors. On the east, this includes the City of Oxford and the smaller population centers of Providence and Stem. On the west, this includes the following communities flanking U.S. Highway 501 from north to south: Roxboro, Somerset, Timberlake, and Rougemont. Land use patterns in the interior of the collider arc region are complex, although homogeneous in terms of types of land uses available. The only strikingly different land use in the project area is actually located outside the collider arc region south of the near cluster quadrant. The Town of Butner is unique in that its major industry is the provision of institutional care to a variety of special segments of the population, including a federal correctional institute and a number of state-run facilities.

Community values and attitudes towards the SSC project are strongly felt and quite mixed, given the large number of letters received from the public as part of the DOE public scoping process (see Volume III: Methodology for Site Selection). Of the 387 letters received by the DOE as of mid-May, 1988, 364 letters were opposed to the project; 15 letters offered no opinion about the project; and 8 letters were in favor of the project. The issues raised in these letters included: labor supply changes, increased demand for water, road and congestion problems, impacts to the educational system, residential relocation, zoning and land use planning, population disturbance, tax base changes, the taking of agricultural land, groundwater withdrawals, geologic hazards, and the disposal of radioactive waste.

B. Facility Level

Table 5.5.10-1 presents land use data for each of the major SSC project facilities. This includes information on county locations, ownership, existing zoning designations, existing land use, and future planned land use. Narrative descriptions are provided below.

Figure 5.5.10-1

PROPOSED NORTH CAROLINA SSC SITE REGION

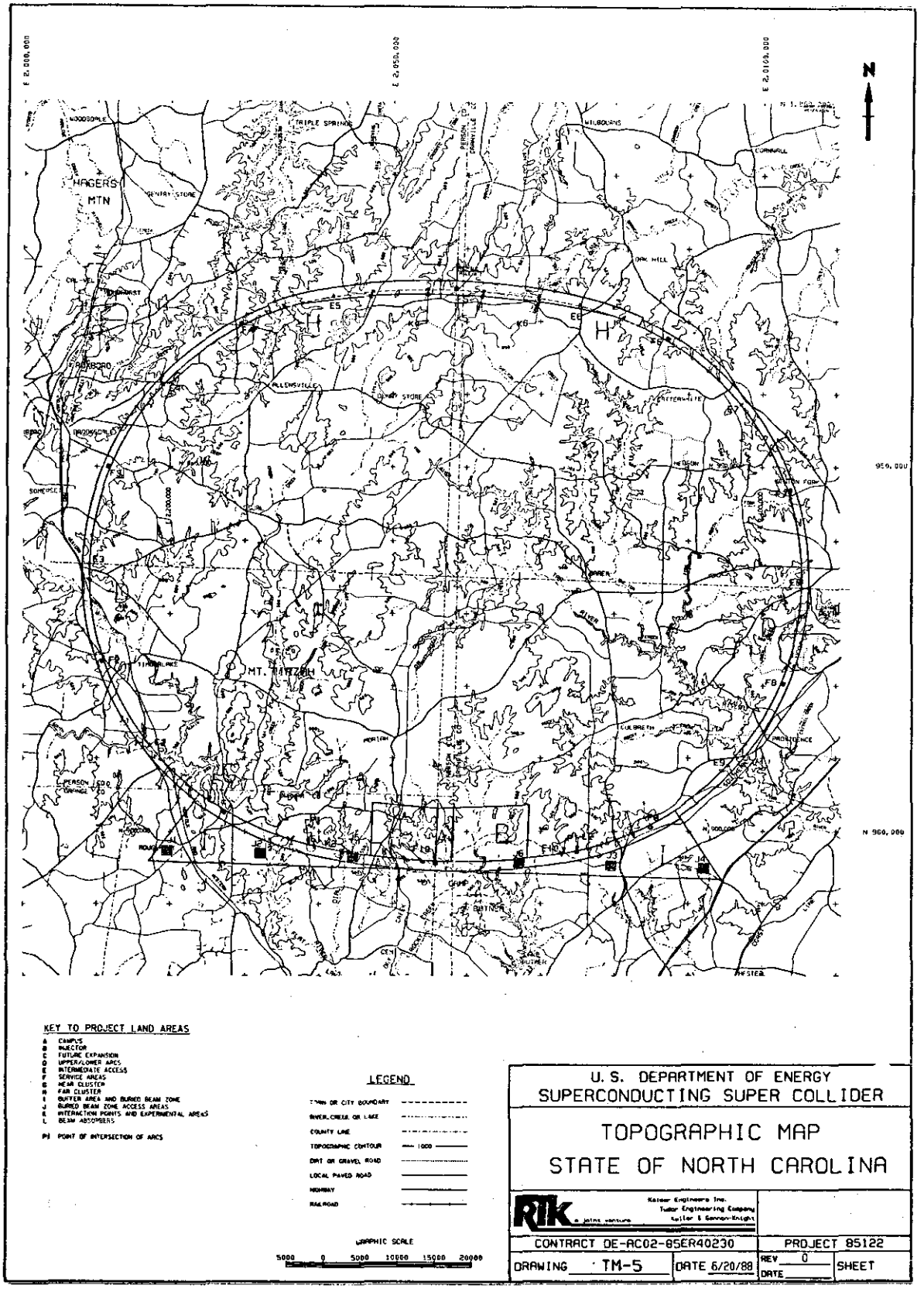


Table 5.5.10-1

LAND USE DATA: SSC PROJECT NORTH CAROLINA SSC SITE

SSC Project Facility	County Location	Ownership Patterns	Existing Zoning	Existing Land Use	Future Planned Land Use
Near Cluster Quadrant					
Campus area A	Durham	Private/public	RD	Rural/military	Same
Injector area B	Granville	Private/public	None	Rural/military	Same
Future expansion C	Durham	Private/public	RD	Rural/military	Same
BABBZ area I	Durham/Granville	Private	RD/None	Agr/rural	Same/none
J1	Durham	Private	RD	Agr	Same
J2	Durham	Private	RD	Forested/agr	Same
J3	Granville	Private	None	Agr/rural	None
J4	Granville	Private	None	Rural	None
Near Cluster Ring	Durham/Granville	Private/public	RD/None	Rural/military	Same/none
E1	Durham	Private	RD	Forested	Same
E10	Granville	Private	None	Forested	None
F1	Durham	Private	RD	Forested/agr	Same
F9	Granville	Private	None	Forested/agr	None
F10	Durham	Public	RD	Military	Same
J5	Durham	Private	RD	Forested	Same
J6	Granville	Private	None	Forested/agr	None
K1	Durham	Public	RD	Forested/military	Same
K2	Durham	Private	RD	Forested	Same
Far Cluster Quadrant					
Far Cluster Ring (H)	Granville/Person	Private	None	Agr/rural	None/same
E5	Person	Private	None	Forested	Same
E6	Granville	Private	None	Forested	None
F5	Person	Private	None	Forested	Same
K3	Person	Private	None	Forested	Same
K4	Person	Private	None	Agr	Same
K5	Granville	Private	None	Agr/forested	None
K6	Granville	Private	None	Forested	None
Western Arc Quadrant					
Western Arc Ring D	Person/Durham	Private	None/R-1/RD	Rural	Same
E2	Person	Private	None	Agr	Same
E3	Person	Private	None	Forested/agr	Same
E4	Person	Private	R-1	Rural	Same
F2	Person	Private	None	Agr	Same
F3	Person	Private	R-1	Forested/agr	Same
F4	Person	Private	None	Agr/rural	Same

Table 5.5.10-1 (Cont)

LAND USE DATA: SSC PROJECT NORTH CAROLINA SSC SITE

SSC Project Facility	County Location	Ownership Patterns	Existing Zoning	Existing Land Use	Future Planned Land Use
Eastern Arc Quadrant					
Eastern Arc Ring	Granville	Private	None	Agr/rural	None
E7	Granville	Private	None	Forested	None
E8	Granville	Private	None	Forested/agr	None
E9	Granville	Private	None	Forested/agr	None
F6	Granville	Private	None	Forested	None
F7	Granville	Private	None	Agr/forested	None
F8	Granville	Private	None	Forested/agr	None
Roads and rail	Durham/Granville/ Person	Private	None/agr	Forested/agr	Same/none
Utilities	Durham/Granville/ Person	Private	None/agr	Forested/agr	Same/none

Sources: Durham County 1987.
Durham County 1986. Durham County Zoning Map.
Person County 1983.
Person County 1963. Person County Zoning Map, Roxboro Township.
Durham County 1987.
Durham County 1987. Durham County General Plan Map.
Person County 1987.
North Carolina Land Resources Information Service 1987. SSC Area Land Use and Land Cover Map.
North Carolina Land Resources Information Service 1988. Land Use Maps for SSC Surface Facilities.
North Carolina Land Resources Information Service 1988. North Carolina SSC Soils Map.

1. SSC Project Near Cluster Quadrant

The near cluster quadrant, located in both Durham and Granville counties, encompasses a rural area of farms, woodlands, and rural residences. Much of this site is designated as prime farmland, which is scattered throughout the area's rolling topography. The quadrant is privately owned with the exception of the state-owned Camp Butner area, a National Guard Military Base/Range, in the southcentral portion. While no zoning ordinances exist for the Granville County area, the western half of the quadrant in Morgan Township, Durham County, is zoned for agriculture/rural residential and is also designated as a Water Quality Basin Area, which restricts certain types and densities of development. The Durham County General Plan calls for the same future agricultural, rural residential, and open space uses that currently exist. Land use plans are currently not in place for Granville County.

a. Campus Area A

Campus area A is in Mangum Township, Durham County, bounded on the east by an area that is close to the Granville County line. Approximately 60% of the northern portion of the site is private property, under woodland and agricultural and rural residential uses. The remaining southern portion is part of Camp Butner.

Land cover of this portion is forested open space. Zoning for the entire site is Rural District (RD). County plans propose no land use changes. A majority of the area is designated as prime farmland, which is to be preserved for agricultural uses according to the Durham County General Plan. It is also part of a designated Water Quality Basin Area.

b. Injector Area B

Injector area B is located in Granville County with a small sliver of the western edge located in Durham County. Camp Butner covers a forested area in the southwest (about 35% of the site), while the remainder is private rural property. Agricultural uses are found in concentrations on the northwest and southeast corners, with the remaining land being forested. Much of the area throughout the site is designated as prime farmland. Several small lakes and creeks are onsite and the northeast corner is crossed by an oil pipeline and an overhead transmission line. There are no zoning ordinances or general plan provisions that currently affect the area.

c. Future Expansion Area C

Future expansion area C, located in Mangum Township, Durham County, consists mostly of private agricultural/rural/residential property, with the forested Camp Butner property covering approximately 30% of the affected area. The area also includes a cemetery, several minor roadways, and a few small lakes. A majority of the area is designated as prime

farmland, which is scattered throughout the site. The Durham County General Plan proposes no land use changes. Durham County zoning for the area is Rural District (RD).

d. Buffer Area and Buried Beam Zone I

1. West Buffer Area and Buried Beam Zone I, Including Buried Beam Zone Access Areas J1 and J2

The west buffer area and buried beam zone I, also in Mangum Township, Durham County, consist of privately held, agricultural/rural residential land. The Village of Rougemont is in the western portion and consists of residences and businesses along roadways near the intersection of roads 1471 and 1740, and Highway 501. The bulk of agricultural uses is found west of site J2, with forested land located predominantly to the east. Substantial areas of designated prime farmland are scattered throughout the site. Crossing the area are the abandoned Norfolk and Western Railroad lines, two overhead transmission lines, and the Flat River along the eastern edge of J2. The Durham County General Plan proposes no land use changes for the area, which is almost entirely zoned as Rural District (RD). The only exceptions are commercial and residential zones found along the major roadways in Rougemont.

Site J1 is located just west of Rougemont, north of Road 1740 and south of Road 1471. Land use on site is predominantly agricultural, with some forested land and a portion of a small lake. Within 1,000 ft are three small lakes, more agricultural property, and residences along roads 1471 and 1740 in the vicinity of Rougemont. The Durham County General Plan proposes no land use changes.

Site J2, located on the west bank of the Flat River, consists of forested land with small areas of agriculture in the north and southwest. Uses within 1,000 ft are similar. The Durham County General Plan calls for a continuation of agricultural/rural/residential uses on both banks of the river, with the floodplain portion itself reserved as open space.

2. East Buffer Area and Buried Beam Zone I Buried Beam Zone Access Areas J3 and J4

The east buffer and buried beam zone is located in Granville County on private property, excluding the extreme western tip which is within Camp Butner. Land use is agriculture and forested land, with roadside residences and a few cemeteries located along roads 1004, 1136, 1132, and 1133. The Village of Stem is intersected on the south where residential/mixed use densities increase within 1,000 ft of the site near the village center. The Southern Railroad line parallels Road 1004 across the area intersecting it again in the north corner, along with an oil pipeline. The majority of the site is designated as prime farmland, and several small lakes are scattered throughout. Surrounding land uses are of the same character, and include the Village of Stem and Interstate 85. There are no zoning ordinances or land use plans affecting the site or its surrounding area.

Site J3, located approximately 400 ft west of Road 1004 and the railroad line northwest of Stem. Land uses are agricultural and rural residential, and the area is crossed by a minor road. Surrounding uses are the same, with some forested land to the northwest, and small lakes all around. It is mostly designated as prime farmland and all privately owned. No zoning restrictions or land use plans exist for the area.

Site J4, intersected in the south by Road 1132, consists of forested land, agricultural, and rural residential uses. Surrounding uses are of the same character with more agriculture to the west, and woodlands to the east. The site is privately owned with no zoning or land use plans in effect.

e. Near Cluster Ring G, Including Intermediate Access Areas E1, E10, Service Areas F1, F9 and F10, Buried Beam Access Areas J5 and J6 and Interaction Points and Experimental Areas K1 and K2

The near cluster ring, located in both Durham and Granville counties, is privately owned except where intersected by Camp Butner in the center. Land use is a mixture of agriculture, rural, residential and forested land as well as a few small lakes and the military base/range itself.

Several linear features traverse the area, including three overhead transmission lines, an oil pipeline, the Southern Railroad line, several roadways, drainages, and the Flat River. The Durham County portion is zoned as Rural District (RD), with no proposed changes in use. No zoning or land use plans exist for the Granville County portion of the ring. A number of parcels throughout the area are designated as prime farmland.

Site F1, located in Mangum Township, Durham County, is either forested or agricultural land use, with some rural residences located along a minor road approximately 1,000 ft to the east. Both the current zoning designation (Rural District) and future land use plans propose no change. The site is under private ownership and is partially designated as prime farmland.

Site E1, located in Mangum Township, Durham County, is on private property and zoned Rural District (RD). It lies entirely within forested land, and a minor road 500 ft to the east is the only nearby improvement. The Durham County General Plan proposes no land use changes for the site.

Site J5, located in Durham County on privately owned land, is zoned Rural District (RD) and composed entirely of forested land. Some agricultural use can be found north of the site, and portions of J5 are designated as prime farmland. Land use plans propose no changes in use for this area.

Site K2 lies entirely within the north-central portion of the J5 site.

Site K1 is located in Durham County in the Camp Butner National Guard Military Base/Range and, as such, is state-owned property. Land cover on and around the site is unimproved forested land with a small drainage located approximately 800 ft to the north and east. The area is designated as prime farmland and zoned Rural District (RD), although expected to remain under present military use according to current land use plans.

Site F10, located in Durham County, is also zoned Rural District (RD), even though it lies on Camp Butner property. The area on and around the site is forested, and designated as prime farmland. The Durham County General Plan proposes no land use changes.

Site J6, located in Granville County approximately 600 ft east of the Camp Butner boundary, is privately owned and mostly forested, with agricultural uses on the edges and surrounding the site. A small lake lies to the northwest, and portions of the site are designated as prime farmland. No zoning ordinances or land use changes proposed for the area.

Site E10, located in Granville County, is composed entirely of privately owned forested land, with some agricultural use occurring about 1,000 ft to the north. An overhead transmission line 300 ft to the east represents the only improvement near the site, portions of which are designated as prime farmland. There are no applicable zoning ordinance or land use plans for the area.

Site F9 is located on private land in Granville County. The site consists of forested land with some agricultural use in the eastern portion. The Southern Railroad line runs about 200 ft south of the site as does an unimproved road. Forested land extends south from the area and, to the north, there are more agricultural lands and two small lakes. Just beyond the 1,000-ft area lies Road 1004. There are no zoning regulations or land use plans in effect for the area.

2. <u>SSC Project Far Cluster Quadrant</u>

a. <u>Far Cluster Ring H, Including Intermediate Access Areas E5, E6, Service Area F5 and Interaction Points and Experimental Areas K3, K4, K5 and K6</u>

The far cluster quadrant, located in both Granville County and the Allensville Township of Person County, is privately owned, with land use consisting mainly of agriculture and forested land. Some rural residences are found along intersecting minor roads, and several small lakes and drainages are located in the area. One overhead transmission line crosses the arc and another is found approximately 1,000 ft to the north. Generally, the area is sparsely developed and of a rural/agricultural character. There are no zoning ordinances or land use plans in effect in either the Allensville Township, Person County or Granville County. The Person County Development Plan 1985-1995 proposes no planned land use changes. Areas scattered throughout the quadrant are designated as prime farmland, and the area is expected to maintain its rural character due to a lack of development pressure.

Site E5, located in Allensville Township, Person County, is unzoned private property. An overhead transmission line is found about 900 ft to the south, and a small drainage ditch is located approximately 300 ft to the south. The remaining areas on and within the 1,000-ft buffer area are unimproved forested land for which no land use changes are planned.

Site K3 is in the Allensville Township, Person County, and is private property. The site lies approximately 900 ft northwest of the intersection of Roads 1542 and 1555. The area is unimporved forested land with some agricultural use and a few farm residences within 1,000 ft along the roadways. There are no zoning restrictions and the Person County Development Plan proposes no changes in use.

Site K4 is located in the Allensville Township, Person County, on an area under cropland agricultural use. Some forested land and two small lakes are found within 1,000 ft, and a small dirt road runs north to south approximately 100 ft west of the site. The area is designated as prime farmland, privately owned, and not under any zoning restrictions. The Perons County Development Plan calls for continuation of existing use and preservation of prime farmland resources.

Site F5, located in Allensville Township, Person County, approximately 800 ft west of the Granville County line, is entirely private forested land, with some agricultural uses found to the southeast and southwest within 1,000-ft buffer zone. Road 1327 passes just at the southeast corner of F5, with one associated residence located about 500 ft to the south. The remaining surrounding area is a continuation of the unimproved woodland. Portions of the SSC site are considered prime farmland, and no zoning ordinances or land use plans affect the area.

Site K5 is located on privately owned land in Granville County. Land use is predominantly agricultural with some forested land on the northeastern portion. Surrounding areas are either forested or under agricultural use, with one farm residence about 1,000 ft to the south. Two minor drainages run near the site: one 500 ft to the north and another 800 ft to the south. There are no zoning or land use plans in effect for the area.

Site E6, located in Granville County, is private land that is mostly forested, with the eastern third of the site under agricultural use. Prime farmlands are found to the east and west of the SSC site, and agricultural uses are found to the east and south within 1,000 ft. A small lake lies approximately 600 ft to the southeast, and the remaining surrounding area is unimproved woodland. There are no zoning ordinances or land use plans affecting the site or its surrounding area.

3. SSC Project Western Arc Quadrant

a. Western Arc Quadrant D, Including Intermediate Access Areas, E2, E3 and E4, and Service Areas F2, F3 and F4

The western arc quadrant, located in the townships of Flat River, Roxboro, and Allensville in Person County, with a small portion in Mangum Township, Durham County, is privately owned and land use consists mainly of agricultural/rural residential, and forested lands. Several small lakes are within the quadrant and it is crossed by the North and South Flat rivers, as well as overhead transmission lines, an abandoned rail line, an oil pipeline, several roadways, and Route 501, which meanders through the southern half. Zoning restrictions only exist only for the small portion in Durham County and the area within the Roxboro Township in Person County. Zoning for both these areas is agricultural/rural residential in nature, i.e., Rural Residential (RD) and R-1, respectively. Land use restrictions are not enforced for the remainder of Person County. The Durham County portion of the quadrant is part of a Water Quality Basin Area, where restrictions on development are applied. The Durham County General Plan and Person County Development Plan propose no change to existing rural use. There is residential development pressure projected for the southern portion of the Flat River Township, which has been designated as an area of transition. Scattered areas throughout the quadrant are designated as prime farmlands, and applicable land use plans recommend continuing agricultural/rural uses to preserve this resource.

Site E2, located in Flat River Township, Person County, approximately 1,000 ft east of Route 501, and on the south bank of the meandering Flat River, is entirely agricultural, while surrounding areas are agricultural and forested with some residential use along the highway. The Flat River and abandoned Norfolk and Western rail line are found within 1,000 ft to the east. The area is privately owned and under no zoning restrictions. The Person County Development Plan sees this as part of a large transition area, given its proximity to the developing areas of Durham County.

Site F2, located in Flat River Township, Person County, just west of Route 501, about 1,000 ft south of its intersection with Road 1131, is predominantly forested land with some agricultural use on the northeast corner. Uses within 1,000 ft are forested land and agricultural, with some residential along Road 1731 to the north. The land is privately owned, unaffected by land use zoning restrictions, and designated as prime farmland. The Person County Development Plan proposes no land use changes.

Site E3, located in Flat River Townsnip, Person County, approximately 600 ft north of Road 1708, is privately owned forested land with some agricultural use on the southeast corner. Agricultural uses extend east of the SSC site as well as 400 ft to the west. Remaining surrounding areas are forested land and a drainage crosses the area. Route 501 and a parallel abandoned railway are just beyond the 1,000-ft area to the

west. A small portion of the area is designated as prime farmland, and no zoning restrictions apply. Land use plans propose no change in use.

Site F3, located in Roxboro Township, Person County, south of Route 158, is privately owned, forested, and 40% agricultural land, with a majority of the area designated prime farmland. Surrounding uses are primarily agricultural with some woodlands to the west. Within 1,000 ft directly east of the site is a small residential concentration including a church and a cemetery. Zoning is low-density residential/agricultural (R-1) use and the county plans indicate no land use change.

Site E4, located in Roxboro Township, Person County, just south of Road 1536 in an area zoned for low-density residential/agricultural (R-1) land use, is primarily agricultural with at least one farm residence, with forested land accounting for the remainder. Surrounding uses are approximately of the same mix, with a few residences found along roads 1536 and 1545 to the north and two small lakes within 1,000 ft to the south. The area is privately owned, with most of the site designated as prime farmland. The Person County Development Plan proposes no land use changes for the area.

Site F4 is located in Allensville Township, Person County, northeast of the intersection of roads 1520 and 1547. Road 1547 intersects the south corner of the site, and Road 1520 is located approximately 300 ft to the west. Land use is agricultural with at least one farm residence on site. Surrounding areas are agricultural/rural residential with several homes located along the neighboring roadways. Also within 1,000 ft are several small lakes, an overhead transmission line and patches of forested land. The area is privately owned and designated as prime farmland. The Person County Development Plan proposes no land use changes; however, there are no zoning restrictions in effect for the area.

4. SSC Project Eastern Arc Quadrant

a. Eastern Arc Quadrant D, Including Intermediate Access Areas E7, E8, and E9 and Service Area F6, F7 and F8

The eastern arc quadrant D, located entirely within Granville County on privately owned property, is predominantly agricultural, forested land, and rural residential with several roadways and drainages crossing the site, including the Tar River and State Route 96. Two overhead transmission lines cross the area, and just outside the area is a third transmission line and the Southern Railroad line. Portions of the area throughout the site are designated as prime farmland. Agricultural uses tend to be concentrated in the south and central portions of the quadrant. Granville County currently does not have a general plan, land use plan, or any zoning controls affecting the area.

Site F6 is located entirely on privately owned, forested land with some agricultural use outside to the southeast, and along Road 1320 to the northwest where a few associated farm residences are found within 1,000 ft. Portions of the site and surrounding area are designated as prime farmland, and no zoning or land use plans affect the area.

Site E7 is located entirely on privately owned, forested land as is the immediately surrounding area. There is some small agricultural/residential use near Route 96 to the northeast. A small lake lies just beyond the roadway, and small drainages are found within 1,000 ft to the south and east. The northeast portion of this area is designated as prime farmland, and no zoning ordinances or land use plans are in effect.

Site F7, privately owned and designated as prime farmland, is mostly agricultural with forested land on the west and southeastern portions, and the edge of a small lake intersected to the south. Road 1302 is located about 600 feet to the south, with agricultural and rural residential frontage usage. The remaining surrounding areas are forested land, with patches of agriculture and farm residential land. There are no zoning ordinances or land use plans that affect the site.

Site E8, located just north of Road 1139, is on privately owned land that is either forested or under agricultural use. Several residences are found to the south in association with the agricultural land, while the forested area extends to the north. The site is designated as prime farmland and is unaffected by zoning or land use plans.

Site F8 is of the same forested/agricultural use mix with agricultural uses extending to the northwest and east across a small drainage. The remaining areas are forested. The area is privately owned and portions are designated as prime farmland. There are no zoning ordinances or land use plans that affect the area.

Site E9 is mostly forested with some agriculture on the west corner and extending beyond. Remaining areas are forested with Jackson Creek located 500 ft to the south. Road 1155 is located about 600 ft north with some agricultural areas and rural residential frontage usage. This privately owned site is designated as prime farmland. There are no land use controls or plans in effect for the area. The Tar River runs approximately .50 mile northeast of the site.

5. Planned SSC Project Roads and Railroad Networks

Location descriptions of planned SSC project road improvements are provided in Section 1.2.1.2. Adjacent land use patterns for the road network are no different than for what has been generally described for the area. There are no future plans that constrain these areas from further improvements. The existing railroad network is adequate for the project, with no improvements deemed necessary.

6. Planned SSC Project Utility Improvements

Location descriptions of planned SSC project utilities are provided in Section 1.2.1.2. Adjacent land patterns for these utility upgrades are no different than for what has been generally described for the area. There are no future plans that constrain these areas from further improvements.

5.5.10.3 Soil and Prime Farmland Resources

A. Factors of Soil Formation and the Resulting Soil Cover

The proposed SSC site occupies the north-central part of the state, part of the Piedmont physiographic province. The soil cover is primarily represented by residual soils developed in materials weathered from the underlying, in-place rocks. The rocks common at the site are the metavolcanics, represented mainly by felsic and mafic slates. Soils that belong to the Georgeville, Herndon, Lignum, and Nason series developed characteristically in weathered metavolcanic parent materials (Soil Survey of Durham County, North Carolina, 1977, USDA-SCS). These four soils amount to 3,780 acres, close to half of the acreage corresponding to the fee simple area. When these soils are located on slopes of less than 6%, they are as a general rule considered prime farmland soils.

A considerable proportion of residual soil has developed on acidic crystalline saprolite, such as: Appling and Cecil soils; and Helena soils developed both on felsic and mafic rocks (Soil Survey of Durham County, North Carolina, 1977, USDA-SCS). These three soils cover 2,230 acres in the fee simple area and are prime farmlands wherever the slope of the terrain is less than 6%. Thus, the indicated seven soil series cover 6,000 acres of the fee simple area.

The soils in the region of the proposed SSC site are acid. They clearly manifest characteristic symptoms associated with acid soils: are strongly leached (have a low base saturation), and many are deficient in important chemical elements such as calcium, magnesium, phosphorus, and potassium, elements essential for normal growth and development of cultivated plants.

The climate at the SSC site is warm and humid. The average air temperatures are around 42°F in winter and around 77°F in summer. When these figures are used to calculate soil temperatures (Soil Taxonomy, Agricultural Handbook No.436, 1975, USDA-SCS), the results indicate that the soil has a thermic temperature regime. The total annual precipitation is 40 to 45 inches of rain. This quantity of water, coupled with specific evapotranspiration conditions at the site, result in an udic soil moisture regime; this means that no part of the soil is ever dry for more than three months and that no part of the soil is continuously dry for a period longer than one and a half months, during the late summer, in any calendar year (Soil Taxonomy, Agricultural Handbook No.436. 1975, USDA-SCS).

The felsic crystallines and metacrystallines that generate the parent material for many soils have a relatively low concentration of bases (cations, such as calcium, magnesium or potassium). In addition, the climate is conducive to extensive weathering and leaching. On many surfaces covered by Udults, as is the case in the fee simple region, the high rate of rock weathering is not high enough to keep pace with the even higher rate of leaching of bases into the lower part of the soil profile or even beyond this depth. Although weathering is intense, it releases few bases into the soil solution because the process has operated for a long period and has already depleted the rock of important elements. Small quantities of bases that are released into the soil solution are rapidly transported downward by the leaching mechanism; the same leaching process has transported and concentrated the clay fraction into an "argillic" horizon having a thickness of 15 to 25 inches, a firm and blocky structured horizon with a low degree of base saturation. Thus, roots tend to grow in the very upper part of the profile where bases are recycled by the plant residues left in the field at the end of the growing season.

The generalized soil map of the United States (Soil Taxonomy, 1975, Agricultural Handbook No.436, USDA-SCS) shows that soil cover at the location of the North Carolina site is represented by the suborder Udults; also present are Udalfs, Fluvents, Aquents, and Dystrochrepts. Table 5.5.10-2 shows that Udults represent 88% of the fee simple area, with the remaining 12% represented by the other four suborders.

A total of 40 soil mapping units were identified at the proposed North Carolina site, representing 21 soil series. Seven soil series cover 84% of the fee simple area. As Table 5.5.10-2 indicates, these are the Appling, Georgeville, Helena, Herndon, Lignum, Nason, and Tatum soil series. The Georgeville and Herndon soils covering more than one-third of the fee simple area are formed in what locally is called "Carolina Slates". These soils are on predominantly sloping upland, well-drained terrain. They have a firm silty clay subsoil (Soil Survey of Durham County, North Carolina, 1977, USDA-SCS). Nason and Tatum soils, covering an area in excess of 1,000 acres, are found on steeply sloping to moderately steep surfaces. Their profile to the depth of the parent material is less than 3 ft, roughly 1 ft shorter than the Georgeville or Herndon soils. Unlike those soils, the Nason and Tatum soils have an additional A2 horizon intensively leached and residually enriched in "unleachable" constituents such as silica oxides (Soil Survey of Durham County, North Carolina, 1977, USDA-SCS). The Appling soil, with a representation of 10% in the fee simple area, is characteristically present on gentler slopes, thus, less subject to geologic erosion and consequently developing a deeper profile; the parent material can be as deep as 5 ft below the surface. The Appling soil has, similar to Nason or Tatum soils, an elluviated, leached-out, A2 horizon. However, in the case of Appling soil, this horizon is normally not thicker than 2 inches (Soil Survey of Durham County, North Carolina, 1977, USDA-SCS). The Helena and Lignum soil series covering close to 2,000 acres of the fee

Table 5.5.10-2

SOIL SUBGROUPS AND SERIES WITH CORRESPONDING ACREAGES AT THE NORTH CAROLINA SSC PROPOSED SITE

Subgroups	Series	Acreages
Typic Hapludults	Appling	773.23
(4,804.75 acres)	Cecil	141.73
	Georgeville	1,616.02
	Herndon	986.99
	Nason	624.76
	Tatum	488.78
	Vance	138.47
	Wedowee	27.94
	Wickham	6.83
Aquic Hapludults	Helena	1,312.35
(1,861.26 acres)	Lignum	548.91
Rhodic Paleudult	Davidson	4.30
Typic Hapludalf	Iredell	85.44
Ultic Hapludalfs	Enon	13.81
(34.43 acres)	Mecklenburg	20.62
Albaquic Hapludalf	Orange	55.53
Typic Udifluvent	Congaree	12.01
Aquic Udifluvent	Cartecay	26.81
Typic Fluvaquent	Wehadkee	291.52
Fluvaquentic Dystrochrept	Chewacla	381.21
Ruptic-Ultic Dystrochrept	Goldston	45.57
Total per Great Groups	Hapludults	6,666.01
	Paleudults	4.30
	Hapludalfs	175.40
	Udifluvents	38.82
	Fluvaquents	291.52
	Dystrochrepts	426.78
Total per Suborders	Udults	6,670.31
	Udalfs	175.40
	Fluvents	38.82
	Aquents	291.52
	Ochrepts	426.78
Total per Orders	Ultisols	6,670.31
	Alfisols	175.40
	Entisols	330.34
	Inceptisols	426.78

simple area, are only moderately well drained and are associated primarily with gentle slopes. These are upland soils with an extremely firm, silty clay and clay subsoil (argillic horizon). The presence in the profile of this horizon with a low hydraulic conductivity, and the occurrence of these soils on relatively flat surfaces, results in an aquic soil moisture regime, at least at times, in the lower part of the profile (Soil Survey of Durham County, North Carolina, 1977, USDA-SCS).

B. Farming Potential of Soils

The Soil Conservation Service has provided a soil capability system intended to assess the suitability of soils for agricultural uses. The system associates each unit of land with a capability class (I through VIII) and a capability subclass identified by a letter subscript. In North Carolina only subscripts "e" and "w" are used. Subscript "e" means that the main limitation of the land is the erosion hazard and subscript "w" means that the soil is excessively wet.

Soils in capability Class I have few limitations and can be used to produce all crops grown in the region. Soils in Class II have moderate limitations; when such limitations are removed, either by draining the land, which in its natural state is too wet, or by using antierosional farming practices when the limitation is the erosion hazard, most surfaces covered by these soils qualify as prime farmlands. Soils in Class III have severe limitations and generally are not prime farmlands. Soils in Class V are no longer amenable for producing cultivated crops, and soils in Class VIII are only used for recreation purposes (Soil Survey of Durham County, North Carolina, 1977, USDA-SCS).

Table 5.5.10-3 presents acreages corresponding to each capability subclass and summed up acreages for each of the two limitations identified at the North Carolina site. Primary data used for compiling the table were obtained from soil surveys (Soil Survey of Durham County and Soil Survey of Orange County, North Carolina, 1977,USDA-SCS). The weighted average capability class for all lands included in the fee simple area is equal to 2.75. This indicates that, in general, soils have severe limitations to farming activities at the site. The fact that 82.8% of the area is covered by soil units of capability Classes II and III is an indication that the soils are of fair quality, with some areas qualifying even as good agricultural lands, provided erosion-preventing measures are consistently undertaken. Such measures are aimed at maintaining the soil in good tilth by returning crop residues to the soil; protecting the soil with soil-protecting crops; and using contour tillage along with diversion, terraces,or stripcropping.

Table 5.5.10-3

CAPABILITY SUBCLASSES AND CORRESPONDING ACREAGES. ACREAGES FOR EACH OF THE TWO LIMITATIONS.

Capability Subclass	Acreage
IIe	3,828.56
IIw	12.01
IIIe	2,192.88
IIIw	217.40
IVe	362.77
IVw	482.11
Ve	232.31
VIe	210.27
VIIe	8.97

Main Limitation	Acreage	Percent
e, erosion hazard	6,835.76	90.6
w, excessive wetness hazard	711.52	9.4

C. Prime, Unique, and Important Farmlands at the SSC Site

The soil cover at the North Carolina SSC site is made up predominantly of Udults, a suborder with a low natural fertility. These are leached soils, naturally poor in nutrients, with a quasi-impeding argillic horizon in the profile. In general, these soils barely pass the criteria for qualification as prime farmlands. Inspection of available data on all soil phases at the North Carolina site lead to the separation of soils into prime farmlands, important farmlands, and lands of secondary importance. The classification of each one of the soils into one of the three groups is presented in Table 5.5.10-4. In few instances, where the classification was ambiguous, the acreage corresponding to a particular soil was assigned to two rather than a single grouping. Thus, one quarter of the acreage covered by Appling sandy loam, 6-10% slope was classified as important rather than prime farmland because the erodability factor K of this soil can reach values in excess of 0.25; when this value is multiplied by 8% or higher values of slope, a product in excess of 2 is obtained and thus such a soil cannot qualify as prime farmland. A similar interpretation was used in the case of Lignum silt loam, 2% to 6% slope characterized by a relatively high K value, 0.43, and Chewacla loam and Wehadkee silt loam, which at times can be used for growing corn or soybean and thus, important to the state. (Soil Survey of Durham County, North Carolina, 1977, USDA-SCS).

Table 5.5.10-4 shows that slightly more than half of the fee simple area is made up of prime farmlands, slightly more than one third is made up of soils of limited productivity but still important to the State of North Carolina, and almost one seventh, by lands with practically no use for cultivated agriculture.

Table 5.5.10-4

SOIL PHASES AT THE NORTH CAROLINA SSC SITE, CORRESPONDING ACREAGES AND THEIR CLASSIFICATION AS PRIME FARMLANDS, IMPORTANT FARMLANDS, AND LANDS OF SECONDARY IMPORTANCE

Soil Phases	Prime Farmlands (acreage)	Important Farmlands	Land of Secondary Importance
Appling sandy loam, 2-6% s.	371.79		
Appling sandy loam, 6-10% s.	301.08	100.36	
Cartecay loam			26.81
Cecil sandy loam, 2-6% s.	39.85		
Cecil sandy loam, 6-10% s.		36.07	
Cecil sandy loam, 10-25% s.			65.81
Chewacla loam		190.60	190.60
Congaree loam		12.01	
Davidson loam, 2-6% s.	2.06		
Davidson loam, 6-10% s.		2.24	
Enon sandy loam, 2-6% s.		13.81	
Georgeville silt loam, 2-6% s.	868.19		
Georgeville silt loam, 6-10% s.		709.45	
Georgeville silt loam, 10-15% s.		38.38	
Goldston silt loam, 6-10% s.		36.60	
Goldston silt loam, 10-25% s.		8.97	
Helena sandy loam, 2-6% s.	1,096.50		
Helena sandy loam, 6-10% s.		215.85	
Herndon silt loam, 2-6% s.	590.16		
Herndon silt loam, 6-10% s.		396.83	
Iredell sandy loam, 2-6% s.		72.54	
Iredell sandy loam, 6-10% s.		6.46	6.46
Lignum silt loam, 2-6% s.	365.94	182.97	
Mecklenburg loam, 6-10% s.		20.62	
Nason silt loam, 2-6% s.	173.32		
Nason silt loam, 6-10% s.		286.44	
Nason silt loam, 10-15% s.		50.51	
Nason silt loam, 15-25% s.			114.49
Orange silt loam, 2-6% s.		55.53	
Tatum silt loam, 6-10% s.		17.16	
Tatum silt loam, 10-15% s.			51.78
Tatum silt loam, 15-25% s.			391.42
Tatum silt loam, 25-50% s.			28.42
Vance sandy loam, 2-6% s.	116.83		
Vance sandy loam, 6-10% s.		21.64	
Wedowee sandy loam, 10-15% s.		26.39	
Wedowee sandy loam, 15-25% s.			1.55
Wehadkee silt loam		145.76	145.76
Wickham sandy loam	1.56		
Wickham sandy loam, 2-6% s.	5.27		
Total	3,932.55	2,647.19	1,023.10
Percent of Total	51.7	34.8	13.5

Sources: Soil Survey of Durham County, North Carolina, 1977, USDA-SCS.
Soil Survey of Orange County, North Carolina, 1977, USDA-SCS.
Soil Taxonomy, Agricultural Handbook No.436, 1975, USDA-SCS.

5.5.11 Socioeconomics and Infrastructure

5.5.11.1 Socioeconomics

SSC development and operation in north-central North Carolina has the potential to affect socioeconomic conditions in as many as 15 counties in that state, as well as five counties and two independent cities in neighboring Virginia (Figure 5.5.11-1). Communities in this region, especially those in and around the Raleigh-Durham metropolitan area, could provide a sizable portion of the project-related workforce. Including most communities within approximately one hour driving time from the site, the region likely would house most relocating workers as well.

For economic and demographic issues, the region of influence (ROI) studied in this EIS includes the larger 20-county area, including the independent Virginia cities of Danville and South Boston. Impacts probably would be greatest, however, in Durham, Granville, and Person counties, where the SSC facilities would be located. Although many project workers may choose to reside elsewhere in the ROI, and many project-related requirements for goods and services likely would be met from the larger region, demand for housing and services probably would be concentrated in these three counties. Based on this reasoning, Durham, Granville, and Person are designated as the primary impact counties for this analysis, and thus are the principal focus of study for housing, services, and public finance impacts. ROI and state relationships also are addressed for these components of the analysis, as appropriate.

A. Economic Activity, Labor Force, and Income

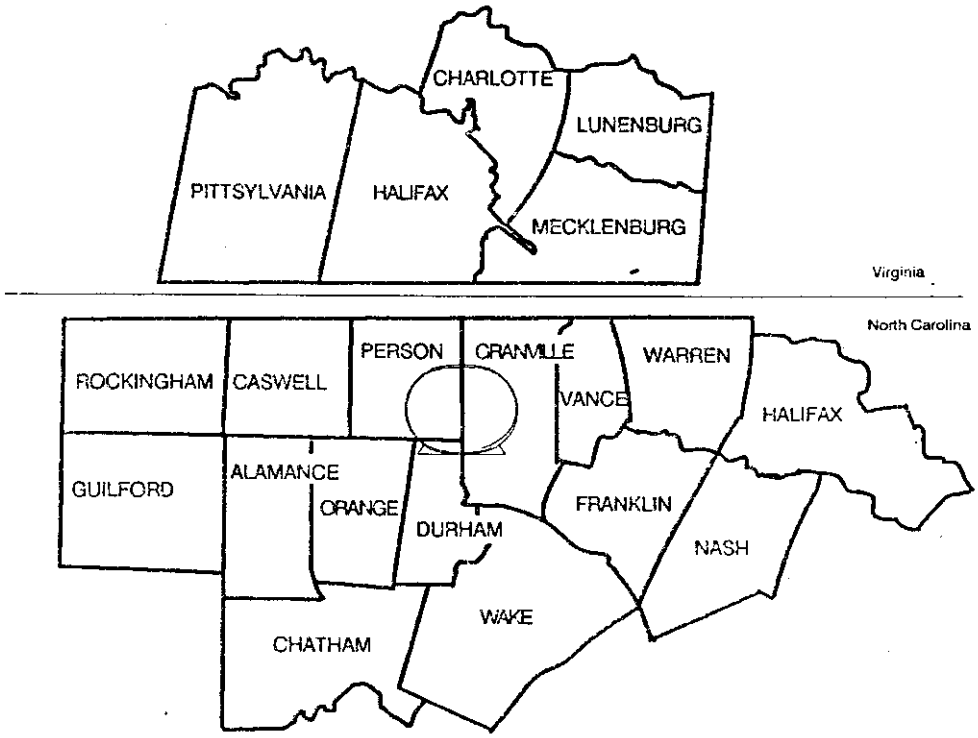
1. Regional Setting

The economy of the North Carolina ROI has steadily expanded during the past two decades (Table 5.5.11-1). The ROI's employment base expanded faster during this period than the nation as a whole. Total employment growth in the region averaged 2.2% annually between 1969 and 1984, compared with the U.S. annual average of 1.9% (U.S. Department of Commerce, Bureau of Economic Analysis 1986).

Annual employment growth in the North Carolina ROI from 1969 to 1984 exceeded national average growth rates in six of the eleven industrial sectors. The agricultural services, forestry, and fishing sector in the ROI experienced the largest percentage growth in employment during this period, increasing at an average annual rate of 4.6%. Other leading sectors in employment growth in the ROI were transportation and public utilities, wholesale trade, retail trade, services, and finance, insurance, and real estate which all grew at average annual rates above 3.0%.

Figure 5.5.11-1

**COUNTIES FOR SOCIOECONOMIC ANALYSIS
IN NORTH CAROLINA'S SSC REGION OF INFLUENCE**



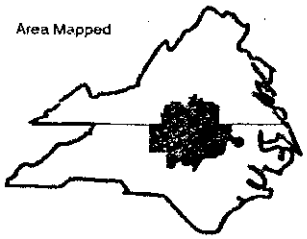


Table 5.5.11-1

HISTORIC ECONOMIC INDICATORS FOR THE NORTH CAROLINA ROI, AND DURHAM, GRANVILLE, AND PERSON COUNTIES

	1969	1974	1979	1984	1987	Average Annual Growth Rate
NORTH CAROLINA ROI						
Total employment[1]	685,234	771,551	865,793	953,919	na[2]	2.2%
Earnings per job[3]	$ 17,983	$ 19,178	$ 18,625	$ 18,810	na	0.3%
Labor force	na	697,547	789,379	863,114	na	2.1%[4]
Per capita personal income[3]	$ 10,354	$ 11,805	$ 12,524	$ 13,565	na	1.8%
Unemployment rate	na	4.3%	4.7%	5.8%	na	na
DURHAM COUNTY						
Total employment	71,587	78,955	93,419	110,220	na	2.9%
Earnings per job	$ 19,903	$ 21,955	$ 21,674	$ 22,926	na	0.9%
Labor force	na	70,620	84,790	94,500	99 250	3.3%[5]
Per capita personal income	$ 11,043	$ 12,587	$ 13,098	$ 14,398	na	1.8%
Unemployment rate	na	3.0%	4.0%	3.6%	3.1%	na
GRANVILLE COUNTY						
Total employment	13,648	14,959	16,885	17,965	na	1.8%
Earnings per job	$ 14,558	$ 16,189	$ 15,910	$ 15,278	na	0.3%
Labor force	na	14,970	15,780	19,120	20,180	2.6%[5]
Per capita personal income	$ 7,262	$ 8,834	$ 9,614	$ 9,919	na	2.1%
Unemployment rate	na	5.9%	6.0%	6.9%	5.4%	na
PERSON COUNTY						
Total employment	10,927	12,176	13,122	13,023	na	1.2%
Earnings per job	$ 15,826	$ 16,263	$ 15,985	$ 15,156	na	-0.3%
Labor force	na	12,830	15,140	14,380	14,660	1.4%[5]
Per capita personal income	$ 8,269	$ 9,459	$ 10,183	$ 10,311	na	1.5%
Unemployment rate	na	9.2%	7.7%	9.8 %	8.5%	na

Notes:
1. Employment is by place of work.
2. na - data not available or not applicable.
3. Earnings and income are in constant 1988 dollars.
4. Labor force average annual growth rate for North Carolina ROI is for 1974-1986.
5. Labor force average annual growth rates for Durham, Granville, and Person counties are for 1970-1987.

Sources: U.S. Department of Commerce, Bureau of Economic Analysis, 1986 (employment, earnings, and income); North Carolina Employment Security Commission 1988, Virginia Employment Commission 1986 (unemployment rates).

Both the farming and mining sectors in the region experienced overall declines in employment during the 16-yr period. The 3.0% average annual decline in farming employment in the North Carolina ROI is consistent with, but more severe than, the national trend of an average annual 1.0% loss in employment from 1969 to 1984. The 6.8% average annual decline in the ROI mining sector, however, was not reflected in national trends, which posted a 4.1% average annual gain over that period. The ROI manufacturing sector, on the other hand, which experienced an average annual loss in employment of 0.2% nationally, grew in the North Carolina ROI at a 0.9% annual rate. Figure 5.5.11-2 shows the distribution of employment in the eleven major industrial sectors in the ROI in 1984. The dominant sectors of the ROI economy, in terms of employment, were manufacturing (with 24.2% of the ROI jobs), services (21.2%), retail trade (15.2%), and government (14.9%).

In 1984, average earnings per worker in the ROI were $18,810, well below the national average of $21,027. Average earnings per worker in 1984 were greatest in transportation and public utilities ($29,277), wholesale trade ($26,975), and manufacturing ($24,079) sectors (all values represent 1988 dollars).

From 1980 to 1986, average annual unemployment rates in the ROI remained consistently below the national average rates. During this period, unemployment rates peaked twice, at 7.6 in 1975 and at 8.1% in 1982 North Carolina, (Employment Security Commission, 1988; Virginia Employment Commission, 1988; U.S. Council of Economic Advisors, 1988). The region's labor force, numbering about 865,000 in 1984, grew at a modest average annual growth rate of 2.1% between 1974 and 1986.

Per capita personal income in the North Carolina ROI in 1984 averaged $13,565. Since 1969, ROI per capita personal income has remained consistently below the national average.

Between 1988 and 2000, employment by place of work is expected to grow at an average annual rate of 1.3%, from an estimated 0.9 million jobs to more than 1.1 million. This level of growth is the same as the 1.3% national annual growth projection for employment between 1988 and 2000 (U.S. Department of Labor, Bureau of Labor Statistics 1987).

2. Primary Impact Counties

a. Durham County

In 1984, Durham County, the largest of the three primary impact counties, provided 11.6% of the employment in the ROI and 78.1% of total employment in the three impact counties. The county similarly received 10.4%

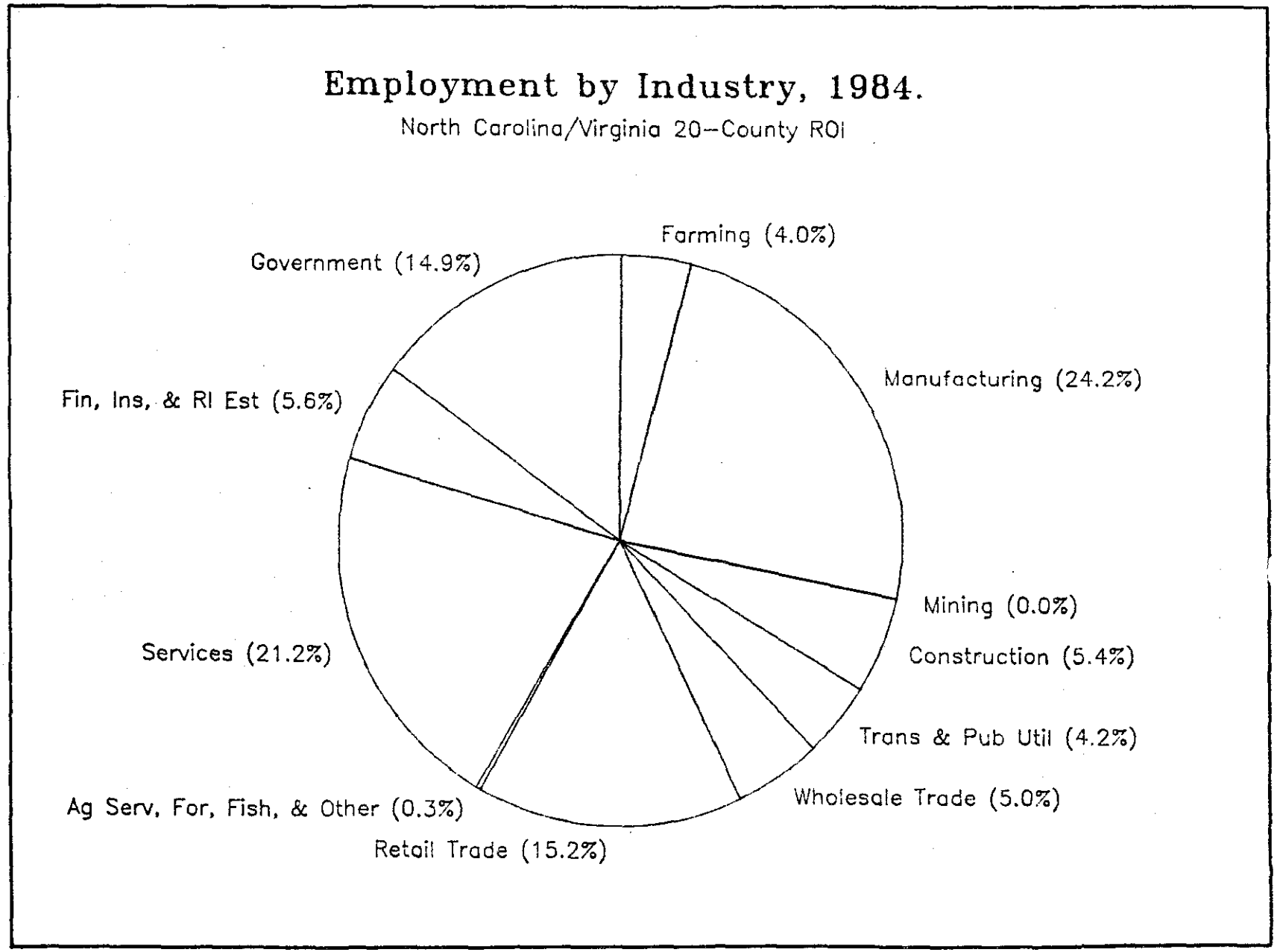


Figure 5.5.11-2

of total personal income in the ROI and 77.4% of total personal income in the primary impact counties. Total employment growth in the county averaged 2.9% annually between 1969 and 1984.

Average annual employment in the eleven industrial sectors grew at rates exceeding the national averages in six sectors but exceeded growth rates of only two ROI sectors. As with the ROI, employment in agricultural services, forestry, and fishing grew fastest from 1969 to 1984, at an average annual rate of 4.1%. The manufacturing, wholesale trade, retail trade, services, and government sectors all posted average annual growth rates exceeding 3.0%. As with the North Carolina ROI, only employment in the farming and mining sectors incurred declines during the period. The distribution of employment in the eleven major industrial sectors in Durham County in 1984 varied slightly from that of the ROI. The four dominant sectors in the county economy, in terms of employment, were the same as those for the ROI, but ranked differently: services (with 33.8% of the total county jobs), manufacturing (22.7%), government (13.4%), and retail trade (12.7%).

Average earnings per worker were $22,926, higher than both the national and ROI averages in 1984 and the highest of the three primary impact counties. In 1984, the highest average earnings per worker were paid in the manufacturing sector, at $36,800.

Average annual unemployment rates since 1970 have remained consistently less than those for the North Carolina ROI and the nation. Since 1969, the average annual unemployment rates in the county have ranged between just 2.8% (in 1985) and 5.4% (in 1975). The county labor force, nearly 100,000 in 1987, grew at an annual average rate of 3.3% between 1970 and 1987.

Per capita personal income in the county during most years remained less than the national average and greater than the North Carolina ROI average between 1969 and 1984. In 1984, per capita personal income ($14,398) was less than the North Carolina ROI average ($13,565) but slightly less than the national average ($14,746).

b. Granville County

In 1984, Granville County, the second largest of the three primary impact counties, provided 1.9% of the employment in the North Carolina ROI and 12.7% of total employment in the three impact counties. County residents received 1.6% of total personal income in the North Carolina ROI and 12.2% of total personal income in the primary impact counties. Total employment growth in the county averaged 1.8% annually between 1969 and 1984.

Employment in the eleven industrial sectors in Granville County grew at rates exceeding the national average in six sectors and ROI averages in five sectors. Employment in the transportation and public utilities sector grew fastest from 1969 to 1984, at an average annual rate of 8.7%, followed by wholesale trade that grew at a 7.7% average annual rate. Only employment in the farming and agricultural services, forestry, and fishing sectors incurred declines in growth during that period. The distribution of employment in the eleven major industrial sectors in 1984 varied from that of the ROI. The four dominant sectors in the county economy, in terms of employment, were government (with 28.9% of the total county jobs), manufacturing (27.7%), farming (13.4%), and services (11.2%).

Average 1984 earnings per job in Granville County were $15,278, which was lower than both the national and North Carolina ROI averages in 1984. In 1984, the highest average earnings per job were paid in the wholesale trade sector at $21,568 and the manufacturing sector at $20,671.

Average annual unemployment rates fluctuated similarly to those of the North Carolina ROI, yet have been consistently greater than the United States. Granville County average annual unemployment rates peaked in 1976 at 8.7% and again in 1982 at 8.5%. Since 1978, average county unemployment rates have remained below those of the United States. Granville County's labor force numbered about 20,200 persons in 1987, having grown at annual average rate of 2.6% since 1970.

Per capita personal income in the county consistently remained below the national and ROI averages between 1969 and 1984. In 1984, per capita personal income ($9,919) was well below both the ROI average ($13,565) and the national average ($14,746).

c. Person County

Person County is the smallest of the three primary impact counties in terms of employment and total personal income. In 1984, Person County provided just 1.4% of jobs in the North Carolina ROI and 9.2% of total employment in the three impact counties. The county similarly received 1.4% of total personal income in the North Carolina ROI and 10.5% of total personal income in the primary impact counties. Total employment growth in the county averaged 1.2% annually between 1969 and 1984.

Average annual employment in the eleven industrial sectors in Person County grew at rates exceeding the national averages in only two sectors and North Carolina ROI rates in just three sectors. As in Granville County, employment in the transportation and public utilities sector grew fastest from 1969 to 1984, at an average annual rate of 10.7%. Employment in the farming and wholesale trade sectors declined during that period: a 2.9% average annual decline in farming employment and 3.3% in wholesale trade. The distribution of employment in the eleven

major industrial sectors in Person County in 1984, in terms of employment, was dominated by manufacturing (with 36.9% of total county jobs), retail trade (13.1%), services (12.6%), and government (11.5%).

Average earnings per job in 1984 were $15,156, which was lower than both the national and North Carolina ROI averages and the lowest of the three North Carolina ROI primary impact counties. In 1984, the highest average earnings per job were paid in the transportation and public utilities sector at $33,193. The next closest earnings per job in 1984 were paid in the manufacturing sector at $19,646.

Of the three primary impact counties, Person County has recorded the highest average annual unemployment rates over the last two decades. Although these rates have fluctuated similarly to those of the North Carolina ROI, the peak average rates have been far greater (15.8% in 1975 and 13.4% in 1982). The data also show that, unlike the current ROI trend, average annual unemployment rates since 1985 in Person County are on the rise. Historically, unemployment rates in the county have been higher than those for the nation. The county's labor force, greater than 15,100 in 1979, was less than 14,700 in 1987; overall growth in this labor force between 1970 and 1987 was recorded at an average annual rate of 1.4%.

Per capita personal income in the county, which peaked in 1978 at $10,615, consistently was below both the national and ROI averages between 1969 and 1984. In 1984, per capita personal income in Person County ($10,311) was below both the ROI average ($17,696) and the national average ($14,746).

B. Demographics and Housing

1. Regional Setting

The population of the North Carolina ROI is dominated by Guilford County (which contains the city of Greensboro) and Wake County (site of Raleigh, the state capitol), which together accounted for more than 41.2% of the region's population in 1985. Population in the region as a whole has grown slowly since 1930, with the majority of the 15 North Carolina counties increasing in size, and the majority of the Virginia counties and independent cities decreasing in size.

By 1980, ROI population had grown to nearly 1.6 million persons, the result of 1.3% annual increases from the 1.4 million residing there in 1970 (Table 5.5.11-2; U.S. Bureau of the Census, 1982c, 1982d). In 1985, population for the region was estimated to exceed 1.6 million (U.S. Bureau of the Census, 1988a, 1988b), representing 1.2% annual growth from 1980. Forecasts place regional population at nearly 1.8 million persons in 1990, with annual growth continuing at 1.2% throughout the entire decade of the 1980s. By the turn of the century, the

Table 5.5.11-2

KEY DEMOGRAPHIC INDICATORS FOR THE NORTH CAROLINA ROI

	1970	1980	1990	2000	2010	2020	2030
Population (millions)	1.37	1.58	1.78	1.99	2.17	2.35	2.52
Avg. Ann. Chg. over Preceding Decade	1.3%	1.3%	1.2%	1.1%	0.9%	0.8%	0.7%
			Age Distribution				
≤ 4 years	8.3%	6.2%	6.2%	5.5%	5.3%	5.2%	5.0%
5 - 19 years	29.9%	24.6%	20.7%	19.3%	18.8%	18.3%	17.5%
≥ 65 years	8.4%	10.2%	12.5%	13.7%	14.7%	15.7%	16.7%

Sources: U.S. Bureau of the Census 1982c, 1982d.

population of the ROI is projected to reach nearly 2.0 million, with annual growth during the 1990s slowing to 1.1%. In 2030, regional population is anticipated to exceed 2.5 million, with average annual growth having slowed to 0.7% from 2020 to 2030.

The age composition of the North Carolina ROI is also expected to change during the next four decades, with proportionally fewer numbers of young persons and proportionally greater numbers of older persons present in the population over time. In 1980, 6.2% of the ROI population were younger than 5 years, 24.6% were age 5 to 19, and 10.2% were age 65 or older (U.S. Bureau of the Census, 1982c, 1982d). By the year 2000, the first two age groups are expected to represent 5.5 and 19.3% of the regional population, respectively, while individuals age 65 and older will comprise 13.7% of the total. This trend is anticipated to continue through 2030, when the proportions belonging to each age group are projected to be 5.0, 17.5, and 16.7%, respectively.

In 1980, the total number of year-round housing units in the ROI exceeded 585,500 (U.S. Bureau of the Census, 1982a). Owner-occupied (or owner available) units comprised 61.0% of the total, renter-occupied (or renter available) units accounted for 35.3%, and the remaining 3.7% were considered unavailable for occupancy, being either in transition (for example, under transfer of ownership) or deemed uninhabitable (for example, because of renovation or condemnation).

Of the total year-round housing units in the ROI, 93.2% were occupied in 1980. Considering only year-round units available for occupancy in the ROI, the 1980 vacancy rates were 1.4% for owner units and 6.4% for rental units. Building permits were issued for more than 100,000 new housing units in the ROI between 1981 and 1986, an average in excess of 17,000 units per year (U.S. Bureau of the Census, 1983, 1985, 1987a).

2. Primary Impact Counties

Durham, Granville, and Person counties represent the area of main interest with respect to demographics and housing. The proposed site area for the SSC includes portions of all three of these counties, with the campus to lie partially in northern Durham County, and partially in western Granville County.

Durham County contains both rural and urban areas, the latter represented largely by the city of Durham. Granville and Person counties, on the other hand, are predominantly rural. In 1980, Durham County contained some 153,000 persons, having grown from its 1970 population of 133,000 at an average annual rate of 1.4% (U.S. Bureau of the Census 1982c). Durham County population continued to grow at an annual rate of 1.1% during the first five years of the 1980s, reaching nearly 162,000 by 1985 (U.S. Bureau of the Census, 1988a).

Granville County's population of nearly 33,000 in 1970 grew at an average annual rate of 0.4% during the ensuing decade, reaching approximately 34,000 by 1980. The average annual population growth of this county increased to 1.5% between 1980 and 1985, with population estimated at nearly 37,000 by the latter date.

The population of Person County was slightly more than 29,000 in 1980, having increased from the 26,000 inhabitants recorded in 1970 at an annual rate of 1.2%. The estimated 1985 population of 30,000 in Person County indicates an annual rate of growth slowing to 0.8% during the preceding five years.

The populations of these three counties are anticipated to continue increasing steadily over the next four decades, with Durham County growing more rapidly as a consequence of expanding metropolitan Durham.

Communities potentially affected by the SSC include Durham and Treyburn in Durham County; Creedmoor, Oxford, and Stem in Granville County; and Roxboro in Person County. Durham, the main metropolitan area in the three primary impact counties, had a population of slightly more than 100,000 in 1980, having increased from 95,000 in 1970 (U.S. Bureau of the Census, 1982b). Treyburn is a small community about 15 minutes north of Durham which currently is developing as a suburban area for that city. The communities of Creedmoor, Oxford, Stem, and Roxboro had populations of 1,641, 7,603, 222, and 7,532, respectively, in 1980. Their 1970 populations of 1,405, 7,178, 242, and 5,370 indicate that with the exception of the town of Stem all have been experiencing recent population growth.

The total number of year-round housing units in Durham County in 1980 was slightly more than 58,000, of which 52.1% were owner units, 46.3% were rental units, and 1.6% were unavailable for occupancy. Of the total year-round units in the county, 95.3% were occupied in 1980. Of those units available for occupancy, 1980 vacancy rates were 1.6% for owner units and 4.8% for rental units.

By contrast, 1980 year-round housing in predominantly rural Granville County numbered more than 11,400, of which 62.7% were owner units, 30.2% were rental units, and 7.1% were unavailable for occupancy. Of the total year-round units in the county, 91.0% were occupied in 1980. Considering only those units available for occupancy, 1980 vacancy rates were 0.7% for owner units and 4.8% for rental units.

With housing conditions similar to those in Granville County, 1980 year-round housing units in Person County numbered nearly 10,700, of which 65.7% were owner units, 29.3% were rental units, and 5.0% were unavailable for ccupancy at the time of the census. Of the total year-round units in the county, 92.8% were occupied in 1980. Considering just those units available for occupancy, 1980 vacancy rates were 0.7% for owner units and 5.9% for rental units.

Housing stock data from 1980 for main communities within the primary impact counties from the U.S. Bureau of the Census (1982a) show that Durham contained 60,300 year-round housing units (4.5% vacant), Oxford 2,800 year-round units (5.5% vacant), and Roxboro 2,970 year-round units (6.0% vacant).

Statistics for the number of building permits issued for new housing construction show that housing growth is occurring at a steady pace in all three primary impact counties. From 1981 to 1986, some 15,000 building permits were issued in Durham County (an average of 2,500 per year), more than 700 were issued in Granville County (an average of 120 per year), and more than 200 were issued in Person County (an average of more than 30 per year). Although the building permits data reveal no conclusive housing growth trends, the actual number of permits issued in 1986 was considerably less than the number issued in the previous year for all three counties (U.S. Bureau of the Census 1983, 1985, 1987a).

A 1987 vacancy survey of housing units in Durham County reported a total vacancy rate that had decreased from that of 1980 (Federal Home Loan Bank of Atlanta 1987).

Temporary lodging in the three primary impact counties is concentrated in Durham County, which presently contains more than 2,700 hotel/motel rooms (Pannell, Kerr, and Foster 1988). Granville and Person counties provide such lodging on a smaller scale, containing 200 and 145 hotel/motel rooms, respectively. Additionally, some 57 trailer hook-ups are listed for Person County (North Carolina Travel and Tourism Division 1988).

C. Public Services

Levels of public service provided by local governments within the North Carolina ROI were analyzed using October 1982 employment data (U.S. Bureau of the Census 1984) and 1986-87 school year statistics (North Carolina Board of Education 1987).

Police and fire protection, provision of health care, and public educational instruction were examined in detail. The levels of general public services were determined by the ratio of employees to regional population and by student/teacher ratios at the primary and secondary public school levels.

1. Regional Setting

Level of service ratios for key public services in the North Carolina ROI component counties, the state of North Carolina, and the nation are presented in Table 5.5.11-3. Total full-time equivalent (FTE) government employment for the ROI falls below state and national averages.

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Table 5.5.11-3

LEVELS OF PUBLIC SERVICE FOR NORTH CAROLINA SSC SITE[1]

Area	Police Protection	Fire Protection[2]	Health and Welfare	Public Education General Education	Public Education Student/ Teacher Ratio	All Other	Total
Alamance County	2.15	0.96	1.77	19.32	18.9	6.14	30.35
Caswell County	0.92	0.82	2.13	17.00	19.6	1.84	22.70
Chatham County	1.41	0.18	1.03	18.14	18.7	3.77	24.57
Durham County	2.77	0.62	3.39	19.81	17.6	6.77	33.36
Franklin County	1.03	0.17	7.43	20.33	18.2	4.06	33.07
Granville County	1.62	0.18	5.99	20.65	18.9	4.11	32.55
Guilford County	2.53	1.50	3.63	19.38	17.8	8.06	35.15
Halifax County	2.01	0.60	2.82	25.65	18.1	6.75	37.82
Nash County	2.67	1.44	2.31	27.15	18.3	9.52	43.08
Orange County	2.08	0.69	1.71	14.28	17.4	8.75	27.50
Person County	1.47	0.48	2.47	24.72	18.0	4.73	33.88
Rockingham County	2.06	0.49	3.32	20.78	17.9	5.06	31.72
Vance County	1.66	1.61	2.59	25.01	18.9	5.85	36.71
Wake County	2.11	1.11	2.01	19.60	17.4	7.76	32.60
Warren County	1.17	0.06	6.47	22.92	16.7	4.81	35.42
Charlotte County, VA	1.39	0.00	1.30	21.77	15.0	4.32	28.78
Halifax County, VA	1.05	0.00	1.47	25.23	15.1	2.29	30.03
Lunenburg County, VA	1.65	0.00	1.07	21.86	14.7	3.79	28.37
Mecklenburg County, VA	1.90	0.00	0.88	21.09	14.3	5.30	29.17
Pittsylvania County, VA	0.92	0.00	0.73	18.63	15.6	2.03	22.30
City of Danville, VA	2.45	1.99	1.10	17.90	14.5	16.21	39.66
City of South Boston, VA	2.68	1.27	0.00	11.70	15.5	11.14	26.79
Region of Influence	2.11	0.92	2.68	20.17	17.5	6.92	32.81
North Carolina	1.84	0.73	5.04	20.50	18.3	6.30	34.41
United States	2.34	1.02	3.84	18.44	18.0	8.71	34.35

Notes: 1. All table values represent full time equivalent (FTE) employees per 1,000 population except student/teacher ratio.
2. Low values indicate counties served primarily by volunteer fire departments.

Sources: Bureau of the Census 1984; North Carolina Board of Education 1987; Virginia Department of Education 1987; U.S. Department of Education 1987.

ROI levels of service for police protection, fire protection, and health care services also fall below average national levels. Only public education levels of service, measured by both general education employees per 1,000 population and student-teacher ratio, are greater for the ROI than for the nation.

Medical facilities are concentrated in the larger cities of the area (i.e., Durham, Raleigh, and Greensboro), though smaller hospitals are widely dispersed throughout the ROI.

2. Primary Impact Counties

Durham, Granville, and Person counties, proposed to host the SSC ring and associated facilities, would likely experience the most direct impacts on local public services and facilities related to SSC development.

a. Durham County

Durham County would contain most of the campus, the future expansion area, and a small portion of the SSC ring. These proposed sites fall within the jurisdiction of the Durham County Sheriff's Department. The Sheriff's Department currently maintains three substations with 129 sworn officers and more than 100 vehicles. Together with the state-operated Butner Public Safety Department, which most closely would serve the campus area, and the Durham City Police Department, police protection in the county is provided at the highest level of service (2.77 FTE employees per 1000 population) in the ROI, which also exceeds the state and national service levels of 1.84 and 2.34, respectively. Combined, these departments operate five stations with more than 400 sworn officers and 300 vehicles.

Fire protection throughout most of Durham County is supplied by five volunteer fire departments; two other departments, operating in incorporated Durham city and Butner, employ-paid firefighters. Combined fire prevention and suppression services for the county are at a level of service lower than the ROI, state, and nation.

Four medical health centers, all located in the city of Durham, provide more than 2,000 beds for regional general public hospital care.

Public educational services and facilities within the county are offered by two districts: Durham County Public Schools and Durham City Public Schools. Together, these districts provide residents with 31 elementary, five secondary, and six combined schools, with instruction at a student/teacher ratio of 17.6 for the county (better than both state and national averages).

b. Granville County

Nearly half of the SSC ring, including the injector facility and half of the far experimental area, are proposed to lie in Granville County. Police protection in the county is provided at a level of service below the ROI, state, and national averages by five city police departments and one countywide sheriff's office. County fire protection services (also provided at service levels below the ROI, state and nation) are supplied by nine volunteer fire departments and one mixed paid/volunteer department.

The Granville Medical Center in Oxford provides general hospital care to the public.

Granville County's public school system provides educational services and facilities to county residents with nine elementary and three secondary schools. Although the total FTE employment in general education in the county exceeds the ROI, state, and national averages, the student/teacher ratio indicates instruction at a level of service lower than the ROI, state, and nation.

c. Person County

Half of the far experimental area and one third of the ring are proposed to lie in Person County. The police protection level of service for Person County falls below ROI, state, and national averages. Law enforcement services in the county are provided by the Roxboro Police Department (with 24 sworn officers and 14 vehicles) and the Person County Sheriff's Department (with 18 sworn officers and 14 vehicles). Fire protection (also provided at service levels below ROI, state, and national averages) is supplied by one mixed paid/volunteer fire department and four solely volunteer fire departments.

The only public hospital in the county, Person Memorial Hospital in Roxboro, offers the public general hospital care with 88 beds.

The Person County public school system maintains eight elementary, one secondary, and two combined schools for public education services. The county employs more FTE employees per 1,000 population in general education (24.72) than do the ROI, state, or nation (20.17, 20.50, and 18.44, respectively). However, the student/teacher ratio for the county (18.0), identical to the national ratio, falls between the ratios of the ROI (17.5) and the state (18.3).

D. Public Finance

1. North Carolina State Government Finances

a. State Government Taxes

North Carolina has a general income tax and a sales tax from which most revenue is derived. Other sources include motor fuel taxes, motor vehicle registration fees, and a public utilities tax. Taxes will be briefly discussed. All dollar values in the public finance discussion are current dollars for the fiscal years cited.

The general income tax covers resident and nonresident individuals, corporations, and banks and other financial institutions. This source provided 48.73% of North Carolina fiscal 1986 tax revenues (Table 5.5.11-4).

The sales tax rate is 3% except 2% for motor vehicles and airplanes, with a $300.00 maximum. This source accounted for 24.81% of North Carolina tax revenues in FY 1986.

Motor fuel is taxed at 14 cents per gallon plus 3% of the average wholesale price plus one-fourth cent per gallon inspection fee. Carriers road tax is the same for fuel used in North Carolina. This source provided 7.60% of North Carolina tax revenues in FY 1986.

Registration fees are a flat $17 for passenger cars and graduated by weight for other vehicles. These fees provided 4.02% of North Carolina revenues in FY 1986.

Gross intrastate receipts are taxed at the following rates for utilities and transportation companies: 3.22% for electric, gas, and telephone; 6% for public sewerage and telegraph; and 3% for freight car companies. This source also includes 0.75% of railroad property value and a few other modest items. These taxes provided 3.62% of FY 1986 North Carolina tax revenues.

Other sources include the alcoholic beverages tax, the insurance companies tax, and others. The largest of these is the insurance companies tax at 2.42% of tax revenues for FY 1986 for North Carolina.

b. State Revenue and Expenditure

General revenues and expenditures for FY 1986 are provided in Table 5.5.11-4. Taxes, intergovernmental revenues, and charges are the major revenue source categories. Income taxes dominate general sales taxes. Total general revenue exceeded total general expenditures by 3%; direct capital outlays were 8% of total general expenditures.

Table 5.5.11-4

NORTH CAROLINA STATE GENERAL REVENUE AND EXPENDITURE (FY 1986)

Revenue/Expenditure	Amount (in thousands)	Per Capita
Revenue		
Total revenue intergovernmental	$ 2,141,705	$ 338
Federal	$ 2,017,531	$ 319
Total taxes	5,579,710	881
Sales and gross receipts	2,312,029	365
General sales	1,384,069	219
Selective sales, gross receipts	927,960	147
Alcohol	127,269	20
Insurance	135,000	21
Motor fuels	424,208	67
Public utilities	199,209	31
Tobacco	16,561	3
Individual income	2,206,749	349
Corporate net income	512,095	81
License	391,692	62
Corporate license tax	95,489	15
Motor vehicle	195,300	31
Occupations and business licenses	54,712	9
Documentary and stock transfer fees	---	---
Property tax	69,007	11
Charges and misc. general revenue	1,182,411	187
Current charges	803,864	127
Total general revenue	$ 8,903,826	$ 1,406
Expenditure		
Total general expenditure	$ 8,649,495	$ 1,366
Direct capital outlay	686,319	108
(Population as of 7-1-86): 6,331,000		

Source: U.S. Bureau of the Census 1987b.

c. Local Government Organization and State Payments to Local Governments

There were 100 county and 484 municipal governments at the time of the 1982 Census of Governments. North Carolina has no independent school systems, but 201 systems were classed as dependent public school systems. Administration is by counties and, in some instances, cities.

There were also 321 special district governments. Important types include metropolitan sewerage districts, metropolitan water districts, power agencies, sanitary districts, and water and sewer authorities. Special districts may collect fees and charges, levy property taxes, and issue debt instruments, under certain conditions.

The major North Carolina intergovernmental expenditure is for common school operations support. The public school support fund and other categorical funds are distributed to counties in North Carolina. There is a small construction program at the State level funded by bonds.

Cities receive part of the revenue from public utility sales taxes, by city of origin. Part of the proceeds of taxes on beer and wine are distributed to cities and counties by population.

Highway aid to cities is provided in an amount equivalent to a one and one-third cent motor fuel sales tax and distributed in proportion to street mileage.

The proceeds of the intangible property tax, a small source, are in part granted to county governments by population and origin factors. Counties must further distribute by shares of property tax levies.

2. North Carolina Local Government Finances

Four units of local government are most important within the primary impact area. These are Durham County, Durham City, Granville County, and Person County. Schools are county-dependent in these cases.

a. Durham County

Revenue and expenditures for FY 1987 are given in Table 5.5.11-5 for Durham County government. Major revenue sources include taxes and intergovernmental revenues. Major tax sources include the property tax and the local option sales tax. For 1987, no capital projects were indicated while revenues exceeded total expenditures by about 7%.

Table 5.5.11-5

DURHAM COUNTY, NORTH CAROLINA
COUNTY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1987

Revenue/Expenditure	Amount	Per Capita
Revenue		
Taxes	$ 69,899,370	$ 414
Licenses and permits	484,793	3
Intergovernmental	47,060,542	279
Investment and rental income	1,782,113	11
Charges for services	3,456,504	20
Other	287,440	2
Total Operating Revenue	$ 122,970,762	$ 729
Expenditure		
Education	$ 33,778,950	$ 200
Other operations	81,344,827	482
Total Expenditures	$ 115,123,777	$ 683

Notes: Population, 1987: 168,638
Assessed Value: $ 6,617,924,408
Source: Durham County 1987.

Durham County jurisdictions had the following 1987 property tax levies:

Jurisdiction	Tax Levy
County government	$ 39,522,277
City government	21,530,761
School district	13,036,037
Special district	1,509,115
Total Durham County	$ 75,598,190

Total 1987 assessed value was $6,745,194,417.

City of Durham. Table 5.5.11-6 provides revenue and expenditure data for the City of Durham for FY 1987. Taxes and intergovernmental revenue dominate the revenue sources. Investment and rental income are also quite substantial. Education is not a city function here. Capital projects are about 9% of total expenditures, which exceeded operating revenues with a deficit of 8% of total expenditures.

b. Person County

Financial data for Person County in FY 1987 are presented in Table 5.5.11-7. Major revenue sources are, again, property or ad valorem and other taxes, including licenses and permits, and intergovernmental revenues. Capital projects were 16% of total expenditures, which include local schools. A small surplus of 3% prevailed in 1987.

Person County property tax levies for 1987 for all governments were as follows:

Jurisdiction	Tax Levy
County Government	$ 7,438,937
City Government	1,117,653
School District	---
Special District	19,865
Total Person County	$ 8,576,455

Total 1987 assessed value was $1,505,488,173.

c. Granville County

Financial data are provided for FY 1987 in Table 5.5.11-8. Again, ad valorem taxes, other taxes and licenses, and intergovernmental revenues were the major receipts. Education and other operating expenditures were less than operating revenues for a surplus of about 10%. No capital outlays were indicated.

Table 5.5.11-6

CITY OF DURHAM (DURHAM COUNTY), NORTH CAROLINA
CITY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1987

Revenue/Expenditure	Amount	Per Capita
Revenue		
Taxes	$ 30,576,838	$ 245
Licenses and permits	1,550,375	12
Intergovernmental	9,328,064	75
Investment and rental income	3,128,760	25
Charges for services	1,677,438	13
Intragovernmental services	1,001,843	8
Fines and forfeitures	192,523	2
Assessments	124,865	1
Other	671,936	5
Total Operating Revenue	$ 48,252,642	386
Expenditure		
Operations	$ 47,866,374	$ 383
Capital projects	4,823,235	39
Total Expenditures	$ 52,689,609	$ 422

Notes: Population, 1987: 124,949
Assessed Value: $ 3,407,110,282
Source: City of Durham 1987.

Table 5.5.11-7

PERSON COUNTY, NORTH CAROLINA
COUNTY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1987

Revenue/Expenditure	Amount	Per Capita
Revenue		
Ad valorem taxes	$ 7,480,383	$ 244
Other taxes, licenses, and permits	2,467,448	80
Intergovernmental	3,139,212	102
Investment income	210,548	7
Charges for services	290,930	9
Other	252,228	8
Total Operating Revenue	$ 13,840,749	$ 451
Expenditure		
Education	$ 3,903,131	$ 127
Other operations	7,334,601	239
Capital projects	2,169,839	71
Total Expenditures	$ 13,407,571	$ 437

Notes: Population, 1986: 30,700)
Assessed Value: $ 1,508,096,307
Sources: For financial data: Person County 1987; for population figure: U.S. Bureau of the Census 1988b.

Table 5.5.11-8

GRANVILLE COUNTY, NORTH CAROLINA
COUNTY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1987

Revenue/Expenditure	Amount	Per Capita
Ad valorem taxes	$ 6,131,220	$ 164
Other taxes and licenses	1,871,743	50
Intergovernmental		
Unrestricted	401,095	11
Restricted	2,086,561	56
Permits and fees	142,905	4
Sales and services	344,828	9
Investment earnings	366,208	10
Miscellaneous	30,389	1
Total Operating Revenue	$ 11,374,949	$ 304
Expenditure		
Education	$ 3,508,420	$ 94
Other operations	6,852,757	183
Total Expenditures	$ 10,361,177	$ 277

Notes: Population, 1986: 37,400
Assessed Value: $ not available

Sources: For financial data: Granville County 1987; for population figure: U.S. Bureau of the Census 1988.

Granville County jurisdictions levied property taxes in 1987 as follows:

Jurisdiction	Tax Levy
County government	$ 6,665,369
City government	1,754,671
School district	---
Special district	379,532
Total Granville County	$ 8,799,572

Total assessed value in 1987 was $913,102,644.

5.5.11.2 Infrastructure

A. Transportation

1. Road

Major highways and roads serving the proposed SSC site are shown in Figure 5.5.11-3. Data on these highways and roads are presented in Table 5.5.11-9.

Metropolitan Durham, 16 mi to the south south west of the proposed SSC site, is served by a freeway system that includes interstate highways I-85 extending to the northeast and west and I-40 extending to the south east. The extension on I-40 to the northwest to an intersection with I-85 to the west of Durham is currently under construction. U.S route 501 extending to the north and south and U.S. 70 extending to the west and southeast supplement this system. A system of arterial highways join these highways. Long-range plans call for the construction of an outer loop freeway around Durham (Transportation Study Group 1988).

Metropolitan Raleigh, the state capital, to the south south east of the proposed site, is served by a freeway system that includes Interstate 40 extending northwest, connecting Raleigh and Durham. Plans call for the extension of I-40 to the southeast. U.S. routes 1 extending to the north northeast and southwest, 64 extending to the east, 70 extending to the northwest and southeast, and 401 extending to the south southeast contribute to this system. A loop freeway also extends around the city. A system of arterial highways join these highways.

Chapel Hill can be reached by traveling southwest from Durham on U.S. Route 501 or by traveling west from Raleigh on I-40 and State Route 54.

The proposed site is served by a network of interstate, U.S. and state highways and roads. These include interstate I-85 on the southeast, U.S. route 15 on the east and U.S. Route 501 on the southwest that connect the site area to Metropolitan Durham. State routes 50 and 56 connect the site area to metropolitan Raleigh. U.S. route 158 crosses the

Figure 5.5.11-3

MAJOR TRANSPORTATION SYSTEMS SERVING THE NORTH CAROLINA SITE

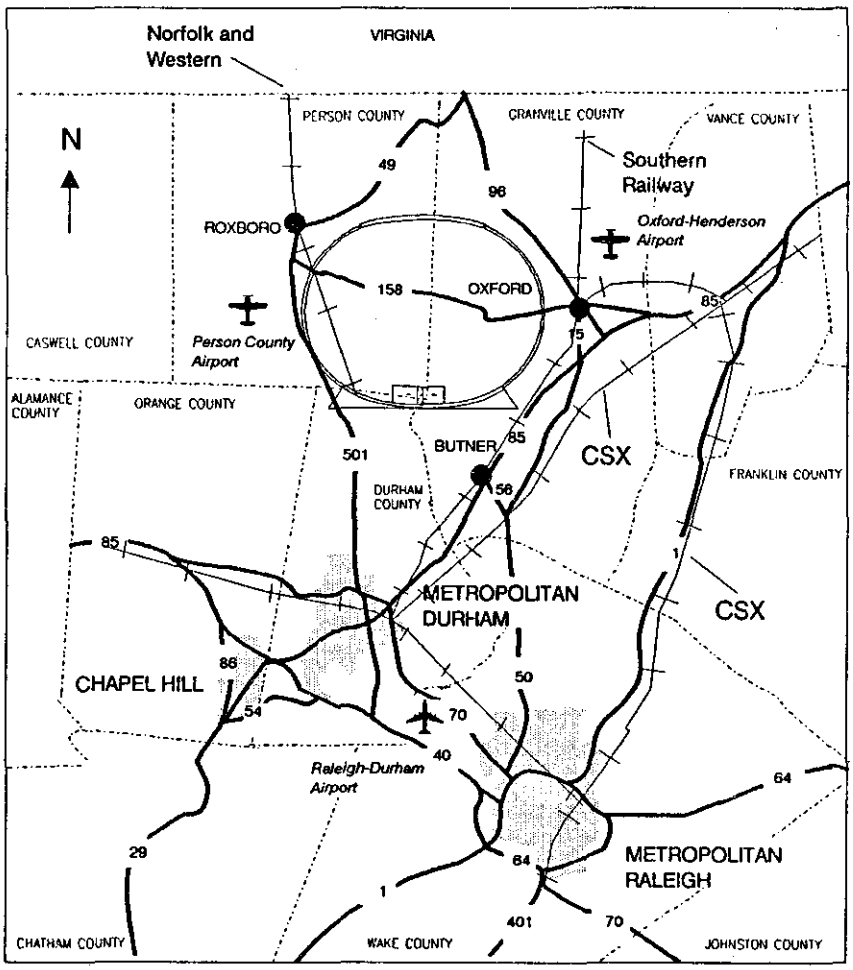

Table 5.5.11-9

PRESENT HIGHWAYS AND ROADS SERVING THE PROPOSED NORTH CAROLINA SSC SITE

Road Segment	Length mi	Lanes	Capacity phph[1]	Peak Hour Volume pcph[1]	LOS[2]
I-85: U.S. Route 70 to U.S. Route 15 near Oxford	23	4	8,000	1,850	a
U.S. Route 15: I-85 near Oxford to U.S. Route 158	4	2	2,800	500	c
U.S. Route 501: I-85 to South of Picks	23	4	8,000	1,800	a
U.S. Route 501: South of Picks to U.S. Route 158	4	2	2,800	800	c
U.S. Route 501: U.S. Route 158 to State Route 49	3	2	2,800	1,550	d
U.S. Route 158: U.S. Route 501 to U.S. Route 15	23	2	2,800	300	b[3]
State Route 49: U.S. Route 501 to State Route 96	15	2	2,800	250	b[4]
State Route 96: U.S. Route 158 to State Route 49	18	2	2,800	150	b
State Route 56: I-85 to State Route 50	3	2	2,800	300	B
State Route 50: State Route 56 to Raleigh	18	2	2,800	400	b[5]

Notes: 1. pcph: passenger cars per hour
2. LOS: Level of service

a. Free flow with individual users virtually unaffected by the presence of others in the traffic system.

b. Stable flow but the presence of other users in the traffic stream begins to be noticeable.

c. Stable flow but operations of individual users becomes significantly affected by interactions with others in the traffic stream.

d. High density, but stable flow with speed and freedom to maneuver severely restricted, and the driver experiences a generally poor level of comfort and convenience.

e. Unstable flow at near capacity level with speeds reduced, maneuvering difficult, and extremely poor level of comfort and convenience.

f. Forced or breakdown flow with traffic exceeding the capacity, unstable stop and go traffic.

3. Portions of U.S. Route 158 close to U.S. Route 501 experience LOS c.
4. Portions of State Route 49 close to U.S. Route 501 experience LOS c.
5. Portions of State Route 50 close to Raleigh experience LOS c.

Sources: NCDOT 1987; Transportation Research Board 1985.

site from east to west. State routes 49 and 96 are located to the northwest and northeast of the site, respectively. Additional state paved and unpaved roads provide access to the proposed locations of the campus, near and far clusters and most other surface facilities.

2. Rail

Rail lines serving the proposed SSC site are shown in Figure 5.5.11-3. The proposed SSC site area is served by a network of local rail lines. The Southern Railway operates a low-speed local line between east Durham and Keysville, Virginia, that passes through Oxford east of the proposed site. The Norfolk and Western Railroad operates a low-speed local line between Lynchburg, Virginia, and Helena, North Carolina (north of Rougemont, North Carolina, 7 mi west of the proposed campus location). This is the closest rail spur to the proposed campus location. Portions of the Norfolk and Western line between Helena and Durham have been abandoned. CSX operates a high-speed local line between Henderson, North Carolina, and Raleigh that passes to the southeast of the proposed site.

The local rail lines discussed above, connect the proposed site to arterial rail lines that connect to main lines. A Southern Railway arterial line extends from Raleigh through Durham to Greensboro, North Carolina, to connect to an Atlanta-Washington main line. A CSX arterial rail line extends from Raleigh to a major classification yard at Hamlet, North Carolina, where connection can be made to a number of main lines. These main lines connect to most major U.S. cities through connections to other railroads.

3. Air

Airports serving the proposed SSC site are shown in Figure 5.5.11-3. The principal airport that would provide passenger and freight service to the proposed SSC site is the Raleigh-Durham Airport. This airport, owned and operated by the Raleigh-Durham Airport Authority, is located between interstate I-40 and U.S. Route 70 approximately halfway between Raleigh and Durham. It is located approximately 25 mi south of the proposed campus location. The airport is currently a medium hub in the U.S. transportation system with more than 1.5-million people enplaned in 1986 (Alman 1988a). Airport operations are not currently congested. However, 5,000 hours of delays were experienced by scheduled airline operations in 1986. Delays are forecasted to increase to 22,000 hours in 1996 (Yatzeck 1988). A $75-million expansion program, including a new 10,000-ft runway and airline terminal were completed in 1986 to mitigate delays.

The Raleigh-Durham Airport is expected to become a major hub in the near future with passenger use forecasted to increase rapidly to more than eight million enplaned passengers by 1995. Most of this growth is expected to occur in connections from one flight to another (Alman 1988a). A new airport master plan that will address growth in the 1989-2010

horizon is currently under preparation. It will resolve the question of new runways, expanded terminal space, and improved ground access required by the forecasted growth (Alman 1988b).

Two publicly owned and operated general aviation airfields are located in the proposed SSC site area. The new Person County Airport, opened in 1987, is located south of Roxboro approximately 13 mi northwest of the proposed campus location. The Henderson-Oxford Airport is located about halfway between these communities approximately 18 mi northeast of the proposed campus location. Both of these airports are capable of handling corporate jet aircraft (Person County Airport Commission 1987; Alman 1988a). Additional general aviation fields are located in Chapel Hill and Knightdale.

4. Waterways

There are no waterways that serve the SSC site. The closest major sea port is located at Portsmouth, Virginia, approximately 120 mi east northeast from the proposed site.

5. Public Transit

a. Bus Service

Municipal bus services are provided in the cities of Raleigh, Durham and Chapel Hill. These services do not currently extend to the SSC site area.

Privately operated, intercity bus service is provided by Greyhound and Trailways bus lines. These lines serve the communities of Butner, Oxford, and Henderson and provide a number of daily trips to Durham and Raleigh. These routes extend to other major cities on the east coast and provide connections to other routes serving most major cities in the U.S. (Kerr Area Rural Transit System 1987).

KARTS provides transportation to the general public within Franklin, Granville, Person, Vance, and Warren counties. Twenty-seven routes are operated within the five-county area and provides more than 5,500-passenger round trips per month using vans and small buses (Kerr Area Rural Transit System 1987).

b. Taxi

Privately operated taxi, shuttle, and limousine service is provided throughout the Raleigh, Durham, and Chapel Hill metropolitan area. In addition, privately operated taxi service is provided in a number of communities in the proposed SSC site area. There are five taxi services in the community of Roxboro and four taxi services in the community of Oxford. Additional services are present in the community of Henderson (Kerr Area Rural Transit System 1987).

c. Rental Car Service

Privately operated rental car services are located at the Raleigh-Durham Airport and at other locations in the Raleigh, Durham, and Chapel Hill metropolitan area.

d. Para-Transit Services

KARTS also provides transportation for authorized clients of 22 contracting human service agencies. This transportation is provided throughout the five-county service area and on extended trips to major medical facilities outside of the service area (Kerr Area Rural Transit System 1987).

B. Utilities

1. Electricity

a. Ownership

The area in the vicinity of the North Carolina site is served by both the Carolina Power and Light Company (CP&L) and Duke Power Company (Duke).

b. Delineation of Service Territory

Duke Power Company is headquartered in Charlotte, North Carolina, and operates in the Piedmont area of North and South Carolina. Its 20,000 mi^2 service area extends from Durham, North Carolina, to Anderson, South Carolina, serving more than 1.5 million residential, commercial and industrial customers in that area. (Duke 1986; Duke 1987a; Duke 1987b).

CP&L provides energy to over 3 million people in a 30,000-mi^2 area that includes about one-half of North Carolina and one-fourth of South Carolina. Most of the service is provided in the coastal plains, but the service area also includes a slice of the Great Smoky Mountains in western North Carolina (Carolina Power and Light 1986).

Both CP&L and Duke are members of the Virginia-Carolinas (VACAR) subregion of the Southeastern Electric Reliability Council (SERC). SERC membership includes 28 systems located in nine states (Virginia, Tennessee, North Carolina, South Carolina, Mississippi, Alabama, Georgia, Florida, and parts of Kentucky) in the southeastern United States. The SERC region covers an area of approximately 350,000 mi^2 with 16 million customers (North American Electric Reliability Council 1987).

c. Interrelationship with Other Electrical Utilities

To further enhance the reliability, security, and strength of its transmission system, CP&L has 34 interconnecting lines with seven neighboring utilities. These interconnections range in voltage from 115 kV to 500 kV, with a combined capacity of over 15,000 MW. The transmission system is the backbone that enables CP&L to serve its current 923,000 customers (Stancil 1900).

SERC transmission systems are directly interconnected with the transmission systems in four other Regional Councils (Southwest Power Pool, East Central Area Reliability Coordination Agreement, Mid-America Interconnected Network, and Mid-Continent Area Power Pool). All are members of the North American Electric Reliability Council (NERC). SERC members actively participate in interregional and intraregional studies and coordinating activities (North American Electric Reliability Council 1987).

The VACAR subregion is composed of seven electric generating utilities located in North Carolina, South Carolina, and Virginia. One of these utilities, Southeastern Power Administration (SEPA), generates electric power solely for sales to other electric utility entities and serves no retail customers directly. A second, Yadkin, Inc. (YADI), serves one industrial customer only. The remaining five utilities are CP&L, Duke, South Carolina Electric and Gas Company, South Carolina Public Service Authority, and Virginia Electric and Power Company.

d. Existing Network

CP&L currently operates a mix of steam, nuclear, and hydroelectric generating plants with a total system capability of approximately 9,600 MW. (Carolina Power and Light 1987a).

The proposed SSC site vicinity is within approximately 50 mi of four CP&L generating plants (Roxboro, Mayo, Cape Fear,and Harris) which, together, provide a combined total generating capacity of over 4,000 MW.

Duke also operates a mix of generating plants with a systemwide capability of approximately 15,000 MW. Two plants (Dan River and Belewes Creek) fall within a 50-60 mi vicinity of the proposed site. They provide a combined capability of approximately 2,300 MW (Duke 1987b; Carolina Power and Light 1987b).

e. Planned Future Upgrades/Additions

CP&L's long-range load forecasts indicate the need for additional capacity beginning in the mid-1990s; however, currently, they are not firmly committed to constructing any additional generating capacity beyond that already installed.

Approximately 1,000 MW of pump storage capacity is expected to be available from Duke's Bad Creek project currently under construction. The Bad Creek plant, located in northwestern South Carolina near the North Carolina line, is scheduled for commercial operation in 1991-1992 (NERC 1987).

2. Natural Gas

a. Ownership

Public Service Company of North Carolina (PSNC) is a publicly held corporation whose common stock is traded on the NASDAQ National Market System (Public Service Company of North Carolina 1987).

b. Delineation of Service Territory

PSNC's service area encompasses 83 communities in 26 North Carolina counties, spannning an area of approximately 10,000 mi^2 and serving over 190,000 customers (Public Service Company of North Carolina 1987).

This area approximately consists of a section in western North Carolina bounded by Brevard in the west, Concord in the east, Statesville in the north and the state line in the south; and a section of northeastern North Carolina bounded by Siler City in the west, Henderson/Oxford in the east, Sanford in the south and the state line in the north (Pbulic Service Company of North Carolina 1987).

c. Interrelationship with Other Natural Gas Utilities

PSNC interconnects with Transco at several locations along its passage through North Carolina and moves natural gas across to its service territories (Salkowitz 1988).

Other natural gas systems with direct interconnections to Transco pipelines and indirect interconnections to the PSNC service network are: North Carolina Natural Gas Corp.; North Carolina Gas Service; and Piedmont Natural Gas Company, Inc. (PSNC map 1986).

PSNC runs a distribution network of pipeline from a major pipeline owned and operated by Transcontinental Gas Pipe Line Corporation (Transco). Transco is the company's pipeline supplier (Public Service Company of North Carolina 1987).

d. Existing Network

PSNC has an existing 14-inch natural gas pipeline running within 1 mi of the proposed SSC campus location from its district office in Roxboro. Also nearby is a pipeline compressor station.

e. Planned Future Upgrades/Additions

For FY 1988, the PSNC construction and capital expansion budget will include funds for a new 12-inch, 21-mi, high-pressure transmission pipeline to expand service capacity to the five-county area in and around Asheville, North Carolina (Public Service Company of North Carolina 1987).

3. Telecommunications

a. Ownership

Telecommunications service to the surrounding area is provided by GTE South, Central Telephone, Southern Bell, and Carolina Telephone.

Southern Bell Telephone and Telegraph Company (Southern Bell), incorporated under the laws of the State of Georgia, is a wholly owned subsidiary of BellSouth Corporation (BellSouth) (Southern Bell 1987).

b. Delineation of Service Territory

Southern Bell furnishes telecommunications service-mainly local exchange, exchange access, and long-distance service within 21 geographic Local Access and Transport Areas (LATAs) in Florida, Georgia, North Carolina, and South Carolina (Southern Bell 1987).

c. Interrelationship with Other Telecommunication Systems

Sufficient information was not available at this time.

d. Existing Network

Southern Bell plans to convert all of its central offices to electronic switches by the end of 1989 (BellSouth 1987).

e. Planned Future Upgrades/Additions

Southern Bell presently has over 152,000 mi of fiber optic cable in its service network and nearly 72% of its central offices have been converted to electronic switching capability. Southern Bell lines in service now total more than 8.9 million (BellSouth 1987).

GTE South has offices in both Durham and Creedmore. Central Telephone has an office in Roxboro.

5.5.12 Cultural and Paleontological Resources

5.5.12.1 Cultural Resources

A. Cultural History and Scientific Basis

The earliest known occupation in North Carolina is the Paleo-Indian Period (10,000 B.C. to 8000 B.C.), although few sites have been located. Most Paleo-Indian remains have been identified as sparsely scattered isolated surface finds of Clovis and Clovis-like Hardaway projectile points. This cultural stage is poorly understood in North Carolina because of the general lack of systematic samples of site locations and other data.

The Early Archaic cultures (8000 B.C. to 6000 B.C.) are characterized by a gradual change in projectile point morphology, from the large lanceolate type points to small corner-notched points. Patterns of settlement and subsistence are unclear, but it appears that hunter-gatherer strategies adapted to the diverse ecology and seasonal changes are most likely, with sites occurring most often in upland areas and in rockshelters (Claggett and Cable 1982).

During the Middle Archaic Period (6000 B.C. to 5000 B.C.), projectile point types became more varied and the artifact assemblage included a greater number of groundstone tools, along with polished atlatl weights. The Morrow Mountain and Guilford points, characteristic of this period, may represent a break with both the earlier and later styles indicating a possible diffusion from the west. In general, there was a shift from sites located in upland areas to bottom land sites near streams. There is some indication of more sedentary settlement patterns and an increase in the number of burial practices (Hargrove et al. n.d.).

Late Archaic sites (3000 B.C. to 1000 B.C.) are generally larger than previously, with denser concentrations of artifacts and well-developed middens. Subsistence patterns are well adapted to diverse ecological niches, and to predictable resources such as fish, shellfish and nuts. The broad-bladed Savannah River projectile point and soapstone bowls are characteristic of the period (Hargrove et al. n.d.).

The Woodland Period that follows is a continuation of the earlier hunter-gatherer subsistence pattern, that continued until around 1500 A.D. In other areas of the eastern United States, the Early Woodland is marked by introduction of maize and other cultigens, but in North Carolina, evidence for early cultigens is generally lacking. Triangular projectile points of the Badin, Vincent, and Yadkin types and ceramics tempered with fine sand and imprinted with cord or fabric do make their appearance. A Mississippian type culture, the Pee Dee, makes a brief intrusion, but the majority of the cultures continued to develop regional variations of the Woodland pattern (Hargrove et al. n.d.).

The first Euro-American description of the North Carolina Piedmont is the account by John Lederer, a German doctor, of his exploration along the Indian Trading Path from Fort Henry in Virginia west to the Catawba Nation near the present town of Charlotte. In 1670, Lederer passed through a number of Indian sites and at least two large villages in Durham County, Oenock, and Adshusheer. The tribes living in North Carolina at that time belonged to the Siouan group. Those encountered by Lederer were identified as the Eno and Occaneechi, among others. Further north, in Granville County, was the Tuscarora territory (Boyce 1978).

Pioneers and settlers used the Trading Path as a gateway to the interior. It served as the basis for an increasingly complex system of roads, and is an important historical element in the growth and development of North Carolina (Cross 1980). By the late 1700s, mills had been established along the rivers and their tributaries. These were an integral part of the agrarian economy of the early settlers, who were mainly of British origin migrating from Virginia and down the river valleys from Pennsylvania. Many of the earliest farm buildings were of log construction, a style that endured through the nineteenth century. By the 1800s, some of these early settlers had established large plantations, notably the Bennehan-Cameron family and the Cains (Hargrove et al. n.d.). Some of the houses built by these families are still standing and are considered good examples of architecture from the Georgian and Federal periods.

The economy of the counties in the proposed project area had been based on diversified agriculture, with most of the inhabitants working small independent farms. Establishment of the railroad in 1848 brought added prosperity and saw an expansion of the farming population. In 1858, the manufacture of tobacco was established at Durham, which became the capital of tobacco production in the country following the Civil War. Log tobacco barns are a remnant of the small tobacco producers. A second boom in the early 1900s resulted in the building of a number of commercial and residential structures in the affected counties that are considered fine examples of their era.

B. Known National Register Sites/Sacred Sites

Several historic properties in the vicinity of the proposed SSC site have been listed on, or determined to be eligible for listing on the National Register. In Durham County, Hardscrabble, and Horton Grove are listed; Durham County Truss Bridge #28 was determined to be eligible in 1979. In Granville County, four National Register nominations are in progress: Marcus Royster House, James Blackwell House, David Adcock House, and Puckett Family Farm (Brown and Esperon 1987). In Person County, four sites are listed on the National Register: Holloway-Walker-Dollarhite House, Roxboro Male Academy, Roxboro Commercial Historic District, and Person County Courthouse. Only one known potentially significant historical site, the Dudley Cunningham house, is located within the far cluster of the proposed SSC boundaries (State of North Carolina 1987). Other sites are currently being evaluated.

One historic archaeological site in the vicinity of the proposed SSC site, a 19th century mill, is eligible for the National Register. Four other sites are included in the Bennehan-Cameron Historic District; five additional potentially significant sites are located within the boundaries of the district but have not been assessed (Hargrove et al. n.d.).

Of the 89 previouly recorded archaeological sites in the vicinity of the proposed area, 51 are not eligible for inclusion on the National Register, 31 have yet to be evaluated, and seven are either eligible or are considered eligible by the State Historic Preservation Officer but are not officially nominated (State of North Carolina 1987).

The North Carolina Commission on Indian Affairs indicates that it has no knowledge of Native American sacred sites within the area. In addition, the Guildford Native American Association, the Haliwa-Saponi Indian Tribe, and the Indians of Person County were contacted by the North Carolina Department of Cultural Resources; no sacred sites were identified by these groups (State of North Carolina 1988).

C. Previously Recorded Sites and Research in the Project Area

Eighty-nine archaeological sites have been previously recorded in the vicinity of the proposed SSC project area, including part of the Bennehan-Cameron Plantation Historic District, which was determined eligible for the National Register in 1978. None of these sites is located within proposed SSC project facilities. Seventy of the sites date exclusively from prehistoric periods, eight date from the historic period, and eleven date to both periods.

Fifty-four historic properties have been identified within the vicinity of the proposed SSC project area; six in Durham County, thirty-nine in Granville County, and nine in Person County. These include houses, mills, a church, a grove, a bridge, a tobacco factory, two masonic lodges, a courthouse, a depot, and a historic district. One site, the Dudley Cunningham house, is located along the northeast portion of the collider ring between intermediate access E6 (far cluster) and service area F6.

No known Native American sacred sites have been identified in the proposed project area.

D. Characterization of Known Resources and Scientific/Educational Potential and Significance

Recorded archaeological sites in the vicinity of the project area indicate that the prehistoric chronology is represented by all phases of the Archaic and Woodland periods. In addition, it is likely that historic archaeological sites are present. The nearby Bennehan-Cameron Historic District and the other sites in the areas that have been identified as significant indicate the likelihood of important unrecorded sites within the project area.

On the basis of information available from reconnaissance-level historical resource surveys conducted in Durham and Person counties (Thomas et al. 1981; Chaggett and Cable 1982) and a recent comprehensive historical and architectural inventory of Granville County (Brown and Esperon 1987), it appears that the significant historic resources in the vicinity of the proposed SSC site date from the late 18th to the early 20th century. They are primarily rural farmhouses with some farm complexes and plantations, one National Register historic district in Roxboro (consisting of 70 commercial and public buildings), a grist mill, a male academy, a train depot, and a metal truss bridge. These resources illustrate vernacular examples of Georgian, Federal, Greek Revival, Victorian, and early 20th-century revival architectural styles. Most buildings are built of wood, with the exception of those in the Roxboro district where a majority of them are masonry.

E. Unknown but Potential Resources

Essentially no intensive survey has been undertaken in the actual proposed SSC area, and data are not available to predict numbers of projected locations of cultural resources. It is likely that previously unrecorded prehistoric and historic archaeological sites will be identified. In addition, an intensive historic buildings survey would likely identify important structures applying architectural and historical criteria. Similarly, historic cemeteries are common in the project vicinity.

5.5.12.2 Paleontological Resources

A. Scientific Basis

For a description and discussion of the geological stratigraphy in the proposed North Carolina SSC site, reference should be made to Section 5.5.1.2.

The proposed SSC site is located within the geological formation referred to as the Carolina Slate Belt. It is a northeast-trending tectonic province of Precambrian to Early Paleozoic metavolcanic and metasedimentary rocks (Sexauer 1983), which extends from southern Virginia to northern Georgia. Worm-like metazoan fossils are known to occur in the metasedimentary rocks of the Carolina Slate Belt. Plant impressions, concostracans, ostracodes and fish fossils are commonly found in the Triassic Durham Basin (Reid 1988) outside the proposed SSC site.

B. Known Paleontological Localities

According to the North Carolina Geological Survey there are no critical paleontological sites that occur within the proposed project area (State of North Carolina 1988).

The northernmost fossil locality reported in the Triassic Durham Basin occurs near the community of Bethesda approximately 15 mi south of the

proposed project area. The fossils reported from this locality include plant impressions, concostracans, ostracods, and fish bones. Similar occurrences of such fossils are common in the Triassic Durham Basin (Reid 1988).

Wormlike metazoan impressions occur in the metasedimentary rocks of the Carolina Slate Belt along the south bank of the South Fork of the Little River approximately 5.5 mi southwest of the proposed SSC site. This is the only reported occurrence of these impressions in the area (Reid 1988).

C. Characterization of Geological Strata and Paleontological Potential

Fossiliferous sites occur in metasedimentary rocks and are common in the Triassic Durham Basin (Reid 1988). The two known fossil sites occur well outside of the proposed SSC project area. There are no known critical paleontological sites in the immediate vicinity of the proposed SSC site area (Carter 1988).

5.5.13 *Scenic and Visual Resources*

5.5.13.1 Visual Character of the Region

The SSC site is within the Piedmont Upland section of the Piedmont physiographic province, a rolling, plateau-like surface of gentle slopes and generally slight relief (Fenneman 1938; Hunt 1967; Pirkle 1982) that flanks the eastern side of the Appalachian Mountains. Elevations generally vary by about 50 ft (Fenneman 1938), but valleys of greater depth occur, often to several hundred feet. Larger streams and their tributaries, toward the eastern edge of the section along the Fall Line, are deep within steep valleys. The only notable topographic features are occasional monadnocks that are isolated and conspicuous. These features are more numerous to the west near the Appalachians in the inner Piedmont.

Even more than the relative consistency of the rolling terrain, it is the prevalence of forest and woodland over nearly all of the region that is the most noticeable feature of the province. Already subtle, the variations in terrain are further muted by a dense mantle of mixed broadleaf deciduous and coniferous evergreen forest. Views are most generally confined to the foreground, except where agricultural clearings provide vistas.

Near their headwaters, streams in the region are wide and shallow, their gradient gentle. Along the eastern boundary, the streams narrow, become more deeply incised, and are relatively swift, with some having pronounced rapids or falls (Fenneman 1938).

Population density in the region is moderate and fairly evenly distributed (White 1979). Although there are several metropolitan areas, the dominant character is rural and agricultural.

5.4.13.2 Visual Character of the Site

A. Topography

The terrain in the site vicinity varies from nearly flat ridges to gradual and steep slopes, valley floors, and included floodplains. Elevations generally vary by 50 to 80 ft. Some rises are prominent, such as Red Mountain, but are not distinctive because of the forest cover. Elevations to the northwest near Roxboro and Brooksdale reach 830 ft, declining to the east to less than 400 ft along the Tar River where it crosses the southeast quadrant. Mt. Tirzah is a rise exceeding 700 ft in elevation that runs diagonally northeast-southwest across the southwest quadrant. The Flat River crosses this rise near Red Mountain, which is part of Mt. Tirzah. Relief in this vicinity is 250 to 300 ft across 3/8 mi. The main part of the Tar and Flat rivers is incised 60 to 110 ft into the adjacent uplands, but relief along the rivers' tributaries is slight.

B. Vegetation

The great majority of the site vicinity is covered by a homogeneous appearing, dense, oak and pine forest. Periodic logging occurs in some areas, resulting in a patchwork of mature forest and cut-over areas. Nearly all of the balance of the site vicinity has been modified by agriculture, principally evidenced by open pastures and row crop farming.

C. Water Features

Due to the preponderance of forest cover, lakes and rivers in the site vicinity are seen only from points along their shores and banks. The major streams in the site vicinity are the Tar River, the Flat River, and Mayo Creek. The Tar River drains most of the eastern half of the ring, flowing to the southeast through a comparatively narrow valley. The Flat River and its two main tributaries intersect the southwestern quadrant to flow into Lake Michie, about 4 mi south of the ring. This lake is a recreational site, serving boating, fishing, picnicking, camping, and hiking. The Flat River is notable in this area for the lack of development along its banks and is enjoyed by naturalists, canoeists, and day hikers (Hinton 1988). Relief along the Flat River near Red Mountain is relatively great, the stream valley being moderately steep-sided and narrow. Mayo Creek drains the tip of the northwestern quadrant, passing through a broad valley to feed Mayo Reservoir. The other important water feature in the area is Lake Butner, an undeveloped, natural appearing area currently used for fishing, picnicking, hiking, and other forms of outdoor recreation.

D. Cultural Modifications

The collider ring encloses a sparsely populated rural/agricultural area that includes substantial areas of forest as well as prime farmland. Associated houses, barns, tobacco sheds, and other structures are, compared to agricultural areas in the Midwest, not usually conspicuous or memorable, partly due to the extent of forest cover. Urban complexes occur within 10 to 30 mi to the south in and around Raleigh, Durham, Chapel Hill, and Research Triangle Park. Overhead transmission lines pass through the injector area, the near cluster ring, the western arc, the eastern arc, the far cluster ring, and near E5. These transmission line structures influence views to an insignificant degree due to the forest cover; they are not visible from other than the most immediate vicinity.

E. Viewshed Definition

Viewsheds in the site vicinity are controlled by the forest cover rather than by topography. The vegetative control is less complete during the winter, due to much of the forest being deciduous. Where areas are thinly forested, such as by fencerows, views that are blocked in the summer are more extensive during the winter. Along most roads, the

views are confined to the direction of travel, seldom extending more than 1/4 mi laterally, and are fragmented by stands of trees. Here, and in the Piedmont in general, the landscape can absorb much change without its being apparent. This is due not only to the vegetative cover, but also because there are few elevated areas from which the surrounding landscape may be seen. Further, the forest skyline is usually raggedly uneven and complex; structures projecting into it are less noticeable than where the skyline is smooth, linear, and horizontal.

An exception to the general limitations on views occurs at Red Mountain. Here, there are a few views in all directions, but these occur only in winter.

5.4.13.3 Sensitivity

A. Travel Routes

The primary travel routes through the project area are U.S. highways 501 and 158. Numerous paved, two-lane secondary roads wind through the areas as well. None are formally or informally designated as scenic highways or roads. Several of the secondary roads are in proximity to subdivisions and rural residences noted below. Segments of these roads that secondarily serve as access to nearby subdivisions (e.g., state routes 1601 and 1004), or roads primarily serving rural residential areas (e.g., state routes 1602 and 1736), are moderately sensitive.

B. Public Use Areas

There are no designated areas of aesthetic, recreational, cultural, or scientific significance within or along the collider ring. However, Webb's Chapel, a restored historic structure considered to be highly sensitive, would be displaced by F5 and presumably, relocated. Several recreational lakes are located in the project vicinity, including lakes Michie and Butner, several miles south of the ring. None of the project features would be visible from the lakes or their immediate environs. In addition, one stream in the area supports some local recreation use and is considered moderately sensitive; canoeing occurs in the spring along about 10 mi of the Flat River (Hinton 1988). This stretch flows through undeveloped lands predominantly natural in appearance and passes within 1/3 mi of the proposed site for F1.

A number of subdivisions and rural residential areas and their access roads are within view of the proposed sites for several SSC surface facilities. The subdivisions are treated as highly sensitive, while the rural residential areas are moderately so. These residential areas are located in proximity to the proposed sites for F1, F3, F4, F7, F9, E4, E8, and Substation #2. In some cases, project visibility is seasonal; vegetation thinly but effectively conceals proposed sites in the summer, but does not do so in the winter.

Especially notable are widely spaced residences to the northeast of F1 along state routes 1601, 1736, 1735, and 1602; those in the subdivision on Red Mountain to the southeast of that facility; Raney Way, a 21-parcel subdivision abutting the site for F9; and the well-kept rural residences immediately adjacent to the sites for F4 and E4.

C. Laws, Plans, Policies, and Regulations

There are no laws, plans, policies, or regulations that indicate a sensitivity for scenic or visual resource protection in the site vicinity.

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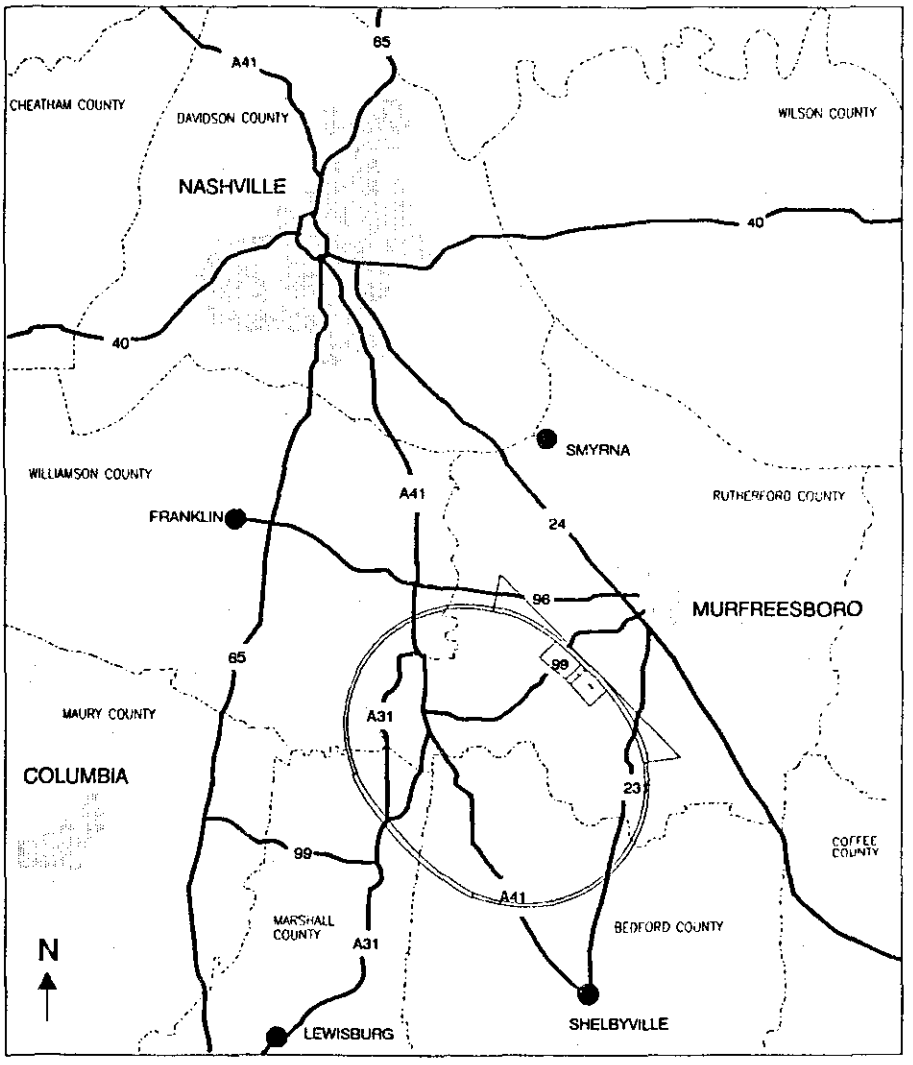
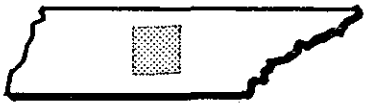
Affected Environments at Site Alternatives

T E N N E S S E E





Tennessee - **The proposed site is in the central portion of Tennessee, approximately 30 miles southeast of Nashville. It includes portions of Bedford, Marshall, Rutherford and Williamson Counties. The entire tunnel would be constructed by tunneling techniques in a homogenous bed of limestone below the water table.**

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5.6 TENNESSEE

5.6.1 Earth Resources

5.6.1.1 Physiography and Topography

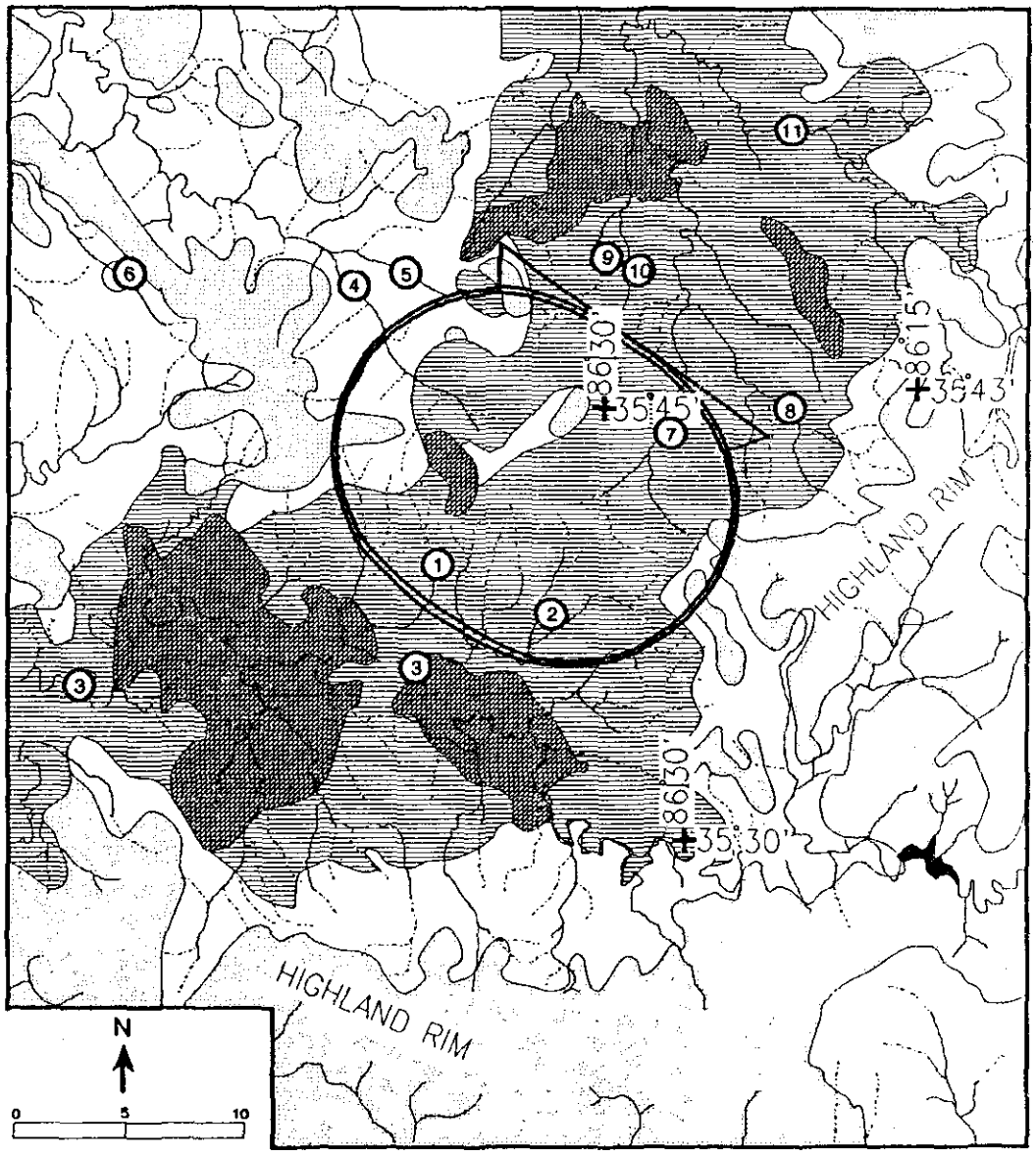
The proposed Tennessee SSC site is situated in the Nashville Basin section of the Interior Low Plateau Physiographic Province (Fenneman, 1938). Nashville Basin is a mature to old plain (Figure 5.6.1-1), underlain by easily eroded rocks. The basin has been slightly tectonically uplifted and moderately dissected by streams. Surrounding the basin is an elevated dissected plateau (Figure 5.6.1-1) that has several hundred feet of relief. The site area is close to the Highland Rim and it includes numerous knobs and hills. The knobs and hills are erosional remnants composed of relatively more erosion-resistant rocks that were left behind as the Highland Rim retreated to the south and east. The site area, underlain by relatively soluble limestone, is an area with a high density of karst features; these include numerous caves, closed depressions (sink holes), and dissappearing streams (Miller 1977).

Elevations in the site vicinity range from 610 ft where the West Fork Stones River flows to the northeast (U.S.G.S. 1983), and 630 ft where Duck River flows to the west (U.S.G.S. 1981c), to over 1,300 ft, where the eastern edge of the site approaches the escarpment of the Highland Rim (U.S.G.S. 1983, and 1980c, respectively). Elevations in the site proper range from 630 ft at Stones River to 1,250 ft along the eastern edge of the ring. The western edge of the ring also traverses hilly ground that rises to 1,170 ft (U.S.G.S. 1980a). However, much of the site topography is rolling bottomland with an average elevation of 750 ft. Relief in the bottomlands ranges from 10 to 50 ft (U.S.G.S. 1980b and c, 1981a, 1983); the most prominent features are slightly incised drainages (5 to 10 ft deep), broad flat areas with exposed bedrock or thin soil (termed glades), and numerous closed depressions (termed sinkholes) mostly less than 20 ft deep. Small streams occasionally drain internally to the sink holes (disappearing streams) (U.S.G.S. 1980b and c, 1981a, 1983); a few streams run into caves and thence underground.

Site drainage is through a well-integrated dendritic stream system. Tributaries of the Duck River drain the southwestern third of the site; Harpeth River and its tributaries drain the northwestern third. The remainder of the site is drained to the northeast by tributaries and main stem of the West Fork Stones River. Depth of stream incision on the lowlands ranges from 5 ft on the smallest creeks to 25 ft on the larger streams. In areas of knobs and hilly highlands, the streams have incised the land by as much as 220 ft. Larger stream courses are meandering, with meander amplitudes of 1 mi or more. Courses of smaller streams frequently have straight segments, suggesting control of the stream alignment by fractures in the bedrock.

Figure 5.6.1-1

TOPOGRAPHIC SETTING OF THE TENNESSEE SITE



Knobs and hilly highlands

Rolling lowlands

Karst areas with caves, sinkholes and disappearing streams

Areas with high density of karst features

Stream, intermittent flow where dot-dashed

Drainages

1. Wilson Creek
2. Alexander Creek
3. Duck River
4. Harpeth River
5. Nelson Creek
6. West Harpeth Creek
7. West Fork Stones River
8. Middle Fork Stones River
9. Overall Creek
10. Armstrong Creek
11. East Fork Stones River

5.6.1.2 Stratigraphy

A stratigraphic column of the rock units in and around the Tennessee site is depicted in Figure 5.6.1-2. Lithologic descriptions of these units are given in Table 5.6.1-1. Information in this section was obtained from various sources, including Wilson (1949), Milici and Smith (1969), Galloway (1919), and Miller et al. (1966). The time scale used to approximate the age of the rock units is the "Decade of North American Geology 1983 Geologic Time Scale" (Palmer 1983).

In general, the stratigraphy of central Tennessee is fairly uniform and well understood. The Ordovician (450-million to 480-million-year-old), Stones River, and Nashville groups, together with the overlying Leipers formation make up the majority of the rock column to be involved in tunnel and shaft construction. Lithologic variations in these generally homogeneous limestone formations are chiefly limited to minor argillaceous, shaley, and cherty facies. The underlying Knox group dolomite has been exploited for zinc and water (see Section 5.6.1.6).

5.6.1.3 Geologic Structure

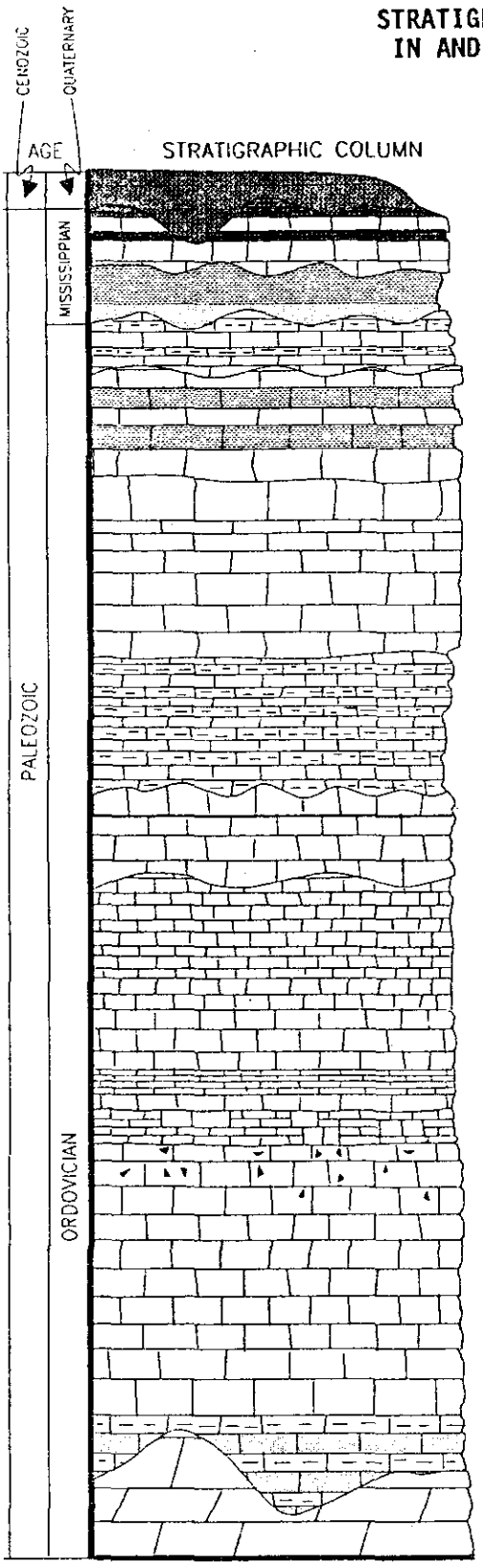
Figure 5.6.1-3 is a geologic map of the vicinity of the Tennessee site. Figure 5.6.1-4 is a cross section along the ring alignment. The sedimentary units described in Section 5.6.1.2 display only minor structural flexures associated with the Nashville dome. The dome, a regional feature encompassing most of central Tennessee, is centered very near the site and the town of Murfreesboro. Beds dip away from the center of the dome at a general rate of 25 to 40 ft/mi (Manhardt 1988b). Local doming and folding may increase these dips over limited distances.

No faults are mapped anywhere in the vicinity of the site, although offsets of a few inches are locally evident in outcrops (Manhardt 1988b). Structure contours interpreted from well logs indicate a general doming of the sediments at tunnel level near the center of the ring. Beds dip away from the domal feature in all directions; dips may increase locally to over 150 ft/mi (Manhardt 1988a). These flexures will probably permit units over and under the Murfreesboro limestone, the principal tunneling unit, to intercept the tunnel horizon (see Section 5.6.1.2 and Figure 5.6.1-4).

The major joint set at the surface trends N65W with a secondary set at N20E. Joints are spaced about one every 5 ft and dips are approximately vertical. Although joints appear open and weathered at the surface, apertures are expected to diminish greatly with depth and isolation from groundwater systems (Manhardt 1988a).

Figure 5.6.1-2

STRATIGRAPHIC COLUMN OF ROCK UNITS IN AND AROUND THE TENNESSEE SITE



	NAMES	APPROXIMATE MAXIMUM THICKNESS (FEET)	DOMINANT LITHOLOGY
	Alluvium	25	Sand, silt, clay, and gravel
	Fort Payne Formation	120	Limestone, shale, and chert
	Chattanooga Shale	35	Shale
	Leipers Formation	100	Earthy limestone and shale
Nashville Group	Catheys Formation	150	Pure and shaley limestone
Nashville Group	Bigby-Cannon Limestone	70	Limestone
Nashville Group	Hermitage Formation	75	Argillaceous limestone
Stones River Group	Upper member Carters Limestone Lower Member	115	Limestone
Stones River Group	Lebanon Limestone	120	Limestone, minor shale
Stones River Group	Ridley Limestone *	115	Limestone
Stones River Group	Pierce Limestone *	28	Limestone, minor shale
Stones River Group	Murfreesboro Limestone *	300	Limestone
Stones River Group	Upper White Unit POND SPRING FORMATION * Lower Green Unit	145	Pure and shaley limestone
Knox Group	Mascot Dolomite		Dolomite

Units involved in tunnel and shaft construction

Sources: Wilson (1949), Milici and Smith (1969), Galloway (1919), Miller et al. (1966)

* Unit penetrated by collider tunnel

Table 5.6.1-1

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Alluvium	Sand, silt, clay, and gravel.	Not mapped in site area; expected to be present along major streams.
Fort Payne Formation	Bedded chert, sandy shale, and limestone.	
Chattanooga Shale	Black, carbonaceous, laminated shale with pyrite nodules, and a sandstone of limited lateral extent at base.	
Leipers Formation	Fine- to coarse-grained, modular, shaly, "earthy" limestone. Local phosphatic calcarenite.	Potentially uppermost unit involved in shaft construction (E7).
Catheys Formation	Modular, shaly limestone, fine- to coarse-grained limestone, and shaly lime-stone. Thin- to medium-bedded and locally cross-bedded and phosphatic.	Potentially involved in shaft construction (E7).
Bigby-Cannon Limestone	Uniformly bedded, fine- to medium-grained limestone. Locally containing irregular mottlings of silt, chert nodules, and very shale beds.	Only the Cannon facies (described) is present at site.
Hermitage Formation	Generally alternating beds of fine-grained, thin-bedded, laminated, shaly limestone, with thin-bedded to locally massive, coarse-grained limestone with local, thin shale partings.	
Carters Limestone	Divided into upper and lower members separated by the T-3 bentonite bed.	
Upper Member	Dense, fine-grained limestone. Locally thin-bedded with thin films of very fine-grained silt or clay, or laminated and clayey.	
Lower Member	Fine-, medium-, and coarse-grained, granular and crystal-line limestone. Locally laminated and inter-bedded with coquina.	
Lebanon Limestone	Generally thin-bedded and dense, brittle, flaggy, and fine-grained limestone with wavy shale partings. Promi-nent massive member in lower middle portion of unit.	

Table 5.6.1-1 (Cont)

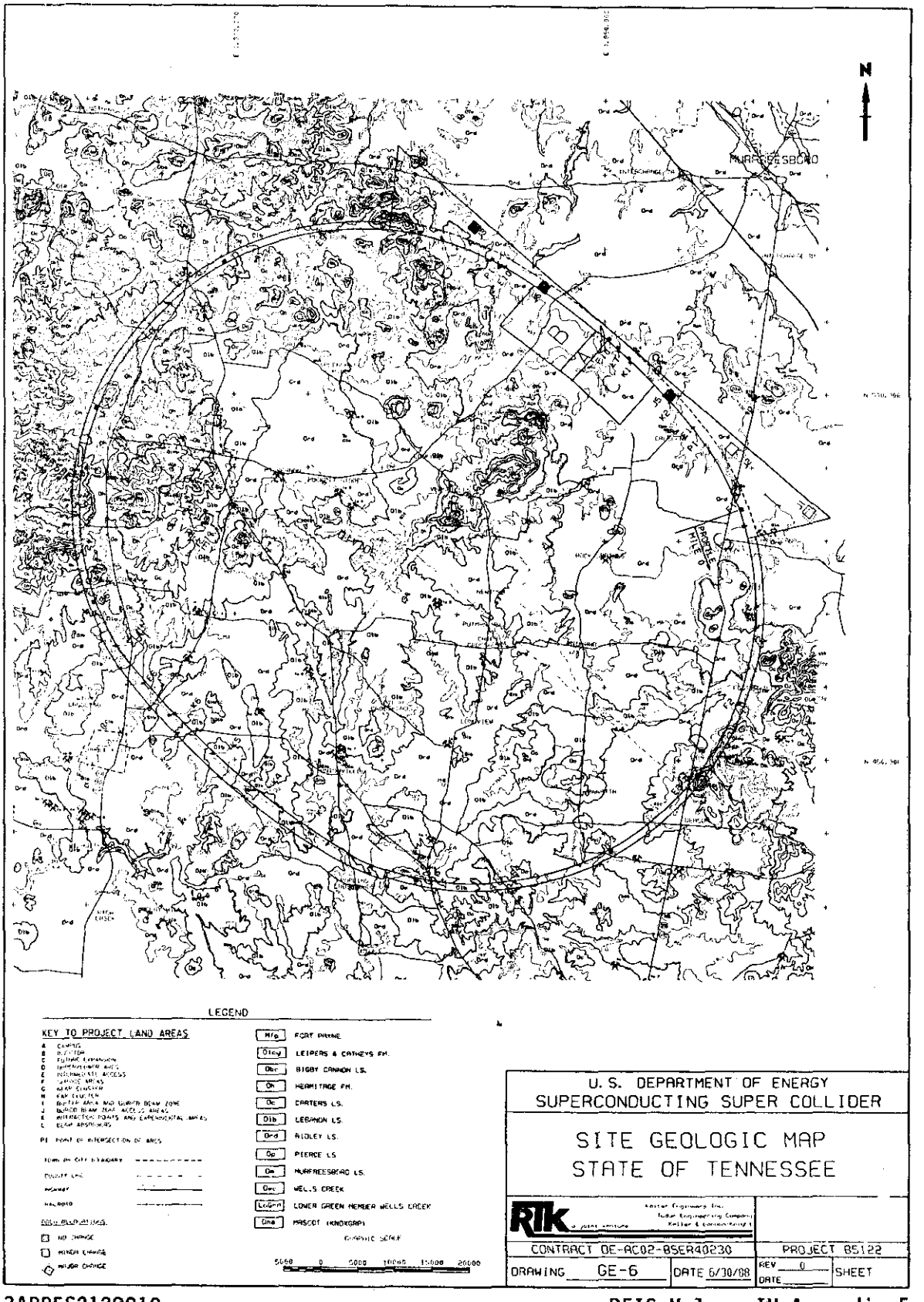
LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Ridley Limestone	Mostly dense and fine-grained massive limestone. Locally medium- and coarse-grained. Thin-bedded member in lower portion of unit contains beds separated by films of calcareous shale.	Uppermost unit encountered at proposed tunnel horizon. Uppermost unit encountered at proposed tunnel horizon.
Pierce Limestone	Platy layers of dense, fine- grained, brittle limestone with thin partings of calcareous shale. Locally medium- to coarse-grained. Partings are up to 0.5 inches thick and are predominantly silt with some clay.	
Murfreesboro Limestone	Dark, dense, brittle, and very fine-grained limestone. Includes rare beds of medium to coarsely crystalline limestone. Very thin partings may contain minute amounts of silt. Local sacharoidal texture represents a dolomitic phase. Stringers, nodules, blebs, and irregular masses of chert are prominent in upper portion of unit.	Principal tunnel unit.
Pond Spring Formation	"Upper white unit" is fine-grained, mottled, thick-bedded limestone. "Lower green unit" is shaly or sandy carbonate of laterally variable thickness.	Lowermost unit potentially encountered at proposed tunnel horizon.
Mascot Formation (Knox Group)	Massive dolomite.	

Sources: Miller, et. al. 1966; Milici and Smith 1969; Galloway 1919; Wilson 1949.

Figure 5.6.1-3

GEOLOGICAL MAP OF THE VICINITY OF THE TENNESSEE SITE



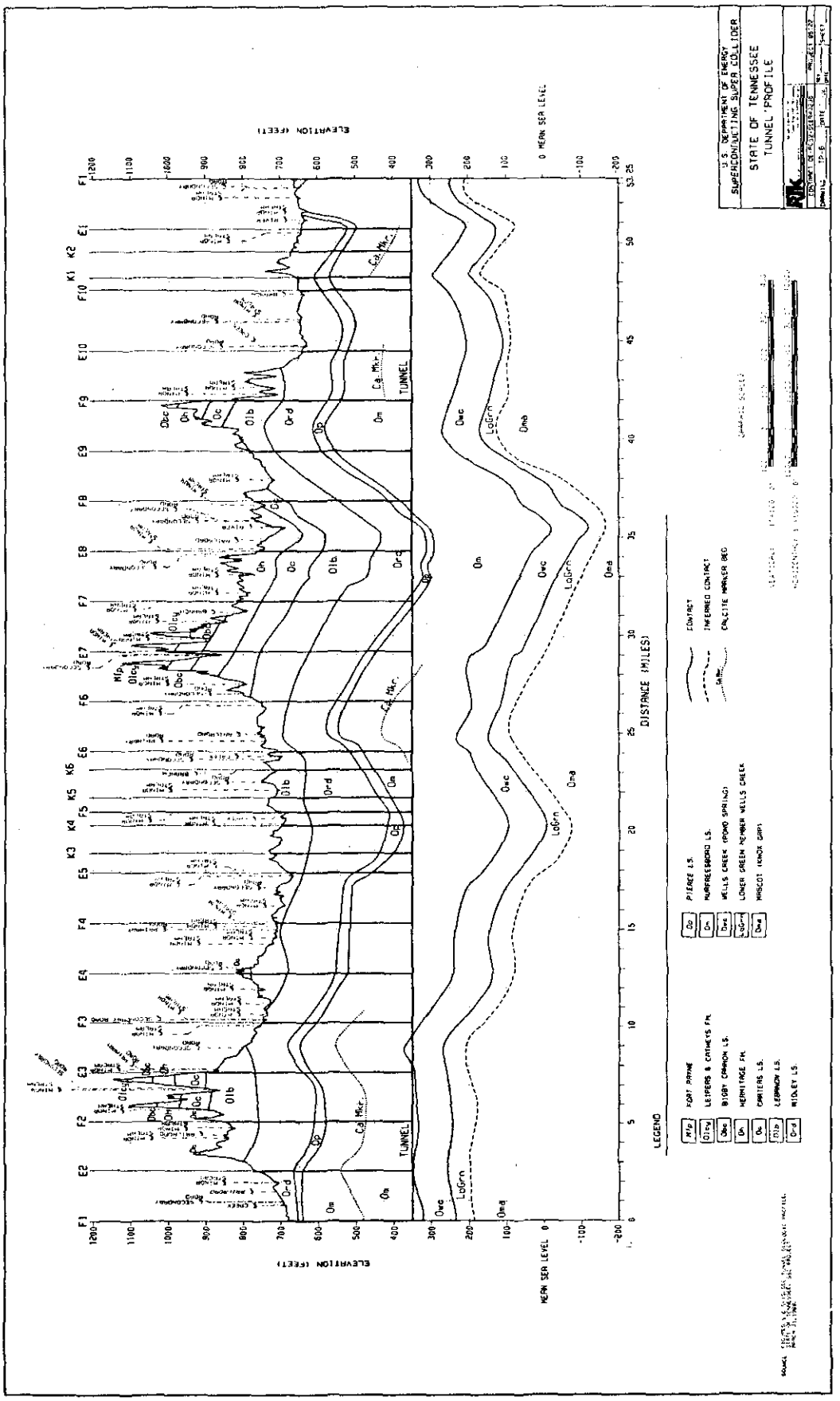


Figure 5.6.1-4

CROSS SECTION ALONG THE SSC RING ALIGNMENT

5.6.1.4 Geoengineering Conditions

The geoengineering materials at the Tennessee SSC site include:

- Soils - Residual and alluvial
- Rocks - shale, limestone, and dolomite

Thin, discontinuous soils occur within the proposed SSC site. With the exception of alluvial soils in the floodplains of major streams, the overburden soil is residual and the result of weathering of underlying limestone formations. Table 5.6.1-2 presents the geotechnical properties of soil. Laboratory test results indicate the residual soil is classified CL (inorganic clays of high plasticity) and CH (inorganic clays of low to medium plasticity), based on the United Soil Classification System (USCS) designation (Kane 1988). The alluvial soils range from mostly low plasticity clays to minor sands and gravel.

The rock formations at the tunnel horizon consist of massive, relatively chert free, unweathered limestone from the Stones River group. These rock formations are very strong with unconfined compressive strengths ranging from 10,000 lb/in^2 to 21,000 lb/in^2. Horizontal bedding planes and vertical fractures are the basic discontinuity features of the rock formations at the site. Table 5.6.1-3 provides information on rockmass properties (Manhardt 1988).

Drill holes and quarry exposures at various locations along the collider ring and experimental halls reveal the following:

- Rock formations have high rock quality designation (RQD) values, and can be classified as "excellent" based on the Deere's classification scheme (Bieniawski 1984).
- Sinkholes, solution cavities, and solution-widened joints are common in the limestone.
- Clayey and calcite laminae were observed within the cores as undulating, irregular features; most of the mechanical breakages occurred along the laminae.
- Clayey and bentonitic laminae, which may have swell/shrink potential, were observed in cores of limestone from the Hermitage formation.
- Murfreesboro limestone contains frequent clayey laminae, occasional chert, calcite veins, and sporadic subvertical fractures.
- Lebanon limestone has well-defined bedding planes, fairly rough vertical fractures, and some well-developed solution cavities.

Table 5.6.1-2

GEOTECHNICAL CHARACTERISTICS OF SOIL

Deposit	Soil Description USCS	Dry Density lb/ft^3	Moisture Content %	Liquid Limit Plasticity Index	Unconfined Strength $lb/inch^2$	Shear Strength $lb/inch^2$	Friction Angle	Calculated Average Bearing Capacity $lb/inch^2$
Residual soil	CL, minor CH	94 (86-98)	25 (23-26)	36/21 (29-51/19-22)	8.2 (5.6-10.8)	4.1 (2.8-5.4)	32° (28°-33°)	23 (16-33)
Alluvial soil	CL	(90-102)	(24-28)	(36-47/17-24)	(7.8-8.1)	(3.9-4.0)	(30°-32°)	(23-25)

Notes:
Values are reported as average with range in parentheses.
CL = inorganic clay of low to medium plasticity
CH = inorganic clay of high plasticity
Source: Kane 1988

Table 5.6.1-3

GEOTECHNICAL CHARACTERISTICS OF BEDROCK

Formation	Seismic Velocity Ratio Vs/Vp	Unconfined Compressed Strength lb/inch^2	Tensile Strength lb/inch^2	Young's Modulus lb/inch^2 x10^6	Poisson's Ratio	Unit Weight lb/ft^3
Carters	(0.50-0.53)	a(16,945-19,668)+	ND	a(1.4-2.0)+	a(0.21-0.32)+	a(168-169)+
Lebanon	(0.50-0.51)	12,093*	ND	ND	ND	167.2*
Ridley	0.52 (0.50-0.51)	23,957 (15,905-34,226)	ND	2.2 (1.5-2.6)	0.28 (0.21-0.33)	169 (168-170)
Pierce	0.50 (0.48-0.54)	22,448 (17,634-29,038)	ND	2.00 (1.8-2.3)	0.26 (0.23-0.29)	168 (168-169)
Murfrees-boro	0.50 0.48-0.55	26,192 (12,862-39,122)	ND	2.7 (1.85-5.2)	0.30 (0.23-0.41)	169 (168-171)

Notes: Values are presented as averages with range in parentheses.
ND No data
+ Range based on two tests
* Based on one test
Source: Manhardt, 1988

- Limestone thickness layers exposed in highway cuts range from 2 to 3 ft; the bedding planes for all the formations consist of smooth, near-horizontal partings.

5.6.1.5 Geologic Hazards

The Tennessee site lies in an area of low seismic risk, (Uniform Building Code seismic risk map Zone 1; International Conference of Building Officials 1988), and could be expected to have only minor damage from earthquakes of Modified Mercalli intensity V or VI. The site is about 80 mi from the Southern Appalachian Seismic Zone (SASZ; Bollinger 1973). Of the 80 to 100 historical earthquakes that occurred within 100 mi of the site, all but 30 were within the SASZ. Generally, earthquakes outside the SASZ are widely scattered and of small magnitude. The nearest earthquake to the site was a magnitude 3.8 (body-wave magnitude), Modified Mercalli intensity IV event in 1956 about 1 mi from the site. The greatest earthquake at the site probably resulted from the 1811-1812 New Madrid, Missouri, earthquakes (about 200 mi away), which caused intensity V to VI shaking at the site (Miller 1977). Based on this low historical seismicity, Algermissen et al. (1982) estimated that earthquake ground motions of 0.06g have a greater than 90% probability of not being exceeded in 50 years.

There are no known active faults in proximity to the site (Howard et al. 1979).

Since bedrock is at or very near the surface at the site, there is minimal potential for earthquake-caused soil liquefaction.

Karst topography that forms over limestone or dolomite by solution, and that is characterized by closed depressions (sinkholes), caves, and underground drainage, is common in the site area where many carbonate rocks are present (Figure 5.6.1-1; Miller 1977). The Ridley and Lebanon limestone outcrop areas, in particular, have many sinkholes, caves, and disappearing streams. Seven caves are known within the site area, as follows (Matthews 1987; Barr 1972):

- Dr. May's Cave, near Almaville, is 6 ft high, 10 to 20 ft wide, and has been explored for 675 ft.

- Patterson Cave, near Patterson, is 8 ft wide, 8 ft high, and has an explored length of 350 ft.

- Echo Cave, near Rockvale, is 15 ft wide, 20 ft high, and has an explored length of 1,160 ft.

- Nanna Cave, near Rockvale, is 10 to 70 ft wide, 12 to 20 ft high, with an explored length of 6,500 ft.

- Snail Shell Cave, near Rockvale, is 6 to 80 ft wide, 10 to 20 ft high, and has been explored for 23,130 ft. Together, Echo Cave, Nanna Cave, and Snail Shell Cave, and their inlets

and outlets, suggest a subterranean system of over 8 miles of cave passages.

- Smyre's Well #1, near Windrow, is a 96 ft deep shaft.
- Smyre's Well #2, near Windrow, is an 85 ft deep shaft.

The caves and sinkholes indicate a potential for hazards because of cavern collapse and flooding. Miller (1977) summarized these problems as follows:

- Several cases of cavern collapse have been documented in the central southern United States carbonate region. Most were attributed to the withdrawal of groundwater, essentially resulting in destruction of the "buoyant" effect, thus weakening the cavern roofs. The collapse of a stock pond in northeastern Montgomery County, Tennessee, was caused primarily by loading.
- Flooding of structures located within depressions results from an imbalance between surface runoff into the sinkhole and discharge into the underlying cavern system. This occurs annually during the period of heaviest precipitation. Some sinkholes never flood because of a well-developed subterranean outlet system. Others contain water perennially caused by plugging of the outlet by clay or other materials. Still others are dry most of the year, but contain water when the water table rises and encounters the sinkhole, in addition to receiving surface runoff.
- An additional concern for construction is that joints in the limestone are frequently widened by dissolution at the surface and require special "bridging."

A small segment of the collider ring alignment on the western edge of the site near Eagleville crosses a hilly area where topographic and geologic conditions result in a potential for landslides (Miller 1977). The mass movements are in the form of translatory slides and shallow slump, with earth flow in the toe. They occur principally in colluvium (gravity-deposited material) derived from natural creep (a very slow form of gravity movement) and slope wash erosion of the Fort Payne formation, the rock unit capping the Highland Rim, and the higher outlying hills and ridges. This material collects at the break in slopes marked by the base of the underlying Chattanooga shale (steeper slopes are found above this contact). Movement occurs when these colluvial wedges are altered by toe removal, oversteepening, or loading, usually during periods of high rainfall, specifically the winter and early spring months (Miller 1977).

Small quantities of natural gas have been encountered by drilling in the Stones River group, but are normally exhausted in a few hours (Manhardt 1988a). Hydrogen sulfide also occurs locally with the natural gas.

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Typical examples of minor gas occurrences are provided by several deep shafts (1,400 ft) that were sunk in the 1970s in middle Tennessee by mining companies exploring and developing zinc ore bodies. The shafts closest to the site were sunk by New Jersey Zinc Company (now Jersey Miniere Zinc) in the Elmwood and Gordonsville area, 50 mi northeast of Murfreesboro. The shafts were collared in the Nashville group of limestones, passed through the same formations that are present in the site area and bottomed in the Knox formation where the zinc ore bodies were to be developed (Manhardt 1988a). New Jersey Zinc's first shaft, which collared in the Stones River Group, was started in 1969 near Elmwood, Tennessee. During the sinking, two small pockets of methane were encountered that bled off in a matter of hours and presented no further problems. Between 1969 and 1980, New Jersey Zinc sank three more shafts that encountered similar minor gas occurrences above the Knox formation, and as with the first shaft, construction was relatively uneventful. The mine workings, which are in the Knox formation, encountered groundwater that was determined in some instances to be saline and occasionally released small amounts of hydrogen sulfide (H_2S gas. The H_2S was easily diluted and removed by forced-air ventilation. The mine has never been classified as gassy during any of the annual testings for gas by the Bureau of Mines (Manhardt 1988a).

5.6.1.6 Geologic Resources

The limestones of central Tennessee provide abundant material for use as aggregate and in cement production. Exploration within these limestone units for oil and zinc has proven unsuccessful to date within the site area. Previous exploitation of small veins of barite, fluorite, zinc, and lead has occurred at several locations in the vicinity of the site, although none of these mines is currently active. Phosphate resources are present in the northwestern corner of the site area. Locations of all mines and wells in the vicinity of the site are shown in Figure 5.6.1-5. These data were gathered from the U.S. Bureau of Mines' Mineral Industry Location System (MILS) database (1988), and from Petroleum Information Corp. (1988).

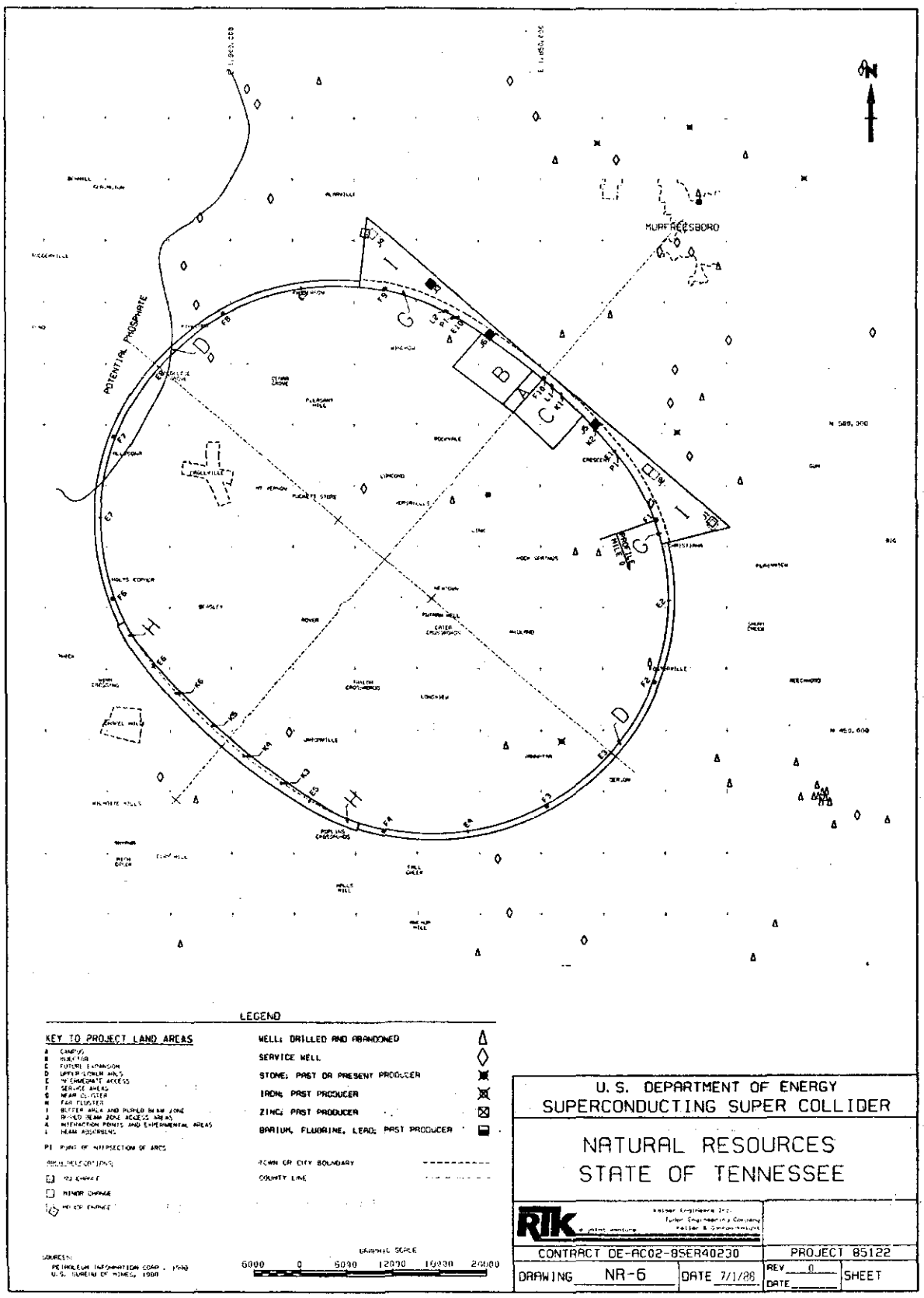
A. Earthen Construction Materials

Limestone resources are abundant in central Tennessee. Large volumes of these resources are exploited for use as aggregate for construction and agricultural purposes (Hershey and Maher 1985). Numerous small stone and sand and gravel operations are indicated on the topographic maps of the area; only those included in the MILS data base are shown in Figure 5.6.1-5. The combined current aggregate production of five quarries in the four counties surrounding the site is 2.95 million tons. The estimated combined reserves of these quarries is considered unlimited (Manhardt 1988b).

The cement industry of central Tennessee is the principal consumer of the abundant limestone resources of the region. Cement production is concentrated in Marion, Franklin, and Davidson counties (southeast and

Figure 5.6.1-5

LOCATION OF ALL MINES AND WELLS IN THE VICINITY OF THE SITE



northwest of the site) (Hershey and Maher 1985). The total annual production of the two plants in Knoxville and Chattanooga is 1.15 million tons; reserves for these plants are estimated sufficient for 30 to 50 years of operation at current levels of production (Manhardt 1988b). Additional cement is available from Kentucky, Alabama, and Georgia.

B. Energy Resources

Oil exploration in the vicinity of the site has been unsuccessful to date. Six drilled and abandoned wells are located inside the ring alignment (Figure 5.6.1-5). Another nine are within 5 mi of the site. Seventeen additional wells in the area are presently classified as service wells. Oil shows have been reported at several horizons within Ordovician limestones (Wilson 1949). Minor amounts of bituminous and petroliferous material have also been reported in Chattanooga shale, which can be considered a potential low-grade oil shale. This formation is locally 10-20 ft thick in the northwestern portion of the site area (McCary 1963a).

Uranium is also found in very small amounts (less than 0.01%) in Chattanooga shale. These deposits are considered well below ore grade (McCary 1963a). Coal occurs in Pennsylvanian (280-million to 320-millionyear-old) rocks of the Cumberland Plateau well east of the study area (Floyd 1965).

C. Metallic Resources

Veins in Ordovician limestones of central Tennessee typically contain barite, fluorite, and calcite, with locally economic amounts of galena and sphalerite, and associated pyrite, quartz, and chalcopyrite. The veins were originally mined by Indians, and later, during the Civil War, slaves were used to recover lead for the Confederate army. With the expansion of the steel industry, fluorite became a valuable commodity for use as a flux. Barite was exploited from local occurrences by at least the early 1930s (Jewell 1947). Currently, zinc appears to be the commodity of principal economic importance; barite and fluorite deposits will be discussed in the following section.

Veins of barite, flourite, galena, and spoterite (filling fractures and faults) have been described throughout the Ordovician section, including all rocks of the Stones River group, and to a lesser extent, up through the Catheys formation (Jewell 1947) (see Section 5.6.1.2). Recent exploration for zinc has concentrated on the zinc potential of the older rocks of the Knox group. Several mining companies have been involved in drilling programs in the region of the proposed site since 1964.

To date, these efforts have resulted in six mine sites, only one of which is currently open in Smith County, about 40 mi northeast of the campus area (Manhardt 1988b). Two mines in Wilson and Trousdale counties, 25 and 45 mi from the site respectively, were opened and later closed. The remaining three are about 60 mi northeast of the site and represent planned mining expansion in the future (Manhardt 1988b).

Although numerous exploratory holes were drilled in the site area, the only reported zinc occurrence in the MILS database was in a deep well about 5 mi northeast of the ring alignment (Bureau of Mines 1988) (see Figure 5.6.1-5). An abandoned iron mine is located just inside the southeastern portion of the ring alignment. This was a surface operation that mined hematite and magnetite (Bureau of Mines 1988).

D. Other Resources

One of the principal natural resources of central Tennessee is phosphate. Phosphate deposits in the area are of three general types. Brown rock is the most significant economically; blue and white rock deposits are lower grade and less economically mined (Floyd 1965). Potential for radioactivity associated with phosphate deposits is discussed in Section 5.6.6.

Brown rock deposits are residual concentrations produced by weathering limestone, most notably Bigby-Cannon limestone. Less significant deposits occur in the Hermitage, Catheys, and Leipers formations (Floyd 1965). These deposits are found in the northwestern portion of the site area in Rutherford and Williamson counties, and extend into Davidson and Sumner counties to the north and Maury and Giles counties to the south (see Figure 5.6.1-5). Scattered deposits also occur in Marshall County (Smith and Whitlatch 1940). In the vicinity of the SSC site, the potentially phosphate-bearing formations occur on the tops of isolated hills.

Most of the past and present phosphate mining of brown rock ore has been located in the Mount Pleasant and Columbia districts of Maury County, the Wales area in Giles County, and the Franklin area in Williamson County (Floyd 1965). The Franklin area, 15 mi northwest of the site, remains in production (Manhardt 1988b).

Commercial-grade reserves of these types of deposits are estimated at about 50-70 million tons. If lower grade reserves are considered, the total would increase notably. These would include the blue phosphate deposits in the Chattanooga Shale in Hickman, Lewis, Perry, and Maury counties (Floyd 1965).

Barite and fluorite resources in the veins described previously have been exploited in numerous areas, including an abandoned mine within the ring alignment (see Figure 5.6.1-5). This property, known as the Arthur Hudson prospect, consists of at least two shafts and several trenches. (Bureau of Mines 1988; Jewell 1947; Maher and Spencer 1983; Maher 1970). The ore body occurred in Carters Limestone at a depth of about 50 ft. Although fluorine, barium, and lead ore were reported in recoverable quantities, no production figures are available, and no production had occurred prior to 1947. The mineralization was discovered in 1919 (Bureau of Mines 1988; Jewell 1947).

Another barite and fluorite occurrence, the Bell-Orren Prospect in northern Rutherford County, consists of two shafts between 25 and 35 ft deep. The ore body at this site is in Ridley limestone. No activity has taken place at this site since about 1900 (Jewell 1947; Maher 1970; Maher and Spencer 1983). No other significant occurrences of barite or fluorite are known within the vicinity of the site.

5.6.2 Water Resources

5.6.2.1 Surface Water Hydrology, Quality, and Use

A. Surface Runoff and Flooding

The proposed Tennessee site falls on a divide between two major rivers in the Ohio River Basin; the Cumberland River and the Duck River (Figure 5.6.2-1). The former flows directly into the Ohio while the latter joins the Tennessee River, which empties into the Ohio. The SSC site falls within the headwater areas of several smaller tributaries to the Cumberland and the Duck (Figure 5.6.2-2). The two largest tributaries, the Harpeth River and the West Fork Stones River, are both in the Cumberland Basin. Also, in the Stones River drainage, are Armstrong Branch, Dry Fork Creek, and Overall Creek. A second, Overall Branch, is a tributary to the Harpeth River. Direct tributaries to the Duck River are Spring Creek, Wilson Creek, North Fork Creek, and Fall Creek (Figure 5.6.2-2) A major improvement in the area is the J. Percy Priest Reservoir with a storage volume of 268,000 acre-ft.

The U.S.G.S. maintains five active gauging stations: three in the Stones River Basin, one on the Harpeth River, and one on the Duck River. Gauging records periods range from nine years to 53 years, and general streamflow characterizations for these gauges are given in Table 5.6.2-1. These gauges are all on streams or rivers well downstream from any intersection with the SSC ring and show a significant base flow (or average flow) of between 1.5 to 2.0 $ft^3/s/mi^2$. Some streams intersecting the ring location commonly have no flow in them at all because of their smaller drainage areas.

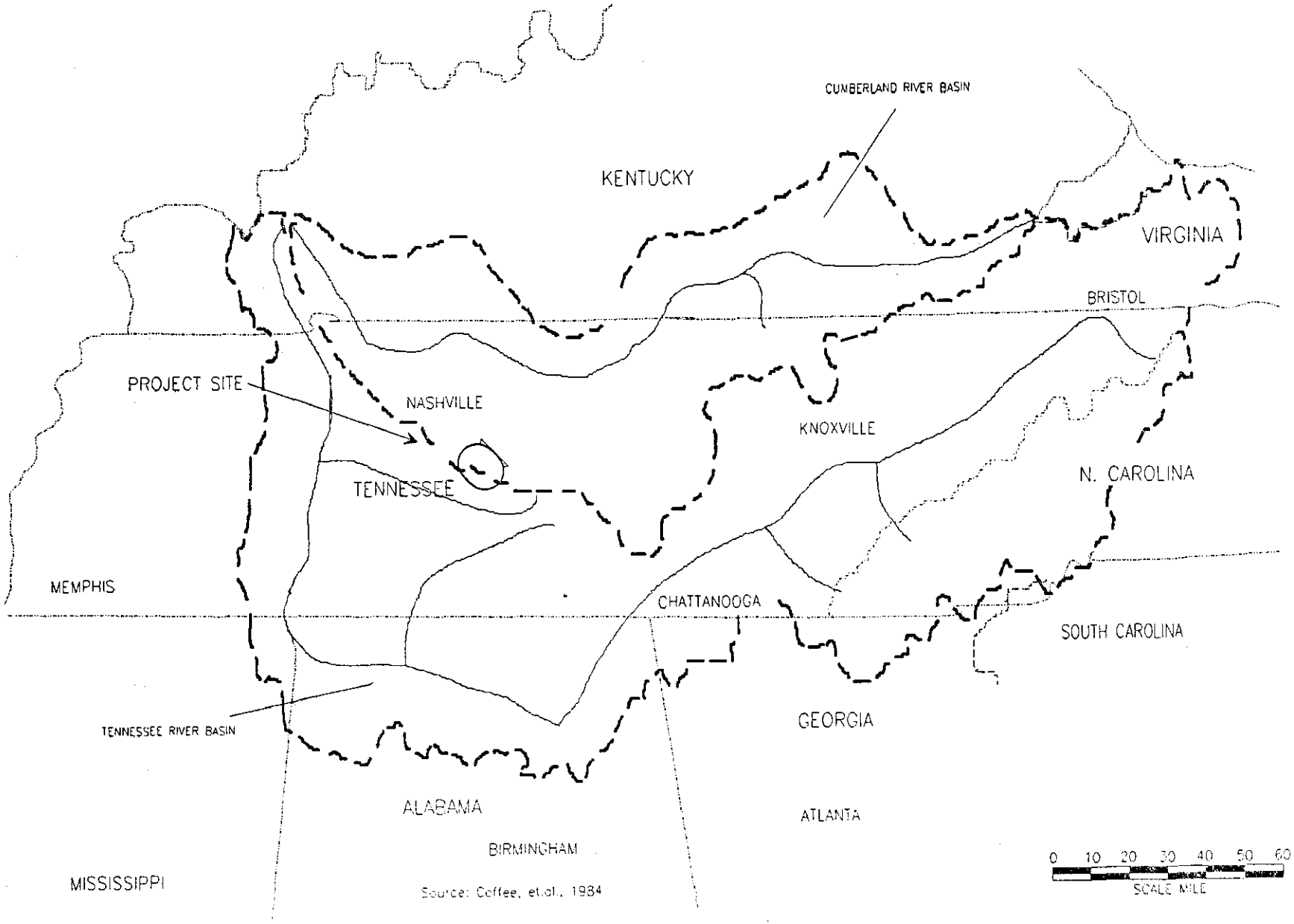
All of these streams and rivers are located in areas of limestone bedrock with poorly developed soils and a scarcity of transportable sediment. As a result, many of the channel bottoms in the ring area are on bedrock with shallow, ill-defined banks. Floodplains of the streams in the ring area are generally broad with a large flooding potential. Table 5.6.2-2 gives channel and floodplain dimensions on the major tributaries at or close to the ring intersection point.

There are no flood control structures on any of the streams within the proposed ring. There are currently no downstream flood control structures that affect water levels at the proposed ring.

The only future flood control structure being studied is in the Harpeth River Basin. The Nashville District Corps of Engineers is currently conducting preliminary feasibility studies for development of a flood control and water supply project on the Harpeth River. This project involves a low-head dam on the Harpeth River to be built east of Interstate 65. The dam would include a small permanent pool for water supply purposes and a flood retention pool for flood control purposes. The water supply would be for Williamson County and the flood protection would be primarily for Franklin, Tennessee, located approximately 5 mi downstream of the dam.

Figure 5.6.2-1

MAJOR WATERSHEDS OF TENNESSEE



Source: Coffee, et.al., 1984

Figure 5.6.2-2

HYDROLOGIC FEATURES - TENNESSEE SITE

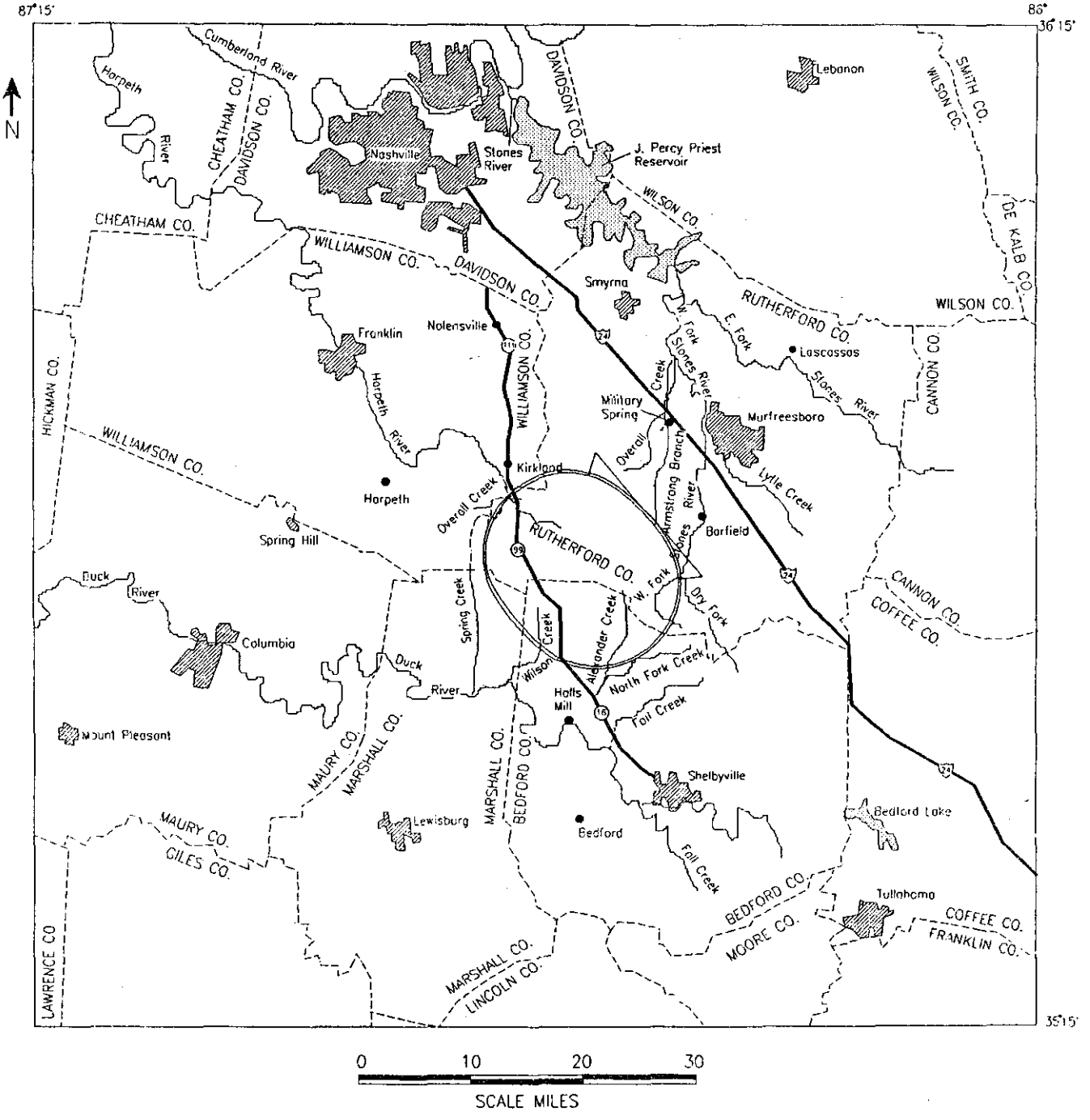


Table 5.6.2-1

GAUGE DATA IN PROJECT VICINITY

U.S.G.S. Gauge	Drainage Area* mi^2	Instantaneous Maximum Flow*	Date	Minimum Flow*	Average Flow*	Flow Duration Q5%	Q25%	Q50%	Q75%	Q95%
East Fork Stones River near Lascassas (No. 0342750)	262	41,200	3/13/75	2.8	460					
West Fork Stones River at Murfreesboro (No. 03428200)	177	31,000	3/13/75	4.7	329					
West Fork Stones River near Smyrna (No. 03428500)	237	63,800	3/13/75	0	431					
Harpeth River at Franklin (No. 03432350)	191	20,200	3/13/75	0.3	298					
Duck River near Shelbyville (No. 03598000)	481	87,000	3/29/02	20.0	809					

*All flow values in cubic feet per second (ft^3/s)
Sources: Lowery, et al. 1987, Randolph and Gamble 1976.

Table 5.6.2-2

CHANNEL AND FLOODPLAIN CHARACTERISTICS
AT THE COLLIDER RING

Drainage Channel	Drainage Area mi^2	Bankfull Channel Width ft	Bankfull Channel Depth ft	Flood-plain Width ft
West Fork Stones River near E1	46.8	45	8	1,000-2,000
Lytle Creek near E1	7.8	25	4	200-500
Dry Fork Creek near F2	4.5	20	6	200-400
Fall Creek near F3	13.8	30	8	-
North Fork Creek near E5	71.9	70	10	300-1,000
Spring Creek near E6	23.7	20	5	500-1,000
Harpeth River between E8 and F8	55.8	25	6	1,000-1,500
Overall Creek near E10	3.9	30	5	100-300
Armstrong Branch near F10	6.0	15	3-1	200-500

Note: Drainage areas were measured from U.S.G.S. topographic maps, or taken from TVA 1988. Channel widths and depths were estimated on site visit. Floodplain widths were measured from maps FEMA 1978, 1979, 1980, and 1981.

With maximum development of the damsite, the flood control backwater for the project could extend upstream to the U.S. Route 31A bridge near College Grove.

B. Surface Water Quality

The Tennessee Stream Use Classification, Rule 1200-4-4 of 1987, defines the water use classification for all surface waters in the state. Specific water quality criteria for each of the seven possible uses are detailed in Rule 12-4-3, General Water Quality Criteria. According to the stream classification rule, the Duck River tributaries draining the project location are all classified for the same four uses: 1) fishing and aquatic life, 2) recreation, 3) irrigation, and 4) livestock and wildlife watering. The Harpeth River is classified for the same four uses and, in addition, 5) domestic, and 6) industrial water supply. The West Fork Stones River is classified for all six uses upstream from Murfreesboro but in Murfreesboro and downstream, it is not classified for domestic water supply and/or recreation in various places. Overall Creek in the Stones River Basin is classified for the same four uses as the Duck River tributaries.

Available water quality data include very little information on the Duck River tributaries (Baker 1988). Some data on the mainstream of the Duck nearest to the SSC tributaries are included in Table 5.6.2-3. They indicate generally good water quality, although standards for fecal coliform were consistently exceeded. The Harpeth River has little water quality data in spite of its size and presence of the city of Franklin. Until 1975, when a new sewage treatment plant went into service in Franklin, the Harpeth River downstream was polluted, but upstream had good water quality. Since 1975, upstream and downstream waters of the Harpeth have good quality (Baker 1988). Some dissolved oxygen problems have been noted in the Harpeth River during low flow conditions, exacerbated by the sewage treatment plant discharge, although the effluent is within its permitted levels (Baker 1988).

The West Fork Stones River primarily drains rural, agricultural land within the proposed SSC ring but flows downstream through Murfreesboro, where it receives a large STP discharge. Water quality data for stations on the West Fork Stones River are also included in Table 5.6.2-3. Generally, waters in all three of these basins exhibit good water quality, although the intermittent nature of the flow has limited macroinvertebrate populations and eutrophic conditions can occur during periods of summer low flow (Baker 1988).

Suspended sediment sampling of central Tennessee streams suggests a general average of less than 800 ton/mi^2/yr (Trimble and Carey 1984). Estimated soil erosion on agricultural fields in Bedford and Marshall counties indicates that more than 80% of the acreage in active farming produces greater than 3,200 ton/mi^2/yr (TVA 1988). However, because active farming accounts for less than half of the land area within the proposed SSC ring, and this is erosion, not sediment yield, actual sediment yield should be closer to the 800-ton value.

Table 5.6.2-3

SURFACE WATER QUALITY DATA IN PROJECT VICINITY

Parameter	Unit	Standard	Maximum	Minimum	Average
Stream: Duck River at Halls Mill Bridge STORET Station No.: 4752562 Period of record: 1967-1984					
Fecal Coliform	#/100 ml	<200	12,300	10	1,137.7
pH		6.5-8.5	7.8	6.5	7.39
Temperature	°C	<30.5	26.3	2.1	17.92
Dissolved Oxygen	mg/l	>5.0	16.55	5.9	8.5533
Dissolved Solids	mg/l	<500	140	120	125
Turbidity	FTU	-	-	-	-
Chloride	mg/l	-	-	-	-
Sulfate	mg/l	-	-	-	-
Nitrate (N)	mg/l	-	1.00	0.40	0.69118
Lead	µg/l	<50	-	-	-
Mercury	µg/l	<0.2	-	-	-
Stream: Columbia Dam Headwaters Duck River Basin STORET Station No.: 001036 Period of record: 1971-1974					
Fecal Coliform	#/100 ml	<200	750	90	450
pH		6.5-8.5			
Temperature	°C	<30.5	7.8	6.8	7.37
Dissolved Oxygen	mg/l	>5.0	13.2	6.3	9.03
Dissolved Solids	mg/l	215<500	104	148.9	
Turbidity	FTU	-	-	-	-
Chloride	mg/l	-	-	-	-
Sulfate	mg/l	-	9	0	5.4
Nitrate (N)	mg/l	-	0.8	0.52	0.67
Lead	µg/l	<50	-	-	-
Mercury	µg/l	<0.2	-	-	-

Table 5.6.2-3 (Cont)

SURFACE WATER QUALITY DATA IN PROJECT VICINITY

Parameter	Unit	Standard	Maximum	Minimum	Average
Stream: West Fork Stones River at Barfield, Tennessee STORET Station No. 034278 Period of record: 1967					
Fecal Coliform	#/100 ml	<200	-	-	-
pH		6.5-8.5			8[1]
Temperature	°C	<30.5			17[1]
Dissolved Oxygen	mg/l	>5.0	-	-	-
Dissolved Solids	mg/l	<500	-	-	-
Turbidity	FTU	-	-	-	-
Chloride	mg/l	-	-	-	-
Sulfate	mg/l	-			13[1]
Nitrate (N)	mg/l	-	-	-	-
Lead	µg/l	<50	-	-	-
Mercury	µg/l	<0.2	-	-	-
Stream: Overall Creek at Ford, near Salem, Tennessee STORET Station No.: 034283 Period of record: 1975					
Fecal Coliform	#/100 ml	<200			260[1]
pH		6.5-8.5	-	-	9[1]
Temperature	°C	<30.5	-	-	-
Dissolved Oxygen	mg/l	>5.0	-	-	-
Dissolved Solids	mg/l	<500	-	-	-
Turbidity	FTU	-	-	-	-
Chloride	mg/l	-	-	-	-
Sulfate	mg/l	-	-	-	-
Nitrate (N)	mg/l	-	-	-	-
Lead	µg/l	<50	-	-	-
Mercury	µg/l	<0.2	-	-	-

Note: 1. Values based on a single sample.
Source: Baker 1988.

C. Surface Water Use

Six municipal water districts serve population centers around the SSC location. Two of these systems rely entirely on groundwater, three on ground and surface water, and only one uses surface water exclusively. Only Smyrna, which uses water from the J. Percy Priest Reservoir relies exclusively on surface water. The Murfreesboro, Franklin, and Nolensville systems use surface water supplemented with groundwater (Alexander et al. 1984). Approximate water use amounts are given in Table 5.6.2-4.

Table 5.6.2-4

SURFACE WATER USE IN PROJECT VICINITY

Source	Use	Quantity Current acre-ft	Quantity Projected acre-ft
STONES RIVER			
Bedford County			
Bedford County U.D. (Duck River)	Municipal System	560	-
Marshall County			
Lewisburg (Duck River)	Municipal System	3,360	-
Rutherford County			
Consolidated U.D. (Percy Priest Reservoir)	Municipal System	3,248	-
Murfreeboro (East Fork Stones River)	Municipal System	7,168	-
Smyrna (Percy Priest Reservoir)	Municipal System	3,808	-
Williamson County			
Franklin (Harpeth River)	Municipal System	2,352	-

Source: Tennessee Department of Health and Environment 1988.

The system in Murfreesboro uses water from the East Fork Stones River as its primary source. However, the safe yield from the river is not adequate to meet the average expected use of water, even with impoundment storage. Thus, groundwater is used to supplement the supply. The same situation exists with the Franklin system. Harpeth River water is not adequate to meet the total demand, so groundwater is also used. The Nolensville Utility District uses groundwater as its primary water source, but supplements this with surface water from Nashville (Alexander et al. 1984).

For the upper Duck River Basin, of which the SSC site is only a small part, 74% of water use comes from municipal supply systems. Municipal system water use is divided among domestic residential use (41%), industry use (34%), and commercial use (14%). Eleven percent of the water in municipal systems is lost or used but not measured (Burchett 1977). Less recent data on the Stones River Basin indicated that surface water is used in municipal supply, industry, irrigation, and stock watering. On an annual basis, municipal and industrial use accounts for 78%, irrigation 13%, and stock watering 4% (Burchett and Moore 1971).

5.6.2.2 Groundwater Hydrology, Quality, and Use

A. Groundwater Hydrology

The principal water-bearing sediments in the SSC area in Tennessee are the carbonate formations, consisting of limestone, dolomite, and some shale that overlie these formations. Unconsolidated soil layers that overlay these formations are generally less than 20 ft in thickness, are clay-rich, and do not yield water to wells. Solution openings, formed in the limestone by circulating water, occur from near surface to about 300 ft below land surface. These solution openings are the source of water to all wells in the area. Groundwater moving through solution openings also feeds surface streams in the area during periods of little or no rainfall (Burchett 1977). The thin soil cover and solution openings in the bedrock result in a situation where shallow groundwater may be easily contaminated by surface sources.

Total thickness of the limestone formations in the area is about 5,000 ft. Vertical joints crisscross the formations and water moving through these joints dissolves and erodes the rock. This widens and enlarges the openings creating solution cavities. In general, solution openings are largest in the more massively bedded formations, but more numerous in the thinly bedded formations (Rima et al. 1977). Solution of the rocks decreases with depth and most wells in the area are drilled just deep enough to obtain adequate water for domestic use. Most solution cavities are shallower than 100 ft and only a few cavities occur below a depth of 300 ft (Burchett and Moore 1971).

Rainfall not returned to the atmosphere by evaporation and transpiration migrates downward to recharge the groundwater system. It is estimated that nearly 60% of the rainfall is lost to evaporation and transpiration. The remaining 40% is added to the groundwater system as recharge and is discharged as outflow, maintaining the base flow of surface streams (Rima et al. 1977). There are no data available on the amount of groundwater recharge that occurs in the region surrounding the SSC site.

Seasonal water level fluctuations may be caused by seasonal differences in withdrawals as well as changes in the water level in the recharge area. Generally, the deeper the water zone and the greater the distance from the recharge area, the smaller the natural fluctuation of the

groundwater level (Newcome 1958). Groundwater in the area is under both confined and unconfined conditions in the solution channels in the limestone. The degree of confinement increases locally with depth. Reported water levels in wells in the area range from less than 2 ft to slightly more than 68 ft (Newcome 1958; Rima et al. 1977).

The principal water-bearing formations of the Ordovician carbonates in the SSC project area are the Carters, Lebanon, Ridley, and Murfreesboro limestones. In some areas of Tennessee, the Knox group, a Mascot dolomite member, is considered to be a water-bearing formation. In general, the more massive, thick-bedded units are water bearing and the thin-bedded units do not yield water to wells. Table 5.6.2-5 is a summary of the hydrogeologic units in the project area in Tennessee. A brief description of each unit follows.

The Hermitage formation ranges in thickness from 60 ft in the south to about 100 ft in the north and is thinly laminated with shaly partings, particularly in the lower part. This shaly nature of the formation makes it a poor water bearer. It also forms an effective seal, restricting the downward seepage of water into the underlying formations. Occasionally, water is encountered in the top of the formation and wells completed in this zone generally do not yield more than 5 gal/min (Newcome 1958).

The Carter limestone that unconformably underlies the Hermitage formation in the project area, is about 65 ft thick and consists mostly of massively bedded limestone. The thick bedding makes possible better development of solution channels where water has access to the formation (Moore et al. 1969). The overlying Hermitage formation restricts vertical seepage of water into Carters limestone, therefore, recharge occurs only at the outcrop areas around the edges of the basin. Wells completed in the solution cavities of Carters limestone generally yield less than 5 gal/min (Brahana and Bradley 1986). Reported hydraulic conductivity ranges from $2x10^{-4}$ to $1x10^{-3}$ cm/s (Geotrans, Inc. 1988).

The Lebanon limestone is approximately 115 ft thick in the area and generally forms a border around the more widely exposed underlying Ridley limestone. Yield of wells tapping this formation is quite variable, ranging from less than 1 to as much as 25 gal/min. However, average well yields are usually less than 5 gal/min (Brahana and Bradley 1986). Hydraulic conductivity ranges from $3.5x10^{-8}$ to $7x10^{-6}$ cm/s (Geotrans, Inc. 1988).

Underlying the Lebanon limestone is the Ridley limestone, a massive bedded fine- to medium-grained limestone. The Ridley limestone has the greatest amount of surface exposure of all the limestone formations in the area and is generally about 105 ft thick (Adams et al. 1986). The Ridley limestone is considered to be the most reliable water-bearing formation above the Knox group (Newcome 1958). The large areas of exposure and chemical purity of the rock present favorable conditions for development of solution channels. Well yields as high as 100 gal/min have been obtained in the Ridley limestone (Brahana and Bradley 1986).

Table 5.6.2-5

SUMMARY DESCRIPTION OF HYDROGEOLOGIC UNITS IN VICINITY OF SSC SITE, TENNESSEE

Hydrogeologic Unit	Approximate Thickness ft	Physical Description	Hydraulic Properties	Water-Bearing Characteristics
Hermitage formation	60-100	Limestone, shaly, sandy, thinly bedded	No Data	Confining unit but locally an aquifer can yield 5 gal/min where solution openings occur
Carters limestone	65	Limestone with thin bentonite beds	Specific capacity = 5.4 gal/min/ft of drawdown $K=2x10^{-4}$ to $1x10^{-3}$ cm/s	Local aquifer generally yields less than 5 gal/min
Lebanon limestone	115	Limestone thin-bedded with shaly partings	$K=3.5x10^{-8}$ to $7x10^{-6}$ cm/s	Local aquifer yields range from 0 to 25 gal/min
Ridley limestone	105	Limestone-massive beds, fine- to medium-grained; shale in middle unit	Specific capacity = 0.67 to 1.2 gal/min/ft of drawdown $K=1.8x10^{-8}$ to $2.5x10^{-3}$ cm/s	Large solution openings yield 100 gal/min
Pierce limestone	25	Limestone-thin bedded, shaly	$K=3.5x10^{-9}$ to $7x10^{-4}$ cm/s	Relatively insoluble yields little or no water to wells
Murfreesboro limestone	420	Massive, dense, limestone	Specific capacity = 1.7 to 3.5 gal/min/ft of drawdown $K=3.5x10^{-9}$ to $7x10^{-4}$ cm/s	In out crop area, large solution openings can yield 100 gal/min. At depth, commonly doesn't yield water to wells
Pond Spring formation (Wells Creek dolomite)	0-75	Limestone, silty dolomite; shale, and conglomerate zones	$K=3.5x10^{-9}$ to $3.5x10^{-5}$ cm/s	Does not yield water to wells. Confining unit
Knox group (mascot dolomite)	5,000±	Dolomite and dense limestone with chert	Specific capacity = 0.01 gal/min/ft of drawdown	Yield of wells is small and generally does not exceed 10 gal/min

Note: K = Hydraulic Conductivity.

Sources: Brahana and Bradley 1986; Rima et al. 1977; Zurawski and Burchett 1980; Adams et al. 1986; Newcome and Smith 1962; Geotrans, Inc. 1988.

Hydraulic conductivity ranges from $1.8x10^{-8}$ to $2.5x10^{-3}$ cm/s (Geotrans, Inc. 1988).

Underlying the Ridley limestone is the Pierce limestone, a thin, silty limestone that is generally only 25 ft thick (Moore et al. 1969). Its area of outcrop is very small and is usually restricted to a thin border around the outcrop of the underlying Murfreesboro limestone. The Pierce Limestone is a very poor source of water, yielding little or no water to wells (Newcome 1958). Hydraulic conductivity ranges from $3.5x10^{-9}$ to $7x10^{-4}$ cm/s (Geotrans, Inc. 1988).

Although the Murfreesboro limestone is 420 ft thick and contains many thick, easily dissolved beds, it is in most places a poor source of water. This is probably because the formation is covered nearly everywhere by 100 to 600 ft of younger rocks (Newcome 1958). In the outcrop areas, the Murfreesboro limestone contains large solution openings and yields as much as 100 gal/min to wells (Brahana and Bradley 1986). Hydraulic conductivity ranges from $3.5x10^{-9}$ to $7x10^{-4}$ cm/s (Geotrans, Inc. 1988).

Underlying the Murfreesboro limestone is the Wells Creek dolomite (Pond Spring formation). The formation consists of up to 75 ft of silty dolomite and dolomitic limestone (Adams et al. 1986). Few wells have been completed in this formation (Newcome and Smith 1962). Hydraulic conductivity ranges from $3.5x10^{-9}$ to $3.5x10^{-5}$ cm/s (Geotrans, Inc. 1988).

Underlying the Wells Creek dolomite is the Mascot dolomite of the Knox group. The unit consists of dolomite and some discontinuous beds of limestone with chert up to 5,000 ft thick. The yield of wells in the Knox dolomite is small and generally does not exceed 10 gal/min. The water levels of wells completed in this confined aquifer are reported to have ranged from 12 ft to 190 ft below land surface (Newcome and Smith 1962).

There are numerous springs in the area and nearly all that are used as supply sources emanate from the Ridley lLimestone. Most of them are contact springs, issuing from horizontal bedding plane openings immediately above shaly zones that occur near and at the base of Ridley limestone. The largest spring in the area is Military Spring located approximately 4 mi west of Murfreesboro. The measured discharge from this spring in late 1975 was 34.3 ft^3/s (Rima et al. 1977).

B. Groundwater Quality

The chemical quality of groundwater in the area reflects the type of rock formations that have been in contact with the water. With an increase in depth and in distance from the recharge area, there is generally an increase in dissolved mineral content in the water. Pyrite, a compound of iron and sulfur, is a common mineral in the rock units of this area. Its solution results in water containing hydrogen sulfide called "sulfur water." Sodium chloride is also sometimes found in undesirable amounts (Adams et al. 1986). The chemical quality of the

Table 5.6.2-6

RANGE OF GROUNDWATER QUALITY IN BEDFORD, MARSHALL, RUTHERFORD, AND WILLIAMSON COUNTIES, TENNESSEE

	Range of Chemical Constituents mg/l				
Source	Total Dissolved Solids	Chloride	Sulfate	Iron	Hardness* $CaCo_3$
National drinking water standards	500	250	250	0.3	
Hermitage	192	5.5	72 (mean)-700	0.25 (mean)-9	30-490
Carters	209-1,156	--	4-840	0-1.2	30-950
Lebanon	190-11,900	2-18	2-880	0.1-0.3	30-2,500
Ridley	263-1,640	5.4-64	17-823	0.04-2.7	200-1,000
Murfreesboro	236-1,240	3-51	3-70	0.1-2.3	219-244
Knox	270-3,002	3-1,248	12-1,500	0.02-2.2	110-1,557

*Typical classifications of water hardness = 0 to 60 mg/l = soft to slightly hars; 60 to 120 mg/l = moderately hard; 120 to 180 mg/l = hard; > 180 mg/l = very hard.

Sources: Adams et al. 1986; Brahana and Bradley 1986; Driscoll 1986; Newcome 1958; Newcome and Smith 1962; Rima et al. 1977; Environmental Protection Agency 1977.

various water-bearing units in the four county area that is within the SSC area (Bedford, Marshall, Rutherford, and Williamson counties) is summarized in Table 5.6.2-6.

A wide range of water quality conditions occurs in the area because of the highly anisotropic nature of the aquifer system. Calcium-magnesium bicarbonate water predominates. Reported total dissolved solids ranges from a low of 190 mg/l in Lebanon limestone to a high of 11,900 mg/l, also in Lebanon limestone. The water from nearly 50% of the wells in the area contains more than the recommended maximum level of total dissolved solids for drinking water in Tennessee (Newcome 1958).

Water from the Hermitage formation is generally of good quality; however, some wells have reported hydrogen sulfide. Water from Carters and Lebanon limestones is similar. Water is generally of good quality but is very hard and about 25% of wells in these formations have reported hydrogen sulfide. Saline water has been reported in about 5% of the wells in Lebanon limestone (Newcome 1958).

Water from Ridley limestone is usually potable but may have a detectable odor of hydrogen sulfide in about one-third of the wells. Quality of water from Murfreesboro limestone is usually of good quality also. Localized areas of highly mineralized water have been reported in the Central Basin from wells in Murfreesboro limestone (Newcome 1958).

Water from Knox dolomite generally is higher in total dissolved solids than the recommended limit and is considered very hard. Within the Central Basin, the quality of water from Knox dolomite is generally reported to be best in Williamson and Marshall counties. Iron concentrations were reported to be less than 0.3 mg/l in about 75% of samples. Chloride exceeds 250 mg/l in water from about 30% of the wells completed in Knox dolomite. Sulfate exceeds 250 mg/l in about 40% of the wells (Newcome and Smith 1962).

C. Groundwater Use

Groundwater in the area is used principally for domestic supplies. Most homeowners outside of city limits have private wells to supply water needs. The majority of municipal, industrial, agricultural, and stock watering needs are supplied by surface water sources in the SSC project area. Table 5.6.2-7 is a summary of groundwater use for 1985 in the area surrounding the SSC project in Tennessee. No large self-supplied commercial or industrial water users are located in the area (Alexander et al. 1984).

In the four county area surrounding the SSC site, groundwater makes up less than 30% of the total water used (Tennessee Department of Health and Environment 1988). Although there are no specific data on the amount of groundwater that is recoverable in the project area, it has been estimated that for the entire Tennessee region, less than 1% of the estimated groundwater recharge is withdrawn for use (Zurawski 1978).

Table 5.6.2-7

1985 GROUNDWATER USE IN BEDFORD, MARSHALL, RUTHERFORD AND WILLIAMSON COUNTIES, TENNESSEE (acre-feet)

County	Public Supplies	Rural Domestic/ Non-Irrigation Agricultural	Industrial Self Supplied	Total
Bedford	515	885	101	1,501
Marshall	90	638	-	728
Rutherford	650	2,083	11	2,744
Williamson	1,154	1,871	0	3,025

*1987 Water Use
Source: Tennessee Department of Health and Environment 1988.

5.6.3 Climate and Meteorology

5.6.3.1 General Description

The climate of the Tennessee SSC site is characterized by warm, humid summers and mild winters. Topography and elevation play major roles in determining local temperature and precipitation conditions (National Oceanic and Atmospheric Administration 1974).

5.6.3.2 Temperature

Temperatures in the region vary from an average low of 31°F in January to an average high of 91°F in July. The extreme high temperature recorded was 107°F in July; the extreme low recorded was -15°F in January. The temperature drops below freezing on the average 74 days per year. Frost penetration reaches an average of 4 inches and an extreme of 13 inches in depth (U.S. Weather Bureau 1941). Frost penetration is, however, expected to be confined to upland areas, and is not generally experienced in the valleys. Normal and extreme temperature and heating degree-day data are shown in Table 5.6.3-1.

5.6.3.3 Precipitation

The principal source of moist air for precipitation is the Gulf of Mexico. Greatest precipitation generally occurs in the winter and early spring because of more frequent large-scale storms passing over and near the state. A secondary precipitation peak in July occurs because of shower and thunderstorm activity (National Oceanic and Atmospheric Administration 1974).

The middle Tennessee climatic region receives an average of 50.60 inches of precipitation per year. The peak month for precipitation is January, with an average of 6.19 inches. The month with the least precipitation is October, with 2.57 inches on average. The region receives an average of 7.0 inches of snow per year. Snow cover rarely persists for more than a few days because of the mild winter temperatures (National Oceanic and Atmospheric Administration 1974). Mean precipitation and snowfall data are shown in Table 5.6.3-2. In addition, 1-, 2-, 5-, 10-, 25-, 50-, and 100-year return periods and extreme rainfall data are shown in Table 5.6.3-3.

Table 5.6.3-1

NORMAL AND EXTREME TEMPERATURE DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Maximum Temperature, °F	49	51	59	71	80	88	91	90	85	74	59	50
Average Minimum Temperature, °F	31	33	39	48	57	66	70	68	61	49	38	32
Highest	78	84	89	90	96	106	107	105	105	94	85	76
Lowest	-15	-13	3	25	34	42	51	47	36	26	-1	-7
Heating in degree, days	780	640	510	190	40	0	0	0	30	160	500	730

Source: U.S. Environmental Science Services Administration 1968.

Table 5.6.3-2

MEAN PRECIPITATION AND SNOWFALL DATA
FOR THE MIDDLE TENNESSEE CLIMATIC REGION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly precipitation, inches	6.19	5.03	5.71	4.17	3.95	3.61	4.26	3.49	3.06	2.57	2.91	4.65
Mean monthly snowfall, inches	2.5	2.5	1.3	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.5	1.0

Source: U.S. Environmental Science Services Administration 1968.

Table 5.6.3-3

MAXIMUM 1-HOUR AND 6-HOUR RAINFALL
BY RETURN PERIOD

Return Period Years	Rainfall (Inches) 1-Hour	6-Hour
1	1.3	2.2
2	1.5	2.5
5	1.9	3.2
10	2.2	3.7
25	2.5	4.1
50	2.75	4.7
100	3.0	5.0

Source: U.S. Weather Bureau 1961.

5.6.3.4 Wind

The prevailing wind direction is toward the north at an annual average speed of 8.0 mi/hr. The winds are strongest in March, averaging 10.0 mi/hr, and weakest in June, July, August, and September, averaging 6.0 mi/hr. The fastest recorded wind speed was 73 mi/hr, which occurred in June. Average wind speed and direction data are shown, by month, in Table 5.6.3-4.

5.6.3.5 Humidity

The relative humidity remains fairly constant on an annual basis and averages 70%. The mean relative humidity peaks in August at an average of 75%, and reaches its lowest value in April, at an average of 65%. Mean and maximum dewpoint and mean relative humidity data are shown in Table 5.6.3-5.

5.6.3.6 Severe Weather

Severe weather can be best characterized as tornadoes, extreme winds, thunderstorms, ice storms, and hail.

Tornadoes are relatively rare. The yearly probability of a point being struck by a tornado is approximately 4.35×10^{-4}, which corresponds to a return period of 2,300 years (Thom 1963). For the period of record 1950-1986, 272 tornadoes were observed within a 50-nautical mile radius of Murfreesboro. These events caused 22 deaths and 599 injuries (National Severe Storms Forecast Center 1988).

Table 5.6.3-4

MONTHLY AVERAGE WIND SPEED AND DIRECTION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average wind speed, mi/h	9.0	9.0	10.0	9.0	7.0	6.0	6.0	6.0	6.0	8.0	8.0	8.0
Wind blowing towards	N	N	N	N	N	N	N	N	N	N	N	N

Source: U.S. Environmental Science Services Administration 1968.

Table 5.6.3-5

DEWPOINT AND RELATIVE HUMIDITY DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean dewpoint temperature, °F	32	33	37	47	57	65	68	67	60	49	38	32
Maximum 12-hour 1,000 mbar dewpoint, °F	64	63	66	70	74	77	78	78	76	73	69	64
Mean relative humidity, %	75	75	70	65	70	70	70	75	70	70	70	75

Source: U.S. Environmental Science Services Administration 1968.

Extreme expected winds are shown in Table 5.6.3-6 by maximum wind speed and return period.

Table 5.6.3-6

EXTREME WIND SPEED AND RETURN PERIOD DATA

Return Period Yr	Wind Speed* mi/h
10	61
25	70
50	71
100	85

*Maximum wind speed
Source: Thom 1968.

Thunderstorms occur in the region an average of 77 times per year, with peak activity in April, May, June, July, and August (National Climatic Center 1981). Hail greater than 0.75 inches in diameter is observed, on the average, 1.7 times per year (U.S. Weather Bureau 1969).

Ice storms and blizzards are rare in Tennessee. The state is located south of the center of most blizzard activity. Damaging glazestorms generally occur once every 5 or 6 years (National Oceanic and Atmospheric Administration 1974).

5.6.4 Air Quality

5.6.4.1 Conditions Affecting Air Quality

A. Topographical

This is a rural site characterized by gently rolling terrain and numerous tree-covered hills (knobs) that reach several hundred feet in elevation above their base. These knobs have gentle enough rises that for most meteorological conditions, major wind direction and dispersion changes are not expected.

B. Meteorological

The ability of the atmosphere to disperse pollutants is categorized by stability classification. The stability classification was described in detail in Appendix 5, Section 5.1.4. The site's relative frequency of occurrence of the six stability classes is shown in Table 5.6.4-1. Class A has the highest degree of dispersion.

Table 5.6.4-1

FREQUENCY OF OCCURRENCE OF ATMOSPHERIC STABILITY CLASSES

Class	Definition	% of Occurrence
A	Extremely unstable	1
B	Unstable	8
C	Slightly unstable	12
D	Neutral	45
E	Slightly stable	13
F	Stable plus extremely stable	21

Source: National Climatic Data Center 1/82-12/86.

G. C. Holzworth's number of "forecast days" of high pollution potential for this site is between 20 and 30, indicating fair dispersion conditions (Holzworth 1972). Holzworth's methodology was described in greater detail in Appendix 5 Section 5.1.4. The influence of winds on dispersion conditions on an annual basis is shown in Table 5.6.4-2. The table is an annual summary of the frequency of wind speed and direction at the Nashville first-order National Weather Service Station (National Climatic Data Center (NCDC) 1988).

Table 5.6.4-2

ANNUAL FREQUENCY OF WIND SPEED AND DIRECTION TENNESSEE SSC SITE

	Speed-knots						
Direction	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	Greater than 21	Total
N	.012179	.031583	.033706	.014912	.000891	.000046	.093316
NNE	.009738	.023476	.017082	.004453	.000137	.000000	.054886
NE	.010989	.025394	.016282	.002946	.000000	.000023	.055634
ENE	.009496	.015757	.006897	.001530	.000023	.000000	.033702
E	.011716	.020484	.006828	.001185	.000000	.000000	.040193
ESE	.011728	.018292	.005435	.000571	.000069	.000000	.036094
SE	.009688	.016807	.009272	.002855	.000343	.000069	.039032
SSE	.010373	.022334	.020142	.008130	.000913	.000183	.062074
S	.027191	.075520	.065129	.033387	.005937	.001096	.208259
SSW	.009644	.021009	.022311	.014661	.002672	.000571	.070868
SW	.006886	.016693	.016670	.011007	.001507	.000365	.053130
WSW	.006183	.014684	.014158	.008016	.001119	.000023	.044182
W	.007254	.017036	.019251	.011784	.001096	.000160	.056580
WNW	.003725	.008952	.014478	.010459	.001576	.000091	.039281
NW	.005601	.016077	.019342	.014752	.001621	.000206	.057599
NNW	.005705	.015643	.018566	.013154	.001941	.000160	.055169
Total	.158095	.359740	.305549	.153779	.019845	.002992	

Source: National Climatic Data Center 1/82-12/86

5.6.4.2 Air Quality

A. Applicable Standards

The National Ambient Air Quality Standards (NAAQS) (40 CFR 50) function as the applicable regulatory levels in the state of Tennessee. The primary standards are shown in Table 5.6.4-3.

B. Background Concentrations

A portfolio of values was assembled to quantify ambient air pollutant concentrations. The values shown, for averaging periods shorter than 1 year, are the highest measured in the region. These values are delineated, along with the applicable standards for each pollutant, in Table 5.6.4-3. Selected ambient air monitoring stations are plotted in Figure 5.6.4-1.

C. Compliance Status

The region is in attainment for all pollutants with the exception of ozone (O_3). Of the counties in the region of influence of the proposed SSC site, Davidson, Rutherford, Summer, Williamson, and Wilson counties are in nonattainment status for ozone. Parts of Davidson County are also in violation of the secondary standards for total suspended particulates and carbon monoxide (EPA 1986).

D. Proximity to Sensitive Areas

The proposed Tennessee SSC site, located in a Prevention of Significant Air Quality Deterioration (PSD) Class II area, allows for moderate growth in air pollutant emissions. The closest PSD Class I area that permits minimal air quality deterioration is Sipsey Wilderness, approximately 75 mi north of the site.

5.6.4.3 Regional Air Pollution Sources

Air pollution sources in the site vicinity include three universities, a tire manufacturing plant, a car assembly plant, and assorted industrial sources. Permitted or actual emissions for these sources are shown in Table 5.6.4-4. These sources are plotted on Figure 5.6.4-1.

Table 5.6.4-4

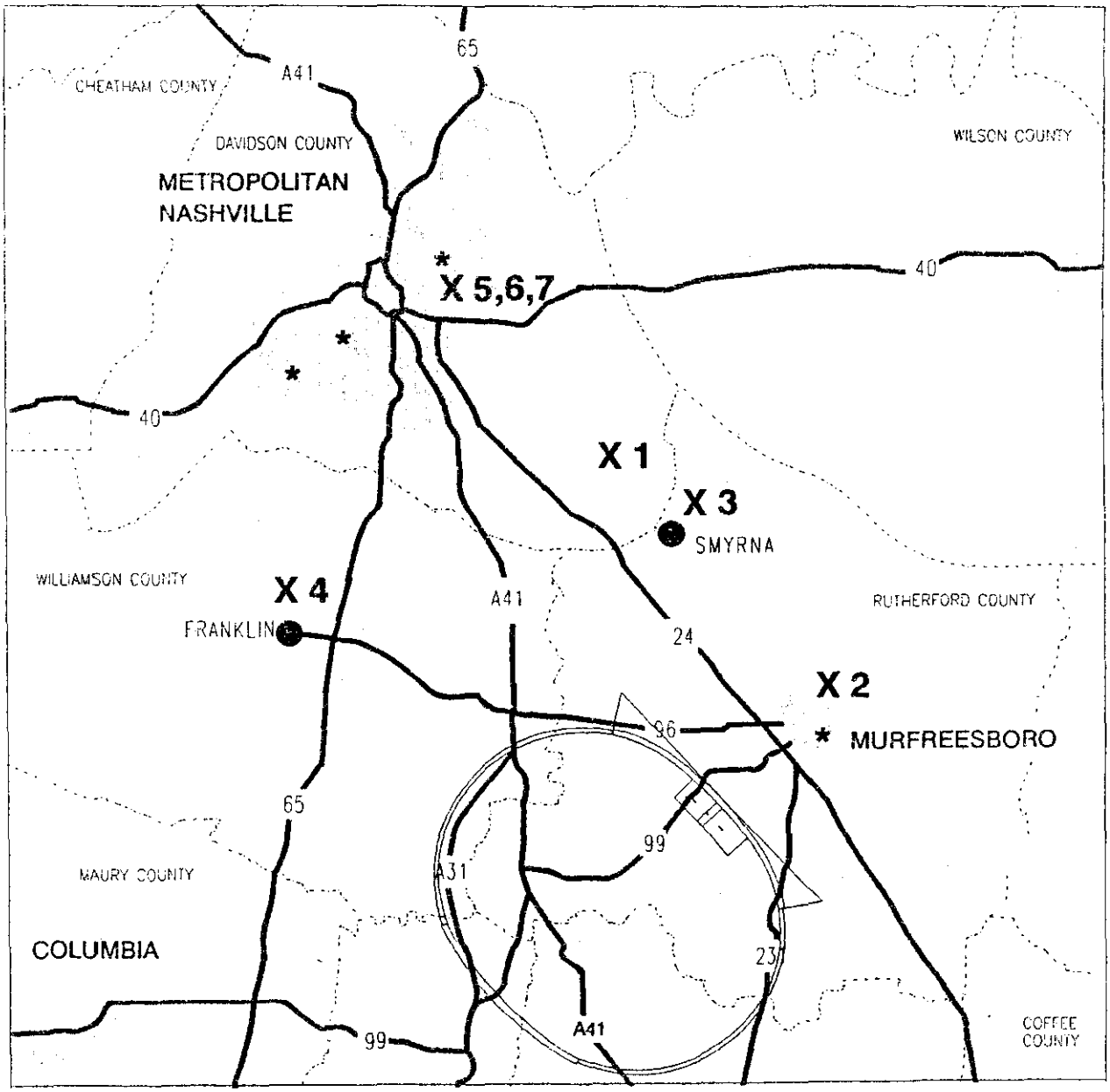
REGIONAL AIR POLLUTANT SOURCES
TENNESSEE SSC SITE

Source Name	Location	Permitted or Actual Emissions (tons/yr)				
		SO_2	TSP	NOx	CO	VOC
Bridgestone Tire	LaVergne	4,993	689	170	15	760
Middle Tennessee University	Murfreesboro	3,317	218	158	15	1
Nissan Motors	Smyrna	2,350	210	520	112	3,872
CPS Industries	Franklin	13	14	13	12	1,215
Vanderbilt	Nashville	1,579	47	85.5	66.6	<1
Nashville Thermal Transfer Corp.	Nashville	415	49	366	45	195
Tennessee State University	Nashville	384	12	28	9	<1

Source: Tennessee Department of Health and Environment, Air Pollution Control Division, 1988

Figure 5.6.4-1

AMBIENT AIR QUALITY MONITORING STATIONS AND
REGIONAL AIR POLLUTION SOURCES
TENNESSEE SSC SITE



X = Air Pollutant Sources

* = Ambient Air Quality Monitoring Station

5.6.5 Noise and Vibration

This section describes background and sources for noise and vibration at the proposed Tennessee SSC site.

5.6.5.1 Ambient Noise Levels

A. Applicable Standards

Applicable noise abatement criteria have been promulgated by the Federal Highway Administration (FHWA) and Department of Housing and Urban Development (HUD). FHWA and HUD noise abatement criteria are discussed in Section 5.1.5. Other than a public nuisance statute, the State of Tennessee has not delineated separate noise abatement criteria.

B. Background Levels

SSC site background noise levels are typical of areas under agricultural use. Measured background levels away from significant noise sources are expected to range from 35 to 45 dBA. The day-night average sound level (L_{dn}) is expected to average 40 dBA (EPA 1982).

C. Proximity to Sensitive Areas

Sensitive receptors in the project locale include a nursing home, a residential care home, residences, horse stables, dairy barns, schools, cemeteries, churches, a plant nursery, and the Recreational Camp for the Deaf. The nursing home is located 2.9 mi from the collider ring, and the residential care home is located 1.8 mi from the ring. Within 1 mi of collider ring surface facilities, there are approximately 1,400 residences, 23 churches, 4 schools, 32 cemeteries, 14 chicken barns, 7 horse stables, and 11 dairy barns. The Residential Camp for the Deaf and the plant nursery are also located within 1 mi of collider ring surface facilities. Sensitive receptors in the project vicinity are shown in Figure 5.6.5-1.

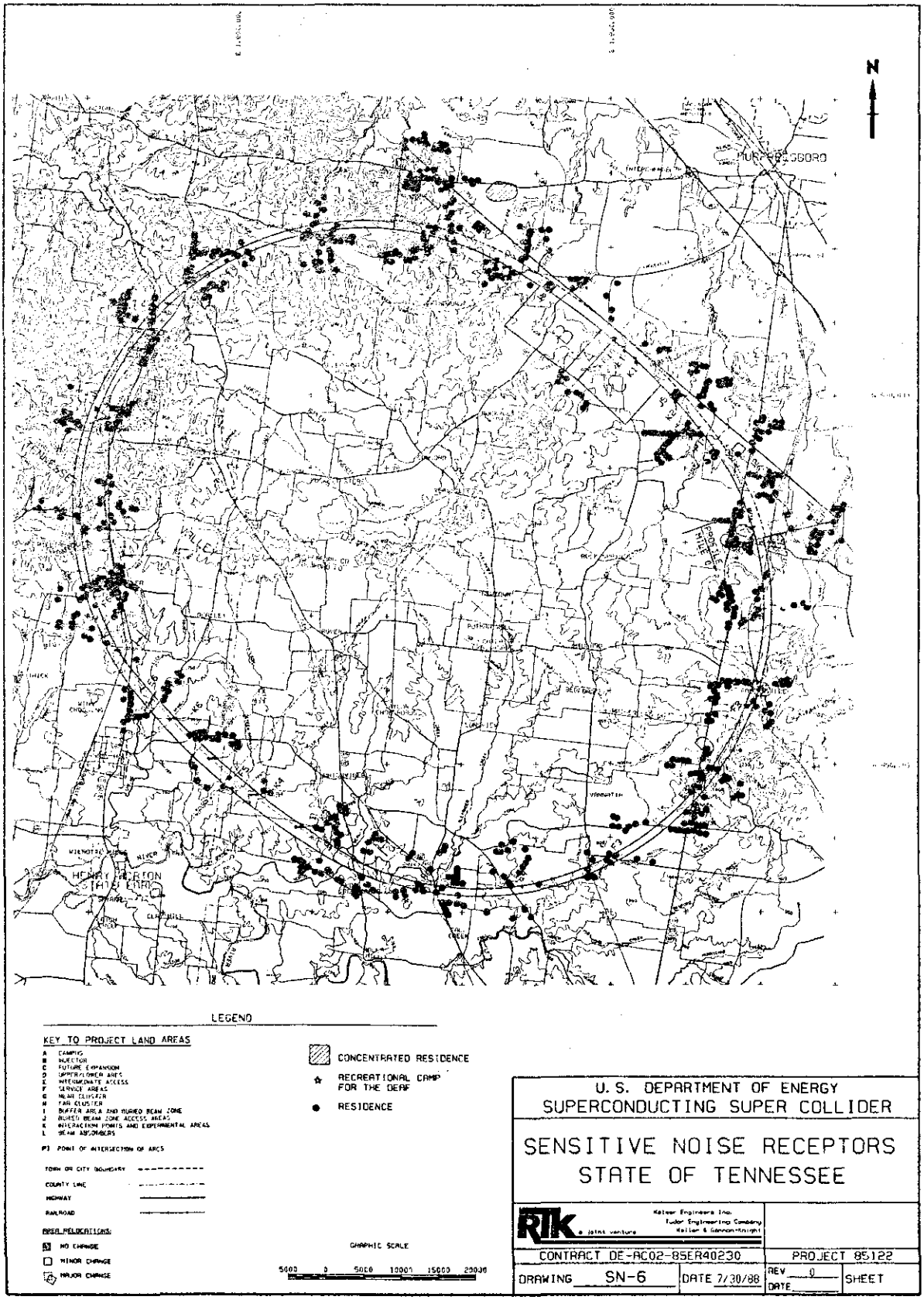
5.6.5.2 Other Noise Sources

Major sources of noise in the region include railroads, a quarry, vehicle traffic, and an automobile speedway. The Louisville and Nashville Rail line crosses the ring in four places, and would be expected to produce noise levels at the edge of the railroad right-of-way in the range of 80-90 dBA. The Rutherford County rock quarry produces noise primarily during the summer months. This is caused by twice-weekly blasting and rock extraction activities.

Primary roads in the area include U.S. routes 31A, 41A, and 231. Measured noise levels at the right-of-way line would be expected to be in the range of 75-85 dBA. Duck River automobile speedway, 3.9 mi from the collider ring, operates on Saturday nights from April through October.

Figure 5.6.5-1

SENSITIVE NOISE RECEPTORS
TENNESSEE SSC SITE



5.6.5.3 Ambient Vibration Levels

Ambient vibration levels are highly dependent on proximity to man-made sources. Naturally occurring vibrations that result from weather phenomena exciting vibrations that travel long distances in the earth, are low frequency (1 Hz or less). Large, distant earthquakes will also produce vibrations at the site.

5.6.5.4 Other Vibration Sources

Major man-made vibration sources include railroads, highways, and quarries. The collider ring is crossed in four places by the Louisville and Nashville Rail line. None of these crossings are within 3,000 ft of an interaction area K. Vibrations produced by the railroad at its southwest (Chapel Hill) ring crossing are shown in Table 5.6.5-1.

No interstate highways cross the collider ring. Two-lane roads crossing the collider ring include state routes (SR) 99, SR 16, SR 231, and SR (alternate) 31. Vibrations produced by these roads were not measured. Quarries are another source of vibration in the vicinity. Blasting activities from a quarry were monitored at the Chapel Hill site, and the resulting vibrations are shown in Table 5.6.5-1. Roads and railroads on the vicinity of the site are shown in Figure 5.6.5-2.

Table 5.6.5-1

REGIONAL VIBRATIONS
TENNESSEE SSC SITE

Source	Location of Measurement Point Relative to Source: Horizontal ft	Vertical ft*	Measured Vibrations: Displacement Range inches	Frequency Range Hz
Train	6	0	3.5×10^{-3}-1.2×10^{-7}	0.2-500
Train	60	0	2.2×10^{-4}-3.9×10^{-8}	1-400
Train	55	200	3.94×10^{-6}-1.6×10^{-8}	.4-400
Quarry blast	N/A	0	2.4×10^{-5}	3
Quarry blast	N/A	200	1.2×10^{-7}	3

Notes:

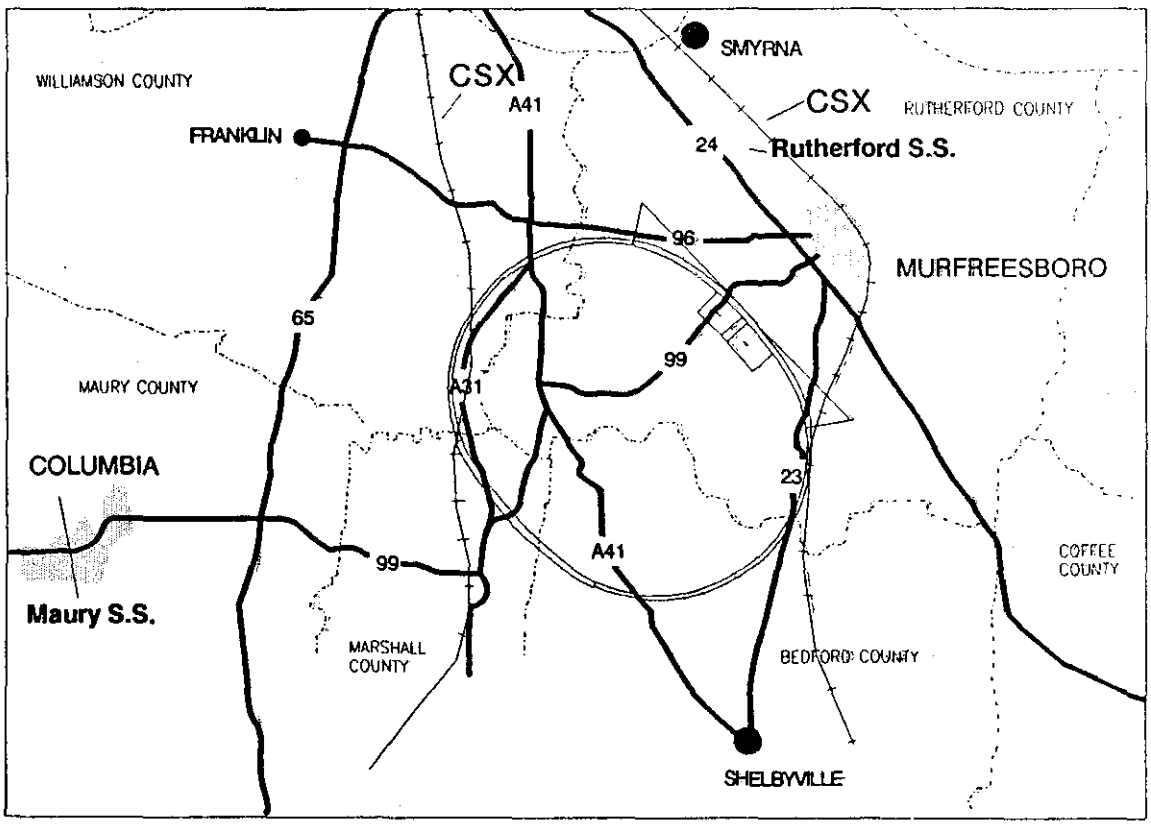
N/A = Not Available

*Feet below ground level

Source: Stokol, et. al., 1987

Figure 5.6.5-2

**REGIONAL VIBRATION SOURCES
TENNESSEE SSC SITE**



5.6.6 Environmental Radiation

5.6.6.1 Natural Radioactivity

A. Radon

Indoor radon levels reported by the University of Pittsburgh Radon Project and the Tennessee Department of Health are presented in Table 5.6.6-1. The reported indoor radon levels in Bedford, Marshall, and Rutherford counties averaged 2.59 pCi/l (Cohen 1988).

The Tennessee Radon Survey (TN Radon 1987) results indicate that the proposed site for the SSC is in an area of potentially low radon occurrence (TN Radmon 1987). The site is surrounded by phosphatic rocks on the west and black shale on the east, both exhibiting a high potential for radon occurrence. Brown phosphate deposits, which may be encountered in small areas, are reported to contain uranium concentrations on the order of 3.6 pCi/g.

The radium content in a core of Murfreesboro limestone that represented the approximate proposed tunnel depth was 0.38 pCi/g.

B. Soil/Rock

Composited samples from three bore holes in the location of the proposed SSC site were analyzed for Ra-226 and total uranium (TN 1987). The Ra-226 concentration varied from 0.10 to 0.33 pCi/g with an average of 0.23 pCi/g. The total uranium varied from 0.31 to 0.81 µg/g with an average of 0.64 µg/g. In addition to the composited samples, three samples identified from the geophysical logs as representing the highest gamma activity were analyzed for Ra-226, uranium, and thorium. The highest concentration was at a depth of 23.5 to 24.2 ft and was 0.73 pCi/g Ra-226, 2.4 µg/g total uranium, and 2.89 pCi/g total thorium. Another core sample from the same hole at a depth of 367.7 to 368.5 ft showed levels of 0.22 pCi/g Ra-226, 0.6 µg/g total uranium, and 0.48 pCi/g total thorium. The last core sample from a different location and at a depth of 362.5 to 363.2 ft had concentrations of 0.38 pCi/g Ra-226, 1.1 µg/g total U and 0.35 pCi/g total thorium.

There are no identified uranium deposits in the proposed area.

C. Water

Groundwater samples from seven wells along the proposed ring and four surface and one spring water samples in the proposed site vicinity were collected and analyzed for gross alpha activity and gross beta activity. Gamma spectroscopy was also performed on the samples (TN 1987). Sample depths for the seven wells ranged from 70 to 900 ft with an average depth of 297 ft. The gross alpha activity ranged from the lower limit of detection (LLD) to 121 pCi/l (high level of suspended and dissolved solids) with an average of 28 pCi/l. The gross beta activity ranged

Table 5.6.6-1

RADON LEVELS

Location	Number of Samples	Geometric Mean pCi/l	Average pCi/l	Percentage of Homes with Radon Levels < 4pCi/l	4-20 pCi/l	>20 pCi/l
United States						
Living space	49659	1.76	4.01	80	18	2
Basement	23984	3.37	7.87	59	34	7
Tennessee						
Living space	1254	2.59	3.66	75	23	5
Basement	218	3.73	6.34	55	40	5
Basement/living*	1787	---	2.7	84	15	1
Bedford County						
Living space	6	1.63	2.10	83	17	0
Basement	N/A					
Basement/living*	10	---	1.7	90	10	0
Marshall County						
Living space	12	2.36	2.94	75	25	0
Basement	7	5.49	5.90	29	71	0
Basement/living*	5	---	1.1	100	0	0
Rutherford County						
Living space	40	2.11	2.56	88	12	0
Basement	5	5.01	7.08	20	80	0
Basement/living*	23	---	3.1	83	17	0
Williamson County						
Basement/living*	57	---	3.1	75	25	0

Notes:
N/A - not available
*TN Radon 1987
Source: Cohen 1988

from LLD to 39 pCi/l with an average of 9 pCi/l. The sample with the highest activity contained a high level of suspended and dissolved solids. Bismuth-214 was detected in three of the samples at concentrations between 4 to 23 pCi/l. Lead-214 was detected in two samples at 27 and 19 pCi/l respectively. Actinium-228 was detected in one sample at a concentration of 5 pCi/l.

The four surface water samples and the spring sample showed alpha activities ranging from 1 to 6 pCi/l with an average of 3 pCi/l. The beta activities ranged far less than LLD to 3 pCi/l with an average of 1 pCi/l.

D. Measured Considerations

Borehole and water radioactivity levels were based on a limited number of samples. These samples may or may not be representative of the radioactivity expected at the site.

5.6.6.2 Man-Made Radiation

In Tennessee, 669 valid radioactive material (RAM) licenses were issued to authorize the use of RAM, including 326 medical licenses, 296 industrial licenses, 22 academic licenses, 10 source material licenses, and 15 special nuclear material licenses at the end of FY85 by the Conference of Radiation Control Program Searchers (CRCPD 1987). Medical users of RAM are the medical institutions, private clinics, eye applicator, mobile nuclear medicine, nuclear pharmacy, RAM teletherapy, rin vitro laboratory analysis, and veterinary use. RAM were also used in well logging, gauging, radiography, manufacturer/distributor, and civil defense. Authorization was awarded to three licensees in providing leak test for radioactive sealed sources for their clients. In Tennessee, 25 RAM licensees are regulated by the Nuclear Regulatory Commission, including 4 reactors and 21 federal operated/owned facilities.

The proposed SSC site is in a rural area that does not contain any of the licensed operations listed above. The site does not encompass any government facilities possessing radioactive materials nor are there any milling or mining activities which would enhance the natural background levels.

5.6.6.3 Background Radiation

Approximately 100 measurements were made at points 1 m above the surface around the proposed collider ring (Tennessee 1988). The instrument used was a hand-held, NaI crystal, scintillation detector. The measured dose equivalent rate ranges from 71 to 193 mrem/year with an average of 123 mrem/year.

5.6.7 Nonradioactive Environmental Hazards

5.6.7.1 Hazardous/Toxic Materials

No hazardous waste disposal or burial sites have been identified in the proposed SSC area. Also, there are no chemical manufacturing facilities.

A total of 66 underground storage tanks, located at 25 facilities, are within 1 mi of the ring (TNDNR 1987). All used to store petroleum products. Only one is known to have leaked and is located at a convenience store in Unionville, about 2 mi from the ring. This site has been investigated for groundwater contamination and was found to have only localized impacts (TNDNR 1987).

A search of the Tennessee Superfund Master List revealed one site in the four-county area that also appears on the Federal National Priorities List (NPL) list. This site is the Lewisburg dump about 30 mi southwest of the SSC site. Another site, the Rockvale dump, located inside the ring near the town of Rockvale, appears on the list but is now closed and no further action is required by the state.

The General Smelting and Refining Company facility appears on the Master List, and is also a RCRA treatment, storage, and disposal (TSD) facility that is presently undergoing a cleanup process under RCRA. This site is in College Grove, near the E8 shaft location on the ring. Lead contamination is the primary concern, and a groundwater monitoring program has been established in conjunction with the closure of an old disposal area. Contamination appears to be confined to the site. This facility is the only RCRA TSD facility in the vicinity of the proposed SSC site.

5.6.7.2 Biological Hazards

No biological hazards are known to exist in the proposed SSC area.

5.6.8 Existing Waste Management Facilities

5.6.8.1 Sewage Facilities

Figure 5.6.8-1 shows the approximate location of the existing sewage treatment plants in Tennessee. Table 5.6.8-1 presents the names, approximate distance from the SSC site, design capacity, and the current average flow of the plants in Bedford, Davidson, Marshall, Rutherford, Williamson, and Wilson counties.

Table 5.6.8-1

EXISTING SEWAGE TREATMENT PLANT CAPACITIES

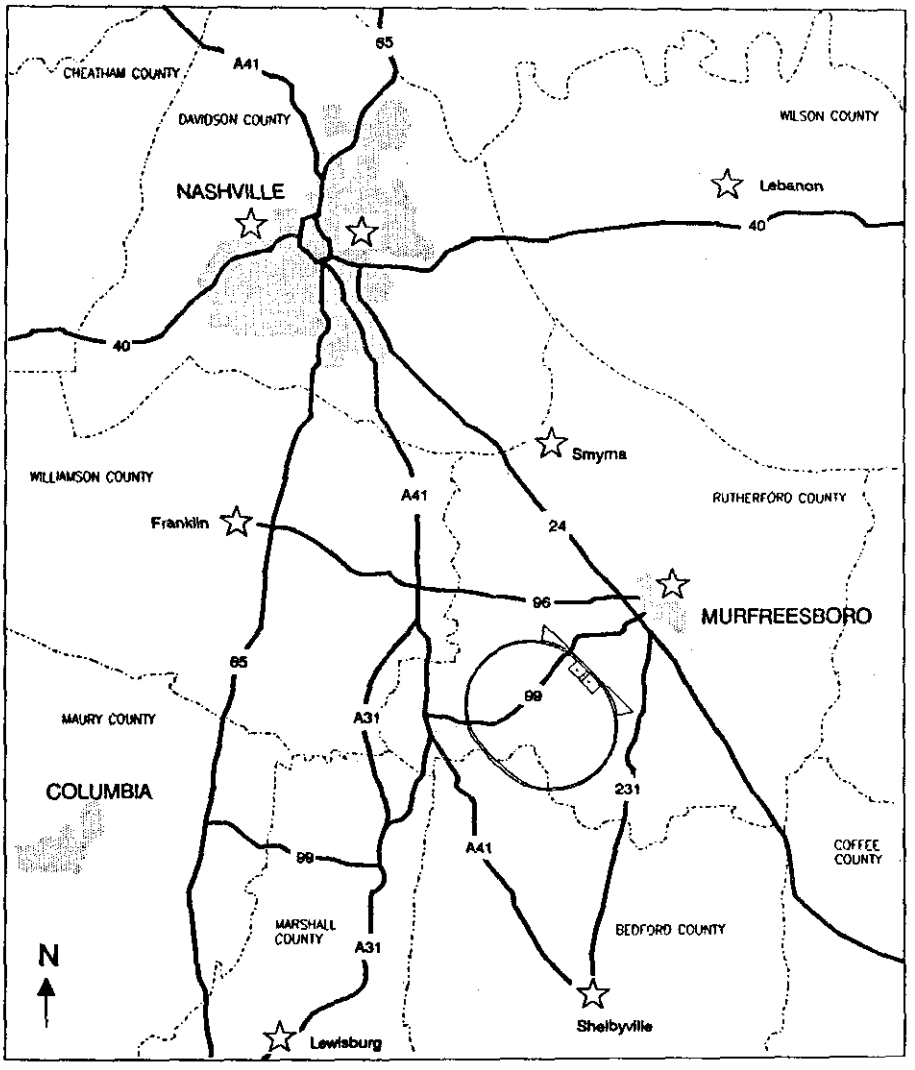
Sewage Treatment Plant	County	Approximate Distance from SSC Site	Design Capacity million gal/day	Average Current Flow million gal/day
Shelbyville	Bedford	21	4.9	1.7
Nashville-Central	Davidson	30	95.5	92.5
Nashville-White's Creek	Davidson	35	25	16.4
Nashville-Dry Creek	Davidson	30	12.5	7.1
Lewisburg	Marshall	30	3	1.7
Murfreesboro	Rutherford	8.5	10	4.78
Smyrna	Rutherford	12	5.2	2.0
Franklin	Williamson	25	2.5	1.4
Lebanon	Wilson	32	4.7	3.2

Source: State of Tennessee, Water Pollution Control

The closest wastewater treatment plant to the SSC campus is the publicly owned treatment works in the City of Murfreesboro.

Figure 5.6.8-1

EXISTING SEWAGE TREATMENT PLANTS
TENNESSEE SSC SITE



☆ Approximate Location of Existing Sewage Treatment Facilities in the Tennessee SSC Area

5.6.8.2 Solid Waste Facilities

Figure 5.6.8.2 shows the approximate location of the existing sanitary landfills in Tennessee. The existing landfill facilities, entity name, distance from the SSC campus, use rate, and remaining capacity are presented in Table 5.6.8-2. Those facilities are in Rutherford, Bedford, Wilson, Davidson, and Williamson counties.

The closest landfill would be Rutherford County landfill. This site has 17 years of remaining life and a 200 acre landfill area.

Industrial wastes such as oil, grease, and cutting oils would be disposed of at oil and grease recycling centers.

Table 5.6.8-2

EXISTING SANITARY LANDFILL CAPACITIES

Facility	Entity	Distance From Campus (Mi)	Use Rate (Ac year)	Remaining Capacity
Rutherford County landfill	County	13	4	18 Mo
Brinkley landfill (Bedford County)	Private	30	4	5 yr
Lewisburg landfill	City	29	1.5	2-3 yr
Rutherford County landfill (BFI)	Private	13	5	17 yr
Wilson County landfill	County	45	4	3 yr
Davidson County landfill	County	35	7-10	1.5-2 yr
Williamson County landfill	County	38	4	8-10 yr

Source: State of Tennessee, Division of Solid Wastes

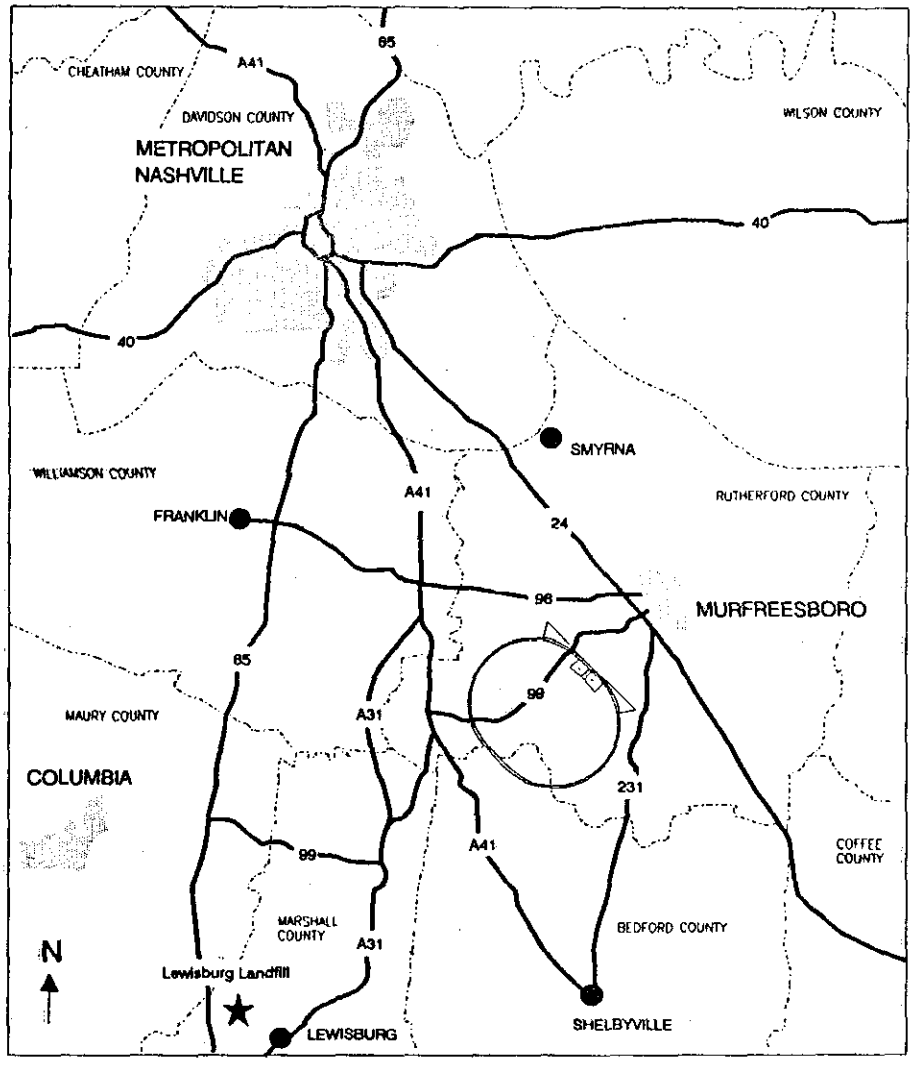
5.6.8.3 Hazardous Waste Disposal Facilities

There are no hazardous waste disposal facilities in Tennessee.

Hazardous waste generators in the state presently contract with permitted disposal facilities in either Emelle, Alabama or Pinewood, South

Figure 5.6.8-2

EXISTING SANITARY LANDFILLS
TENNESSEE SSC SITE



★ Approximate Location of Existing Sanitary Landfills in the Tennessee SSC Area

Carolina for final disposition of their wastes. In addition, waste exchange and commercial recycling operations exist in Tennessee.

5.6.8.4 Low-Level Radioactive/Mixed Waste Disposal Facilities

There are no commercial low-level radioactive/mixed waste disposal facilities currently operating in Tennessee.

In 1986, the radioactive material users in Tennessee generated 2,318 m^3 (13,469 Curies) of LLRW, as reported by the commercial waste disposal site operators. Utilities generated 18.5% of the waste by volume. Industrial facilities, academic, and medical institutions generated 80.7%, 0.7% and 0.1% of the total volume respectively. Utility wastes consisted of spent resins/filter sludges/evaporator bottoms (20.68%), dry compressible waste/contaminated equipment (78.55%), and irradiated components (0.77%). These LLRW included Class A (99.4%), Class B (0.3%), and Class C (0.3%) wastes (EG&G 1987).

5.6.9 Ecological Resources

5.6.9.1 Regional Ecological Characteristics

A. Definition of Drainage Basin and Boundaries of Ecological Resources Potentially Impacted

The proposed SSC alignment is bisected by the divide between the Tennessee River and the Lower Cumberland River. The Tennessee River basin is located in the south and east and the Lower Cumberland River is located to the north and west (Figure 5.6.9-1). Within the area of the ring are the headwaters of the East Fork Stones River, the West Fork Stones River, and the Harpeth River (tributaries of the Lower Cumberland River). Tributary drainage along the north side of the Duck River between Shelbyville and Henry Horton State Park are part of the Tennessee River Basin.

B. Relationship of Ecological Resources with Other Resources

In addition to the proposed site's location on a divide, it is also situated in an area of karst topography (limestone sinkholes and caves). The presence of unusual plant communities such as cedar (limestone) glades, with relatively large numbers of endemic species, hallmark this site. As a result, the interrelationship between surface waters, surface geological structures, and ecological resources are tightly coupled, and exact siting of facilities is important in determining the impact of the SSC construction.

C. Classification of Ecosystem Types and Their Distribution

The Tennessee site is in an area of diverse terrestrial communities that vary principally with soil depth and moisture. Hardwood forests and other deep soil communities are intermixed with shallower soil-based red cedar communities and shallow soil cedar glades. Small communities may occur around sinkholes that contain species dependent upon higher soil moisture conditions. Both these sinkhole-dependent and cedar glade communities are characterized by the possible presence of endemic, relict, or other unusual plant and animal species.

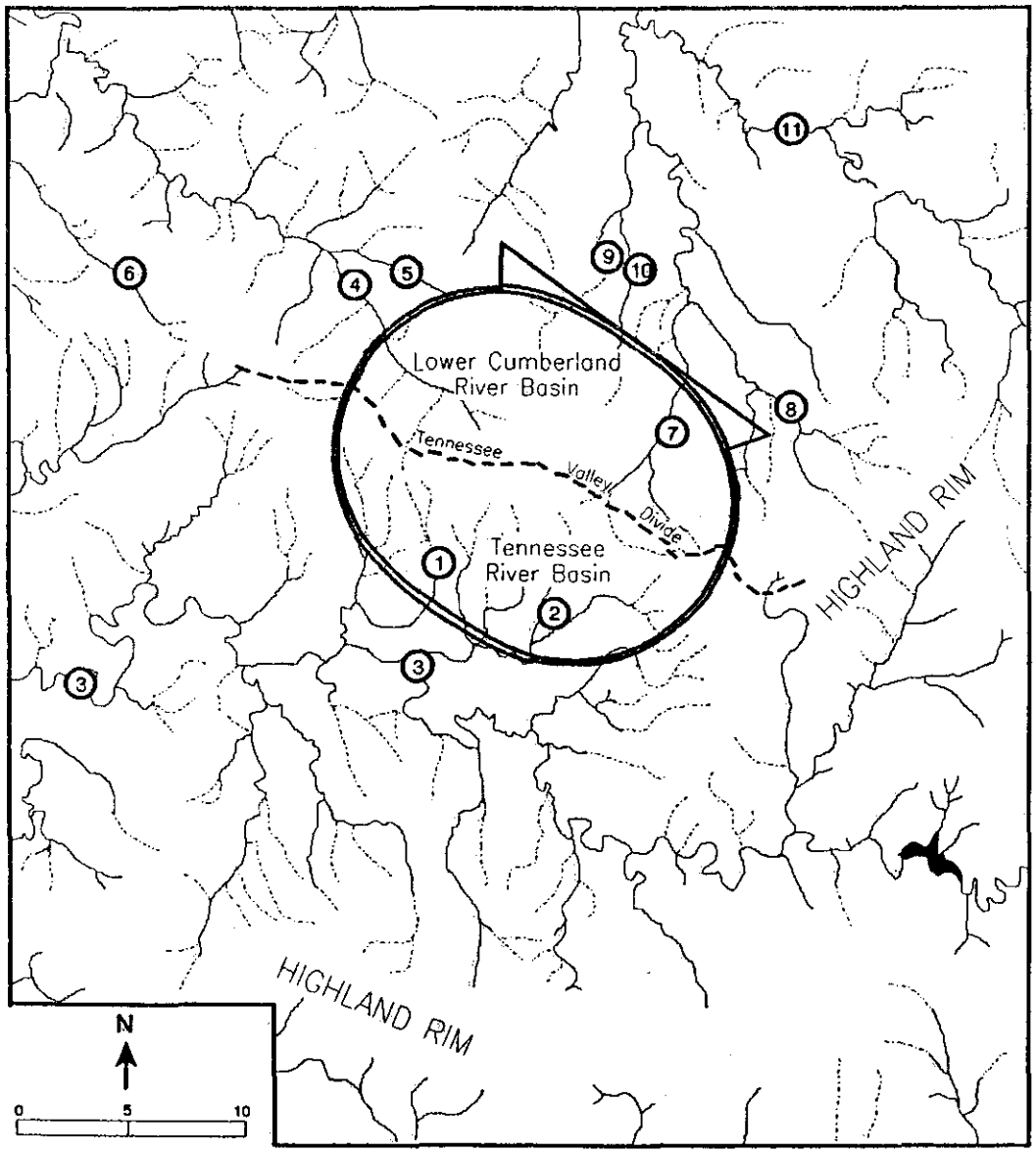
Numerous freshwater aquatic communities, including small ponds, small streams, and small rivers, are present in the area of the SSC site. Some of the smaller streams in the area are subject to seasonal dryness in all but the deepest pools. Emergent wetlands along stream and river courses are not common but do occur. The number and quality of aquatic communities in the area are typical of Middle Tennessee, with the exception of the absence of larger rivers.

5.6.9.2 Terrestrial Ecosystem Characteristics and Dynamics

The terrestrial ecosystems occupying the SSC site are a patchwork of forested, agricultural, cedar forest stands, and cedar glades. The distinct types are described in the following sections.

Figure 5.6.9-1

RIVER BASINS OF THE TENNESSEE SSC SITE VICINITY



Stream, intermittent flow where dot-dashed

Drainages
1. Wilson Creek
2. Alexander Creek
3. Duck River
4. Harpeth River
5. Nelson Creek
6. West Harpeth Creek
7. West Fork Stones River
8. Middle Fork Stones River
9. Overall Creek
10. Armstrong Creek
11. East Fork Stones River

A. Plant Community Composition and Dynamics

1. Forests

The four-county area surrounding the proposed SSC site is occupied by three major forest types. It is estimated that 25% of the forest contains dense stands of red cedar (Juniperus virginiana); 58% contains mixed hardwood species; and 17% is covered by a mix of cedar and hardwood (Tennessee 1987). The Tennessee Valley Authority (TVA) estimated in 1986 that approximately 1/3 of the four-county area was occupied by commercial forest.

The Tennessee Department of Conservation has developed the following classification system for the terrestrial plant communities of Middle Tennessee (Tennessee Department of Conservation 1985).

a. Broadleaf Forest Physiognomic Series - Mesic Broadleaf Forest

- Hackberry-oak-elm cover type
- Sugar maple-hickory-oak cover type
- Hackberry-shagbark hickory-ash cover type
- Shagbark hickory-sugar maple cover type
- Sugar maple-oak cover type.

b. Mixed Broadleaf Physiognomic Series - Subxeric Mixed Broadleaf-Needleleaf Forest

- Blue ash-red cedar cover type
- Red cedar-white ash cover type.

c. Limestone Cedar Glade Physiognomic Series

- Xeric and Ephemeral Spring Herb Communities
  - Annual herbs, succulents, glade moss, nostoc type
  - Foliose lichen, prairie-clover, annual grasses type
  - Nostoc, annuals, prairie-clover, bluet, onion type
  - Prairie-clover, poverty-grass, false pennyroyal type.
- Subxeric Glade Moss, Grass-forb Communities
  - Poverty-grass, prairie-clover, ruellia type
  - Glade moss, panic-grass, ruellia type
  - Annual and perennial grasses and forbs, sedge, woody plants, lichen, moss type.

A brief description of the seven forested plant communities follows.

Hackberry-Oak-Elm

This hardwood community is dominated by hackberry (both Celtis laevigata and Celtis occidentalis), with oaks, especially Shumard oak (Quercus shumardii) and chinquapin (Quercus muehlenbergii), and elms, both American elm (Ulmus americana), and slippery elm (Ulmus rubra), being canopy codominants. Thirty-one woody plant species are represented in the subcanopy and canopy layers. The shrub and herbaceous layers of this community include 80 plant species.

Sugar Maple-Hickory-Oak

This community represents the most mesic community encountered in Middle Tennessee. Thirty-two woody species are associated with the canopy and subcanopy. The dominant species in both of the upper layers is sugar maple. Codominant in the canopy layer are shagbark hickory (Carya ovata) and chinquapin oak, beech (Fagus grandifolia), tulip poplar (Liriodendron tulipifera), white ash (Fraxinus americana), Shumard oak, and northern red oak (Quercus rubra). The shrub and herbaceous layers of this community may contain any of the 153 different plant species.

Hackberry-Shagbark Hickory-Ash

This community is dominated by hackberry, shagbark hickory, and ashes, primarily white ash. It is a mesic hardwood that occurs primarily on slopes. The canopy and subcanopy contained 27 plant species, and 72 species were found in the shrub and herbaceous layers. This forest type is similar to others found in the area, but can be distinguished by its generally low and open character. Honey-locust (Gleditsia triacanthos) and osage-orange (Maclura pomifera) are common in this plant community. These species and other evidence indicate a disturbed hardwood community, probably a result of cutting or grazing.

Sugar Maple-Oak

This plant community represents the most common deciduous forest type of Middle Tennessee. The canopy and subcanopy layers contain 43 species, dominated by sugar maple and, in decreasing order of importance, chinquapin oak, Shumard oak, northern red oak, white oak, and post oak. Up to 158 species are associated with the shrub and herbaceous layers.

Shagbark Hickory-Sugar Maple

Shagbark hickory and sugar maple together are the dominant species of this community. Thirty-three woody species are present in the canopy and subcanopy. The shrub and herbaceous layers contain up to 104 species. This community is believed to represent a transition from the glade forests dominated by red cedar to the more mesic hardwood forest. With increasing soil accumulation or suppression of grazing, shade-intolerant red cedar will be gradually replaced by several of the

hardwood species, such as Shumard oak, shagbark hickory, ashes, and elms, which are present in lesser proportions in the red cedar-dominated glade forest.

Red Cedar-White Ash

Red cedar (Juniperus virginiana) is the dominant species of this community with white ash being a codominant in the canopy. Other important canopy species are shagbark hickory, chinquapin oak, and Shumard oak. Thirty woody species are reported in the canopy and subcanopy. This is the typical cedar glade forest that first develops in the larger fissures of limestone bedrock and surrounds or is surrounded by the open herbaceous cedar glade communities. The shrub and herbaceous layers of these forest communities are composed of 103 plant species. A noteworthy feature of this community is the high cover of mosses and lichens on the rocks and soil. This community has the highest percent cover value of any of the plant communities in the area.

Blue Ash-Red Cedar

Together blue ash and red cedar compose almost 65% of this community. Only 17 species are found in the canopy and subcanopy of this relatively depauperate community. The shrub and herbaceous layers may contain up to 68 species. This community is a variant of the typical glade community dominated by red cedar and described above.

2. Wetlands

In general, wetlands are less common in Middle Tennessee than in nearby western areas. While less common, these wetlands still play important roles for the ecological resources of the area. The most frequently occurring types of wetland are all palustrine and range from forested wetlands, to shrub wetlands, to emergent wetlands. Forested and shrub wetlands are associated with many reaches of perennial streams throughout the area. Emergent wetlands are most commonly limited in size and associated with pond margins.

Wetlands in the area of the SSC are primarily associated with the upper watersheds of tributaries of the Duck River, including Plum Branch, Spring Creek, Cove Branch, Overall Creek, Nelson Creek, and the Harpeth River. Other wetlands are associated with North Fork Creek, several tributaries of the Stones River, and Armstrong Branch.

3. Agricultural Communities

Historically the four-county area encompassing the SSC site was supported by an agricultural economy, although the importance of agriculture to the economy has lessened in recent decades. Crop production in the area is diversified. Major crops include soybeans, wheat, corn, and sorghum. However, none of the four counties is a leader in the production of these crops. Total acreage, yield per acre, and total production of major crops in the four counties area for 1986 are summarized in Table 5.6.9-1.

Table 5.6.9-1

**AGRICULTURAL CROP SUMMARY
FOR FOUR-COUNTY AREA OF TENNESSEE (1986)**

Crop	Acres	Yield/AC/AV	Production (Bu)
Soybeans	35,500	27	950,000
Wheat	31,600	25	465,000
Corn	51,000	52	1,890,000
Sorghum	10,200	52	326,000

Source: Tennessee Agricultural Statistics 1987.

In general, the acreage of soybeans and wheat are declining while the acreage of corn and sorghum are increasing.

Commercial forest land occupies approximately 32% (433,200 acres) of the four-county area surrounding the proposed SSC site. More than 95% of this land is in independent private ownership and occurs as small woodlots of less than 100 acres. Oak-hickory is the dominant forest type, averaging 63% of the forested area, while eastern red cedar dominates 22%. Principal commercial species include red oaks, hickories, and eastern red cedar, with yellow poplar, elm, beech, and hackberry also harvested. Most of the timber in the area is of poor quality because of the shallow, droughty soils with frequent rock outcropping common to the area. Thus, typically only the highest quality trees are harvested.

This four-county area is among the leading regions in Tennessee in the production of cattle, calves, beef cows, and milk cows; animals for which Tennessee's production ranks high among the other states. Additional species in production, although of lesser importance are swine, sheep, poultry, and other livestock.

B. Animal Community Composition and Dynamics

No significant migratory pathways for animals are known to cross the SSC alignment. Because of the topography of the region, the most significant avian migration corridor in the vicinity is to the east along the Cumberland Plateau escarpment. Raptors use the updrafts created by these linear ridges. Bald eagles, peregrine falcons, and sandhill cranes may also use this pathway east of the proposed SSC ring. It is likely that forested areas throughout the SSC area are used for foraging by flocks of small songbirds during migration, as they do throughout the region during spring and fall migration.

Important waterfowl species of the region include Canada goose, wood duck, blue-winged teal, and mallard. These species depend on shallow open water, larger wooded streams, or swamp habitats in association with agricultural fields.

Upland game birds of the region are wild turkey, bobwhite, and mourning dove. The wild turkey requires forested areas, especially mast-producing forests interspersed with open land use such as pasture, agricultural fields, or orchards. This species has a home range of 4 to 5 mi^2. The bobwhite is present in open, early successional habitats. Nesting occurs in undisturbed areas where grass grows long and thick. Mourning doves are seasonally migratory and have a long history of mixing well with many of man's activities.

Major game mammals of the region include eastern cottontail, gray and fox squirrels, and whitetail deer. All are abundant and are relatively insensitive to low-level activities by man.

Caves in the vicinity of the SSC alignment serve as home to a number of obligate cave-dwelling animal species as well as some species making part-time use of the caves, such as bats. Because such habitats are extremely limited, many of these species are listed as threatened or endangered, e.g., blind cave salamander. These protected populations are discussed with other threatened and endangered species in Section 5.6.9.5.

C. Ecosystem Level Processes

Middle Tennessee is a productive collage of old field successional habitats, forests, and streams. The nutrient cycles of these systems are highly coupled between soil, plants, and microorganisms, especially symbiotic microbes or mycorrhizae. These symbiotic relationships support rapid soil stabilization and rapid revegetation of cleared areas.

However, long-term productivity of these systems is largely dependent upon maintenance of soils. Consequently, erosive processes are detrimental to terrestrial system stability and reclamation efforts and provide a significant source of aquatic system pollutants as well.

5.6.9.3 Aquatic Ecosystems

Aquatic habitats in the area of the proposed site consist primarily of small streams and ponds. Commercial harvesting of either fish or mussels is unlikely. However, several of the streams in the area support a sport fishery, such as the smallmouth bass in Stones River.

The aquatic flora and fauna of the region are not well studied. However, some information suggests that generally good water quality and habitat conditions do support a healthy aquatic population, although somewhat lacking in diversity. In general, the streams in the vicinity of the SSC contain invertebrate populations, including intolerant species (e.g.,

Plecoptera, Ephemeroptera, and Trichoptera) in reaches of continuous flow. The more mainstream segments normally support typical lotic, warm water fisheries (Table 5.6.9-2).

Most streams in the area share the same limiting factor to their ecology: wide ranges of flow with zero flow conditions common during dry seasons in the small order segments with resulting low oxygen availability. During low-flow conditions, nutrients from nonpoint sources associated with agricultural land use can lead to localized eutrophic instream conditions. (Baker 1988)

Table 5.6.9-2

FISHERIES IN STREAMS IN SSC VICINITY

Family Species	Common Name	Harpeth River	W.F. Stones River	Other Streams*
Cyprinidae				
Campostoma anomalum	Common stoneroller	X	X	X
Cyprinus carplo	Carp	X	X	X
Hybopsis amblops	bigeye chub			
Notropis sp.	Shiner	X	X	X
Notropis ardens	Rosefin shiner		X	X
Notropis boops	Bigeye shiner		X	X
Notropis chrysocephalus	Common shiner			
Notropis cornutis			X	X
Notropis galacturus	Whitetail shiner		X	X
Notropis lirus	Mountain shiner			X
Pimephales notatus	Bluntnose minnow		X	X
Semotilus atromaculatus	Creek chub			
Lepisosteidae				
Lepisosteus osseus	Longnose gar	X		
Ictaluridae				
Icataluris sp.	Catfish	X		
Ictaluris punctatus	Channel catfish		X	
Catostomidae				
Hypentelium nigricans	Northern hogsucker	X	X	
Minytrema melanops	Spotted sucker		X	X
Erimyzon oblongus	Greek chubsucker			X
Moxostoma erythrurum	Golden redhorse			
Moxostoma sp.	Redhorse sucker	X		
Percidae				
Percina caprodes	Logperch	X	X	
Percina sp.	Darter	X	X	
Etheostoma caeruleum			X	
Etheostoma camurum			X	
Etheostoma blenoides			X	
Etheostoma simoterum			X	
Etheostoma squamiceps	Spottail darter			X
Etheostoma flabellare	Fantail darter			X
Etheostoma striatulum	Striated darter			X

Table 5.6.9-2 (Cont)

FISHERIES IN STREAMS IN SSC VICINITY

Family Species	Common Name	Harpeth River	W.F. Stones River	Other Streams*
Sciaenidae				
Aplodinotus grunniens	Drum	X		
Cottidae				
Cottus carolinae	Banded sculpin	X		X
Clupeidae				
Dorosoma cepedianum	Gizzard shad	X	X	
Dorosoma petenense	Threadfin shad	X		
Centrarchidae				
Lepomis macrochirus	Bluegill sunfish	X	X	X
Lepomis cyanellus	Green sunfish	X	X	X
Lepomis megalotis	Longear sunfish	X	X	X
Lepomis microlophus	Redear sunfish	X	X	
Ambloplites rupestris	Rockbass	X	X	
Micropterus punctulatus	spotted bass	X	X	X
Micropterus salmoides	Largemouth bass	X	X	
Micropterus dolomieui	Smallmouth bass	X	X	
Chaenobryttus gulosus	Warmouth			
Lepomis gulosus	Warmouth			X
Atherinidae				
Labidesthes sicculus	Brook silverside		X	
Poeciliidae				
Gambusia affinis	Mosquitofish		X	
Labidesthes sicculus	Brook silverside			X
Amblyopsidae				
Fundulus notatus	Blackstripe topminnow			X

*Fall Creek, North Fork Creek, Wilson Creek, Spring Creek, and/or Caney Creek.

Source: Baker 1988.

5.6.9.4 Economically, Recreationally, and Culturally Important Species

Several farms in the SSC area are dedicated to raising and training Tennessee Walking Horses. The number, quality, and value of this resource is not known at this time. Because of its relative importance to "horse fanciers," however, these horse farms are acknowledged as culturally important.

No other economically, recreationally, or culturally important species are known to be present in this area.

5.6.9.5 Threatened and Endangered Species

A. Federally Listed and Candidate Species

The U.S. Fish and Wildlife Service has listed the following species under its jurisdiction as possibly being in the vicinity of the proposed SSC alignment:

1. Listed Species

- Tennessee purple coneflower - *Echineacea tennesseensis*
- Gray bat - *Myotis grisescens*
- Indiana bat - *Myotis sodalis*
- Tan riffle shell mussel - *Epioblasma walkeri*
- Birdwing pearly mussel - *Conradilla caelata*
- Cumberland monkeyface pearly mussel - *Quadula intermedia*
- Bald eagle - *Haliaeetus leucocephalus*
- Peregrine falcon - *Falco peregrinus*

2. Status Review Species

- Sandwort - *Arenaria fontinalis*
- Tennessee milk-vetch - *Astragalus tennesseensis*
- Gattinger's lobelia - *Lobelia appendiculata* var. *gattingeri*
- Tennessee glade cress - *Leavenworthia exigua* var. *exigua*
- Leafy prairie-clover - *Dalea foliosa*
- Cumberland rosinweed - *Dilphium brachiatum*
- Limestone fameflower - *Talunum calcaricum*
- Snow wreath - *Neviusia alabamensis*
- Stone's River bladderpod - *Lesquerella stonensis*
- Cleft phlox - *Phlox bifida* var. *stellaria*
- Large rock cress - *Arabis perstellata* var. *ampla*
- Eastern blue star - *Amsonia tabernaemontana* var. *gattingeri*
- Water stitchwort - *Arenaria stitchwort*
- Tennessee cave salamander - *Gyrinophilus palleucus*
- Hellbender - *Cryptobranchus alleganiensis*
- Coppercheek darter - *Etheostoma aquali*

Listed species are under the statutory protection of the Endangered Species Act. Status Review species are not legally protected at this time, but are being considered for listing in the future.

B. State-Protected Species

A review of the Tennessee Natural Heritage Project's database (1987) indicates the possible presence of a number of species listed as threatened or endangered by the State of Tennessee. In Tennessee, species status is determined by two agencies, the Tennessee Wlildlife Resources Agency and the Heritage Program of the Tennessee Department of Conservation. The list and status of the species listed by the state are presented in Table 5.6.9-3.

5.6.9.6 Unique Ecosystems and Communities Potentially Affected

A. Statutorily Protected Areas

No statutorily protected areas are known to occur within the collider ring alignment. This includes such areas as wilderness, wild or scenic rivers, wildlife refuges, and state or federal parks or forests. State protected lands, such as Cedars of Lebanon State Park, are nearby.

B. Remnant Communities, Virgin Stands, and Unique Assemblages

Many of the Threatened and Endangered Species under protection by either state or federal law in this area are found in or are associated with cedar glade communities. Cedar glades are the most distinctive botanical resource of the area, occupying flat limestone outcrops in natural openings in the cedar or cedar-hardwood forests. These openings may range from several square yards to several acres in size. Cedar glades are characterized by assemblages of particular plant species, some of which occur only in cedar glades (endemic). Bridges and Orzell (1986) estimate that there are 16 endemic or near endemic plant species associated with cedar glades in Middle Tennessee. These species are reported to represent approximately 6% of the native flora of the area. Among the cedar glade endemics are:

- Glade cress (Leavenworthia exigua var. exigua)
- Necklace glade cress (Leavenworthia torulosa)
- Limestone fameflower (Talinum calcaricum)
- Leafy prairie clover (Dalea foliosa).

Cedar glade plant communities are relatively common in the general area of the proposed SSC alignment.

C. Marginal Range Associations and Transition Zones

Middle Tennessee, the site of the proposed SSC alignment, is characterized by many diverse types of habitats. As a result, there are numerous transitional areas. Rock outcropping and cedar glades are intermixed with pasture lands, croplands, and forests. The relatively large number of bird and small mammal species present in the area is in part a result of this diversity and variability. Additionally, the site traverses a divide between the Tennessee River and the Lower Cumberland River. These two basins, while somewhat similar, do have differences in average rainfall and in general terrain.

Table 5.6.9-3

TENNESSEE THREATENED AND ENDANGERED SPECIES IN SSC VICINITY

SPECIES	STATUS
Glade onion (Allium stellatum)	Endangered
Carolina anemone (Anemone caroliana)	Endangered
Tennessee milk-vetch (Astragalus tennesseesis)	Endangered
Sandwort (Arenaria fontinalis)	Endangered
Ground plum (Astragalus n. sp.	Endangered
Leafy prairie clover (Dalea foliosa)	Endangered
White prairie-clover (Dalea candida)	Endangered
Prairie clover (Dalea purpurea)	Endangered
Glade cress (Leavenworthia exigua var. exigua)	Threatened
Necklace glade cress (Leavenworthia torulosa)	Threatened
Duck River bladderpod (Lesquerella densipila)	Threatened
Shorts bladderpod (Lesquerella globosa)	Threatened
Stones River bladderpod (Lesquerella stonesis)	Endangered
Tennessee coneflower (Echinacea tennesseensis)	Endangered
Evolvulus (Evolvulus pilosus)	Endangered
Missouri primrose (Oenothera missouriensis)	Endangered
Gattinger's lobelia (Lobelia appendiculata var. gattingeri)	Threatened
Snow wreath (Neviusia alabamensis)	Threatened
False gromwell (Onosmodium subsetosum)	Endangered
Sunneybell (Schoenolirion croceum)	Threatened
Limestone fameflower (Talinum calcarigum)	Threatened
Water speedwell (Veronica comosa)	Endangered
Blazing star (Liatris cylindracea)	Endangered
Canada lily (Lilium canadense)	Threatened
Cleft phlox (Phlox bifida stellaria)	Threatened
Hairy fimbristylis (Fimbristylus puberula)	Threatened
Narrow-leaved umbrella-wort (Mirabilis albida)	Threatened
Pope's sand-parsley (Ammoselinum popei)	Threatened
Prairie dock (Silphium pinnatifidum)	Threatened
Tennessee cave salamander (Gyrinophilus palleucus)	Threatened
Hellbender (Cryptobranchus alleganiensis)	In need of management
Bald eagle (Haliaeetus leucocephalus)	Endangered
Peregrine falcon (Falco peregrinus)	Endangered
Bewick's wren (Thryomanes bewickii)	Threatened
Grasshopper sparrow (Ammodramus savannarum)	Threatened
Gray bat (Myotis grisescens)	Endangered
Indiana bat (Myotis sodalis)	Endangered
Birdwing pearly mussel (Contadilla caelata)	Endangered
Cumberland monkeyface pearly mussel (Quadrula intermedia)	Endangered
Coppercheek darter (Etheostoma aquali)	Threatened

5.6.10 Land Resources

5.6.10.1 Regional Setting

A. Jurisdictional Setting

The proposed Tennessee site is located approximately 15 mi south of Nashville in an area bounded by Murfreesboro on the north, Chapel Hill and Shelbyville on the south, covering incorporated portions of northern Bedford County, northeastern Marshall County, southern Rutherford County, and southeastern Williamson County (See Figure 6.1.10-1). The county seats of each jurisdiction and the year of respective establishment are as follows: Shelbyville, Bedford County (1807), Lewisburg, Marshall County (1836), Murfreesboro, Rutherford County (1803), and Franklin, Williamson County (1799) (Crutchfield 1986). The area of each jurisdiction (Crutchfield 1986) is listed below:

County	Area (mi^2)
Bedford	475
Marshall	376
Rutherford	624
Williamson	584
Total	2,059

The SSC project is situated in areas that are represented by the following federal, state, and local elected officials (State of Tennessee 1987):

- United State Senate
  Albert Gore, Jr.
  James R. Sasser

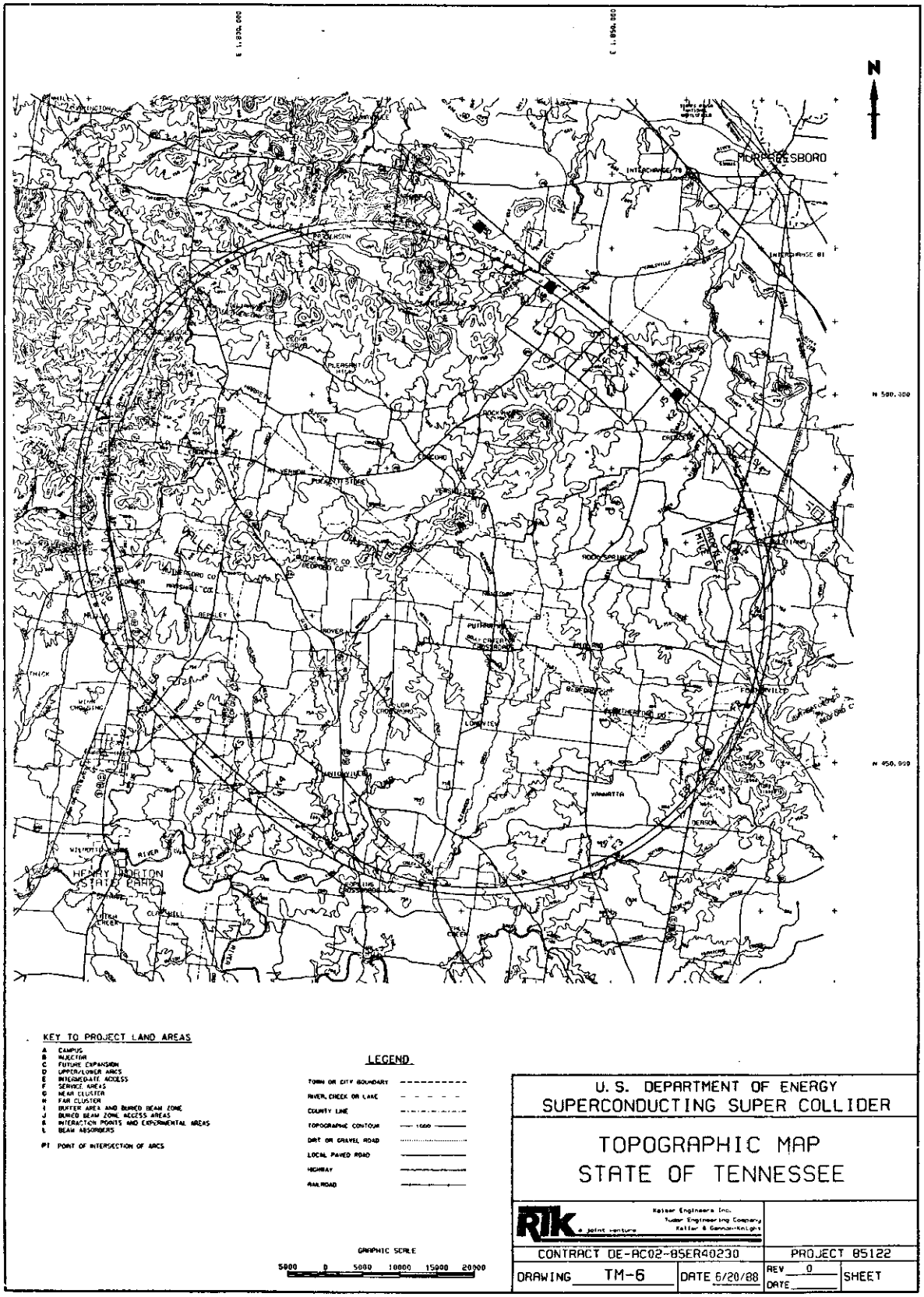
- United States House of Representatives
  James Hayes Shofner Cooper, 4th District
  Barton Jennings Gordon, 6th District

- State Senate
  John R. Rucker, 16th District
  William A. Richardson, Jr., 23rd District

- State House of Representatives
  John T. Bragg, 48th District
  Fred R. Hobb, 49th District
  Clarence W. Phillips, 62nd District

Figure 5.6.10-1

PROPOSED TENNESSEE SSC SITE REGION



- Bedford County Board of Supervisors
- Marshall County Board of Supervisors
- Rutherford County Board of Supervisors
- Williamson County Board of Supervisors

B. Ownership Patterns

Land ownership in the SSC project four-county area is predominantly private, with scattered parcels under some form of federal, state, or local government ownership, which includes the U.S. Army Corps of Engineers J. Percy Priest Lake. This land ownership pattern is consistent with ownership patterns of middle Tennessee.

C. Historic Land Uses

The growth of middle Tennessee is linked intimately to its geologic setting. The SSC project site area is situated toward the edge of the Nashville Basin of the Interior Low Plateau physiographic province (Fenneman 1938). The project site area is located near what is termed the Highland Rim which, in itself, has elevations of several hundred feet. As such, the SSC project site area has a surface terrain that features numerous knobs and hills, underlain by a near-surface bedrock of relatively soluble limestone. As a result, the area is characterized, in part, by having thin soils and an underground that includes a number of karst features, such as caves, sinkholes, and disappearing streams (Miller 1977). Given these conditions, natural limits are placed on development that affect building location and layout, as well as site densities, because of constraints imposed by septic tank field limitations (Colvert 1988). Settlement patterns in the area are, by necessity, dispersed and not always directly related to drainage patterns. Agriculture has been the historic economic base of the region, with Murfreesboro, the former state capital (1819-1826), being the primary urban center for the region (City of Murfreesboro 1987).

D. Existing Land Use Plans, Policies, and Controls

Land use planning in middle Tennessee is conducted at the state, regional, and local levels of government; the local level includes not only county-level activities, but also municipalities (Waller 1988). Land use planning at the state level is conducted primarily by the Department of Economic and Community Development, Local Planning Assistance Office. Activities conducted include providing localities with technical assistance in the preparation of local comprehensive plans and land use controls.

Land use planning at the regional level is conducted by state-mandated multicounty planning and development districts, whose purpose is to provide intergovernmental coordination on multijurisdictional programs or projects. These development districts are also empowered to develop

regional development plans, including land use policies. These plans are advisory in nature, since state statutes prohibit these districts from implementing land use controls. The development district created for the middle portion of the state was the Mid-Cumberland Council of Govern- ments and Development District (MCCOG/DD), whose 1967 charter member governments included Williamson County and the cities of Murfreesboro and Smyrna (Mid-Cumberland Council of Governments and Development District 1987). Member governments were added over the years to include, among others, Rutherford County. In response to the area's recent rapid development, it was determined that the original charter of the organization needed to be clarified and broadened to include the power of review over private development projects that have regional development implications (Edwards 1988). State legislation was passed in 1987 that created the Greater Nashville Regional Council out of the MCCOG/DD (Tennessee Code Annotated, Title 64, Chapter 1, Part 9, 1987). The Greater Nashville Regional Council includes 13 counties and 49 incorporated municipalities and metropolitan governments. Major activities include: administration of programs for the aging; economic and community development; Small Business Administration loan fund management, through its Mid-Cumberland Development Corporation; regional planning; and job training partnership program administration (Mid-Cumberland Council of Governments and Development District 1987). Regional planning activities include: research; planning efforts related to water quality, solid waste management, coordination of development standards, urban transportation planning, proposed Interstate-840 planning; technical assistance, regional data center information management; and state and local project review (Mid-Cumberland Council of Governments and Development District 1987).

Key plans by the Greater Nashville Regional Council/MCCOG/DD include: Regional Development Strategy 1976-2000 (1976); Recreation for the Mid-Cumberland Region (1982); Land Use Inventory(1985); and Mid-Cumberland Regional Infrastructure Assessment/Capital Improvements Program (1986). Studies projected to be completed by September 1988 include a final population and economic forecast; a water, wastewater, and solid waste inventory; and an analysis of land use and growth trends based on 1977 and 1985 LANDSAT data (Edwards 1988).

Under Tennessee state law, enabling legislation was passed in 1935 that granted localities the authority to: 1) prepare comprehensive land use plans or general plans; 2) establish planning commissions, if desired; 3) enact zoning ordinances; and 4) adopt and administer subdivision regulations (Waller 1988). These planning commissions are given broad powers by which to develop their plans; however, State law provides that the plan shall include, among other things, the following:

- The general location, character, and extent of public ways, ground, and other public property.

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- The general location and extent of public utilities and terminals, whether publicly or privately owned, for power, light, heat, sanitation, transportation,, communication, water, and other purposes.

- The removal, relocation, extension, widening, narrowing, vacating, abandonment or change of use of existing public ways, grounds, open spaces, buildings, properties, utilities or terminals.

- The general character, location and extent of community centers, town sites or housing developments.

- The location and extent of forests, agricultural areas, and open development areas for the purpose of conservation, food and water supply and, sanitary and drainage facilities for the protection of urban development.

- A land classification and utilization program.

- A zoning plan for regulation of the height, area, bulk, location and uses of buildings; distribution of population; and uses of land for trade, industry, habitation, recreation, agriculture, forestry, soil and water conservation, and other purposes.

Plans developed by regional or municipal planning commissions are advisory in nature and are certified to the legislative body as adopted by the planning commission (Waller 1988). When a plan has been adopted and certified by the planning commission, mandatory referral of public construction projects to the planning commission for review and approval is required of all local governmental agencies (Waller 1988).

To date, approximately two-thirds of Tennessee's 95 counties and three-fourths of the 336 municipalities have established and maintain active planning programs and planning commissions (Waller 1988). Both Rutherford and Williamson Counties are currently revising their Comprehensive Plans and have zoning ordinances and/or subdivision regulations in place; Bedford and Marshall Counties are actively preparing land use plans and, will subsequently enact zoning ordinances (Waller 1988). Municipalities, such as the City of Murfreesboro (1987, 1984), Smyrna (1977, 1979, 1986), LaVergne (1976), and Shelbysville (1969) have plans and/or zoning ordinances in effect.

E. Existing Land Use

Existing land use in Middle Tennessee continues to build on the area's historically developed land use patterns. Agriculture is still the dominant land use activity in the proposed SSC project four-county area. As a result, existing land uses are predominantly rural residential, rural farm, and rural open space Waller (1988). Eagleville, located on the western interior edge of the collider arc region is the only incorporated locality (Waller 1988). It serves its community of approximately

500 people with a small commercial core and has recently developed a small industrial park (Waller 1988). There are other small "crossroad" communities that dot the interior of the collider arc region, whose focal points include either a commercial center, church, school, or other community feature (Waller 1988).

Eastern Rutherford County, particularly along Interstate-24, continues to be the most intensely developed, considering the location of the 3,600-employee Nissan Manufacturing Plant in Smyrna with its attendant satellite residential and commercial developments (Rutherford County Industrial Development Council 1987). New developments are occurring as either suburban in-fill projects from Nashville to Murfreesboro or as extensions to the urbanized fringe, heading south along State Route 231/10 towards Christiana.

F. Future Planned Land Uses

Middle Tennessee is expected to continue to grow rapidly, as the full potential of the area is realized in response to the following major development projects, either recently built and on-line or under construction: the Nissan Manufacturing Plant, including the new expansion, in Smyrna, the American Airlines Hub Operation in Nashville, and the General Motors Saturn Plant, scheduled for completion in 1993, in Spring Hill (Waller 1988). The saturn plant could emply 1,800 to 5,000 workers when fully built (Colvert 1988). In addition, there are tentative plans to relocate the Tennessee National Council to the site of the former U.S. Air Force Base at Smyrna (Colvert 1988). The counties most affected by these developments include Rutherford, Nashville-Davidson, and Williamson and Maury, respectively. Comprehensive plans are being revised to accommodate this growth amid development constraints imposed by the natural setting and each government's ability to finance the necessary physical infrastructure and attendant community services needed to support an increased population.

G. Community Values/Attitudes Toward Development

There is a strong development ethic that prevails at all levels of government, as evidenced by the rapidly changing character of Middle Tennessee. This ethic is expressed in a variety of ways, where pragmatic solutions to problems are sought. The expressed goals of the Greater Nashville Regional Council as listed below (Mid-Cumberland Council of Governments and Development District n.d.), best summarize this planning orientation:

- Coordinate activities within the region to ensure that compatible systems develop and to eliminate costly duplication of projects and services.

- Provide the latest management tools, research data, and information to local officials to enable them to make the best decisions for their jurisdictions.

- Promote the region as an attractive place to live, work, and play.
- Develop jobs for the labor force.
- Assist local governments in seeking federal, state, or private funding and in administering such funding.
- Promote tourism.
- Enhance the quality of life in the most beautiful section of Tennessee.
- Respond to the specific needs of the member governments.

5.6.10.2 Local Setting

A. Project Level

The proposed SSC project site is located in portions of southern Rutherford County, northern Bedford County, northeastern Marshall County, and southeastern Williamson County on lands that are unincorporated (see Figure 5.6.10-1). The SSC project site, including the interior of the collider arc region contains no federal parklands, such as national parks, monuments, preserves, rivers, scenic or historic trails, historic sites, recreation areas, and parkways. It should be noted, however, that the 351-acre Stones River National Battleground and cemetery commemorating the 1862-1863 civil war Battle of Stones River and its Federal dead is located in the City of Murfreesboro. There are also no federal or state-designated wilderness areas or wild and scenic rivers located in the SSC project site.

The project study area is almost exclusively rural in nature, with land use patterns in the interior of the collider arc region being limited to a few types and arrayed in a fairly broad pattern. The western portion of the site has more wooded, rolling terrain contained in larger farm units, and is, therefore, less developed than the eastern side. A settlement pattern based on either a linear axis or a crossroad network is prevalent, with the greatest variety of land uses occurring along either U.S. Highway 231/10 on the east and State Route Alternate 31 on the west. Examples of such development on the eastern edge of the collider arc region, listed from Murfreesboro south to Highway 82, include several automotive salvage/maintenance-storage yards, a large rock and gravel quarry operation, an open-air market, several new residential developments, the Christiana Elementary School, and several Tennessee walking horse farms. Examples of development on the western edge of the collider arc region, include the following com-munities listed from north to south: Kirkland, College Grove, Holts Corner, and Chapel Hill. Several industrial and manufacturing firms are located along this corridor. Other significant land uses in the collider arc region include the 1,500-acre Bill Rice Ranch, a private religious-affiliated educational

complex for deaf children in the north along State Route 96 (Mid-Cumberland Council of Governments and Development District 1982), several commercial broiler chicken facilities, and Tennessee walking horse farms in the south in the vicinity of Deason.

Recreational resources in the SSC project study area include a variety of facilities. Regional scale attractions include the 7,050-acre J. Percy Priest Lake northeast of Smyrna and the associated 11,264-acre state-managed Percy Priest Wildlife Management Area, where water-oriented recreational activities as well as hiking and nature study opportunities are available. Other important state-managed recreational facilities include the Henry Horton State Resort Park located south of Chapel Hill. This facility is the former estate of Tennessee's 36th governor, Henry J. Horton, and is noted for its 18-hole championship golf course, convention, and meeting facilities, a 72-room inn, 90 campsites, cabins, and other recreational amenities. The SSC project study area also includes a number of municipal and private recreational facilities. A noteworthy example is the City of Murfreesboro 125-acre Old Fort Park, which contains the civil war-era, Fortress Rosecrans, the largest and most elaborate earthworks fortification ever built in this country. Portions of the fort are still intact (City of Murfreesboro 1987).

A noteworthy natural recreational resource in the interior of the collider arc region is Snail Shell cave, located approximately two mi north of Rockvale. This particular cave is the largest underground cavern in one of the most extensive known cave systems in Tennessee (Barr 1972). Snail Shell cave together with Echo cave and Nanna cave forms a vast underground complex of which 8 mi of passages have been explored and mapped. Large underground lakes are present, the largest of which holds 1.0 to 2.5 million gallons of water.

Community values and attitudes toward the SSC project are favorable, given the relatively few number of letters received from the public as part of the DOE public scoping process (see Volume III: Methodology for Site Selection). Of the 72 letters received by the DOE as of mid-May, 1988, 60 letters were in favor of the project; eight letters offered no opinion about the project; and four letters were opposed to the project. The types of issues raised in these letters included impacts to the educational system, labor supply changes, and road and congestion problems.

B. Facility Level

Table 5.6.10-1 presents land use data for each of the major SSC project facilities. This includes information on county locations, ownership, existing zoning designations, existing land use, and future planned land use. Narrative descriptions follow.

B. Site Specific Description

Table 5.2.10-1 presents in summary details of major SSC project facilities according to county location, ownership patterns, existing zones, existing land use, and future planned land use. Discussions of each major facility are given in the following paragraph subsections.

1. SSC Project Near Cluster Quadrant

The near cluster quadrant is located in unincorporated Rutherford County, which is generally of a rural character. Land use consists mainly of agricultural cropland and pasture, forested land, rural residences, and open space. Large areas of prime farmland are concentrated in the central and eastern areas. Several roadways and drainages cross the area, including the Florida short route (U. S. Route 231), state routes 96 and 99, Overall Creek, and the West Fork Stones River. The Louisiana and Nashville rail line also crosses the quadrant, and rural/farm residences are lightly scattered along minor roadways. The residential community of Christiana is intersected on the northern edge, including two cemeteries and an elementary school. A small number of schools, churches, and cemeteries as well as additional residences, are found within 1,000 ft of the site area. Excluding transportation right-of-ways, the land is privately owned and is zoned R-15 (Residential-15) for agricultural/rural residential use under the jurisdiction of Rutherford County. County land use plans propose no change while allowing for some rural residential growth.

a. Campus Area A

Campus area A consists of agricultural cropland and pasture, with a majority of its southern half covered in forest. Minor roadways intersect on the northeastern corner, and very few residences are located on the site. A few small lakes are encountered and approximately 30% of the area is designated as prime farmland, mostly in the north. The area is zoned R-15 (Residential-15) and land use plans propose no change in use.

b. Injector Area B

Injector area B is bisected by State Route 99, and land use is a mix of cropland, pasture, forested land and rural open space, with a number of farm residences found along Route 99. A few residences are located along minor roads in other parts of the area. A majority of the site is designated as prime farmland and zoned R-15 (Residential-15). County land use plans propose no change in use.

c. Future Expansion Area C

Future expansion area C consists mainly of agricultural use in pasture and cropland. Forested land is found in large patches on the east and west corners, and the Armstrong Valley Road runs north/south through the central agricultural areas. Farm residences are found along this road and a few other minor roadways and a small cemetery is located at the

Table 5.6.10-1

SSC PROJECT TENNESSEE SITE FACILITY DESCRIPTION: LAND USE DATA

SSC Project Facility	County Location	Ownership Patterns	Existing Zoning	Existing Land Use	Future Planned Land Use
Near Cluster Quadrant					
Campus area A	Rutherford	Private	R-15	Agr	Same
Injector area B	Rutherford	Private	R-15	Agr/rural	Same
Future expansion C	Rutherford	Private	R-15	Agr/rural	Same
BABBZ area I	Rutherford	Private	R-15	Agr/rural	Same
J1	Rutherford	Private	R-15	Agr/rural	Same
J2	Rutherford	Private	R-15	Rural	Same
J3	Rutherford	Private	R-15	Forested/agr	Same
J4	Rutherford	Private	R-15	Forested/agr	Same
Near Cluster Ring	Rutherford	Private	R-15	Rural	Same
E1	Rutherford	Private	R-15	Agr	Same
E10	Rutherford	Private	R-15	Agr/forested	Same
F1	Rutherford	Private	R-15	Agr/open	Same
F9	Rutherford	Private	R-15	Agr/forested	Same
F10	Rutherford	Private	R-15	Agr/open	Same
J5	Rutherford	Private	R-15	Agr	Same
J6	Rutherford	Private	R-15	Forested/rural	Same
K1	Rutherford	Private	R-15	Rural	Same
K2	Rutherford	Private	R-15	Agr	Same
Far Cluster Quadrant					
Far Cluster Ring (H)	Marshall/Bedford	Private	None	Rural	None
E5	Bedford	Private	None	Forested	None
E6	Marshall	Private	None	Agr	None
F5	Bedford	Private	None	Agr/open	None
K3	Bedford	Private	None	Forested/agr	None
K4	Bedford	Private	None	Agr/open	None
K5	Marshall	Private	None	Forested	None
K6	Marshall	Private	None	Agr/open	None
Eastern Arc Quadrant					
Eastern Arc Ring D	Rutherford/Bedford	Private	None/R-15	Rural	Same/none
E2	Rutherford	Private	R-15	Farm residential	Same
E3	Bedford	Private	None	Agr	None
E4	Bedford	Private	None	Forested/open	None
F2	Rutherford	Private	R-15	Agr/open	Same
F3	Bedford	Private	None	Open/agr	None
F4	Bedford	Private	None	Open/agr	None
Western Arc Quadrant					
Western Arc Ring D	Marshall/Williamson/ Rutherford	Private	R/R-15/none	Rural	Same/none
E7	Williamson	Private	R	Forested/open	Same
E8	Williamson	Private	R	Open/agr	Same
E9	Rutherford	Private	R-15	Forested/open	Same
F6	Marshall	Private	None	Forested/open	Same
F7	Williamson	Private	R	Agr/open	Same
F8	Williamson	Private	R	Open/agr	Same
Roads	Rutherford	Private	R-15	Rural	Same/none
Utilities	Rutherford/Marshall	Private	R-15/R/none	Rural	Same/none

Source:

area's center. Approximately one-half of this site is designated as prime farmland. Zoning is R-15 (Residential-15), and land use plans propose no change in use.

d. Buffer Area and Buried Beam Zone I

1. West Buffer Area and Buried Beam Zone Access Areas J3 and J4

The west buffer area and buried beam zone access areas consist of half forested land and half agricultural, which is split between pasture and cropland. Rural residences are lightly scattered along State Route 96, Windrow Road, and Kingwood Lane. There are large areas of undeveloped forest. A small residential development is located in the western section near Lockwood Lake, and a cemetery lies at the edge on Route 96. The eastern extreme area is crossed by Overall Creek and Route 99. A small part of the site, mostly the northcentral and eastern sections, is designated as prime farmland. Zoning is R-15 (Residential-15) and land use plans propose no change in use for the area.

Site J3 consists almost entirely of forested land with some agricultural use on the north corner. Surrounding areas to the south are all forested, while to the north mixed forested, cropland, and pasture uses are found. Some areas to the north and east are prime farmland, and no other uses are within 1,000 feet of the site.

Site J4 is crossed on the southern corner by State Route 96, and contains a mix of forested area and croplands. A stream runs north/south through the center, and at least one residence is found on site along Route 96. Several more roadside residences are located within 1,000 ft of the proposed site. Land use plans propose no change in land use.

2. East Buffer Area and Buried Beam Zone Access Areas J1 and J2

The east buffer area and buried beam zone access areas are crossed in a north/south direction by the West Fork Stones River, U. S. Route 231, and the Louisville and Nashville rail line. Cropland farming is the most common use, with significant areas of pasture, rural open space and forested land found throughout. A rural residential development of approximately 40 homes is located in the center and farm residences lightly dot the few minor roads. The small residential community of Christiana lies on the southern edge, and within the site are two cemeteries, an elementary school, and several rural residences associated with the town. Within 1,000 ft of the area are two churches and a school to the north, churches and residences in Christiana, and several farm residences along the remaining perimeter. Most of the site area is considered to be prime farmland. It is zoned R-15 (Residential-15), and land use plans propose no change in use.

Site J1 consists largely of cropland and rural open space, with a large cemetery located on a minor road in the southcentral portion of the site. A few residences are along this road within 1,000 ft of the proposed site, and some forested land lies to the north. Most of the site area is designated prime farmland.

Site J2 is intersected by U. S. Highway 231 and a perpendicular minor roadway. Land use is a mix of agricultural cropland, pasture, and forested land with a few farm residences along the roadways. Surrounding uses are of the same rural mix, but include several rural residences concentrated to the south and a small lake to the east. Portions of the area are designated as prime farmland.

e. Near Cluster Ring G, Including Intermediate Access Areas E1 and E10, Service Areas F1, F9, and F10, Buried Beam Access Areas J5 and J6, and Interaction Points and Experimental Areas K1 and K2

The near cluster arc is of the same rural land use character as that described for the near cluster quadrant in general. The same features cross the arc, except State Route 96, which runs east/west to the north. Like the neighboring areas, it is zoned agricultural, and county land use plans propose no change in use. The western fifth is nearly all forested, while the remainder is of mixed R-15 (Residential-15) use, mostly prime farmland.

Site F9, located 500 ft west of Opossum Trot Road, consists of cultivated cropland, pasture and woodland. Surrounding uses are the same, with forested land to the north and west. At least one farm residence is found along this road within 1,000 ft of the proposed SSC site, and prime farmland lies along its western edge.

Site E10 is located 200 ft north of Overall Creek and a paralleling minor road. Land use on and surrounding the site is the same cropland, pasture, forested land mix, with a few farm residences found within 1,000 feet to the east and southeast along roadways. Portions of the area are designated as prime farmland.

Site J6 also consists of forested land, cropland and pasture, with a few farm residences, a small lake, and a minor road within 1,000 ft of the proposed SSC site. Approximately 60% of the site is designated as prime farmland.

Site F10 is located several hundred feet east of the Armstrong Valley Road, and north of another minor roadway. Land use is agricultural, pasture, cropland, and rural open space. Several rural residences are found within 1,000 ft along the roadways, as is the Cherry Grove Church. The area is almost entirely designated as prime farmland.

Site K1 and the surrounding area is of mixed rural use with forested land to the east, pasture and crop farming to the west. Three farm residences are found within 1,000 ft to the southwest. Areas west of the site are designated as prime farmlands.

Sites J5 and K2 are under agricultural use as cropland and pasture, with forested land found to the south and west. A minor road and at least one farm residence is on the site, as well as a small lake. No other uses or residences are within 1,000 ft, and most of the area is designated as prime farmland.

Site E1 is on an area of pasture and cropland, with some forested areas within 1,000 ft to the east. No residences or other improvements are located near the site. Designated prime farmlands lie to the west.

Site F1 is a mixed area of cropland, pasture and rural open space. It is crossed on its western edge by Christiana Creek, and about 1,000 ft to the east of U. S. Route 231. There is one possible farm residence located along the highway within 1,000 ft of the site. The remaining surrounding uses are the same. Parts of the area, especially to the west, are designated as prime farmland.

2. SSC Project Far Cluster Quadrant

a. Far Cluster Ring H, Including Intermediate Access Areas E5 and E6, Service Areas F5, and Interaction Points and Experimental Areas K3, K4, K5, and K5

The far cluster quadrant is located in unincorporated areas of Marshall and Bedford counties on a mixture of forested land, rural open space, and cropland agriculture. Residential density is extremely low with only occasional farm houses along rural roadways. The area is crossed by the Louisville and Nashville Rail Line, U. S. Route 31A, Spring Creek, Wilson Creek, North Fork Creek, an overhead transmission line, and several minor roadways. No population centers are encountered in the quadrant, and the land is privately owned. About one-half of the area lies in each of Bedford and Marshall counties. Bedford County currently does not have any land use plans, zoning, or subdivision regulations affecting the area. No zoning restrictions or land use plans are in effect for the Marshall County area; however, county subdivision regulations are enforced. Proposed zoning being formulated for both counties is rural and consistent with the existing use.

Site E10 is located in Bedford County, just north of the intersection of Clem Creek, and a minor roadway about 1,500 ft west of North Fork Creek. The site is entirely forested land with some rural open space and cropland use within 1,000 ft of the proposed SSC site. Also within this area is an overhead transmission line to the south, and at least one farm residence is located along the road to the north. Some prime farmlands are located to the west and southeast of the site.

Site K3 is located in Bedford County on an area of forested land, rural open space, and cropland agriculture. A minor road runs east/west to the north of the site, and one farm residence is found along it within 1,000 ft. No other uses are noted in the remaining surrounding areas.

Site K4, located in Bedford County, consists of cropland agriculture and rural open space uses, with no residences or other structures within 1,000 ft. Surrounding uses are the same with some small forested patches, a minor road and Wilson Creek.

Site F5, located in Bedford County, about 800 ft east of the Marshall County line, is a mix of cropland agriculture and rural open space with

small parcels of forested land scattered around the site. A minor road lies 300 ft to the east, and there are two farm residences within 100 ft of the site along the road.

Site K5, located in Marshall County on forested land, is surrounded by more forest cover, croplands, and rural open space. Two farm residences are found approximately 600 ft to the southwest.

Site K6, located in Marshall County, on cropland agriculture and rural open space, is crossed on the southeast by the Plum Branch of Spring Creek. An east-west running minor road crosses the center of the site and surrounding land use is cropland and open space mixed with some patches of forest cover. No residences or other users are found within 1,000 ft.

Site E6, located in Marshall County approximately 800 ft east of Spring Creek and 400 ft north of the smaller West Fork, is mostly cropland agriculture with small areas of rural open space. Surrounding uses are the same, with some small patches of forest cover. No residences, roads, or other users are found within 1,000 ft and some areas to the east are designated as prime farm lands.

3. SSC Project Eastern Arc Quadrant

a. Eastern Arc Quadrant D, Including Intermediate Access Areas E2, E3, and E4, and Service Areas F2, F3 and F4

The eastern arc quadrant is also characterized by a mixture of cropland, forested land, rural open space, and pasture. It is located in both Rutherford and Bedford counties and includes part of the unincorporated community of Fosterville. Zoning in the Rutherford County section is R-15 (Residential-15), which is a low density, mixed residential zone. Future land use plans propose no change in use. No zoning restriction or land use plans currently exist for Bedford County. The Louisville and Nashville rail line, U.S. Route 231, and State Route 16 cross the arc, and the community of Christianson lies just east of its northern end. Small sections of prime farmland are scattered throughout the area.

Site E2, located in Rutherford County, is an existing residential/farm complex site, east of a small reservoir. A minor road runs along the eastern edge and at least one other residence is within 1,000 ft. Remaining surrounding uses are cropland agriculture, forested land, and rural open space. The area is zoned R-15 (Residential-15) and is planned to remain as such. Small areas designated as prime farmland are located to the northeast.

Site F2, located in Rutherford County, is under use as either cropland agriculture or rural open space. A minor road crosses the northwest corner and several farm residences are found along it within 1,000 ft. Remaining surrounding uses are the same. The area is zoned R-15 (Residential-15) and is planned to remain as such. North of the site are areas designated as prime farmland.

Site E3, located in Bedford County, is crossed on the northeast corner by U.S. Route 231. Land use is cropland agriculture, with surrounding areas being cropland, rural open space, and some forested land. Several farm residences are located along the roadway within 1,000 ft. No zoning regulations or land use plans currently exist for the area.

Site F3, located in Bedford County, consists of rural open space with some cropland agricultural use. Surrounding land use is of the same character with a few farm residences located near Coop Road some 400 ft to the south. No zoning restrictions or land use plans exist for the area and some prime farmlands are found to the northeast.

Site E4 is located in Bedford County on forested land and rural open space. Surrounding uses are the same with some cropland agriculture. No residences or other improvements are within 1,000 feet and no zoning regulations or land use plans exist for the area. Some prime farmlands are found about 500 ft east of the site.

Site F4 is located in Bedford County, on land that is mostly rural open space with some cropland agricultural use. Surrounding uses are generally of the same character with a road and several farm residences to the north and two overhead transmission lines, all within 1,000 ft of the site. No zoning restrictions or land use plans currently exist for the area and small patches of prime farmland are found to the south and east.

4. SSC Project Western Quadrant

a. Western Arc Quadrant D, Including Intermediate Access Areas E7, E8, and E9, and Service Areas F6, F7 and F-8

The western arc quadrant, located in unincorporated areas of Marshall, Williamson, and Rutherford counties, is characterized by a fairly even mix of forested land, cropland, farming, pasture, and rural open space with a light sprinkling of farm/rural residences. The crossroads community of Kirkland lies partially within the arc and College Grove is approximately 100 ft outside the area. The arc is crossed by State Routes 11 and 16, the Louisville and Nashville Rail Line and the Harpeth River. It is privately owned and small portions are designated as prime farmland. Zoning in Rutherford and Williamson counties is R-15 (Residential-15) and R (Rural District), respectively, allowing only the lowest densities of farm/rural residences. No zoning instructions or land use plans exist for those portions within Marshall County. The only other zoning designation encountered is Kirkland, a designated "Crossroad Center" for Williamson County, which provides for some types of commercial development in established rural communities. Both Williamson County and Rutherford County land use plans call for a continuation of rural/agricultural use in and around the arc area.

Site F6, located in Marshall County, consists of forested land, rural open space, and pasture. Surrounding uses are the same and no residences or other structures are located within 1,000 ft of the site. No zoning restrictions or land use plans exist for this area.

Site E7, located in Williamson County, consists entirely of forested land and rural open space. No other uses are found within 1,000 ft of the site. The area is zoned R (Rural District), which allows varying low-density residential uses; land use plans call for continuation of the area's rural character. Small patches of prime farmland are located near the site.

Site F7 is located in Williamson County approximately 500 ft south of Jordan Road. Like site E7, zoning is R (Rural District) and land use plans propose no changes in use. The site is composed of cropland, pasture, and rural open space, and no other uses are found within 1,000 ft. Much of the area around the site is designated as prime farmland.

Site E8 is also located in Williamson County about 800 ft northwest of the community of College Grove. College Grove Road lies 500 ft to the south and the Louisville and Nashville rail line lies 500 ft to the east, beyond Stoke Mill Road. Land use of this site is rural open space with a small amount of pasture. Several residences are found within 1,000 ft along the roadways and in College Grove, which is designated as a Crossroad Center zone. Land use plans propose no change in use and areas west of the site are designated as prime farmland.

Site F8, located in Williamson County, is composed mostly of rural open space with some pasture use. Surrounding areas also include cropland, forest land, a few farm residences, and a small lake, all within 1,000 ft of the site. Zoning is R (Rural District) and expected to continue as such in accordance with county land use plans. Some areas south of the site are designated as prime farmland.

Site E9, located in Rutherford County, is zoned for agricultural use. Land use is either forested or rural open space, which is consistent with the surrounding areas. There is a small cemetery located 500 ft to the north, otherwise there are no residences or other uses within 1,000 ft except for some occasional cropland farming. Land use plans propose no changes in use, and small scattered areas to the west are designated as prime farmland.

5. Planned SSC Project Road and Railroad Networks

Location descriptions of planned SSC project road improvements are provided in Section 1.2.1.2. Adjacent land use patterns for the road network are no different than those generally described for the area.

There are no future plans that constrain these areas from further upgrading. The existing railroad network is adequate for the project, with no improvements deemed necessary.

6. Planned SSC Project Utility Improvements

Location descriptions of planned SSC project utilities are provided in Section 1.2.1.2. Adjacent land use patterns for these utility upgrades are no different than those generally described for the area. There are no future plans that constrain these areas from further improvements.

5.6.10.3 Soil and Prime Farmland Resources

A. Factors of Soil Formation and the Resulting Soil Cover

The proposed Tennessee SSC site is part of four counties: Rutherford County hosts almost three-quarters of the fee simple area. The remaining acreage is located in Bedford, Marshall, and Williamson counties. Information on the soil cover in Bedford County is available (yet not formalized as a soil survey volume); however, the soils in Marshall and Williamson counties have never been systematically mapped. Although referred to as the whole fee simple area, the analysis applies solely to the 5,700 acres located in Rutherford County. This acreage includes the campus, injector, future expansion, near cluster, and four abort/external beam areas, J1, J2, J3, and J4.

The northeastern part of the site, located in Rutherford County, is part of the physiographic region known as the central basin. The dominant soil parent material is a clayey residuum weathered from limestone (Gladeville and Talbott soil series), or an old alluvium with or without loess, underlain by the clayey limestone-generated residuum (for the Bradyville, Harpeth, and Lomond soil series). These five soil series comprise 60% of the 5,700 acres discussed in this section.

The Tennessee site, although completely covered by limestone, is characterized by leached soils. The relatively high average annual precipitation, equal to 50 inches, results in a soil cover with a udic moisture regime, characterized by almost 6 months of recharge (rainfall with little evapotranspiration), a surplus of water in the soil lasting through late spring, and a direct transition from a period of water utilization by the plants, to recharge, without an intermediary period of water deficiency; thus, soils never dry excessively (Soil Taxonomy 1975). On most surfaces, the downward percolation of the soil solution throughout some part of the soil profile lasts at least 6 out of 12 months. In the short period when evapotranspiration exceeds recharge the upward flux of water in the soil profile occurs as unsaturated flow and thus the flux is minimal. The dominating year-around downward flux of water removes by dissolution the calcium carbonate from the upper limestone and, both by weathering and residually, generates a soil characterized by a fine-silty particle size class (the fine earth contains at least 18% clay and the whole soil has, by weight, less than 15% particles larger than 1/100 of an inch (Soil Taxonomy 1987). Leaching of sparingly soluble constituents lead ultimately to the formation of acid soils. The pH of the soil cover can be as low as 5.1. The abundance in clay size particles coupled with a relatively high precipitation/evaporation ratio results in soils of excessive wetness. Other soils such as the Almaville, Byler, and Woodmont soil series that cover 250 acres have developed a compact brittle horizon (fragipan) that almost completely restricts root penetration. All these characteristics, and the high frequency of rock outcrops, make the proposed Tennessee SSC site a site with limited agricultural potential, particularly in terms of cultivated croplands.

The generalized soil map of the United States (Soil Taxonomy 1975) shows that at the proposed Tennessee site, the soil cover is represented characteristically by the suborder Udalfs, with Aqualfs, Aquolls, Rendolls, Udolls, and Udults. Table 5.6.10-2 shows that Udalfs, covering more than 3,000 acres, represent 58%; Aquolls, Rendolls, and Udolls represent 26%; and Udults represent 13% of the reduced fee simple area. The remaining 3% are covered by Aqualfs.

A total of 47 soil mapping units (soil phases) were identified in Rutherford County; they represent 26 soil series. Three, Bradyville, Lomond, and Talbott (all Udalfs), cover 40% of the reduced fee simple area and are located on uplands. Unlike Talbott that developed directly into limestone residuum, Bradyville and Lomond developed on old alluvium overlying weathered limestone. This difference has profound repercussions in terms of the natural productivity. Although all three soils have a silty clay-clayey firm subsoil, the Talbott clayey subsoil is at a shallow depth, as superficial as half a foot; at two feet the Talbott subsoil is represented by a firm, plastic clay. Unlike the other two soils that have a friable upper subsoil, the Talbott subsoil is impermeable for roots. While the Bradyville and Lomond soil series qualify as prime farmlands as long as the slope of the terrain is not in excess of 5%, the Talbott soil, often associated with limestone outcrops, is classified as land of secondary importance.

In addition to the three indicated soil series, a little over 400 acres are covered by a Gladeville association in which the leading soil occupies roughly 40% of the area; Gladeville is a very shallow soil normally less than one foot, lying directly over weathered limestone. The Harpeth soil, another major component of the soil cover, has a surface horizon of 12 inches and an unusually deep subsoil, a silty loam and a friable silty clay loam in excess of 5 feet. In this soil the firm clay is encountered at depths in excess of 5-6 feet. The Harpeth soil, similar to the Bradyville and Lomond, qualifies as prime farmland as long as the terrain has a slope below 5%.

B. Farming Potential of Soils

The Soil Conservation Service soil classification system identifies for each soil phase its suitability for agricultural use. The system, known as capability grouping, has three levels of classification. The most general category, the capability class, separates soils into eight classes: class I comprises soils that can be used to produce practically all local crops; classes II and III include soils with moderate and severe limitations; class V soils have limitations so severe that they are economically unsuitable for cultivated crops; class VIII represents soils that have only a recreational/wilderness use. The second level of classification is the subclass showing the main limitation that prevents the soil from being a class I soil. This is indicated by a subscript e,w, or s. The third level of classification, the capability unit, indicates a particular set of management practices to be used for a particular subclass; this level is not used, thus is not discussed in this section.

Table 5.6.10-2

SOIL SUBGROUPS AND SERIES WITH CORRESPONDING ACREAGES AT THE TENNESSEE SSC SITE

Subgroups	Series	Acreages
Typical Hapludalfs: (1641.908 acres)	Bradyville	1,061.800
	Mimosa	39.590
	Talbott	540.518
Ultic Hapludalfs: (236.616 acres)	Capshaw	220.381
	Hampshire	7.553
	Stiversville	8.682
Aquic Hapludalf:	Tupelo	122.400
Typic Paleudalf:	Hillwood	2.136
Mollic Paleudalf:	Lomond	549.232
Aquic Paleudalf:	Nesbitt	173.822
Rhodic Paleudalf:	Cumberland	119.060
Typic Fragiudalf:	Byler	185.388
Glossaquic Fragiudalf:	Woodmont	45.271
Vertic Ochraqualf:	Dowellton	134.528
Typic Fragiaqualf:	Almaville	14.056
Cumulic Hapludolls: (296.390 acres)	Arrington	99.438
	Egam	196.952
Lithic Hapludoll:	Barfield	166.302
Fluvaquentic Hapludoll:	Lynnville	44.159
Lithic Haplaquoll:	Dilton	100.582
Vertic Haplaquoll:	Roellen	220.063
Fluvaquentic Haplaquoll:	Eagleville	183.420
Lithic Rendoll:	Gladeville	413.618
Humic Hapludult:	Harpeth	678.238

Table 5.6.10-2 (Cont)

SOIL SUBGROUPS AND SERIES WITH CORRESPONDING ACREAGES AT THE TENNESSEE SSC SITE

Subgroups	Series	Acreages
Alfic Eutrochrept:	Inman	9.910
Typic Fluvaquent:	Melvin	1.551
Total per Great Groups	Hapludalfs	2,000.924
	Paleudalfs	844.250
	Fragiudalfs	230.659
	Ochraqualfs	134.528
	Fragiaqualfs	14.056
	Hapludolls	506.851
	Haplaquolls	504.065
	Rendolls	413.618
	Hapludults	678.238
	Eutrochrepts	9.910
	Fluvaquents	1.551
Total per Suborders	Udalfs	3,075.833
	Aqualfs	148.584
	Udolls	506.851
	Aquolls	504.065
	Rendolls	413.618
	Udults	678.238
	Ochrepts	9.910
	Aquents	1.551
Total per Orders	Alfisols	3,224.417
	Mollisols	1,424.534
	Ultisols	678.238
	Inceptisols	9.910
	Entisols	1.551

Table 5.6.10-3 presents the proportion of soils characterized by different capability subclasses. Disregarding the subclass nomenclature (the letter designation) and substituting roman numerals an acreage-weighted average capability class for the reduced fee-simple area was calculated, and found to be equal to 3.34. This relatively large value means that, when all soils of the investigated area are considered, one can conclude that the soil cover has severe limitations in its agricultural use.

Table 5.6.10-3 indicates a large variation in the suitability of soils for agricultural uses. The table shows that almost a quarter of the acreage is class I, which means that this acreage has practically no limitations associated with its use. This high proportion of class I soils came as a surprise since central Tennessee with its characteristic Alfisols is not known for a high level of natural productivity. Table 5.6.10-3 also shows that a little over a quarter of the reduced fee simple acreage is covered by soil phases that belong to capability classes VI and VII. Unlike the erosion hazard and, to a certain extent, the excessive wetness hazard, generally determined by outside conditions rather than intrinsic soil characteristics, the droughtness or the shallowness of a soil are characteristics that reflect and almost define a soil of poor agricultural quality.

C. Prime, Unique, and Important Farmlands at the SSC Site

The description of soils in Sections A and B above has identified a soil cover of limited agricultural potential. If statistics compiled for the whole Rutherford County are also applicable for the 5,700 acres, then one can say that most of this acreage is used as pasture and hay with relatively small acreages of corn, small grain, cotton, soybeans, and tobacco (Soil Survey of Rutherford County, Tennessee 1977).

Soil phases analyzed from the standpoint of compliance with criteria for prime farmland (7 CFR 5, Identification of Important Farmlands 1986), generated the data included in Table 5.6.10-4. Although the overall conclusion of the table is that half of the reduced feesimple acreage is prime farmland, this acreage is marginally good agricultural quality. The other half is equally divided between important farmlands and lands of secondary importance. Important farmlands are would-be prime farmlands that do not qualify because the slope of the terrain is in excess of that required for prime farmland qualification i.e., Bradyville silt loam and Bradyville silty clay loam, 5 to 12% slope, severely eroded, and Cumberland silty clay loam, 5 to 12% slope, severely eroded. Important farmlands are also represented by soils having a fragipan in the soil profile i.e., Almaville silt loam, Byler silt loam, 2 to 5% slope and Woodmont silt loam; or soil complexes with a high proportion of rock outcrops, Bradyville-Rock outcrop complex, 0 to 2% slope; or soils with a relatively superficial clayey subsoil that impedes root penetration, Capshaw silt loam, 2 to 5% slope and Cumberland silty clay loam, 2 to 5% slope, severely eroded.

Table 5.6.10-3

CAPABILITY SUBCLASSES AND CORRESPONDING ACREAGES/ACREAGES FOR EACH LIMITATION

Capability Subclass	Acreage
I	1,305.95
IIe	1,055.75
IIw	534.83
IIIe	306.29
IIIw	508.08
IVe	79.89
IVw	148.58
IVs	182.06
VIe	32.33
VIs	420.12
VIIs	1,088.62

Main Limitation	Acreage	Percent
Erosion hazard (e)	1,474.26	26.0
Excessive wetness (w)	1,191.49	21.0
Shallow, droughty, stony (s)	1,690.80	29.9
No hazard	1,305.95	23.1

Lands of secondary importance are represented by soil phases of either complexes or associations, with an unusually high proportion of rock outcrops and/or extremely slopey terrain.

A generalization from the reduced fee-simple (5,700 acres) to the total fee simple (7,770 acres) can only be attempted using information submitted by the State of Tennessee in a Prime Farmland Map. This map indicates a higher proportion of prime farmland included in the reduced fee simple acreage, because roughly 600 acres identified by the State of Tennessee as being prime farmland is marked in this section as being only important farmland. Thus, the Byler silt loam, 2 to 5% slope was removed from the group of prime farmland as indicated by the state and included in the important farmlands because the soil presents a fragipan at 18 to 34 inches that restricts root development and is often waterlogged during rainy periods (Soil Survey of Rutherford County 1977). The Capshaw soil also removed from the state Prime Farmland List has a superficial clayey subsoil at 4 to 8 inches that prevents roots from proper development (Soil Survey of Rutherford County 1977). The Eagleville silty clay loam is likely to be an important rather than a prime farmland because of its susceptibility to maintain a high water table, and generally poor drain (Soil Survey of Rutherford County 1977). In the case of Egam silt loam and Tupelo silt loam, half of their acreages were retained as prime farmlands (according to the state indication) and half were transferred to the group of important farmlands as a result of the survey descriptions. (Soil Survey of Rutherford County 1977). Similar arguments were invoked to justify the reversal from prime to important farmlands of Melvin silt loam, Nesbitt silt loam, 2 to 5% slope and Roellen silty clay.

The prime farmland map presented by the state also includes the far cluster the bypass, roughly 2,000 acres of land. The proportion of prime farmland in the far cluster and bypass is slightly in excess of 20% of the land, roughly 420 acres. Consequently, the total prime farmland included in the fee simple area at the Tennessee site is approximately 3,200 acres; this figure represents the sum of 2,750 acres inventoried in the reduced fee simple area and the 420 acres in the far cluster and bypass.

Table 5.6.10-4

SOIL PHASES, CORRESPONDING ACREAGES, AND THEIR CLASSIFICATION AS PRIME FARMLANDS, IMPORTANT FARMLANDS, AND LANDS OF SECONDARY IMPORTANCE

Soil Phases	Prime Farmlands	Important Farmlands	Lands of Secondary Importance
Almaville silt loam		14.056	
Arrington silt loam	99.438		
Barfield silty clay loam, 1-8% s.		9.200	
Bradyville silt loam, 0-2aa5 s.	178.413		
Bradyville silt loam, 2-5% s.	479.375		
Bradyville silt loam, 5-12% s.		49.749	
Bradyville silty clay loam, 2-5% s., severely eroded		9.257	
Bradyville silty clay loam, 5-12% s., severely eroded		3.307	
Bradyville-Rock outcrop complex, 0-2% s.		179.928	
Bradyville-Rock outcrop complex, 2-12% s.			146.038
Byler silt loam, 0-2% s.	131.859		
Byler silt loam, 2-5% s.			53.529
Capshaw silt loam, 0-2% s.	161.86		
Capshaw silt loam, 2-5% s.		58.521	
Cumberland silt loam, 0-2% s.	15.375		
Cumberland silt loam, 2-5% s.	75.761		
Cumberland silty clay loam, 2-5% s., severely eroded		21.442	
Cumberland silty clay loam, 5-12% s., severely eroded		6.482	
Dilton-Rock outcrop complex			43.581
Dowellton silt loam		134.528	
Eagleville silty clay loam		118.792	
Egam silt loam	98.476	98.476	
Gladeville-Rock outcrop-Talbott association, rolling			1,034.046
Gullied land			30.914
Hampshire silt loam, 5-12% s., eroded		7.553	
Harpeth silt loam, 0-2% s.	636.556		
Harpeth silt loam, 2-5% s.	41.682		
Hillwood gravelly silt loam, 2-12% s.		2.136	
Inman flaggy silty clay loam, 12-30% s.			9.910

Table 5.6.10-4 (Cont)

SOIL PHASES, CORRESPONDING ACREAGES, AND
THEIR CLASSIFICATION AS PRIME FARMLANDS, IMPORTANT FARMLANDS, AND
LANDS OF SECONDARY IMPORTANCE

Soil Phases	Prime Farmlands	Important Farmlands	Lands of Secondary Important
Lomond silt loam, 0-2% s.	283.624		
Lomond silt loam, 2-5% s.	265.608		
Lynnville silt loam	44.159		
Melvin silt loam		1.551	
Mimosa-Rock outcrop complex, 5-20% s.			12.911
Mimosa-Rock outcrop complex, 20-40% s.			54.578
Nesbitt silt loam, 0-2% s.	92.545		
Nesbitt silt loam, 2-5% s.		81.277	
Roellen silty clay loam	82.651		
Roellen silty clay		137.412	
Stiversville silt loam, 5-12% s.		2.425	
Stiversville silt loam, 12-20% s.		6.257	
Talbott silt loam, 2-5% s., eroded		223.419	
Talbott silt loam, 5-12% s., eroded			46.442
Talbott silty clay loam, 2-5% s., severely eroded			9.853
Talbott silty clay loam, 5-12% s., severely eroded			13.223
Talbott-Barfield-Rock outcrop complex, 2-12% s.			217.585
Tupelo silt loam	61.200	61.200	
Woodmont silt loam		45.271	
Total	2,748.582	1,316.568	1,628.281
Percent of Total	48.3	23.1	28.6

5.6.11 Socioeconomics

5.6.11.1 Socioeconomics

SSC development and operation at the site southwest of Murfreesboro proposed by the State of Tennessee could measurably affect socioeconomic conditions in as many as 21 middle Tennessee counties (Figure 5.6.11-1). The combined workforce of these counties, especially that group involved in construction and services, may provide a sizable portion of the SSC work force. The middle counties include all communities within one hour driving time from the site, and would most likely house relocating workers. The Nashville metropolitan area would service many of the SSC's needs and because of its proximity to the campus, the City of Murfreesboro would also provide goods and services. The economic activity in these cities would filter through the region and affect smaller cities as well.

The region of influence (ROI) studied for economic and demographic issues in this EIS includes the entire 21-county area. Bedford, Marshall, and Rutherford counties were designated as primary impact counties because they make up the area where nearly all the project would be located and where most workers would relocate. Housing markets in Davidson and Williamson counties, especially around southern Nashville and Franklin, could also attract some of the SSC population.

A. Economic Activity, Labor Force, and Income

1. Regional Setting

With the exception of two years of setbacks (1975 and 1980), the economy of the 21-county region has grown steadily for the past two decades (Table 5.6.11-1). Expansion in the employment base was greater than the national average. Total employment growth averaged 2.4 percent annually between 1969 and 1984, compared with the U.S. annual average of 1.9% (U.S. Department of Commerce, Bureau of Economic Analysis 1986).

The mining sector experienced the largest percentage growth with an average annual rate of 5.6%, greater than the national average of 4.1%. Other leading sectors in ROI employment growth were retail trade, which grew at a 4.0% annual rate; services, which grew at an annual rate of 3.7%, and transportation and public utilities, which posted a 3.6% annual growth rate.

Farming was the only sector in the region to experience an overall decline in employment during the 16-year period. With a 0.7% average annual loss in farm employment, this decline is consistent with the national trend for that period. The U.S. farming sector experienced an average annual 1.0% loss in employment from 1969 to 1984. The manufacturing sector, on the other hand, which experienced an average annual loss in employment of 0.2 percent nationally, grew in the ROI at a 1.3% annual rate. Figure 5.6.11-2 shows the distribution of employment in

Figure 5.6.11-1

COUNTIES FOR SOCIOECONOMIC ANALYSIS IN THE TENNESSEE SSC ROI

Table 5.6.11-1

HISTORIC ECONOMIC INDICATORS FOR THE TENNESSEE ROI, AND BEDFORD, MARSHALL, AND RUTHERFORD COUNTIES

	1969	1974	1979	1984	1987	Average Annual Growth Rate
TENNESSEE ROI						
Total employment [1]	450,436	525,715	592,256	640,598	NA [2]	2.4%
Earnings per worker [3]	$17,638	$17,925	$18,528	$18,414	NA	0.3%
Labor Force	NA	458,260	536,550	588,960	636,460	2.6% [4]
Per capita personal income [3]	$10,476	$11,779	$12,608	$13,230	NA	1.6%
Unemployment rate	NA	4.2%	4.8%	6.6%	5.2%	NA
BEDFORD COUNTY						
Total employment	13,142	13,542	14,268	13,645	NA	0.3%
Earnings per worker	$14,991	$14,818	$14,998	$14,341	NA	-0.3%
Labor force	NA	11,850	12,600	12,330	12,990	0.3% [4]
Per capita personal income	$ 9,558	$10,235	$11,193	$11,196	NA	1.1%
Unemployment rate	NA	7.3%	6.0%	10.4	7.4%	NA
MARSHALL COUNTY						
Total employment	8,931	10,338	12,289	12,725	NA	2.4%
Earnings per worker	$14,859	$14,882	$16,560	$16,379	NA	0.7%
Labor force	NA	8,670	9,670	11,220	10,210	1.6% [4]
Per capita personal income	$ 8,979	$10,476	$11,669	$12,271	NA	2.1%
Unemployment rate	NA	5.3%	4.1%	6.6%	6.8%	NA
RUTHERFORD COUNTY						
Total employment	26,218	27,895	33,213	41,508	NA	3.1%
Earnings per worker	$16,466	$16,154	$17,397	$19,292	NA	1.1%
Labor force	NA	32,600	39,070	49,920	57,260	4.9% [4]
Per capita personal income	$10,065	$10,461	$11,636	$12,403	NA	1.4%
Unemployment rate	NA	4.4%	4.5%	5.7%	5.0%	NA

Notes:

1. Employment is by place of work.
2. NA - data not available or not applicable.
3. Earnings and income are in constant 1988 dollars.
4. Labor force average annual growth rates are for 1970-1987.

Sources: Department of Commerce 1986; Tennessee Department of Employment Security 1988.

the eleven major industrial sectors in the ROI in 1984. The dominant sectors of the ROI economy, in terms of employment, are services (23.7%), manufacturing (19.8%), retail trade (15.6%), and government (12.4%).

Average earnings per worker for the ROI were $18,414 below the national average in 1984. Average earnings per worker in 1984 were greatest in transportation and public utilities ($29,515) and mining ($27,040) (all values represent 1988 dollars).

Since 1969, the unemployment rate in the Tennessee ROI has consistently remained below the national average, except in 1981 and 1982. Most recently, unemployment in the ROI was 5.2% (Tennessee Department of Employment Security 1988; U.S. Council of Economic Advisors 1988). The ROI's labor force has grown at an average annual rate of 2.6% from 1970 through 1987 and numbered nearly 640,000 persons in 1987.

Per capita personal income in the Tennessee ROI in 1984 was $13,230. This value is much lower than that for the nation as a whole and has remained below the national average every year since 1969.

Between 1988 and 2000, employment is expected to grow at an average annual rate of 1.4%, from an estimated 7 million jobs to 8 million. This level of growth approximates the 1.3% national annual growth projection for employment between 1988 and 2000 (U.S. Department of Labor, Bureau of Labor Statistics 1987).

2. Primary Impact Counties

a. Bedford County

In 1984, Bedford County with the second highest employment rates and incomes of the primary impact counties, provided 2.1% of the employment in the ROI and 20.1% of total employment in the three primary impact counties. The county similarly received 2.2% of total personal income in the ROI and 18.4% of total personal income in the primary impact counties. Total employment growth in the county averaged 0.3% annually between 1969 and 1984.

Average annual employment grew at rates exceeding the national and ROI average rates in four of the eleven industrial sectors. Employment in agricultural services, forestry, and fishing grew fastest from 1969 to 1984, at an average annual rate of 8.5%. The wholesale trade and finance, insurance, and real estate sectors both posted average annual growth rates exceeding 4.0%. Only employment in the farming and construction sectors incurred declines in growth during that period. The distribution of employment in the 11 major industrial sectors in predominantly rural Bedford County in 1984 varied somewhat from that of the ROI. The four sectors in the county with the highest employment were manufacturing (33.5% of the total county jobs), farming (13.8%), services (13.7%), and government (12.6%).

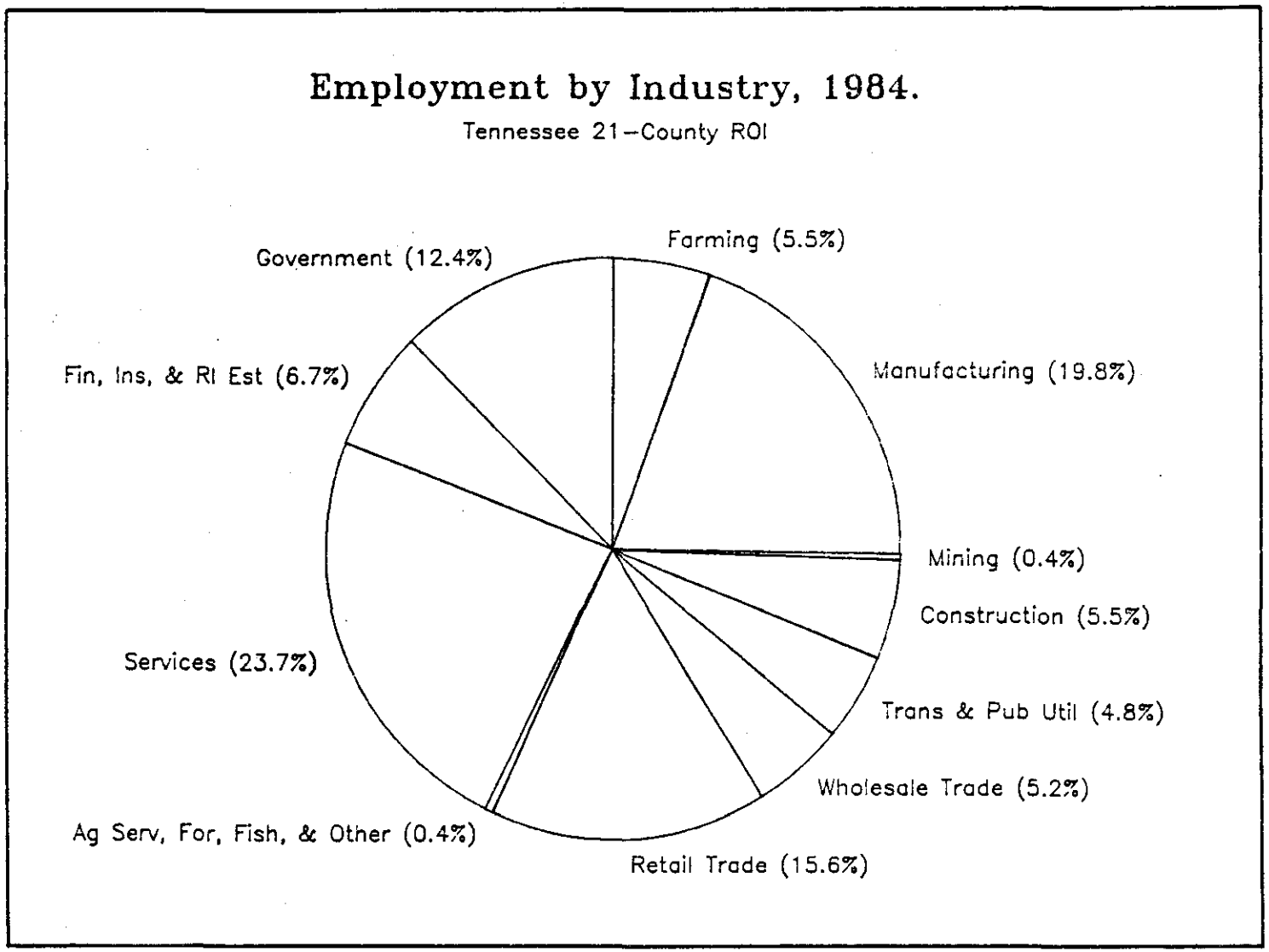

Figure 5.6.11-2

EMPLOYMENT BY INDUSTRY
TENNESSEE SSC REGION

Average 1984 earnings per worker were $14,341, less than both the national and ROI averages in 1984 and the lowest of all ROI primary impact counties under consideration for SSC development. In 1984, the highest average earnings per worker were paid in the transportation and public utilities sector at $30,174.

Of the three primary impact counties, Bedford County has recorded the highest unemployment rates over the last two decades. Additionally, unemployment rates in the county have been consistently greater than those for the Tennessee ROI, and since 1979, have been greater than those of the United States as a whole. Unemployment trends in the county, with peaks in 1975 at 14.7% and in 1982 at 17.2%, have been similar to, but more severe than, those of the ROI (Tennessee Department of Employment Security 1988). The County's labor force has remained relatively constant since 1970, growing at an average annual rate of only 0.3%, and numbered slightly less than 13,000 persons in 1987.

Per capita personal income in the county typically was also less than both the national and ROI averages between 1969 and 1984. In 1984, per capita personal income ($11,196) was less than both the Tennesse ROI average ($13,230) and the national average ($14,746) and was the lowest of the three Tennessee ROI primary impact counties.

b. Marshall County

Marshall County is the smallest of the three primary impact counties with respect to employment and total income. In 1984, Marshall County provided 2.0% of the employment and 18.7% of total employment in the three primary impact counties. County residents received 1.7% of total personal income in the ROI and 14.1% of total personal income in the primary impact counties. Total employment growth in the county averaged 2.4% annually between 1969 and 1984.

From 1969 to 1984 average annual employment in the eleven major industrial sectors grew at rates exceeding the average national rates in seven sectors but exceeding the average ROI rates in just three sectors. As in Bedford County, employment in agricultural services, forestry, and fishing grew fastest from 1969 to 1984, at an average annual rate of 6.8%. The manufacturing and wholesale trade sectors followed with average annual growth rates of 4.1% and 3.7%, respectively. Only employment in the farming and mining sectors incurred declines during the 1969-84 period. The distribution of employment in the eleven major industrial sectors in Marshall County in 1984 was similar to that of Bedford County. The four dominant sectors in county employment, were manufacturing (with 50.7% of the total county jobs), services (12.5%), farming (12.0%), and government (8.3%).

Average 1984 earnings per worker were $16,379, less than both the national and ROI averages. The highest average earnings per worker in Marshall County were paid in the transportation and public utilities sector at $24,956.

Over the last twenty years, unemployment rates in Marshall County have moved with those of Bedford County and the Tennessee ROI and, since 1980, have remained consistently greater than those for the ROI. Average annual unemployment rates peaked in 1975 at 9.9% and again in 1982 at 12.7%. Recent data show these rates falling in 1987 to 6.8% (Tennessee Department of Employment Security 1988). The labor force declined by about 1,000 persons between 1984 and 1987, has grown since 1970 at an annual average rate of 1.6%, and included about 10,200 persons in 1987.

Between 1969 and 1984, per capita personal income in the county fluctuated but remained consistently less than both the national and ROI averages. In 1984, per capita personal income in Marshall County ($12,271) was less than both the ROI average ($13,230) and the national average ($14,746).

c. Rutherford County

Rutherford County, has the largest employment and total income of the three primary impact counties, but plays a small role in the ROI economy. In 1984, Rutherford County provided 6.5% of the employment in the ROI and 61.2% of total employment in the three primary impact counties. The county received 8.0% of total personal income in the ROI and 67.5% of total personal income in the primary impact counties. Total employment growth in the county averaged 3.1% annually between 1969 and 1984.

From 1969 to 1984 employment in the eleven industrial sectors in Rutherford County grew at rates exceeding the average national rates in nine sectors and exceeding the average ROI rates in eight sectors. Employment in finance, insurance, and real estate grew fastest from 1969 to 1984, at an average annual rate of 9.5%, followed by the manufacturing, transportation and public utilities, and mining sectors, which grew at average annual rates of 6.3%, 5.6%, and 5.2%, respectively. Farming and government sectors incurred declines during the period. The distribution of employment in the eleven major industrial sectors in Rutherford County in 1984 was similar to that of Tennessee ROI. The four dominant sectors in the county economy, in terms of employment, were manufacturing (with 30.0% of total county jobs), services (17.0%), government (15.0%), and retail trade (12.9%).

In 1984 average earnings per worker in Rutherford County were $19,292, less than the national average but greater than the Tennessee ROI average. The highest average earnings per worker in Rutherford County were paid in the manufacturing sector at $29,233, followed by the transportation and public utilities sector at $24,956.

Over the last two decades, unemployment rates in Rutherford County have been the least volatile of the three primary impact counties. Although increasing and decreasing unemployment trends are similar to those of the other counties in the ROI, the peak average annual unemployment rates have not been nearly as high (7.3% in 1975 and 9.7% in 1982). With the exception of 1980 and 1981, average annual unemployment rates in Rutherford County have remained below the national rates (Tennessee Department of Employment Security 1988). At an average annual rate of 4.9%, the County's labor force has grown faster than the labor force of the ROI as a whole, and much more rapidly than the other two primary impact counties. In 1987, this labor force included more than 57,000 persons.

From 1969 to 1980, per capita personal income in the county fluctuated below both the national and ROI averages. However, county per capita income showed continued, steady growth between 1980 and 1984. In 1984, per capita personal income in Rutherford County ($12,403) was less than both the ROI average ($13,230) and the national average ($14,746) but the highest among the three primary impact counties.

B. Demographics and Housing

1. Regional Setting

Davidson County, in which Nashville is located, contained approximately 41.3% of the ROI's population in 1985 (Bureau of the Census 1988). As a whole, the population of the region has grown slowly over the last half century. Although several counties have had population loss during this time period the most dominant present trend is toward the growth of counties (like Williamson County) and communities (such as Franklin and Brentwood) near Davidson County as suburban Nashville expands.

In 1980, the population of the Tennessee ROI surpassed 1.1 million persons, having grown at an average annual rate of 1.8% from approximately 0.9 million in 1970 (Table 5.6.11-2; Bureau of the Census 1982b). By 1985, regional population increased to total nearly 1.2 million (Bureau of the Census 1988), indicating a 1.2% average annual growth during the preceding 5 years. Projections of the ROI population place nearly 1.3 million persons in the region in 1990, a consequence of 1.4% annual growth from 1980. By the turn of the century, nearly 1.4 million persons are projected to be living in the Tennessee ROI, average annual growth having slowed to 0.6% during the preceding decade. In 2030, regional population is expected to exceed 1.5 million, with the annual rate of increase about 0.4% from 2020.

Table 5.6.11-2

KEY DEMOGRAPHIC INDICATORS FOR THE TENNESSEE ROI

	1970	1980	1990	2000	2010	2020	2030
Population (millions)	0.94	1.12	1.29	1.37	1.43	1.49	1.55
Avg. ann. chg. over preceding decade	1.3%	1.8%	1.4%	0.6%	0.44%	0.41%	0.40%
			Age Distribution				
≤ 4 years	8.1%	7.0%	7.6%	7.5%	7.2%	6.7%	6.3%
5 - 19 years	29.1%	24.5%	20.6%	21.0%	20.2%	19.8%	19.6%
> 65 years	9.6%	11.1%	12.4%	12.7%	13.4%	14.1%	15.1%

Source: Historic data by U.S. Bureau of Census 1982.

Changing regional age structure is anticipated to accompany the projected growth in ROI population, resulting in fewer young persons and more older persons. In 1980, 7.0 percent of the regional population were younger than 5 years, 24.5 percent were 5 to 19 years, and 11.1% were age 65 and older (Bureau of the Census 1982b). By 2000, the first two age groups are expected to represent 7.5% and 21.0% of the regional population, respectively, while the latter age group will comprise 12.7% of the total. By 2030, 6.3% and 19.6% of the regional population are to represent the younger age groups while 15.1% will be 65 or older.

According to the Bureau of the Census (1982a), in 1980 there were more than 425,000 year-round housing units in the Tennessee ROI, 43.9% of which were located in Davidson County. Of the total number of year-round units in the ROI, 64.1% were occupied (or available for occupancy) by owners, 33.1% were occupied (or available for occupancy) by renters, and the remaining 2.8% were considered unavailable for occupancy, being either in transition (for example, under transfer of ownership) or deemed uninhabitable (for example, because of renovation or condemnation).

Of the total year-round housing units in the ROI, 93.7% were occupied in 1980. Considering just year-round units available for occupancy in the ROI, the 1980 vacancy rates were 1.7% for owner units and 7.3% for rental units. Trends in the regional growth of year-round housing units from 1981 through 1986 can be inferred from the number of building permits issued for the construction of new units. During that period more than 70,000 permits were issued, an average of more than 11,000 per year (U.S. Bureau of the Census 1983; 1985b; 1987a).

2. Primary Impact Counties

Bedford, Marshall, and Rutherford counties were defined as the primary impact area for purposes of the demographics and housing analysis. Portions of the proposed SSC site rest in all three of these counties, with the campus site to be located in central Rutherford County.

Predominantly rural Bedford County's population of approximately 21,100 in 1930 has increased by only 6,000 persons in the last 50 years (Bureau of the Census 1982b). In 1980 the population was more than 27,900, having increased at an average annual rate of 1.1% from the 25,000 persons residing there in 1970. By 1985, its population was estimated to be 28,900 (Bureau of the Census 1988), annual growth having slowed to 0.7% during the preceding five years.

The population of Marshall County also increased by only slightly more than 4,000 persons from its 1930 population of 15,600. Its average annual growth from 1970 (17,300 persons) to 1980 (19,700 persons) was approximately 1.3%, which fell to 0.9% between 1980 and 1985 (20,600 persons).

Rutherford County differs from the above two counties both in terms of population size and growth. The 59,400 inhabitants of this county, recorded in 1970, grew to approximately 84,000 by 1980, a result of 3.5% average annual increase throughout the 1980s. By 1985, Rutherford County population had grown to 98,600, with the annual growth during the five preceding years slowing slightly to 3.2%.

Although the populations of Bedford and Marshall counties are expected to continue increasing slowly over the next several decades, the Rutherford County population is expected to continue its rapid growth, because of both the increasing sprawl of Nashville and the growing community of Murfreesboro. Of the several communities within a 30 min commute from the proposed SSC campus, Chapel Hill (Marshall County), Murfreesboro (Rutherford County), and Shelbyville (Bedford County) are anticipated to experience some of the greatest effects in terms of demographics and housing. Their populations in 1980 were 861, 13,530, and 32,845, respectively (U.S. Bureau of the Census 1982b).

In 1980, year-round housing in Bedford, Marshall, and Rutherford counties amounted to under 49,000 units, or 11.4% of the ROI housing stock. Over 30,000 of the units were located in Rutherford County, where 63.0%

were owner units, 34.4% were rental units, and 2.6% were unavailable for occupancy at the time of the census. Of the total year-round units in the county, 91.9% were occupied in 1980. Of those units available for occupancy, vacancy rates were 3.2% for owner units and 10.3% for rental units.

Year-round housing units in Bedford and Marshall counties numbered 10,000 and 7,000, respectively; for both counties, approximately 68% of the units were owner-occupied or available, 28% renter-occupied or available, and 4% unavailable for occupancy.

Of the total year-round units in Bedford County, 92.1% were occupied. Of units available for occupancy, vacancy rates were 1.5% for owner units and 8.9% for rental units. Among the total year-round units in Marshall County, 93.7% were occupied in 1980. Of the units available for occupancy, vacancy rates were 1.4% for owner units and 6.0% for rental units (Bureau of the Census 1982a). Over 12,300 year-round housing units were recorded in Murfreesboro in 1980, 92.6% of which were occupied. Approximately 5,400 such units were present in Shelbyville during the same year, with 93.1% occupied.

Data regarding the number of building permits issued for housing construction in Bedford and Marshall counties indicate slow housing growth in each county. Between 1981 and 1986, less than 300 permits were issued in Bedford County and less than 60 were issued in Marshall County (with 56 permits authorized in 1986 for the latter). Issuance of building permits in Rutherford County, on the other hand, showed an accelerating trend in year-round housing units. From 1981 to 1986 in Rutherford County nearly 9,000 building permits were issued (almost 1,500 annually) with 27% of those permits authorized in 1986 (Bureau of the Census 1983; 1985; 1987a). A 1987 vacancy survey of Rutherford County housing units reported a decrease in the total vacancy rate since 1980 (Federal Home Loan Bank of Cincinnati 1987).

Temporary lodging in the form of hotel/motel rooms may be found in Bedford (255 rooms), Marshall (123 rooms), and Rutherford (1,695 rooms) counties.

C. Public Services

Levels of public service provided by local governments within the Tennessee ROI were analyzed using October 1982 employment data (Bureau of the Census 1984) and 1986-87 school year statistics (Tennessee Department of Education 1987).

Police and fire protection, provision of health care, and public educational instruction were examined in detail. The levels of general public services were determined by the ratio of employees to regional population and by student/teacher ratios at the primary and secondary public school levels.

218-829 - 88 - 10 (BOOK 5)

1. Regional Setting

Level of service ratios for key public services are presented in Table 5.6.11-3 for the Tennessee ROI component counties, the whole ROI, Tennessee, and the United States. Total government fulltime equivalent (FTE) employment in the ROI is 31.15 per 1,000 residents, a level of service falling below both the state and national averages. For health care and educational levels of service (both employment to population ratio and student/teacher ratio), the ROI averages are below national averages and are below or at state averages. The ROI level of service for fire protection exceeds both the state and nation while the ROI police protection level of service exceeds that of the state but falls below that of the nation.

General health care services and facilities serving the ROI are concentrated in Davidson County (Nashville). Eighteen hospitals and 50 clinics in that county alone offer ROI residents more than 6,500 beds.

The Tennessee SSC facilities are proposed for Bedford, Marshall, Rutherford, and Williamson counties. While Williamson County would only contain portions of the ring, Bedford, Marshall, and Rutherford counties would be hosting the key facilities of the project and would likely experience the most direct effects on public services and facilities associated with SSC development.

2. Primary Impact Counties

a. Bedford County

One-third of the SSC ring, including roughly half of the far experimental area, is proposed to lie in unincorporated areas of Bedford County. Law enforcement services are supplied by the Bedford County Sheriff's Department with twelve sworn officers headquartered in Shelbyville. Fire suppression and prevention services, with 28 fulltime and 11 volunteer personnel, are also located in Shelbyville.

One hospital in Shelbyville currently serves residents of Bedford County with more than 100 beds.

The Bedford County Public School system provides public education services and facilities to county residents. The school system maintains seven elementary, one middle, and three high schools, located in Shelbyville, Unionville, and Wartrace. The school system's 17.70 FTE employees per 1,000 population represents a general education level of service better than the ROI and state levels of service (ratios of 15.25 and 16.41 FTE employees per 1,000 population, respectively) but the county ratio falls below that of the nation (18.44 FTE employees per 1,000 population). These relative levels of service are similarly reflected in the 20.0 Bedford County student/teacher ratio as compared to 20.3 for the ROI and state of Tennessee, and a lower 18.0 for the nation.

Table 5.6.11-3

LEVELS OF PUBLIC SERVICE FOR TENNESSEE SSC SITE[1]

Area	Police Protection	Fire Protection[2]	Health and Welfare	Public Education General Education	Public Education Student/ Teacher Ratio	All Other	Total
Bedford County[3]	1.54	1.47	9.10	17.70	20.0	8.78	38.58
Cannon County	0.98	0.00	0.98	13.39	21.2	6.25	21.59
Cheatham County	1.30	0.05	3.79	17.58	22.3	3.15	25.86
Coffee County	1.72	1.10	0.39	17.80	17.4	8.77	29.78
Davidson County	2.78	2.00	3.91	13.82	19.1	11.31	33.81
DeKalb County	1.99	0.07	0.00	15.01	20.7	8.98	26.05
Franklin County	1.75	0.53	10.47	15.41	20.3	6.28	34.46
Giles County	1.75	0.37	7.92	14.50	24.3	9.79	34.31
Grundy County	1.74	0.58	0.00	18.57	20.8	6.09	26.98
Lincoln County	1.51	0.64	8.99	16.65	21.9	8.34	36.14
Marion County	1.88	0.49	0.00	19.17	21.5	5.82	27.36
Marshall County[3]	1.62	0.76	0.00	17.62	22.1	10.20	30.21
Maury County	1.90	1.08	10.10	16.19	19.1	8.96	38.22
Moore County	0.89	0.22	0.44	18.18	19.8	3.55	23.28
Rutherford County[3]	1.95	1.15	1.18	16.86	20.3	6.16	27.30
Smith County	1.47	0.20	0.07	14.66	20.9	3.88	20.29
Sumner County	1.99	0.65	4.91	15.49	22.6	6.85	29.90
Trousdale County	2.77	1.47	0.16	16.62	19.5	11.08	32.10
Warren County	1.81	0.49	4.90	15.80	21.2	6.22	29.22
Williamson County	1.57	0.40	0.29	16.90	21.0	4.68	23.83
Wilson County	1.14	0.78	0.00	14.32	22.9	5.28	21.53
Region of influence	2.16	1.27	3.75	15.25	20.3	8.72	31.15
Tennessee	2.13	1.18	4.80	16.41	20.3	9.34	33.86
United States	2.34	1.02	3.84	18.44	18.0	8.71	34.35

Notes:

1. All table values represent full time equivalent (FTE) employees per 1000 population except student/teacher ratio.
2. Low values indicate counties served primarily by volunteer fire departments.
3. Primary impact counties.

Sources: U.S. Bureau of the Census 1984; Tennessee Department of Education 1987; U.S. Department of Education 1987.

b. Marshall County

Although Marshall County is proposed to host less than one-sixth of the SSC ring, approximately half of the far experimental area is planned for placement in the county. Police protection in the county is supplied at a level of service lower than those of the ROI, state, and nation. Fire protection services, predominantly volunteer, closest to the far experimental area are located less than 3 mi away in Chapel Hill.

Three clinics and one hospital, with nearly 120 beds, provide general health care to county residents.

The Marshall County Public School system maintains three elementary, one middle, and three high schools in Lewisburg, Cornersville, and Chapel Hill. General public education levels of service in the county as indicated by employment to population ratios, like those of Bedford County, exceed those of the ROI and state but are exceeded by that of the nation. However, inspection of student/teacher ratios among the county (22.1), ROI (20.3), state (20.3), and nation (18.0) suggest that Marshall County maintains the poorest level of instructional service.

c. Rutherford County

The proposed sites for campus, injector, expansion area, and other near cluster facilities are in Rutherford County, less than 10 mi from Murfreesboro. Police protection at the site is provided by the Rutherford County Sheriff's Department, which maintains one central sheriff's office in Murfreesboro and staffs 36 sworn officers. Together with the Murfreesboro Police Department, which provides law enforcement services to city residents with more than 80 sworn officers, police protection in the county is supplied at a level of service lower than those for the ROI, state, and nation.

Fire protection services in the county are maintained at a level of service greater than the nation but less than the ROI and state. Fire protection services closest to the proposed campus site are provided by a 99-member paid fire department located in Murfreesboro.

In addition to the concentration of health care facilities in Davidson County, two hospitals with more than 350 combined beds in Murfreesboro provide general care to county residents.

Two school systems operate in Rutherford County: Murfreesboro Public Schools and Rutherford County Public Schools. Murfreesboro Public Schools offer public education through six elementary schools in the city. Rutherford County Public Schools offers educational services through the secondary level: 17 elementary, three middle, and five high schools. Based on employment to population ratios, the school systems together provide general education services at a level of service greater than the ROI and state but lower than that of the nation. With

respect to student/teacher ratios, Rutherford County provides instructional service on a par with the ROI and state of Tennessee, all with student/teacher ratios of 20.3, but not equal to the national average of 18.0.

D. Public Finance

1. Tennessee State Government Finances

a. State Government Taxes

Tennessee has several sales and income taxes at the state level. The largest revenue source is the sales and use tax. Several business taxes on income, revenue, and assets are in place. Motor fuel taxes and motor vehicle registration fees are significant state-source revenues. A brief discussion of major sources indicates their main features. All dollar values in the public finance discussion are current dollars for the fiscal years cited.

The sales and use tax rate is 5.5% at the state level and is applied to the sale, use, consumption, distribution, lease, or rental of tangible personal property. The base includes repairs to tangible personal property, motor vehicles, admission charges, and selected services. In fiscal year 1986, 57.03% of state tax revenues were from this source (Table 5.6.11-4).

The state excise tax is an income tax on corporations, financial institutions, and other similar for-profit organizations. The current rate is 6% of net earnings. In FY 1986, this tax accounted for 10.27% of state tax revenues.

The franchise tax is levied on corporations and is 25 cents per $100 of stock, surplus, and undivided profit. In FY 1986, 4.39% of tax revenues were obtained from this source by the State of Tennessee.

The gasoline tax is levied at a rate of 16 cents per gallon. Diesel fuel is taxed at 15 cents per gallon. Motor vehicle fuel taxes provided 11.29% of tax revenues in FY 1986 for Tennessee.

Fees are charged for different classes of motor vehicles. These increase by size for personal use vehicles and by weight for freight vehicles. There are also small title fees. Motor vehicle fees amounted to 4.18% of Tennessee tax revenues in FY 1986.

Other taxes in Tennessee include the cigarette and tobacco excise taxes and alcoholic beverage excise taxes and license fees. The tobacco taxes provided 2.5% of Tennessee tax revenues in FY 1986 and were the largest of these tax sources.

b. State Revenue and Expenditure

FY 1986 general revenues and expenditures are presented in Table 5.6.11-4. Taxes, intergovernmental revenues, and charges are the major revenue categories. Sales tax revenues dominate; taxes have been discussed above. Total general revenue exceeded general expenditure by 4%. Direct capital outlays were about 12% of total general expenditures.

c. Local Government Organization and State Payments to Local Governments

There were 94 county and 335 municipal governments in Tennessee at the time of the 1982 Census of Governments. Nashville and Davidson counties consolidated as a metropolitan government in 1963 and are considered a municipality. There were only 15 independent school district governments and 38 city and 94 county school systems. The school systems are fiscally provided for by the city or county governing bodies.

There were also 469 special district governments. Important agencies include municipal power districts, sanitary districts, water treatment districts, and utility districts. There is also a state subordinate School Bond Authority that was established to finance public school construction in the state.

The principal expenditure by the State of Tennessee is for elementary and secondary (K-12) education. Most K-12 education is provided by county and city school functions in Tennessee. There are a few special school districts. The largest share of state funding is the foundation aid program, which provides operations funding at the local level. It includes an equalization feature. A number of other categorical grant programs are available for education. School capital funding is provided mostly by local governments.

Some state taxes are earmarked, sometimes in part, for specific functions such as sales and use tax funding for education, which includes 65.097% of revenues as well as revenue from motor vehicle registrations, which is apportioned 98% to the highway fund. Parts of severance taxes are returned to locals for education and roads. Tennessee Valley Authority payments are shared among cities, counties, and the state. The state obtains 15% of business tax revenues, which are otherwise a local source in Tennessee.

A few revenue sources are dedicated, in part, to cities and/or counties. For instance, 50% of the mixed drink tax is returned to the city or county of sale. Alcoholic beverage taxes are granted 17.5% to counties. The two-part beer tax is, for one part, returned to city and county governments by site of sale and, for the other part, 20% is dedicated to local governments. The excise (corporate income) tax is given 2.5% to cities and counties. The sales and use tax is given 4.6084% to municipalities.

Table 5.6.11-4

TENNESSEE STATE GENERAL REVENUE AND EXPENDITURE (FY 1986)

Revenue/Expenditure	Amount in thousands	Per Capita
REVENUE		
Total intergovernmental	$ 1,852,921	$ 386
Federal	1,812,191	377
Total taxes	$ 3,271,963	$ 681
Sales and gross receipts	2,517,290	524
General sales	1,865,934	388
Selective sales, gross receipts	651,356	136
Alcohol	61,615	13
Insurance	109,498	23
Motor fuels	369,323	77
Public utilities	20,696	4
Tobacco	81,256	17
Individual income	67,432	14
Corporation net income	268,618	56
License	332,259	69
Corporations license tax	147,816	31
Motor vehicle	126,719	26
Occupations and business licenses	31,400	7
Documentary and stock transfer fees	40,279	8
Property tax	---	---
Charges and misc. general revenue	761,388	159
Current charges	486,913	101
Total general revenue	$ 5,886,272	$ 1,226
EXPENDITURE		
Total general expenditure	$ 5,670,889	$ 1,181
Direct capital outlay	688,512	143

Notes: Population as of 7-1-86: 4,803,000

Source: U.S. Bureau of the Census, "State Government Finances in 1986," GF-86-No.3, October 1987.

Motor fuel taxes are subject to complex distribution procedures. The first 11 cents of the gasoline tax is distributed 28.6% to counties and 14.3% to cities. An additional 1 cent is granted two-thirds to counties and one-third to cities. The diesel tax is expected to be apportioned 19.78% to counties and 9.89% to cities in fiscal year 1987-1988. These distributions are partially on the basis of population.

2. Tennessee Local Government Finances

Bedford, Marshall, and Rutherford counties, are considered the primary impact area in local government finance. Chapel Hill and Murfreesboro, in Marshall and Rutherford counties, respectively, are also included.

a. Bedford County

As shown in Table 5.6.11-5, Intergovernmental revenues are dominated by those for schools. Property and local sales taxes are the major local revenue sources. Schools and roads are the main operating expenditures. No capital projects were reported for this period. Operating revenues exceeded total expenditures by 8%.

Jurisdictions recorded the following 1986 property tax collections:

Jurisdiction	Tax Collections
County government	$3,965,000
City government	1,485,000
Total Bedford County	$5,450,000

In Tennessee, school districts and other functions are normally not separate taxing jurisdictions. Total 1986 assessed value was $97,653,028.

b. Marshall County

As shown in Table 5.6.11-6, FY 1986 intergovernmental revenues are schools and roads. Property and local option sales taxes are the largest local revenue sources. Schools and roads are the main expenditures. Capital projects are shown to be 2% of total expenditures. An 8% deficit, based on total expenditures, was recorded for 1986.

Marshall County jurisdictions recorded 1986 property tax collections, as follows:

Jurisdiction	Tax Collections
County government	$3,227,000
City government	1,478,000
Total Marshall County	$4,755,000

Total FY 1986 assessed value was $102,192,843.

Table 5.6.11-5

BEDFORD COUNTY, TENNESSEE
COUNTY REVENUES BY SOURCE AND EXPENDITURES BY FUNCTION - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Federal		
Revenue sharing	$ 156,000	$ 5
Schools	977,000	33
Other	37,000	1
Total federal	$ 1,170,000	39
State		
Schools	$ 5,346,000	$ 183
Roads	1,153,000	39
Other	231,000	8
Total state	$ 6,730,000	230
Local		
Property tax	$ 3,965,000	$ 136
Equivalent payments	335,000	11
Local sales	2,163,000	74
Local beverage	64,000	2
Licenses & permits	159,000	5
Interest income	225,000	8
Fees	201,000	7
Other local	897,000	31
Total local	$ 8,009,000	274
Total Operating Revenue	$ 15,909,000	$ 545
EXPENDITURE		
General	$ 2,023,000	$ 69
Schools	9,862,000	338
Roads	1,507,000	52
Debt service		
Principal	662,000	$ 23
Interest	717,000	25
Other	0	0
Operating expenditure	$ 14,771,000	$ 506
Capital projects	0	0
Total op. expend. & cap. projects	$ 14,771,000	$ 506
Intergovernmental Expenditure	$ 542,000	$ 19

Notes: Assessed Valuation, 1986: $ 97,653,000: Population: 29,200

Sources: For financial data: Tennessee Comptroller of the Treasury, March, 1988; for population figure: U.S. Bureau of the Census, Local Population Estimates, Machine Readable Data File, April, 1988.

Table 5.6.11-6

MARSHALL COUNTY, TENNESSEE
COUNTY REVENUES BY SOURCE AND EXPENDITURES BY FUNCTION - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Federal		
Revenue sharing	$ 145,000	$ 7
Schools	651,000	31
Other	0	0
Total federal	796,000	38
State		
Schools	$ 3,747,000	$ 179
Roads	1,235,000	59
Other	127,000	6
Total state	5,109,000	244
Local		
Property tax	$ 3,277,000	$ 157
Equivalent payments	205,000	10
Local sales	2,055,000	98
Local beverage	70,000	3
Licenses & permits	465,000	22
Interest income	423,000	20
Fees	255,000	12
Other local	624,000	30
Total local	7,374,000	353
Total Operating Revenue	$ 13,279,000	$ 635
EXPENDITURE		
General	$ 1,879,000	$ 90
Schools	7,259,000	347
Roads	1,471,000	70
Debt service		
Principal	360,000	17
Interest	311,000	15
Other	0	0
Operating expenditure	$ 11,280,000	$ 540
Capital projects	3,144,000	150
Total op. expend. & cap. projects	14,424,000	690
Intergovernmental Expenditure	$ 389,000	$ 19

Notes: (Population: 20,900) (Assessed Valuation, 1986: $ 102,193,000)

Sources: For financial data: Tennessee Comptroller of the Treasury, March, 1988; for population figure: U.S. Bureau of the Census, Local Population Estimates, Machine Readable Data File, April, 1988.

c. City of Chapel Hill

As seen in Table 5.6.11-7, road funding from the state, local sales tax, and property tax revenues are the major revenue sources for FY 1986. General expenditures and debt service are the major expenditures. A surplus of 14% of total expenditures is shown. No capital projects are indicated.

d. Rutherford County

As shown in Table 5.6.11-8, schools receive the major shares of state and federal intergovernmental funds. Property taxes and the local option sales taxes are the major local revenue sources. Other sources include property tax equivalent payments and several nontax sources. The major operating expenses are general expenses, schools, and roads. Expenditures by the county also include support for schools and intergovernmental transfers of local option sales tax revenues. Capital project expenditure was 6% of operating expenditure. Operating revenue exceeded total expenditure by about 8%.

Rutherford County jurisdictions recorded the following 1986 property tax collections:

Jurisdiction	Tax Collections
County Government	$12,645,000
City Government	5,304,000
Total Rutherford County	$17,949,000

Total 1986 assessed value was $741,209,968.

e. City of Murfreesboro

As shown in Table 5.6.11-9, Murfreesboro, received substantial support from the state, especially for schools, and local sales tax revenues and more school support from Rutherford County. The major local source is the property tax. General government led schools and then roads in shares of operating expenses. Capital projects were 9% of total expenditures. Total expenditures exceeded operating revenues by 6%. However, the source document (Tennessee Comptroller of the Treasury 1988) indicated that Murfreesboro had substantial enterprise fund revenues in excess of expenditures from which to draw funds.

Table 5.6.11-7

CHAPEL HILL (MARSHALL COUNTY), TENNESSEE
CITY REVENUES BY SOURCE AND EXPENDITURES BY FUNCTION - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Federal		
Revenue sharing	$ 7,000	$ 8
Schools	0	0
Other	0	0
Total federal	$ 7,000	$ 8
State		
Schools	$ 0	$ 0
Roads	18,000	21
Other	30,000	35
Total state	$ 48,000	$ 56
County		
Local sales tax	$ 13,000	$ 15
School ADA	0	0
Other	0	0
Total county	$ 13,000	$ 15
Local		
Property tax	$ 20,000	$ 24
Equivalent payments	3,000	4
Local beverage	0	0
Licenses & permits	1,000	1
Interest income	18,000	21
Other local	45,000	53
Total local	$ 87,000	$ 102
Total Operating Revenue	$ 156,000	$ 184
EXPENDITURE		
General	102,000	120
Schools	0	0
Roads	1,000	1
Debt service		
Principal	25,000	29
Interest	9,000	11
Other	0	0
Operating expenditure	137,000	161
Capital projects	0	0
Total op. expend. & cap. projects	$ 137,000	$ 161
Intergovernmental Expenditure	0	0

Notes: Population: 850

Sources: For financial data: Tennessee Comptroller of the Treasury, March, 1988; for population figure: U.S. Bureau of the Census, Local Population Estimates, Machine Readable Data File, April, 1988.

Table 5.6.11-8

RUTHERFORD COUNTY, TENNESSEE
COUNTY REVENUES BY SOURCE AND EXPENDITURES BY FUNCTION - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Federal		
Revenue sharing	$ 480,000	$ 5
Schools	2,060,000	20
Other	24,000	0
Total Federal	$ 2,564,000	$ 25
State		
Schools	$ 14,363,000	$ 140
Roads	1,558,000	15
Other	560,000	5
Total State	$ 16,481,000	$ 160
Local		
Property tax	$ 12,645,000	$ 123
Equivalent payments	2,990,000	29
Local sales tax	12,592,000	123
Local beverage	219,000	2
Licenses & permits	2,583,000	25
Interest income	1,681,000	16
Fees	1,041,000	10
Other Local	4,089,000	40
Total Local	$ 37,840,000	$ 368
Total Operating Revenue	$ 56,885,000	$ 554
EXPENDITURE		
General	$ 9,889,000	$ 96
Schools	29,308,000	285
Roads	2,859,000	$ 28
Debt service		
Principal	5,685,000	55
Interest	1,537,000	15
Other	0	0
Operating expenditure	$ 49,278,000	$ 480
Capital projects	3,523,000	34
Total op. expend. & cap. projects	$ 52,801,000	$ 514
Intergovernmental expenditure	$ 9,333,000	$ 91

Notes: Population: 102,700
Assessed Valuation, 1986: $ 741,210,000

Sources: For financial data: Tennessee Comptroller of the Treasury, March 1988; for population figure: U.S. Bureau of the Census, Local Population Estimates, Machine Readable Data File, April, 1988.

Table 5.6.11-9

MURFREESBORO (RUTHERFORD COUNTY), TENNESSEE
CITY REVENUES BY SOURCE AND EXPENDITURES BY FUNCTION - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Federal		
Revenue sharing	$ 613,000	$ 15
Schools	315,000	8
Other	517,000	13
Total Federal	$ 1,445,000	$ 35
State		
Schools	$ 3,513,000	$ 86
Roads	689,000	17
Other	1,404,000	34
Total State	$ 5,606,000	$ 137
County		
Local sales	$ 5,192,000	$ 127
School ADA	1,430,000	35
Other	1,251,000	31
Total County	$ 7,873,000	$ 192
Local		
Property tax	$ 5,019,000	$ 123
Equivalent payments	565,000	14
Local beverage	1,000,000	24
Licenses & permits	713,000	17
Interest income	1,825,000	45
Other local	1,150,000	28
Total Local	$ 10,272,000	$ 251
Total Operating Revenue	$ 25,196,000	$ 615
EXPENDITURE		
General	$ 12,079,000	$ 295
Schools	8,311,000	203
Roads	1,144,000	28
Debt service		
Principal	803,000	20
Interest	1,886,000	46
Other	0	0
Operating expenditure	$ 24,223,000	$ 591
Capital projects	2,467,000	60
Total op. expend. & cap. projects	26,690,000	652
Intergovernmental expenditure	$ 0	$ 0

Notes: Population: 40,960

Sources: For financial data: Tennessee Comptroller of the Treasury, March 1988; for population figure: U.S. Bureau of the Census, Local Population Estimates, Machine Readable Data File, April, 1988.

5.6.11.2 Infrastructure

A. Transportation

1. Roads

Major highways and roads serving the proposed SSC site are shown in Figure 5.6.11-3. Data on these highways and roads are presented in Table 5.6.11-10.

Metropolitan Nashville, the state capital, 30 mi to the north northwest of the proposed SSC site, is served by a freeway system that includes interstate highways I-24 extending to the northwest and southeast, I-40 extending to the east and west, and I-65 extending to the north and south. An extensive system of arterial and beltway freeways and highways join these interstates.

Currently traffic on freeways and highways serving Nashville exceed level of service Class D conditions during peak hours. Expansion and improvement plans for many interstate, arterial, and feeder highways and roads include expansion of Interstates I-40 and I-65 within the Nashville area (Nashville 1987).

The proposed SSC site is served by a network of interstate, U.S., state, and county highways and roads that include Interstate I-24 on the northeast and I-65 on the west. U.S. Route A31 crosses the western portion of the site extending from U.S. Route A41 to Lewisburg. U.S. Route A41 crosses the southwestern portion and connects the site to Nashville and Shelbyville. U.S. Route 231 crosses the eastern portion and connects the site with I-24 near Murfreesboro and Shelbyville. State Route 96 passes to the north and connects I-24 near Murfreesboro to I-65 near Franklin. State Route 99 crosses the northwestern portion and connects the site to I-24 near Murfreesboro and I-65 near Columbia. Additional county paved and unpaved roads provide access to most of the proposed locations for surface facilities.

Highway improvements are planned for the proposed SSC site area with or without the SSC. A new interstate highway I-840, extending from I-40 west of Nashville to I-40 east of Nashville, will form a southern bypass around Nashville. This highway will pass to the north of the proposed SSC site and will provide an interstate connection between I-24 and I-65 (TDOT 1986-1). In addition, U.S. Route 231 from Murfreesboro to Shelbyville will be reconstructed to four lanes (TDOT 1986-2).

2. Rail

As shown in Figure 5.6.11-3, the proposed SSC site is served by two main line railroads operated by CSX Transportation The first crosses the western portion of the site and extends south from Nashville to Birmingham, Alabama. An existing siding is located on this line at Lewisburg. The other crosses the eastern portion and extends southeast

Figure 5.6.11-3

MAJOR TRANSPORTATION SYSTEMS SERVING
THE TENNESSEE SITE

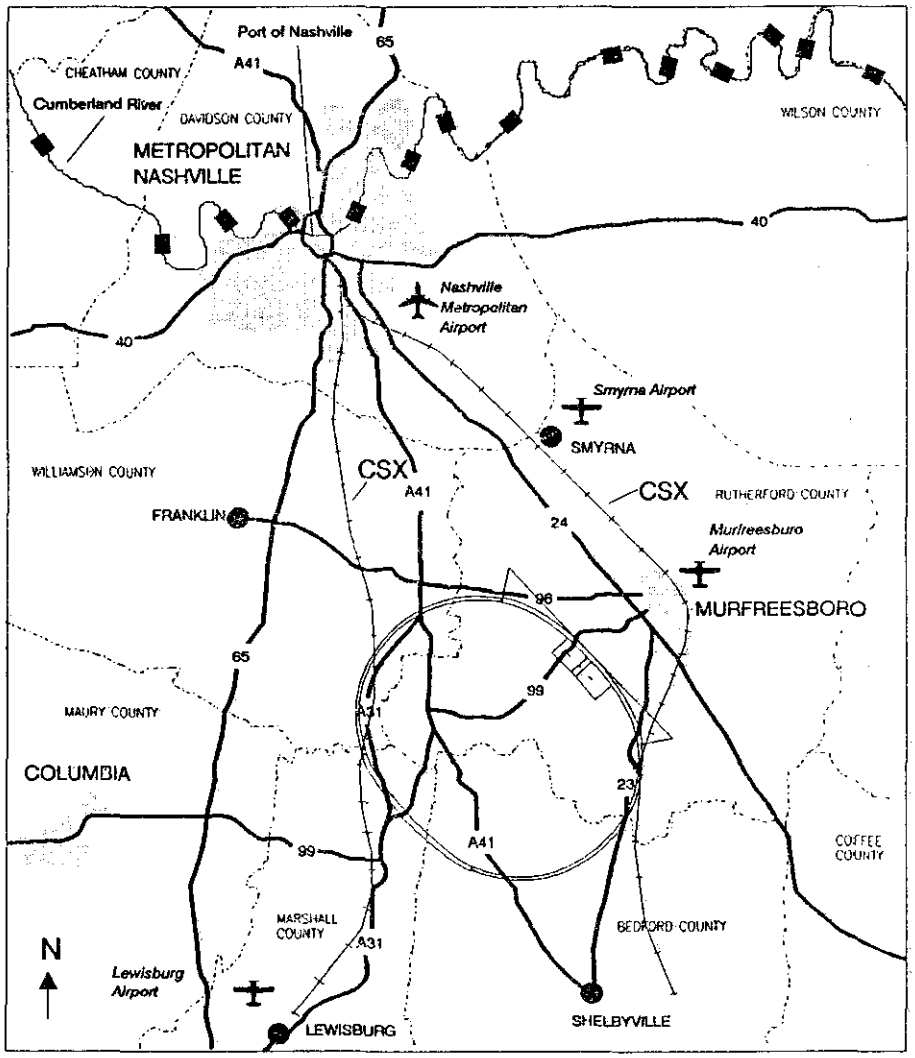

Table 5.6.11-10

PRESENT HIGHWAYS AND ROADS SERVING THE PROPOSED TENNESSEE SSC SITE

Road Segment	Length mi		Capacity Lanes	Peak Hour Volume pcph	LOS[2]
I-24: SR 254 to State Route 96	15	4	8,000	3,000	B
I-24: State Route 96 to U.S. Route 231	3	4	8,000	2,100	A
I-65:SR 254 to State Route 96	9	4	8,000	3,200	B
I-65: State Route 96 to State Route 99	19	4	8,000	1,700	A
U.S. Route A41: SR 254 to State Route 96	14	2	2,800	650	C[3]
U.S. Route A41: State Route 96 to U.S. Route 231	30	2	2,800	350	B[4]
U.S. Route A31: U.S.Route A41 to West State Route 99	15	2	2,800	250	B
U.S. Route 231: I-24 to U.S. Route A41	23	2	2,800	800	C[5]
State Route 96: I-24 to U.S. Route A41	13	2	2,800	450	C
State Route 96: U.S. Route A41 to I-65	11	2	2,800	750	C[6]
State Route 99: State Route 96 to U.S. Route A41	18	2	2,800	300	B[7]
State Route 99: U.S. Route A41 to U.S. Route A31	6	2	2,800	100	A
State Route 99: U.S. Route A31 to I-65	12	2	2,800	150	B

NOTES:

1. PCPH: Passenger Cars Per Hour
2. Level of Service
   - A: Free flow with individual users virtually unaffected by the presence of others in the traffic stream.
   - B: Stable flow but the presence of other users in the traffic stream begins to be noticeable.
   - C: Stable flow but operations of individual users becomes significantly affected by interactions with others in the traffic stream.
   - D: High density, but stable flow with speed and freedom to maneuver severely restricted and the driver experiences a generally poor level of comfort and convenience.
   - E: Unstable flow at near capacity level with speeds reduced, maneuvering difficult and extremely poor level of comfort and convenience.
   - F: Forced or breakdown flow with traffic demand exceeding the capacity, unstable stop and go traffic.
3. Portions of U.S. Route A41 close to State Route 254 experience LOS D.
4. Portions of U.S. Route A41 close to State Route 96 and U.S. Route 231 experience LOS C.
5. Portions of U.S. Route 231 close to I-24 experience LOS D.
6. Portions of State Route 96 close to I-65 experience LOS D.
7. Portions of State Route 99 close to State Route 96 experience LOS C.

Sources: TDOT 1986-3; TRB 1985.

from Nashville to northern Alabama. A rail yard is located on this line at Murfreesboro 6 mi northeast of the proposed campus site. The railroad density on both of these lines exceeded 5 million gross ton/mi in 1981 (Tennessee Department of Transportion 1982). These railroads connect the proposed site area with other cities on the main lines and with most other major U.S. cities through connections to other railroads.

AMTRAK passenger service is provided at Dyersburg and Memphis at the western end of the state (Tennessee Department of Transportation 1982).

3. Air

Airports serving the proposed SSC site are also shown in Figure 5.6.11-3. The principal airport that would provide passenger and freight service to the proposed SSC site is the Nashville Metropolitan Airport, owned and operated by the Metropolitan Nashville Airport Authority. This airport, located south of Interstate I-40, 6 mi east-southeast of downtown Nashville, is approximately 28 mi north-northwest of the proposed campus location. More than 4.5 million passengers were served in 1986 (Nashville 1987). Airport operations are not currently congested. However, scheduled airline operations experienced 4,000 hours of delays in 1984. Delays are forecasted to increase to more than 5,000 hours in 1994 (Federal Aviation Administration). American Airlines is currently establishing a hub at the Nashville Metropolitan Airport. A new terminal was completed in September 1987, and a new parallel runway is scheduled for completion by the end of 1989 (Moore 1987).

Publicly owned and operated general aviation fields are located at Smyrna, Murfreesboro, Shelbyville, and Lewisburg. The Smyrna Airport, owned and operated by the Metropolitan Nashville Airport Authority, is located approximately 16 miles north-northwest of the proposed campus location. The Smyrna Airport used to be an Air Force base and can handle corporate jets, airliners, and cargo planes (Nashville 1984). The Murfreesboro Municipal Airport, owned; and operated by the City of Murfreesboro, is the closest airport. It is located approximately 9 mi northeast of the proposed campus location and generally caters to small single-engine aircraft (Murfreesboro 1979). The remaining two airports at Shelbyville and Lewisburg, 15 mi south and 26 mi southwest of the proposed campus location, respectively, can handle corporate jet aircraft (Shelbyville undated; Lewisburg 1977).

4. Waterways

The City of Nashville is located on the Cumberland River, which gives it access to an extensive water transportation system. The Cumberland River flows into the Ohio River, which flows into the Mississippi River. The Ohio River provides access to the Tennessee River, which connects to the Gulf coast through the Tennessee-Tombigbee Waterway. The Mississippi River provides access directly to the Gulf coast and to the Great Lakes at Chicago through connection to the Illinois River and the Sanitary and Ship Canals. The Port of Nashville handled more than 3.7 million tons of waterborne freight in 1986 (Nashville 1987). Three multipurpose

barge terminals are located in Nashville, approximately 35 mi north-northwest of the proposed campus location. CSX Transportation provides rail access to the proposed SSC site through connections to two of these facilities. Truck connections to these facilities are also available (unverified).

5. Public Transit

a. Bus Service

Bus service in the Nashville metropolitan area is provided by the Nashville Metropolitan Transit Authority (MTA). The MTA provides service over 30 fixed routes radiating out from the center of Nashville. Approximately 96 buses are used. A trip survey completed in 1985 indicated that the weekday passenger count was approximately 30,000 passengers. Special fares are available on the fixed-route bus system for the elderly and the handicapped. A 5-yr plan for transit improvements includes an increase in the bus system, establishment of a busway or light rail transit system along two corridors, and establishment of a rubber-tired trolley system downtown. The development of private interest in the establishment of a monorail system in tourist areas is being investigated (Metropolitan Transit Authority 1986). The MTA does not provide service to the proposed SSC site area.

Intercity bus service is provided in the proposed SSC site area on routes following Interstates 24 and 65 and U.S. Routes A31 and A41 (TDOT 1978).

b. Taxi Service

Privately operated taxi, shuttle, and limousine service is provided throughout the Nashville metropolitan area. A study conducted in 1987, recommended that shuttle service be established between the Nashville Metropolitan Airport and the communities of Manchester on I-24 southeast of the proposed campus location and Lewisburg on U.S. Route A31 southwest of the proposed campus location (Tennessee Valley Aerospace Region 1987).

c. Rental Car Service

Privately operated rental car services are located at the Nashville Metropolitan Airport and other locations in the Nashville metropolitan area. Additional rental car services are located at general aviation fields in Smyrna, Murfreesboro, and Lewisburg (Flight Guide 1988).

d. Para-Transit Services

The MTA provides a door-to-door transportation service to those elderly and handicapped individuals unable to use the fixed-route bus service. This service provides approximately 5,000-passenger trips per month. The MTA also provides a ridesharing program. This program establishes employer-based ridesharing programs, provides computer matching for

transit, carpools and vanpools, and operates a vanpool program. The MTA operated 12 vanpools in FY 1986. Plans call for an expansion of the ridesharing program (Metropolitan Transit Authority 1986). In addition, the MTA has established park-and-ride lots for use by carpoolers, vanpoolers and bus riders (Nashville 1987).

The Mid-Cumberland Human Resource Agency provides a demand/response, fixed-route, and ridesharing transportation service. This service, provided by vans and specialized buses in 13 middle Tennessee counties, is open to the general public and provides transportation for medical, shopping, business, education, employment, and recreational purposes. The Agency also provides a ridesharing service and operates four vanpools (Volpe 1988).

The Mid-Cumberland Council of Governments also provides a regional vanpool program. This program operates nine vanpools, including two between Murfreesboro and the Nashville metropolitan area (MCCOG undated).

B. Utilities

1. Electricity

a. Ownership

The area in the vicinity of the Tennessee site is served by the transmission network of the Tennessee Valley Authority (TVA).

The TVA is a wholly owned corporation of the United States government. Established by Congress in 1933, the TVA is charged with developing the resources of the Tennessee Valley region. This includes providing for flood control, producing electric power, and encouraging economic and industrial development. (Tennessee Valley Authority annual report 1987).

b. Delineation of Service Territory

The TVA electric power and distribution system provides power to 110 municipal and 50 cooperative electric systems for distribution to 3.2 million customers. The locally owned distributors serve 80,000 mi^2 in parts of seven states (Tennessee, Virginia, North Carolina, Mississippi, Alabama, Georgia, and Kentucky) with a population of an estimated 7 million (Tennessee Valley Authority annual report 1987)

c. Interrelationship with Other Electric Utilities

The TVA provides electric power to municipal and cooperative power distributors for final retail distribution to residential, commercial, and industrial customers (Tennessee Valley Authority Power Program Summary 1987).

The TVA area is an individual subregion of the Southeastern Electric Reliability Council (SERC). This subregion is composed of three member companies: the Tennessee Valley Authority, Nantahala Power and Light Company, and Tapoco, Inc. (Tipps 1987). SERC membership includes 28 systems in nine states (Virginia, Tennessee, North Carolina, South Carolina, Mississippi, Alabama, Georgia, Florida, and parts of Kentucky) in the southeastern United States. The SERC region covers an area of approximately 350,000 mi^2 with 16 million customers (North American Electric Reliability Council 1987). SERC transmission systems are directly interconnected with the transmission systems in four other Regional Councils (Southwest Power Pool, East Central Area Reliability Coordination Agreement, Mid-America Interconnected Network and Mid-Continent Area Power Pool). All are members of the North American Electric Reliability Council (NERC). SERC members actively participate in interregional and intraregional studies and coordinating activities (North American Electric Reliability Council 1987).

d. Existing Network

TVA currently has approximately 23,500 MW of capacity in service to meet summer peak loads. An additional 5,500 MW of nuclear capacity exists but is presently out of service. The types of capacity and their percent contribution to the TVA total power supply (assuming the nuclear units are operating normally) are shown in Table 5.6.11-11 (Tennessee Valley Aurhority 1987).

Table 5.6.11-11

TVA GENERATING CAPACITY FOR 1987

Unit Type	Capacity (MW)	Percent of TVA Capacity
Coal-fired	15,838	54.7
Combustion turbine	2,066	7.1
Hydro[a]	4,011	13.9
Nuclear[b]	5,491	19.0
Pumped storage	1,532	5.3
Totals:	28,938	100.0

Notes:

a. Includes power from the Corps of Engineers and the Aluminum Company of America

b. Browns Ferry and Sequoyah nuclear capacity is currently out of service for safety work and evaluation.

Source: Tennessee Valley Authority Annual Report 1987.

The referenced source delineates the existing and authorized transmission line system for the TVA (Tennessee Valley Authority Power Program Summary 1986).

e. Planned Future Upgrades/Additions

TVA plans to upgrade future capacity by providing the addition of nuclear capacity and implementing conservation and load management activities to reduce power system demands.

Watts Bar and Bellefonte Nuclear Plants are currently under construction and will add 4,700 MW of capacity to the power system. The Watts Bar Unit 1 addition is scheduled to load fuel in June 1988. The commercial operating date for Watts Bar Unit 2 and Bellefonte Units 1 and 2 are under review (Tipps 1987).

Estimated savings from load management and conservation measures for the summer and winter of 1995 are 2,050 and 3,250 MW respectively (Tipps 1987).

By 1996 TVA is projecting to add 177 mi of 500 kV lines and 187 mi of 161 kV lines. Several 500 kV lines and associated substations are scheduled to be completed in 1988 (Tipps 1987).

2. Natural Gas

a. Ownership

The natural gas systems in the vicinity of the proposed site appear to be owned and controlled by the local municipalities. *

3. Telecommunications

a. Ownership

The utility providing telecommunications service for the vicinity of the proposed site is the South Central Bell Telephone Company.

South Central Bell Telephone Company (South Central Bell), incorporated under the laws of the State of Georgia, is a wholly owned subsidiary of Bell South Corporation and a publicly held corporation. (South Central Bell Telephone Company Annual Report 1987).

b. Delineation of Service Territory

South Central Bell provides telecommunications products and services in 17 calling zones encompassing 78% of the population and 63% of the geographic area in Alabama, Kentucky, Louisiana, Mississippi, and Tennessee (South Central Bell Telephone Company Annual Report 1987).

c. Interrelationship with Other Telecommunications Systems

Sufficient information concerning system interrelationships was unavailable for review.

d. Existing Network

South Central Bell presently has over 65,800 mi of fiber optic cable in its service network, and 432 of its central offices have been converted to digital switches. South Central Bell lines in service now total more than 6.8 million (South Central Bell Telephone Company Annual Report 1987).

South Central Bell has a #5ESS digital electronic switching center in Murfreesboro built by AT&T and installed in 1985. Cable facilities presently provide 1.54 megabit/s service (South Central Bell Telephone Company Annual Report 1988).

Interexchange facilities between Murfreesboro and Nashville provide two major routes: one is a 6-GHz, 90-megabit/s digital radio route; the second is a cable route which is a combination of fiber-optic cable and T1C cable (South Central Bell Telephone Company Annual Report 1988).

e. Planned Future Upgrades/Additions

South Central Bell plans to convert all of its central offices to electronic switching by the end of 1990 (South Central Bell Telephone Company, Annual Report 1987)

Under current South Central Bell plans, their combination fiber-optic/T1C cable will be entirely upgraded to fiber optics by 1991 (South Central Bell Telephone Company Annual Report 1988).

5.6.12 Cultural and Paleontological Resources

5.6.12.1 Cultural Resources

A. Cultural History and Scientific Basis

Paleo-Indian occupation in Tennessee begins around 10,000 B.C. Jennings (1978) cities the Wells Creek site (Dragoo 1976) as evidence for an early and relatively intense Paleo-Indian occupation. The nomadic Paleo-Indian subsistence was based on big game hunting. Sites are generally small campsites identified on the basis of Clovis and Folsom type projectile points. No sites from this period have yet been documented for the proposed project area.

The Archaic period (8000 B.C. to 1000 B.C.) is characterized by a shift in subsistence and settlement patterns with adaptations to local resources. Groundstone milling stones and axes are evident during the early period. The Eva Site (5000 B.C.), located east of the Tennessee River, is an example of the Middle Archaic. The site contained a large, dense shell midden, fiber tempered ceramics, and atlatls with bannerstone weights. Archaic Morrow Mountain and White Springs/Sykes projectile points seem to overlap or are contemporary (Dickson 1979). Several small sites, found in association with streams and representing short-term Archaic occupation dating to about 2000 B.C. have been recorded in the proposed project region (Hudson 1976).

The Ledbetter Phase occurs during the Late Archaic (1500 B.C. to 1000 B.C.). Sites from this phase have been recorded along the Duck River immediately south of the proposed project area. Dickson (1979) found that the area along the Duck River appears to have been more intensively occupied during the Archaic and the Early Woodland than during other periods that are represented in the area. The decline of sites in the following period could be a result of a stable population occupying a lesser number of concentrated settlements or an actual decline in population. The Ledbetter Phase may be transitional to the following Wade Phase (1200 B.C. to 700 A.D.) in the Duck River valley.

In general the Woodland Period (1000 B.C. - 700 A.D) represents a gradual change in subsistence. The hunting-gathering technology becomes more effective with more efficient exploitation of resources. Underground storage pits are documented and settlement becomes more permanent. Local styles of pottery develop. Rudimentary agriculture, increasingly elaborate burials, earthworks, and burial mounds are characteristics of the later Woodland period. The Woodland is seen as a transitional period from an economy based on hunting-gathering to one based on agriculture. Corn was acquired around 200 B.C. and sites situated in the floodplains were ideal for its cultivation. Diagnostic ceramics of the Woodland are tempered with crushed rock or grit, often with cord or fabric marked design. Reel and bar shaped gorgets of stone and copper and ear plugs are recorded and extensive trade networks are believed to have been established by the end of the Woodland, but are not well documented (Hudson 1976).

There is a hiatus in corn agriculture, possibly because of climatic change, from 400 A.D. until 900 A.D., when it reappears with the Mississippian Culture. In middle Tennessee there are no clearly defined phases within the Mississippian culture and divisions are based on temporal spans. The Mississippian begins around 900 A.D. and is seen as the initial growth period, termination occurs around 1450 A.D. (Benthall 1983). The Mississippian is characterized by large earthen platform mounds, the practice of intense horticulture, and the development of organized chiefdoms. A distinctive trait found in the Central Basin of Tennessee is the Shell tempered ceramics (Faulkner 1977), the small, triangular Madison polished stone artifacts are characteristic of Mississippian sites. Shell artifacts are also found and include beads, gorgets, and spoons (Tennessee Division of Archaeology 1987).

Previous investigations of the Central Basin area of Tennessee have identified a variety of Mississippian site types. These include large mound complexes, small mound sites, farming villages, hamlets, farmsteads, and seasonal camps (Tennessee Division of Archaeology 1987). Large mound complexes are usually regional ceremonial and political centers that contain multiple mounds. Small mound sites are probably under the influence of the centers, and usually include a single mound. The small mound sites are located along principal tributaries. Farming villages comprising a large group of families, have a number of structures, middens, and one or more cemeteries. In contrast, hamlets represent a smaller number of families and consist of three to ten structures, middens represent single family occupations and generally have only one or two structures. Transitory seasonal camps, usually lithic workshops or hunting camps, have no permanent structures.

Of these site types, the mound center and the farming villages have been subject to the most archaeological study. Much of the information about these sites is based upon early study by professional and amateur archaeologists (Haywood 1823; Jones 1867; Thruston 1890).

One hundred thirty-seven sites belonging to the Mississippian period have been recorded in the Central Basin. Unfortunately, many of the early studies were performed without recording the types of data used in modern archaeological research.

Ethnographically the Cherokee, a tribe of Hokan-Siouan linguistic stock, inhabited large areas of Tennessee as well as the Carolinas, Georgia, and northern Alabama. In Tennessee they occupied villages and towns located on ridges or bluffs above the floor level of the rivers. Corn agriculture was the more important vegetal food in their subsistence. Some of the Cherokee towns, between 1000 A.D. and 1500 A.D. were palisaded, but more often settlements consisted of clusters of buildings without fortification (Williams 1979). Intrusion into their territories and pressure from continual settlement culminated in 1838 with the rounding up and removal all of the Cherokee nation west of the Mississippi River. Hundreds perished on the infamous "Trail of Tears."

The first European to enter Tennessee was probably the Spanish explorer De Soto, who sailed up the Mississippi River to a spot near Memphis in 1541. However, the first permanent European settlements in the northeast part of the state were not established until 1769 when the English were ceded rights to the land after the French and Indian War.

During the Frontier period of the 1800s homesteaders established small farms, growing grain crops, and the major industry in the central basin associated with agriculture, was grist milling.

Tennessee played a major part in the Civil War, from 1861 to 1865. Two famous battles were fought close to the proposed SSC project area; at Murfreesboro, the Battle of Stone Creek, and at Franklin. During the Civil War saltpeter was intensively mined in many Tennessee caves, as an important ingredient in gunpowder (Mathews 1971).

Tobacco growing was also developed as an industry in Tennessee, along with cotton. Plantations were part of the economic structure of these two industries, but do not seem to be documented for the immediate project area although slave cbins have been recorded as structural components for historic farms.

B. Known National Register Sites/Sacred Sited

Nine known National Register properties in the vicinity of the proposed SSC project area that have been identified (State of Tennessee 1987) include Boxwood (house) Southwest of Murfreesboro: Chapel Hill Cumberland Presbyterian Church; Marymount (house) southwest of Murfreesboro; Morgan House southeast of Midland; Parks Place (house) north of Kirkland; Absalom Scales House north of Eagleville; Bostwick Female Academy north of Kirkland; William H. McCord House in Eagleville; and Swain House in Chapel Hill. Seven properties in the College Grove vicinity of Williamson County were nominated to the National Register in January, 1988. None of these properties would be affected directly by the proposed SSC. However, other structures more than 50 years old are located in the proposed SSC project vicinity and could be affected.

There are no federally recognized Native American tribes or groups currently in Tennessee. Surveys of the proposed project area have not identified any Indian burial sites or other areas known to be considered sacred by such groups.

C. Previously Recorded Sites and Research in the Project Area

While the area of the proposed project has not been systematically or thoroughly surveyed for archaeological sites, there are 26 previously recorded archaeological sites in the general project vicinity. Eight of the sites are in Bedford County, eleven in Marshall County, one in Rutherford County, and six in Williamson County. Although there are some data on each site, none have been evaluated to determine eligibility for inclusion on the National Register.

Several previous surveys have been undertaken in the proposed SSC project area. Tennessee Department of Transportation archaeologists (Ward 1985a, 1985b) surveyed new alignments of state roads; no cultural resources were located. During a similar survey (Ward 1982), an assessment was made of a ca. 1890 metal truss bridge over North Fork Creek in the Poplins Crossroads vicinity near the proposed SSC far cluster. Several other TDOT surveys were completed pertaining to nearby bridge replacements; Duvall (1983) recorded the remains of a historic milldam and mill race approximately 1.5 mi from the proposed SSC project area.

Other studies pertinent to the assessment of cultural resources in the proposed SSC area include the Normandy reservoir survey (Faulker and McCollough 1973) and the Columbia reservoir surveys (Klippel, Elemendorf and Graham n.d.; Dickson 1976; Jolley and Newman 1982). Historical inventories have been completed by the Tennessee Historical Commission and pertaining to the improvement of State Route 99 (Slater 1985).

The Tennessee Division of Archaeology conducted a reconnaissance survey to assess the potential for prehistoric and historic period archaeological sites within the proposed SSC site (Fielder, Prouty, and Spires 1988). Three locations of prehistoric archaeological materials were identified in this survey. Two small lithic scatters, 40RD164 and 40RD165, possibly dating to the Archaic, were located just outside the collider ring near intermediate access E10. A third Archaic site (40BD3), which will require additional evaluation, was located in Bedford County on a terrace along North Fork Creek within the proposed far cluster.

To identify historic period archaeological sites the Division of Archaeology surveyors used an 1878 D.G. Beers Co. historic map covering the proposed SSC project area (Fielder, Prouty, and Spires 1988). Eighteen site locations are located within the campus, injector, and future expansion areas. Twenty-five potential sites are shown in the far cluster. The historic Thomas Spain ranch and cotton gin on Armstrong Valley Road is located in the proposed SSC campus area. The archaeological remains of slave cabins and the cotton gin building site could be significant to historical research.

The Tennessee Division of Archaeology and the Tennessee Historical Commission also conducted a reconnaissance survey to identify historic architectural and engineering properties in the proposed SSC project area that might be eligible for the National Register (Fielder, Prouty, and Spires 1988). This survey involved those areas where direct and visual impacts from construction of facilities might occur. Previously, the Tennessee Historical Commission had intensively surveyed the Rutherford County portion of the SSC project area for buildings and structures at least 50 years old (Tennessee Historical Commission n.d.). Forty buildings were recorded in the campus, injector, and future expansion areas at the north end of the ring. An additional 30 buildings were recorded in areas near other proposed SSC facilities.

Of the 40 buildings within the project area only one farm complex is considered to retain sufficient architectural integrity to be eligible for the National Register (Fielder, Prouty and Spires 1988). The Sanders Farm was initially established around 1810. It is located within the proposed SSC future expansion area. The present farm house was built by R. A. Smith in 1869 in the rural Greek Revival architectural style. A log slave cabin and smokehouse that predate the house are also present on the property. In addition, other structures on the farm that are considered significant as examples of vernacular architecture include a log corn crib (1930), a mule barn (1930), a lumber house, and another barn.

The survey also noted a total of 10 cemeteries in the proposed project area, ranging from 2 to 75 graves and dated based on earliest interment from 1813 to 1856.

One existing historic bridge in the proposed SSC project area, located on Overall Creek in the Overall community west of Salem and designated as number 75 Abandoned-5 by the Tennessee Department of Transportation, was abandoned because of construction of a new concrete structure. It is a Warren through truss with vertical members; the deck is missing. The Tennessee Historical Commission has determined that the bridge is not eligible for the National Register (Fielder, Prouty, and Spires 1988).

D. Characterization of Known Resources and Scientific/Educational Potential and Significance

The prehistoric and historic archaeological sites described above are indicative of the kinds of research that could be undertaken within the proposed SSC project area. Data are not available to predict the number or likely distribution of such resources; however, it is expected that sites representing several portions of the local culture history will be identified during intensive survey procedures.

Within the Central Basin, basic questions remain about Archaic, Woodland, and Mississippian societies. Prehistoric sites could be important for research concerning site functions, subsistence, stratigraphy, settlement patterns, and intersite use patterns. The Tennessee Division of Archaeology (1987) has documented numerous research questions pertaining to the Mississippian Period. These questions reflect current directions of archaeological research into the systemic nature of prehistoric economies, political structure, settlement arrangements and hierarchies, ecological bases, population size, and social organization. Issues are raised pertaining to cultural relationships with other regions and the growth and decline of Mississippian societies.

The large number of potential historic archaeological sites is indicative of the intensity of early historic settlements and the growth of local farming and other community activities. A principal area of research at these sites is the historic ethnicity of the local populations and their concomitant standing structures and potential archaeological remains.

Further archaeological research questions could involve early effects of local transportation and communication systems, and the commercial relationship of the project area with other regions. Very little is known at this time about the extent and integrity of historical archaeological sites.

Although most historic standing structures have been well inventoried and not found eligible for the National Register, further investigations might reveal other properties besides the Sanders Farm with historical or architectural significance.

E. Unknown but Potential Resources

With the exception of the historic building studies, intensive surveys of the proposed SSC project area have not been undertaken. Relatively little of the surrounding area has been systematically studied. It can be expected, however, that previously unrecorded prehistoric archaeological sites will be located particularly in association with the drainage systems.

Historic archaeological sites are also expected to be discovered based upon a review of historic maps. Other archival information could supplement the listing of locations to be field-examined. Additional historic cemeteries could be identified.

No data is currently available about potential Native American sacred sites. Requests for information from descendants of Native American groups that traditionally occupied the proposed project area could produce information about such locations.

5.6.12.2 Paleontological Resources

A. Scientific Basis

The geological stratigraphy in the proposed Tennessee SSC site area is described and discussed in Section 5.6.1.2.

The Ordovician Period is the earliest stratigraphic level likely to contain fossils that will be impacted during tunneling procedures. Formations from this period include the Stones River and Nashville groups. The Stones River group, which dates to the Middle Ordovician, consists mainly of limestone beds as does the Nashville group, which occurs in the Upper Ordovician. These limestone beds contain many fossils including: gastropods, bryozoans, pelecepods, brachipods, cephalopods, graptolites, ostrocods and trilobites. Corals are also present; these grew in abundance in what is now the Central Basin area (Miller 1974).

The Mississippian Period is represented by Chattanooga shale and Fort Payne formations which are located mostly on hills outside the project area. Chattanooga shale deposits are considered important since they contain the first land and vertebrate fossils found in Tennessee. These

are generally poorly preserved and are not very abundant, but they include a variety of fish, including Dinichthys and sharks. Plant fossils, including driftwood, spores, and algae are found. Toothlike or platelike pieces of an unknown animal, and referred to as conodonts, are present. These are considered characteristic since they occur within a very narrow geological time range (Miller 1974).

The most abundant fossils of the Mississippian are the Crinoids, which are found in the Fort Payne deposits of limestone, shale, and chert. The Crinoids formed large mounds as they died and collected in the muddy sediments and are preserved as limestone bioherms; lime zones composed of these bioherms are common in Middle Tennessee (Miller 1974).

The present Central Basin was formed during the Tertiary and Quaternary periods after the chert rocks of the Fort Payne deposit were breached by erosion exposing the underlying limestones which in turn were rapidly eroded (Miller 1974). Land animals were abundant during the Quaternary Period and included Pleistocene era mastodon, mammoth, sabertoothed cats, giant ground sloths, camels, jaguars, and giant panthers. Remains of these and other, now extinct, mammals have been found at various locations in Tennessee. Remains have been found in river deposits above the present floodplains and frequently in caves (Miller 1974; Mathews 1971).

B. Known Paleontological Localities

There are no known rare or unusual fossil localities recorded in the proposed project area that would be affected by SSC construction activities (Corgan 1976).

C. Characterization of Geological Strata and Paleontological Potential

Ordovician limestones, which occur in the SSC area as the Stones River and Nashville deposits, contain a variety of invertebrate fossils, including large amounts of corals.

The Mississippian Period, which is represented in the project area by Chattanooga shale, later limestone, shale, and chert Fort Payne deposits, may contain important vertebrate fossils and the diagnostic conodonts.

Remains of Pleistocene mammals may occur in alluvial deposits of the Quaternary Period or in caves, several of which are located within the proposed SSC project area (Mathews 1978).

5.6.13 Scenic and Visual Resources

5.6.13.1 Visual Character of the Region

The proposed SSC site is within the Nashville Basin section of the Interior Low Plateaus. The basin is somewhat flat to hilly, but is surrounded by infacing escarpments as much as 400 feet high (Hunt 1967). The slopes of these escarpments are termed the Highland Rim, a rolling landscape with sharply incised valleys (Fenneman 1938). Karst topography is common, evidenced by caves, sinkholes, and disappearing streams.

The Nashville Basin was originally vegetated predominantly by chestnut-oak-yellow poplar southern hardwood forest (White 1979). Agricultural activity has substantially reduced the extent of this forest, replacing it with pastures and croplands.

Rivers are meandering and deeply entrenched in steep walled valleys (Hunt 1967). They are part of the Mississippi River system, the major rivers being the Ohio, Cumberland, and Tennessee rivers, the latter two draining into the Ohio River. While the Ohio and Cumberland rivers flow westerly, the Tennessee River flows to the north through the province. There are few natural lakes in the region. However, there are many reservoirs that are part of the river basin development that dominates all the major rivers noted.

The Interior Low Plateaus is a sparsely populated rural region with comparatively few towns and cities having a population exceeding 25,000. Over most of the area, rural-agricultural land use is evident: farms, small communities, and rural residences widely spaced along paved or gravel two-lane roads.

5.6.13.2 Visual Character of the Site

A. Topography

The great majority of lands enclosed by the collider ring is flat to rolling bottomland with an average elevation of 750 ft. Relief here is slight, ranging from 10 to 50 ft. Many sinkholes occur, but they are mostly less than 20 ft deep. Because of its proximity to the Highland Rim, the site vicinity also includes many knobs and hills. These principally occur within and along the northern and western quadrants between E10 and F6, although there are some prominent hills near the center of the ring and along the eastern quadrant between E2 and E3. At several points in these areas, elevations exceed 1,100 to 1,200 ft. However, from few locations are these landforms especially noticeable or dominant; the rises are gentle, muted by forest, and usually screened from view by forests and fence rows. Because of shallow soils in the area, incision by streams is only 5 to 10 ft, with banks being poorly defined.

B. Vegetation

Where the land has not been cleared for pastures, croplands, dwellings or roads, cedar glades and dense stands of mixed hardwoods prevail. Cedar glades occur where topsoil is especially thin and the bedrock is exposed and consists of red cedar. Stands of hardwoods include beech, oak, hickory, gum, walnut, tulip tree, locust, and elm. Agricultural fields are varied in size but are separated one from the other by similar appearing fence rows of hardwoods, cedars, and shrubs. Woodlots of hardwoods and cedars are common at the backs and corners of most fields and pastures.

C. Water Features

The Tennessee Valley Divide bisects the proposed site diagonally, separating the headwaters of several tributaries to the Duck and Cumberland rivers. Because of shallow soils in the area, many flow across bedrock, causing most of the streams in the area to be shallow, little incised, small, and inconspicuous. They tend to be low in gradient, meandering, and without rapids. It is not unusual, given the karst topography, for streams to be intermittent and/or discontinuous, occasionally being little more than a ribbon of bedrock tracing a course across open fields. Where perennial, streams can be picturesque, lined with trees, shrubs, and meadows.

D. Cultural Modifications

The site vicinity is an agricultural area mixed with rural residences and some subdivisions. Most farms are modest in size, although there are a few sizable dairy farms within the project bounds. Only one large show horse operation is in the vicinity (located near K2). Land use is often mixed within the same general area, occasionally to the point of confusion. It is not uncommon to see small farmsteads, mobile homes, newer homes, abandoned houses, and auto salvages yards juxtaposed. In such areas, there is no readily defined visual character. Crossing the site vicinity are several transmission line corridors, notable for their urban industrial scale and their notching the forest canopy at hilltops.

E. Viewshed Definition

As is the case for several of the other proposed SSC sites, viewsheds in the site vicinity are controlled more by the forest cover than by the rolling topography. Such control is reduced somewhat during the winter, because of the preponderance of deciduous species. For much of the site area the degree of cleared land is substantial, and there are many modest vistas across fields in the flat to rolling bottomlands, these views usually ending at a fence row or woodlot. Roads in the area have been constructed to avoid the ridges and hilltops, probably because of the exposure of bedrock at the higher elevations. As a result, there are few elevated viewing positions and distant views. An exception occurs along U.S. Highway 231 near E3 where comparatively distant views to the west, north, and south are briefly available.

5.6.13.3 Sensitivity

A. Travel Routes

The principal routes crossing the site are U.S. Highway Alternates 41 and 31, State Highway 10 passing north-south through the west half of the site; U.S. Highway 231/State Highway 10, crossing north-south along the eastern tip of the site; and State Highways 99 and 65, crossing east-west through the upper half of the site. Highway U.S. 231/State Highway 10 is a designated scenic parkway; views from this road are accorded high sensitivity. There are many paved and unpaved two-lane secondary roads throughout the area. Apart from U.S. Highway 231/State Highway 10, none of these are formally or informally designated as scenic routes.

B. Public Use Areas

There are no designated areas of aesthetic, recreational, cultural, or scientific significance within or along the collider ring. However, there are areas of rural residential development that are in proximity to the proposed sites for several surface facilities. Rural residences (moderately sensitive) are close to F2, F9, E9, F8, and E8. The balance of the above-ground facilities either would not be within sensitive views, such as those from residences, or would be, but the viewing position is in lands to be acquired fee simple and sensitivity becomes moot.

C. Laws, Plans, Policies, and Regulations

U.S. Highway 231/State Highway 10 is a designated scenic parkway. The purpose of scenic parkway designation is to promote the public enjoyment of "natural and scenic assets and recreational resources" (Section 54-17-202, Tennessee Code Annotated, 1987). Certain provisions against allowing new advertising, establishing junk yards, and dumping apply to scenic parkways, but none specifically address other kinds of development. Two facilities would be within 0.25 mi of U.S. Highway 231, these being E3, and F1.

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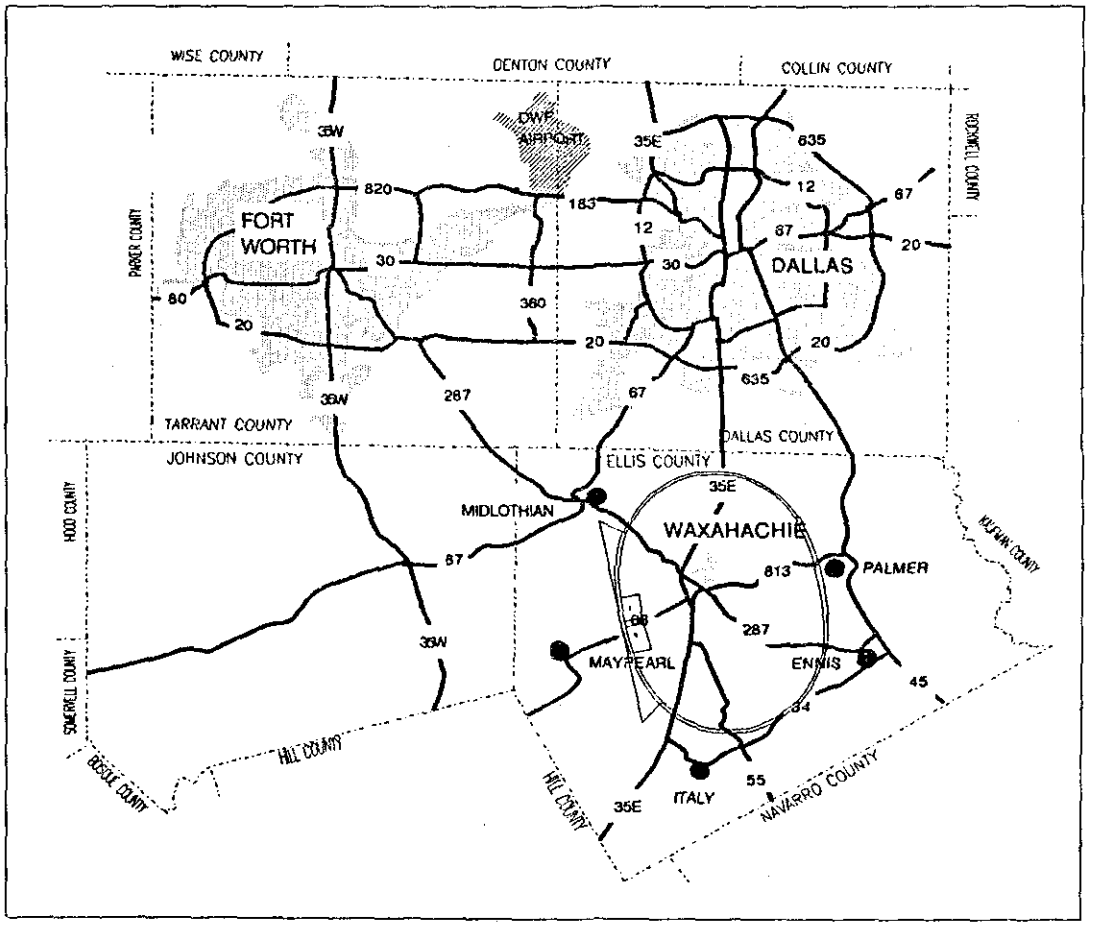
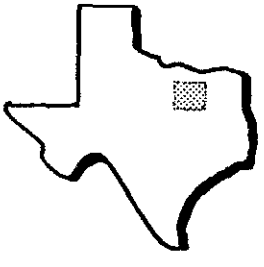
Affected Environments at Site Alternatives

T E X A S





Texas - **The proposed site is located in the northeastern portion of Texas, approximately 25 miles south of Dallas and 35 miles southeast of Fort Worth. *It is entirely within Ellis County.* The entire tunnel would be constructed by tunneling techniques in chalk and marl above the water table.**

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5.7 TEXAS

5.7.1 Earth Resources

5.7.1.1 Physiography and Topography

The proposed Dallas-Fort Worth SSC site is in the Western Gulf section of the Coastal Plains physiographic province in an area characterized by submature to mature erosion of southeast dipping coastal plain strata (Fenneman 1931). The eroded surface contains several low, west-facing escarpments with flat to rolling prairies between (Figure 5.7.1-1). The White Rock (Austin chalk) escarpment just west of the site is one of the most prominent escarpment features. The prairies follow the dip direction of the underlying rocks and generally slope gently to the southeast. The site lies in the White Rock (Austin chalk) and Black Rock (Taylor marl) prairies (Fenneman 1931).

Much of the site has a relatively flat to slightly rolling prairie surface, grading to rolling prairie at a few incised drainages. Elevations in the site vicinity range from 840 ft at the crest of the White Rock escarpment (U.S.G.S. 1982) to 360 ft where Waxahachie and Onion creeks depart to the southeast (U.S.G.S. 1978f and h). Relief on the flat portions of the prairie surface is quite gentle with 40- to 50-ft-high swells, 1 to 2 mi wide (U.S.G.S. 1978a, b, c, e, and f). The largest drainage, Waxahachie Creek, is incised 80 to 120 ft below the flat prairie surface (U.S.G.S. 1978a, b, e, and f).

Drainage in the site area generally forms a trellis pattern. Creeks generally flow from northwest to southeast, down the dip slope of the underlying strata, and collect in northeast-southwest-trending creeks that follow the foot of the adjacent escarpment (Figure 5.7.1-1). The site is traversed by the tributaries and main stems of Red Oak, Waxahachie, Onion, and Chambers creeks, all of which flow southeast to join the Trinity River (U.S.G.S. 1978b and f). Most of the streams flow only intermittently. Waxahachie, Onion, and Chambers creeks meander within 0.25 to 1.5-mi-wide floodplains.

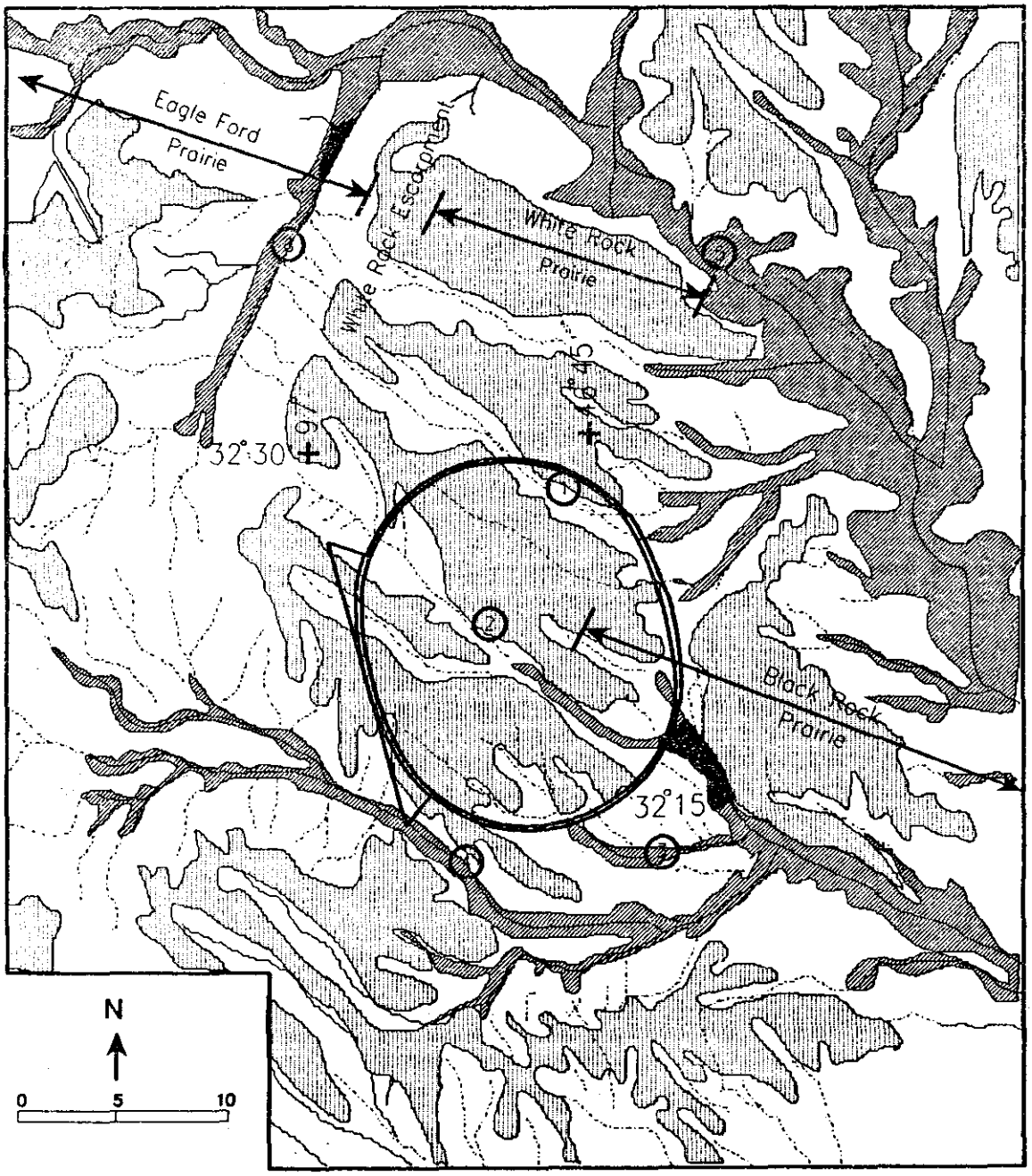
5.7.1.2 Stratigraphy

A stratigraphic column of the major sedimentary units within and surrounding the Dallas site is depicted in Figure 5.7.1-2. Lithologic descriptions of these units are given in Table 5.7.1-1. Information provided in this section was obtained from various sources, including Thompson 1967; Texas Bureau of Economic Geology 1972; Pessagno 1969; Shuler 1918; Peckham et al. 1963; and Reaser 1957. The same scale used to approximate the age of the rock units is the "Decade of North American Geology 1983 Geologic Time Scale" (Palmer 1983).

The stratigraphic column at the Texas SSC site is dominated by massive beds of chalk, claystone, shale, and sandstone, all of Cretaceous age deposited between about 73 and 103 billion years ago. The Cretaceous units are part of a 1,750- to 4,400-ft-thick wedge of sediment that

Figure 5.7.1-1

TOPOGRAPHIC SETTING OF DALLAS-FORT WORTH SITE



Flat prarie, little disected

Rolling prarie, incised drainages

Alluvial plains

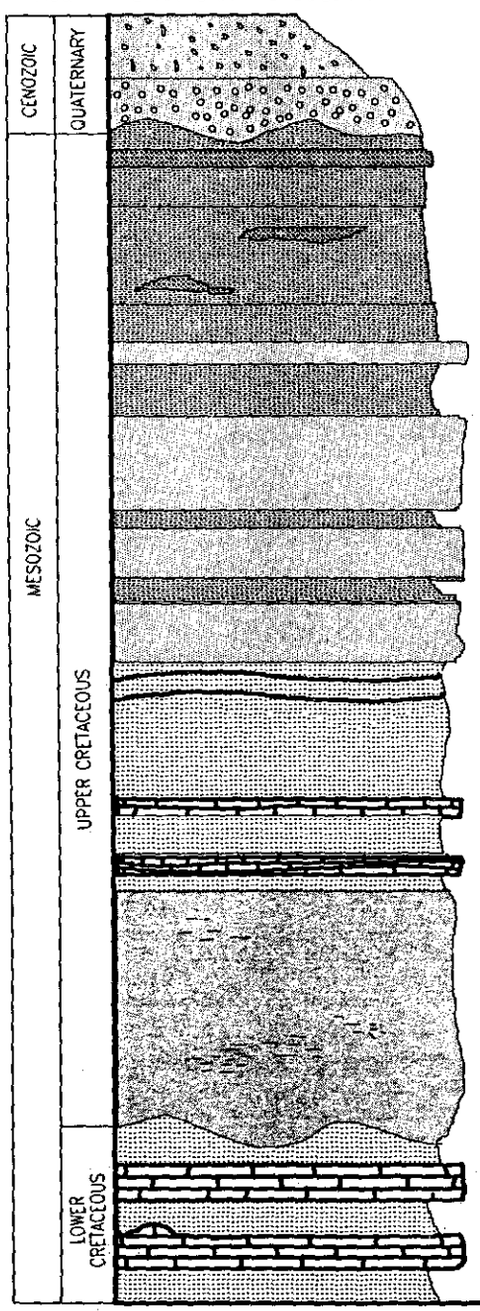
Streams intermittent where dot-dashed

Lake

Drainages
1. Red Oak Creek
2. Waxahachie Creek
3. Onion Creek
4. Chambers Creek
5. Trinity River
6. Mountain Creek

Figure 5.7.1-2

STRATIGRAPHIC COLUMN - TEXAS SSC SITE



AGE		NAMES		APPROX MAXIMUM THICKNESS (FEET)	DOMINANT LITHOLOGY
CENOZOIC	QUATERNARY	Recent Alluvium	Units encountered by tunnel and shafts	20	Gravel, sand, and silt
		Terrace Deposites		51	Gravel, sand, silt, and clay
MESOZOIC	UPPER CRETACEOUS	Navarro Group		490	Marl with interbedded sandstone
		Taylor Marl: Wolf City Formation		80	Claystone with sandstone lenses
		Taylor Marl: Ozan Formation		500	Claystone with interbedded chalk
		Austin Chalk		500	Chalk with interbedded claystone
		South Bosque Formation (Eagle Ford Shale)		467	Shale with bentonite seams and limestone beds
		Woodbine Sands		405	Sandstone with some clay and shale
	LOWER CRETACEOUS	Washita Group		543	Limestone and shale

Sources: Thompson, 1967; Texas Bureau of Economic Geology, 1972; Pessagno, 1969; Shuler, 1918; Peckham et al., 1963; Reaser, 1957

Table 5.7.1-1

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Recent Alluvium	Gravel, sand, silt, silty clay, and organic matter.	Principally uncon-solidated floodplain deposits.
Terrace Deposits	Dark gray to tan, calcareous gravel, sand, silt, and clay.	Commonly stratified and weakly cemented.
Navarro Group	Poorly sorted, typically glauconitic, thinly laminated clay, fine-grained sand and sandy clay with some lime-stone and marl.	Not present at site but does occur in the stratigraphic sequence elsewhere in the region.
Austin Chalk	Primarily gray chalk with interbedded calcareous claystone. Upper and lower portions are mostly massive, light gray, chalk (microgra-nular calcite), with some interbeds and partings of calcareous clay. Middle portion is typically thin-bedded gray marl and cal-careous shale with interbeds of massive chalk - marcasite/pyrite nodules are common.	This unit will host 70% of the tunnel.
Taylor Marl	Only the two lowermost members are recognized at the site.	
(1) Wolf City Formation	Principally marl, sand, sand-stone, and mudstone. Upper portion contains fine-grained, calcareous, yellowish gray sand and silt. Lower portion is predominantly calcareous dark gray mudstone.	Partially eroded at site.
(2) Ozan Formation	Montmorillonitic, blocky calcareous on claystone inter-bedded with thin limestone lenses in lower portion. Includes some glauconite, phosphate pellets, hematite, and pyrite nodules.	This unit will host 30% of the tunnel. Silt sand content increases upward. Conchoidal fracture.
South Bosque Formation (Eagle Ford Shale)	Predominantly bituminous, selenitic shale with some calcerous concretions Includes platy, medium to dark gray, locally bentonitic beds of sandstone and sandy limestone in upper and middle portions. shale,	Base of unit marked by a hard limestone bed.

Table 5.7.1-1 (Cont)

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Woodbine Sands	Fine-grained, well sorted, cross-bedded, reddish brown sandstone that is locally carbonaceous, conglomeratic (ironstone), or tuffaceous. Includes some clay, lignite, and gray, jarositic shale.	
Washita Group	Alternating shale, limestone, clay, and some sand.	

Sources: Pessango 1969 (Austin Chalk and Taylor Marl Formations and Navarro Group); Reaser 1957 (Austin Chalk Formation); Texas Bureau of Economic Geology 1972 (All units); Shuler 1918 (Alluvial deposits, Woodbine, Austin Chalk, and Taylor Marl Formation, and Eagle Ford Shale); Thompson 1967 (Navarro group); Peckham et al. 1963 (Woodbine Formation).

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strike north-northeastward and dip southeast. The units that will be affected by construction are, from oldest to youngest, the Eagle Ford shale, the Austin chalk, the Taylor marl and alluvium. The bed rock units are composed of varying amounts of chalk, claystone, and shale.

The alluvium overlies the Cretaceous sediments and is composed of unconsolidated accumulations of gravel, sand, silt, and clay deposited as terraces or along stream channels. Underlying the construction affected units are the Cretaceous-age woodbine sands and the Washita group. The Woodbine sands unit, composed of sandstone, is the principal aquifer in the area and the Washita group, composed of shale, limestone, and clay, is a nonwater-bearing unit.

5.7.1.3 Geologic Structure

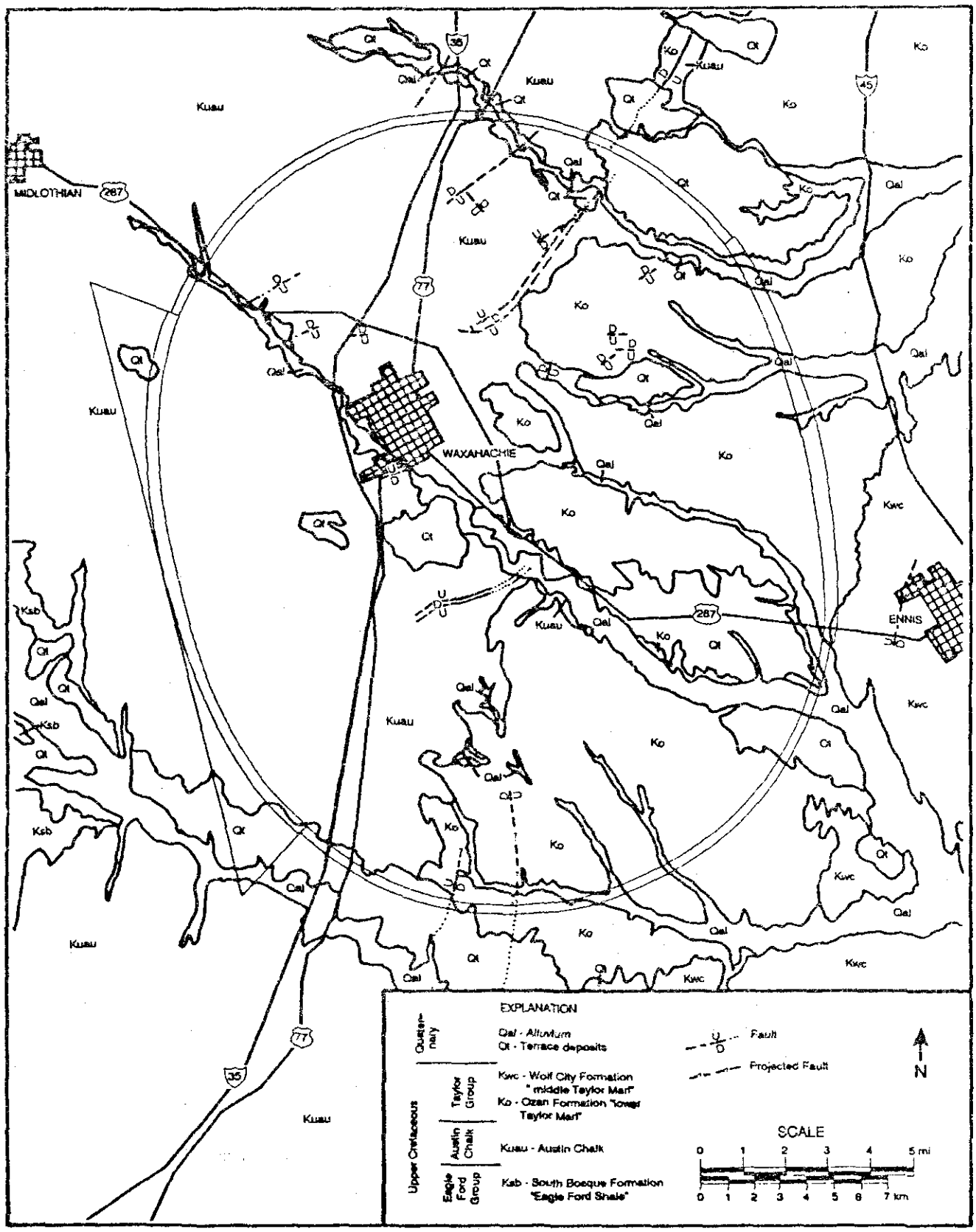
The Texas SSC site lies along the eastern margin of the Texas Craton in a thick sedimentary sequence with a shallow southeasterly dip. The sediments are exposed at the surface as broad, northeast-trending belts that are progressively older to the west. Chalk and marl are the predominant rock types at the site (see Section 5.7.1.2). A geologic map of the vicinity of the proposed site is presented in Figure 5.7.1-3. A cross section along the proposed ring is presented in Figure 5.7.1-4.

Rapid and abundant deposition of material in the Gulf of Mexico Basin and associated subsidence of the Gulf Region resulted in several linear zones of structural failure subparallel to the edge of the basin along the margin of the Texas Craton. Downwarping of the gulf is interpreted to have been hinged on the Ouachita Belt, a buried mountain range, composed of Paleozoic (older than 225 million years) rocks, that extends beneath the proposed site (Caran et al. 1982). These zones of structural failure in the overlying Cenozoic and Mesozoic sediments generally consist of inactive, northeast-trending, steeply dipping, down-to-the-east normal faults of moderate displacement. The closest of these zones to the site are the Mexia-Talco fault zone to the east of the site, which is paralleled to the west by the Balcones fault system to the west of the site. The majority of the mapped Balcones faults occur in a broad belt that stretches from Valverde County in southwestern Texas to Waco in McLennan County, south of the proposed site. However, the northeastern limit of this fault belt appears to extend into the site area and coincides with the local northeast-trending faults and associated grabens (Reaser 1961; Texas Bureau of Economic Geology 1987).

The characteristics of faults mapped in the vicinity of the site (shown in Figure 5.7.1-3) are summarized in Table 5.7.1-2. Small-scale faulting and the development of numerous horsts and grabens is common in the Austin chalk (Shuler 1918). Displacement along individual faults is commonly on the order of several feet, although displacements of up to 100 ft in the area have also been reported (Texas Bureau of Economic Geology 1987; Reaser 1961). Faults mapped in the site area include two sets of graben-bounding faults, two faults across the southern portion of the ring, three faults within the north and northeastern portions of

Figure 5.7.1.-3

MAP OF VICINITY OF THE PROPOSED SITE



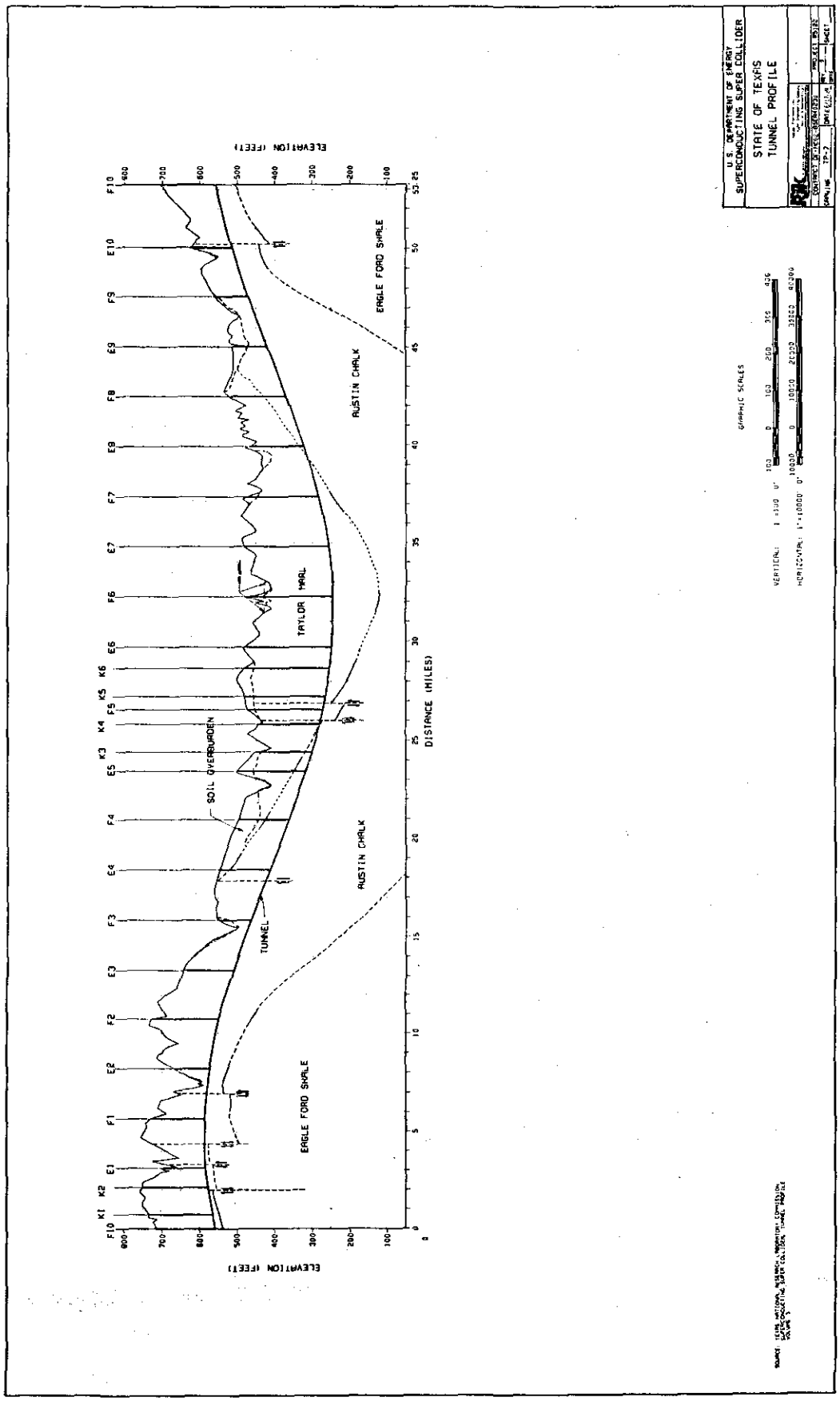


Figure 5.7.1-4

CROSS SECTION ALONG THE PROPOSED RING

Table 5.7.1-2

SUMMARY OF FAULT CHARACTERISTICS

Fault	Location	Strike	Dip	Thickness	Displacement/Age
Unnamed fault	Across southern ring	N15E	--	--	--/Miocene(?)
Unnamed fault	Across southern ring	N15E-N5W	--	--	--/Miocene(?)
2 Faults (graben)	Center of ring	N70E	--	--	--/Miocene(?)
Unnamed fault	1.25 mi east	N15-20E	--	--	--/Miocene(?)
Unnamed fault	1 mi inside west arc	N45E	--	--	--/Miocene(?)
Unnamed fault	1 mi inside northwest arc	N65E	--	--	--/Miocene(?)
Unnamed fault	.5-1 mi inside north arc	N50E	--	--	--/Miocene(?)
2 Faults (graben)	1-2 mi inside north arc	N30E	--	--	--/Miocene(?)
Unnamed fault	1 mi northeast of arc	N40E	--	--	--/Miocene(?)

the area enclosed by the ring, and two about 1 mi outside the ring (Texas Bureau of Economic Geology 1987; Reaser 1961). The reported abundance of small-scale faulting throughout the chalk as well as the extension of the Balcones system of larger scale faults into the site area suggests that additional faults not recognized to date may be identified in the future.

Joints in the Austin chalk and Taylor marl are moderately abundant. A primary joint set strikes from N20W to N60E and a secondary set is oriented between N20W and N20E. Average spacing between joints ranges up to about 8 ft; dips are predominantly vertical (Texas Bureau of Economic Geology 1987).

5.7.1.4 Geoengineering Conditions

Geoengineering materials at the Texas SSC site are:

- Overburden soils
- Austin chalk
- Taylor marl
- Eagle Ford shale.

Overburden soils include terrace deposits and residual soils developed on the chalk and marl. Residual soils are found throughout the site; terrace materials are present at several shaft locations. Overburden soils are generally clays (CH (inorganic high-plasticity clay) and CL (inorganic low-plasticity clay)) of moderate to high plasticity with shrink/swell potential (Allen 1975). Locally, the terrace materials may include saturated basal sands and gravels of varying thickness. Table 5.7.1-3 presents the geotechnical properties of soils at the site.

The Austin chalk, Taylor marl, and the Eagle Ford shale compose the near-surface rocks at the site. Rock formations at the collider ring alignment include Austin chalk and Taylor marl (a claystone). The Austin chalk is found at shaft and experimental hall locations in the remainder of the site and the booster facilities; Taylor marl is also found at shaft and experimental hall locations in the southeastern portion of the site. The contact between the Austin chalk and the Taylor marl is expected twice along the collider ring alignment and in at least four shafts. The Eagle Ford shale will be encountered only at the base of experimental halls K1 and K2 if these are sited as the ring was proposed. A possible reorientation of the ring would keep the halls above the Eagle Ford shale.

The rock materials generally are of fair to good quality (Mason, Johnston, and Associates, Inc. 1987). Austin chalk generally displays low strength and moderate slake durability. Unweathered claystone of the Taylor marl displays very low strength, swell potential, and moderate to high slake potential. Geoengineering properties of the Taylor marl are also expected to be relatively uniform with the exception of marly zones containing

Table 5.7.1-3

GEOTECHNICAL CHARACTERISTICS OF SOILS

Deposit	Soil Type USCS	Dry Density lb/ft^3	Moisture Content %	Liquid Limit/ Plasticity Index	Unconfined Compressive Strength lb/ft^3
Residual soil overlying Austin chalk	CH, CL, minor CL-ML	98.9 (89.9-111.0)	24.3 (13.8-32.2)	53/31 (24-80/8-53)	29 (6-58)
Residual soil* overlying Taylor marl	CH, CL, minor CL-ML	101.1 (91.8-113.7)	23.4 (7.0-30.2)	56/33 (25-83/9-48)	26 (7-56)
Terrace materials	CL, SC	(106-113)	(9-25)	(22-67/5-43)	(21-44)

Notes: Data presented as averages with ranges in parentheses.
SC - Clayey sand
CL - Inorganic low plasticity clay
CH - Inorganic high plasticity clay
CL-ML Inorganic low plasticity clay and silt

* May contain minor terrace deposits undifferentiable from residual soils.

Sources: Mason, Johnston, and Associates, Inc. 1987; Southwestern Laboratories 1987.

Table 5.7.1-4

GEOTECHNICAL CHARACTERISTICS OF ROCK FORMATIONS

Unit	Seismic Velocity Ratio	Unconfined Compressive Strength lb/inch^2	Tensile Strength lb/inch^2	Young's Modulus lb/inch^2	Poisson's Ratio	Dry Density lb/ft^3	Moisture Content %	Slake Durability %
Austin chalk	ND	2230 (642-3807)	257 (79-405)	0.356 (0.075-0.660)	ND	128 (101-151)	12 (5-20)	91 (46-97)
Taylor marl	ND	400 (123-1,136)	64 (18-117)	0.038 (0.009-0.079)	ND	120 (98-135)	16 (11-22)	23 (0-55)
Eagle Ford shale	ND	310 (183-485)	141 (73-174)	0.017 (0.011-0.022)	ND	120 (114-131)	15 (11-19)	9 (3-22)

Notes: Data presented as averages with ranges in parenthesis.
ND = No Data Available

Sources: Mason, Johnston, and Associates, Inc. 1987; Southwestern Laboratories, 1987.

bentonite and bentonite seams. The Eagle Ford shale has very low strength, swell potential, and moderate to high slake potential. Geotechnical properties of the rock formations expected at the site are presented in Table 5.7.1-4.

Drill-hole data, cores and exposures in quarries at various locations along the collider ring reveal the following:

- Residual soils derived from the Austin chalk are locally very thin (on the order of 1 ft).
- Weathered claystone at the top of the Taylor marl should perform like a stiff clay.
- In drill cores, the joints in the Taylor marl are tight and steeply dipping; these joints are expected to be impermeable.
- Bedding discontinuities are uncommon in the unweathered marl because of bonding across bedding planes; however, this bonding breaks down upon drying.
- Exposures of chalk show good lateral continuity of beds over long distances, except where interrupted by small displacement faults.
- In the chalk, the joint spacing is about 8 ft, with the frequency increasing near the faults. In surface exposures, the joints are continuous over about 10 to 20 ft lengths.
- Bedding planes are readily apparent in weathered, open excavations, although the chalk is massive in cores. Bedding thickness generally ranges from about 2 inches to 2 ft in quarries near the site.
- The properties of the Eagle Ford shale will be anisotropic because of the bedding.
- An exposure in a local quarry showed water seepage in the Eagle Ford shale.

5.7.1.5 Geologic Hazards

The site is near the boundary between the Gulf Coastal Plain and the central interior of the United States. Seismicity in the site region is among the lowest in the United States; the site is within Zone 0 of the Uniform Building Code seismic risk map (International Conference of Building Officials 1988). This zone is characterized as an area where earthquake damage is not expected.

Only four historic earthquakes have occurred within 100 mi of the Texas SSC site. None of these events were larger than magnitude 4.0 and all had epicentral modified Mercalli (MM) intensity less than or equal to VI. The four events occurred at Rusk, Texas, in 1891 (magnitude-3.8); Wortham-Mexia, Texas, in 1932 (magnitude-4.0); Chico, Texas, in 1950 (magnitude-3.8) (Coffman and Von Hake 1973); and Center, Texas, in 1981 (magnitude-3.1) (Davis et al. 1987). The Wortham-Mexia earthquake was located closest to the proposed Texas SSC site. This magnitude 4.0 event had an epicentral MM intensity of VI, but was not felt in the SSC region.

There are no faults in proximity to the site that have been active in Quaternary time (last 1.8 million years). The nearest potentially active fault is the Meers fault along the northern margin of the Wichita-Amarillo uplift about 160 mi northwest of the site (Madole 1988; Tilford 1987). The effects of large earthquakes in distant tectonically active areas, such as the Wichita-Amarillo uplift, and the New Madrid, Missouri area, are also small. A maximum credible earthquake of magnitude 6.5 on the Wichita-Amarillo uplift (Rameli and Slemmons 1987) will generate a modified Mercalli intensity of less than VII at the site. Accelerations at the site from these events, using the attenuation relationship of Chandra (1979) would be less than 0.03g, which is less than the accelerations estimated by Algermissen et al. (1982). Algermissen et al. estimated that the ground motion with a 90% probability of not being exceeded in 50 yrs is 0.04g.

Saturated surficial alluvial deposits at the site may be susceptible to liquefaction if strongly shaken by an earthquake. However, considering the small magnitude and infrequent nature of earthquakes in the site area, the potential for liquefaction is very low.

No other geologic hazards are expected at the site. Ground subsidence because of withdrawal of water or hydrocarbons is not expected; no subsidence caused by groundwater withdrawal has been reported in the site area. Subsidence is not expected in the future because the aquifer units are cemented sandstones and local communities are switching from the groundwater to surface water supply. Hydrocarbons are not being pumped in the site vicinity. There is no volcanic activity in the area. The site topography is sufficiently subdued that landslides are not expected. The rocks at tunnel depth are not gassy.

5.7.1.6 Economic Geologic Resources

Texas is a major producer of cement and aggregate. Although cement is produced in large amounts in the vicinity of Waxahachie, sources of high-quality aggregate are limited. Oil and gas are the only known potentially significant energy resources in the region, although no oil and gas production occurs in the vicinity of the site.

A. Earthen Construction Materials

Areas of potential cement material and sand and gravel production in the vicinity of the site are shown in Figure 5.7.1-5. In Ellis and Dallas counties, the Austin chalk crops out extensively and is used in the manufacture of abundantly available cement (Garner et al. 1979). However, chalk lacks the strength and abrasion characteristics required for use as aggregate for high-strength concrete and commonly contains potentially expansive clays.

Sources of gravel include operations along the Trinity River in northeastern Ellis County and southeastern Dallas County, which may be able to produce 6 to 8 million ton/yr; 20% of these untapped reserves are thought to be suitable for use as aggregate in concrete (Davis 1988).

The only proven source of usable aggregate is located at operations 90 mi away from Waxahachie near Bridgeport in Jack County (Davis 1988). These operations produce about 25 million tons of aggregate (crushed limestone) annually that meet the specifications of the Texas Department of Highways and Transportation. In 1986, the entire production of closer sources in Dallas, Ellis, Henderson, Navarro, Parker, and Wise counties (10 to 80 mi from the site) was 5.7 million tons (McBride 1988).

Texas ranked first in the U.S. in the production of Portland cement in 1985 (Ohl and McBride 1987). In 1986, cement production in Dallas, Tarrant, and Ellis counties totaled 2.55 million tons, compared to an annual production capacity of 4.4 million tons. These plants are all between 10 and 50 mi from the site (McBride 1988).

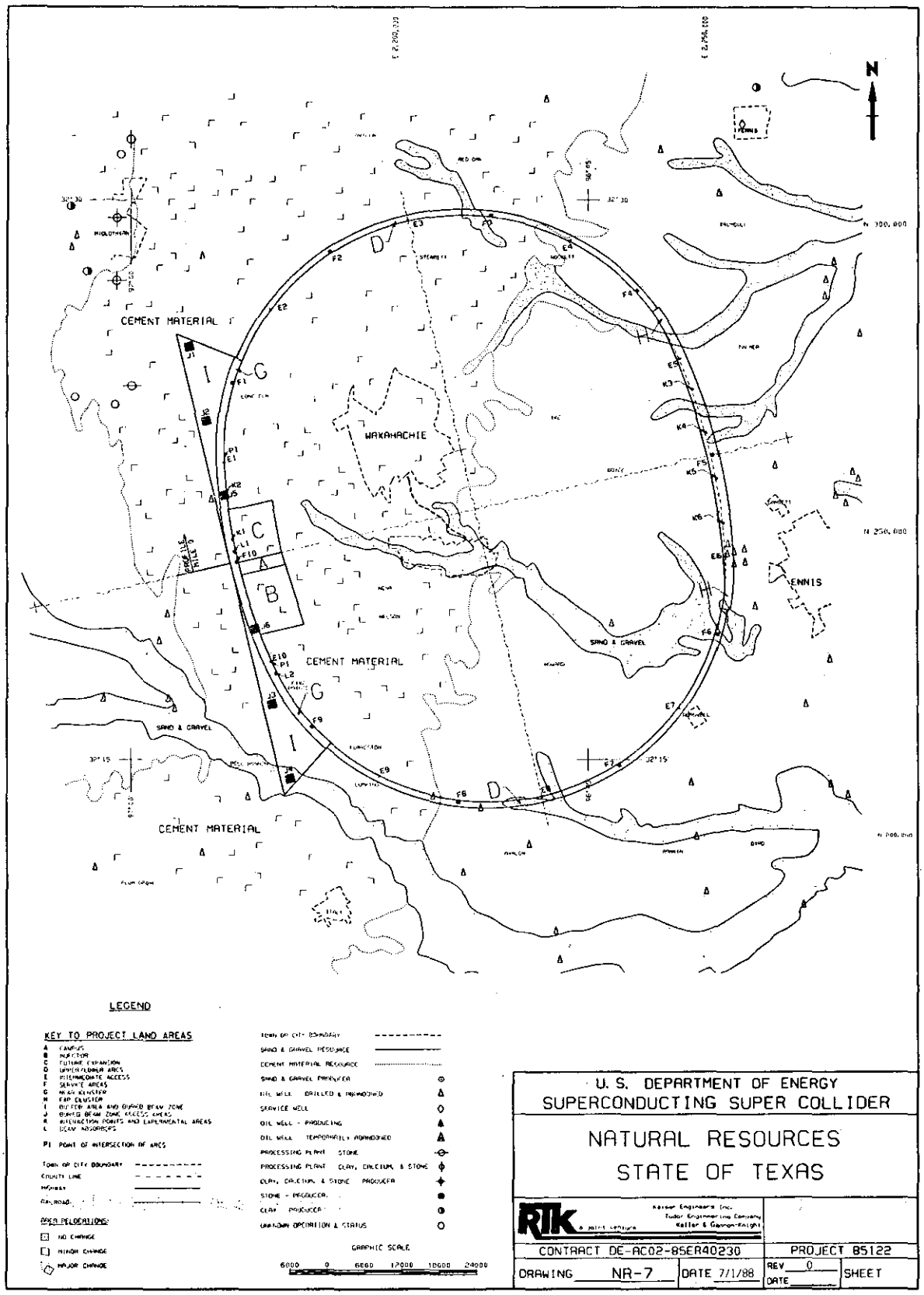
B. Energy Resources

Most of the oil and gas production in the area of the proposed SSC site is limited to the Corsicana Shallow and the Corsicana-Powell oil fields to the east and south. Oil in the Corsicana Shallow field in eastern Ellis County is produced from the Wolf City formation, the upper member of the Taylor marl, which has been largely removed by erosion in the site area (Garner 1988). The Corsicana-Powell oil field in Navarro County produces from several horizons including the Wolf City formation and the deeper Woodbine sand, which extends throughout the region (Garner 1988).

Oil and gas well locations and status (Petroleum Information Corp. 1988) are plotted on Figure 5.7.1-5. There are three abandoned oil wells on or inside the ring location and 35 wells within 5 mi of the site. One well, about 10 mi southeast of the site, is reportedly producing oil. With the exception of a temporarily abandoned well and a service well, all other wells shown in the figure have been permanently abandoned. Well depths range from 250 to 13,110 ft; the producing well is 860 ft deep (Petroleum Information Corp. 1988). Oil occurrences have been defined through regional exploration efforts; no producing wells are known within the immediate vicinity of the site and the potential for undiscovered occurrences beneath the site is small.

Figure 5.7.1-5

NATURAL RESOURCES OF TEXAS



Other energy resources have not been identified in the site area. Although warm groundwaters are associated with the Balcones fault zone, no specific geothermal potential has been found. Lignite deposits occur about 40 mi from the site. No uranium deposits are known within the region (Garner 1988; Garner et al. 1979; McBride and Dobbs 1983).

C. Metallic Resources

Sporadic occurrences of sulfide mineralization have been reported throughout the stratigraphic column (see Section 3.7.1.2). However, no economic metallic deposits have been identified in the region (Garner et al. 1979).

D. Other Resources

No significant geologic resources other than those discussed in this section have been identified at the site.

5.7.2 Water Resources

5.7.2.1 Surface Water Hydrology, Quality, and Use

A. Surface Runoff and Flooding

The Texas SSC site is situated in the central part of the Trinity River basin in east-central Texas. The Trinity River originates in the extreme southeastern corner of Archer County, northwest of Fort Worth (Figure 5.7.2-1). It passes approximately 10 mi east from the project site (Figure 5.7.2-2) then flows south-southeast to join the Gulf of Mexico at Galveston. Elevations in the basin range from 812 ft above mean sea level (MSL) at its headwaters northwest of Fort Worth to sea level at the Trinity/East Bay outlet in the Gulf of Mexico. The drainage area of the Trinity River basin at Liberty, Texas, about 25 mi upstream from Trinity Bay, is 17,468 mi^2. At Rosser, Texas, directly east from the project site, the drainage area is 8,147 mi^2. Average discharge in the river during a 49-yr period of record (water years 1924-1925, 1939-1986) at Rosser is 2,628 ft^3/s; the minimum discharge during this period was 32 ft^3/s for several days during the 1924-1925 water years (Buckner et al. 1987).

Major drainage systems within the project site include Red Oak, Waxahachie, Big Onion, and Chambers creeks. These streams along with selected tributaries are shown in Figure 5.7.2-2; their drainage areas and approximate channel dimensions at the ring crossing are shown in Table 5.7.2-1. The major drainage systems flow through the site from the northwest to the southeast and ultimately discharge into the Trinity River. Red Oak Creek originates in southern Dallas County and the main stem and its major tributary to the south, Grove Creek, cross the collider ring. Elevations in Red Oak Creek range from 850 ft above MSL in its headwaters near Cedar Hill to 550 ft above MSL where it crosses the ring. The drainage area of Red Oak Creek below its confluence with Grove Creek is 156 mi^2 (Federal Emergency Management Agency (FEMA) 1987).

Waxahachie Creek originates entirely within Ellis County northwest of the project site. It crosses the collider ring near intermediate access E8, flows southeast through the City of Waxahachie, and discharges into the upper reaches of Lake Bardwell near service area F6. Mustang Creek also joins Lake Bardwell at the southeast ring crossing immediately north from F6. Other major tributaries to Waxahachie Creek include North Prong Creek; which joins Waxahachie Creek at the northwest ring crossing; and South Prong Creek; which joins Waxahachie Creek between the City of Waxahachie and Lake Bardwell. The drainage area of Lake Bardwell is 178 mi^2 (Corps of Engineers 1976). Waxahachie Creek joins Chambers Creek about 3.25 mi downstream from Bardwell Dam.

Big Onion Creek originates along the western collider ring near buried beam zone access J5. It flows to the southeast and crosses the collider ring near intermediate access E8 and then joins Chambers Creek about 0.75 mi upstream from Waxahachie Creek.

Figure 5.7.2-1

MAJOR WATERSHEDS IN TEXAS

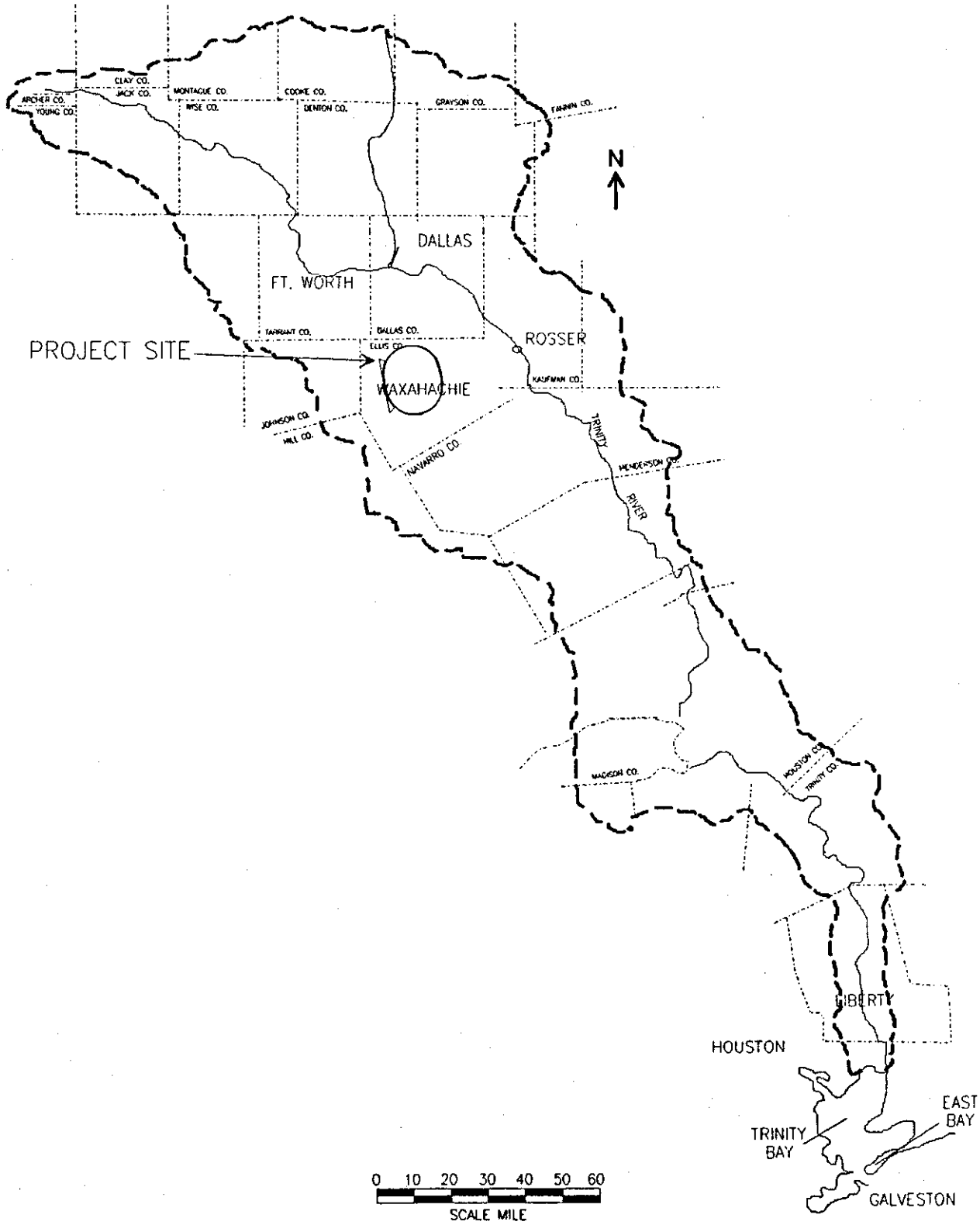


Figure 5.7.2-2
HYDROLOGIC FEATURES - TEXAS SSC SITE

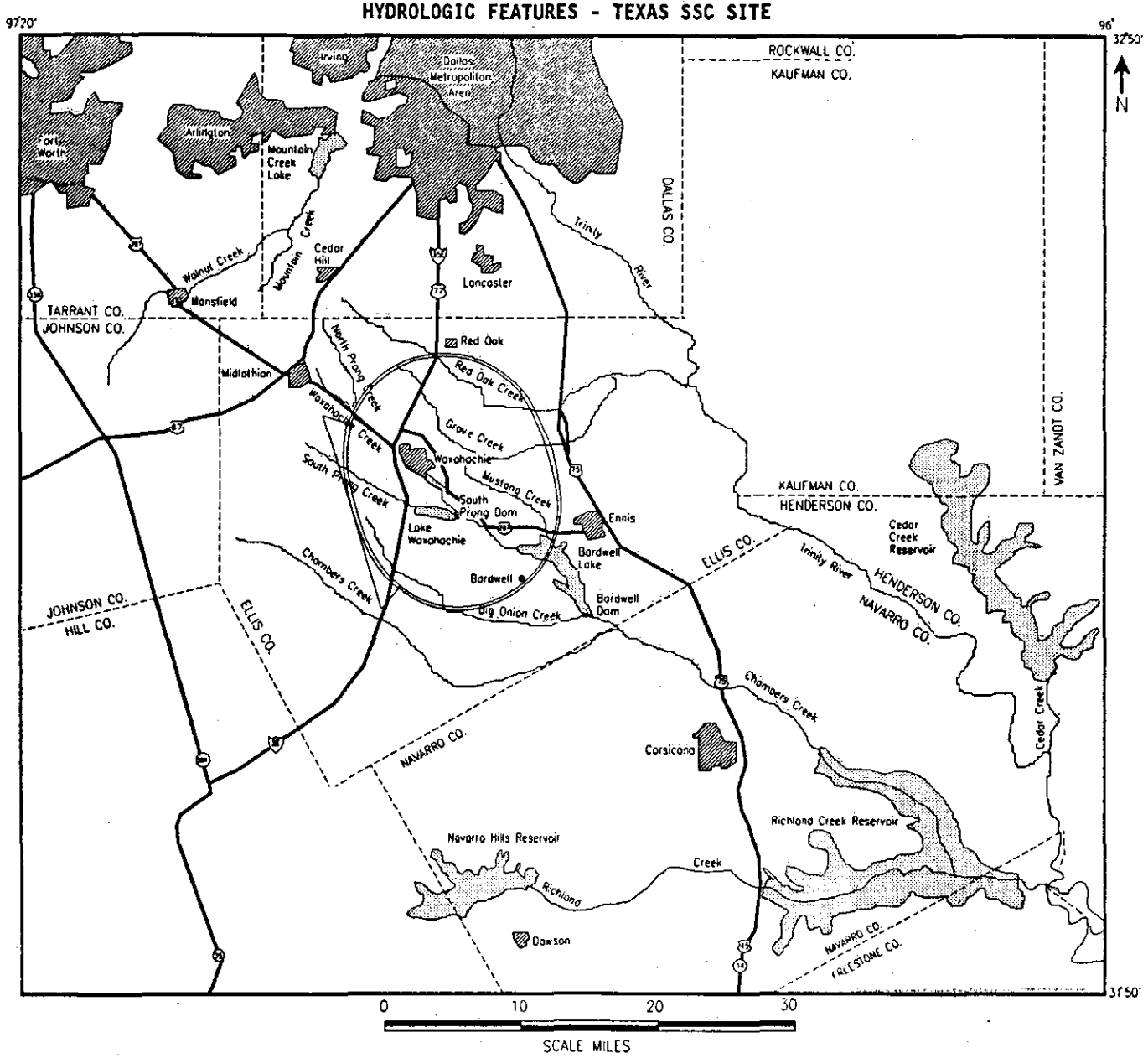


Table 5.7.2-1

CHANNEL AND FLOODPLAIN CHARACTERISTICS AT THE COLLIDER RING

Drainage Channel	Drainage Area mi^2	Bankfull Channel Width ft	Bankfull Channel Depth ft	Width of Floodplain ft
Chambers Creek at J4	107	50	20	800
South Prong Creek near J2	--	75	15	300
Waxahachie Creek near E2	45	75	20	300
North Prong Creek near E2	--	80	25	300
Red Oak Creek near F3	43	70	20	1,000
Red Oak Creek near E5	64	35	15	2,000
Grove Creek near K3	42	50	20	2,000
Mustang Creek near F6	--	Lake	Lake	3,300
Waxahachie Creek near F6	109	Lake	Lake	4,000
Big Onion Creek near E8	49	50	15	1,500

Source: Stafford 1988; FEMA 1987.

Chambers Creek rises in the central part of Johnson County, west from the project site, and flows to the southeast about 77 mi to its confluence with Richland Creek about 17 mi southeast from Corsicana. Elevations range from 786 ft above MSL in its headwaters to 300 ft above MSL at Richland Creek. The drainage area of the Chambers Creek watershed at its confluence with Richland Creek is 1,073 mi^2 (U.S. Department of Agriculture 1955). The creek crosses the project area at the location of buried beam zone access J4. Richland Creek joins the Trinity River about 0.75 mi downstream from Highway 287.

In addition to the stream channels that cross the project area, major surface water features include two large reservoirs: Lake Waxahachie and Lake Bardwell. Bardwell Dam is 4.5 mi east of the collider ring, and its reservoir, Lake Bardwell, is situated directly over a section of the collider ring with a drainage area of 178 mi^2. Bardwell Dam is a rolled earthfill dam 82.4 ft high and 15,400 ft long. It was constructed in 1965; its original storage capacity was 140,000 acre-ft and surface area was 6,080 acres. Between 1965 and 1972, 2,360 acre-ft were lost to sedimentation (Corps of Engineers 1976). The lake is used for flood control and water supply.

South Prong Dam was constructed in 1956 on South Prong Creek about 4 mi southeast from the City of Waxahachie. The earthfill dam is 66 ft high and 4,100 ft long and forms Lake Waxahachie. The initial storage capacity of Lake Waxahachie was 13,500 acre-ft, and the surface area was 690 acres. Its drainage area is 30 mi^2; the reservoir is used for flood control and water supply (Dowell and Petty 1973).

Gauge data streamflow records are available at five U.S.G.S. gauges in the project vicinity (Table 5.7.2-2).

The accuracy of runoff records in Waxahachie Creek is influenced by storage, evaporation, and diversions from Lake Waxahachie, and, beginning in 1965, diversions from Lake Bardwell. Flow-duration data demonstrate that flow generally diminishes to zero each year at these stations, including Chambers Creek, which has a drainage area of nearly 1,000 mi^2. Flooding has been a common problem in both the Chambers Creek and Red Oak Creek watersheds. In 1922, a major flood occurred in Chambers Creek that damaged numerous businesses and bridges in the City of Waxahachie. Lives were lost in 1918 and again in 1935. During a 20-yr period of flooding records, from 1923 to 1942, a total of 89 destructive floods were recorded in the Chambers Creek watershed (U.S. Department of Agriculture 1955).

In 1955, the Soil Conservation Service prepared the Chambers Creek Watershed Work Plan for flood protection and damage reduction. The plan included a combination of land treatment measures for soil and water conservation and structural measures for flood prevention. The planned structural measures included 148 floodwater-retarding structures and

Table 5.7.2-2

GAUGE DATA IN PROJECT VICINITY

Gauge	Drainage Area mi^2	Instantaneous Maximum Flow*	Date	Minimum Flow*	Average Flow*	Flow Duration* Q2 %	Q25 %	Q50 %	Q75 %	Q95 %
Waxahachie Creek near Bardwell (No.08063800)	178	---	---	---	72.2	909	2.2	1.6	0.24	0
Chambers Creek near Corsicana (No. 08064500)	963	40,000	5-3-44	0	423	4,920	191	25.3	1.8	0
Richland Creek near Dawson (No. 08063100)	333	25,500	7-3-61	0	141	1,620	20	2.6	0.25	0
Walnut Creek near Mansfield (No. 08049700)	62.8	9,570	5-3-79	0	15.1	115	1.8	0.19	0.01	0
Mountain Creek near Cedar Hill (No. 08049600)	119	28,300	5-7-69	0	45.7	460	7.5	0.57	0.01	0

*All flow values in cubic feet per second (ft^3/s).

Source: Buckner et al. 1987; Gancarz 1988.

83.5 mi of stream channel improvements (U.S. Department of Agriculture 1963). As of October 1, 1987, the Soil Conservation Service completed construction of 72 floodwater-retarding structures in Ellis County with total storage capacities in excess of 85,000 acre-ft (U.S. Department of Agriculture 1987).

Floods have also been a common problem in the Red Oak Creek watershed. During the 20-yr evaluation period from 1923 to 1942, a total of 38 major floods were recorded in the watershed. Damaging floods were expected to occur on an average of about twice each year (U.S. Department of Agriculture 1970). A recent floodplain management study of Red Oak Creek indicated that the 500-yr recurrence interval flood would damage 71 buildings in the floodplain and inundate 12,530 acres of land. The 100-yr flood would damage 51 buildings and inundate 11,287 acres (U.S. Department of Agriculture 1984). In 1950, a watershed work plan, similar to that for Chambers Creek, was prepared for the Red Oak Creek watershed to include flood protection, structural, and land treatment measures. That plan was updated with a supplemental work plan in 1970 (U.S. Department of Agriculture 1970). However, because of the rapid changes in land use from agricultural to urban, it was no longer considered feasible to construct the planned floodwater-retarding structures. It was decided instead to resolve the problem of increasing flood damages in the watershed with a program of floodplain management (U.S. Department of Agriculture 1984).

In 1987, a flood insurance study was completed for the unincorporated area of Ellis County by the Federal Emergency Management Agency in conjunction with the Soil Conservation Service. Detailed studies, complete with flood profiles, were completed for Red Oak Creek, including its tributary within the project site, Grove Creek. Approximate studies were completed for the remaining streams in the project area. Flood boundaries developed as part of these flood insurance studies were superimposed on a map of the project site, and the width of flooding near appropriate project facilities was measured. Flooding widths are tabulated in Table 5.7.2-1 (Federal Emergency Management Agency 1987).

B. Surface Water Quality

Water quality standards and requirements in Texas were first developed by the Texas Water Quality Board staff in 1967. In compliance with the Federal Water Pollution Control Act Amendments of 1972, the early standards were reviewed and approved by the Environmental Protection Agency (EPA) in 1973. Since 1973, the water quality standards have been amended on five subsequent occasions. The most recent revisions were approved by the Texas Water Development Board in 1984 and the EPA in 1985. On September 1, 1985, the responsibility for the application and development of water quality standards in Texas was assumed by the Texas Water Commission. Water quality strategies are being developed to meet the 1988 goals of Public Law 95-217, as amended by Public Law 97-117. Wherever attainable, these goals require that water quality support both aquatic life and water contact recreation. (Texas Water Commission 1986).

Water quality standards for surface supplies consist of three parts:

- o With minor exceptions, general water quality criteria apply to all surface waters of the state.
- o Numerical criteria apply to specific surface water segments.
- o Designation of water uses considered desirable for specific surface water segments.

General water quality criteria were developed to support the state policy to preserve water quality for the health, enjoyment, and use of the public and to prevent degradation by these uses. Water uses deemed desirable by the commission included recreation, domestic water supply, aquatic uses, and other miscellaneous uses such as agricultural and industrial water supply (Texas Water Commission 1986).

The numerical water quality criteria along with specific water uses have been developed for designated segments of certain river basins in Texas. In the Trinity River Basin, 35 segments have been designated, and numerical water quality criteria have been established for each. Designated segments in the vicinity of the project site include Chambers Creek (Segment 0814), Lake Bardwell (Segment 0815), and Lake Waxahachie (Segment 0816). The Chambers Creek segment extends from its confluence with Richland Creek to the confluence of North Fork Chambers Creek with South Fork of Chambers Creek, located west from the project. The designated uses include contact recreation, high-quality aquatics, and public water supply (Texas Water Commission 1986).

The U.S.G.S. has collected water quality data from streams and reservoirs in the project area since 1975. Data for Waxahachie Creek near Waxahachie, Lake Bardwell, and Chambers Creek near Corsicana are shown in Table 5.7.2-3, along with the numerical water quality standards adopted for the classified uses and designated segments. Data are not available for Lake Waxahachie; however, the quality should be similar to that shown in Waxahachie Creek.

The data shows that the maximum concentration of chloride in Waxahachie and Chambers creeks exceeded the state standard for the indicated uses. In Chambers Creek, the maximum concentration of dissolved solids and sulfate also exceeded state standards. In Lake Bardwell, all water quality data shown in Table 5.7.2-3 met state standards and the average concentrations for both Waxahachie and Chambers creeks also met state standards.

There are a total of 16 NPDES permits issued for stream channels in Ellis County. These permits establish limitations on discharge into the surface streams.

Table 5.7.2-3

SURFACE WATER QUALITY DATA IN PROJECT VICINITY

Parameter	Unit	Standard	Maximum	Minimum	Average
Stream: Waxahachie Creek near Waxahachie 1980 to 1982 Classified for Contact Recreation, High-Quality Aquatic Habitat, Public Water Supply.					
Flow	cfs	---	80	2.1	26.6
Fecal Coliform	#/100ml	<200	---	---	---
pH		6.5-9	8.2	7.8	8.1
Temperature	°C	<32.2	26	7	19.5
Dissolved Oxygen	mg/l	>5.0	13.6	5.8	7.8
Dissolved Solids	mg/l	<500	363	150	278
Turbidity	FTU	---	---	---	---
Chloride	mg/l	<65	78	10	26.6
Sulfate	mg/l	<110	70	18	41.6
Nitrate	mg/l	---	---	---	---
Lead	mg/l	---	---	---	---
Mercury	mg/l	---	---	---	---
Stream: Lake Bardwell 1976 to 1982 Classified for Contact Recreation, High-Quality Aquatic Habitat, Public Water Supply.					
Storage	cfs		68,880	42,010	51,328
Fecal Coliform	#/100ml	<200	---	---	---
PH		6.5-9	8.2	7.3	7.8
Temperature	°C	<32.8	28.5	6.0	18.9
Dissolved Oxygen	mg/l	>5.0	11.3	5.2	8.0
Dissolved Solids	mg/l	<300	193	159	171.0
Turbidity	FTU	---	---	---	---
Chloride	mg/l	<50	18	8.6	13.9
Sulfate	mg/l	<50	33	18	26.2
Nitrate	mg/l	---	---	---	---
Lead	mg/l	---	---	---	---
Mercury	mg/l	---	---	---	---

Table 5.7.2-3 (Cont)

**SURFACE WATER QUALITY DATA
IN PROJECT VICINITY**

Parameter	Unit	Standard	Maximum	Minimum	Average
Stream: Chambers Creek near Corsicana, 1975 to 1981 Classified for Contact Recreation, High-Quality Aquatic Habitat, Public Water Supply.					
Flow	cfs	---	9,440	0.2	600
Fecal Coliform	#/100ml	<200	---	---	---
pH		6.5-9.0	8.6	7.4	7.8
Temperature	°C	<32.2	31.0	4.5	19.6
Dissolved Oxygen	mg/l	>5.0	---	---	---
Dissolved Solids	mg/l	<500	581	161	336
Turbidity	FTU	---	---	---	---
Chloride	mg/l	<65	100.0	4.9	42.6
Sulfate	mg/l	<110	170.0	25.0	79.2
Nitrate	mg/l	---	---	---	---
Lead	mg/l	---	---	---	---
Mercury	mg/l	---	---	---	---

Source: Buckner et al. 1987; Gancarz 1988.

C. Surface Water Use

Surface waters in the project site include intermittent flow in the stream channels and storage in various surface reservoirs. Records indicate a total of 13 water rights in the project area with authorized annual usage ranging from 5 acre-ft/yr to 9,600 acre-ft/yr, and totaling 15,691 acre-ft/yr. Water uses include recreation, irrigation, and municipal water supply (Gancarz 1988). The major water supply features include Lake Waxahachie on South Prong Creek and Lake Bardwell on Waxahachie Creek.

Lake Waxahachie stores 13,500 acre-ft for beneficial use and provides potable water to the City of Waxahachie, which has an annual authorized usage of 2,810 acre-ft. Lake Bardwell has a beneficial use storage capacity of 54,900 acre-ft and provides municipal water to both Waxahachie and Ennis. Their combined authorized annual usage is 9,600 acre-ft.

The recommended source of water for the near cluster area is a fresh water source supplied by the Tarrant County Water Control and Improvement District No. 1. The district currently supplies water to the Fort Worth area through a 72-inch raw water pipeline from its Cedar Creek Reservoir about 38 mi east-southeast from Waxahachie. Storage capacity of the reservoir is 678,900 acre-ft, and it supplies a firm yield of about 150 million gal/d. To increase its dependable supply of water, the district began construction of the Richland-Chambers Reservoir in 1979. The new reservoir project is located 46 mi southeast from Waxahachie. When completed, it will store 1,135,000 acre-ft and will contribute a firm annual supply of 187 million gal/d to the district water supply. That project will include pumping plants and a 90-inch raw water pipeline from the reservoir to Fort Worth. Projected reservoir completion is mid-1988. Both the 72-inch and 90-inch pipelines cross the project site and pass within 10 mi of Waxahachie. When completed, the Richland-Chambers project will increase the district water supply to over 470,000 acre-ft/yr (Tarrant County Water Control and Improvement District No. 1 1987).

Water use within the district in 1985 was estimated to be 181,000 acre-ft. Water use for the year 2000 is projected at 308,000 acre-ft; by 2020, the use is projected to be 370,000 acre-ft. Current and projected surface water use in Ellis County for Lake Waxahachie, Lake Bardwell, Tarrant County Water Control and Improvement District No. 1, and local agricultural diversions, are tabulated in Table 5.7.2-4.

5.7.2.2 Groundwater Hydrology, Quality, and Use

A. Groundwater Hydrology

The principal water-bearing sediments in the SSC area are the Twin Mountains formation of the Trinity group and the Woodbine formation. The floodplain alluvium near the larger streams is also used for local irrigation. All other aquifers in the area are of minor importance and

Table 5.7.2-4

SURFACE WATER USE IN PROJECT VICINITY

Source	Use	Quantity	
		Current acre-ft	Projected acre-ft (to year 2020)
Ellis County			
Lake Waxahachie	Municipal	2,400	2,400
Lake Bardwell	Municipal and Industrial	7,151	7,367
Tarrant County Water Control and Improvement District No. 1	Municipal and Industrial	9	9,505
Local Diversions	Agriculture	1,177	1,394

Source: Texas Water Development Board 1988.

supply only small quantities of water. Recharge of groundwater to the deep aquifers is chiefly from precipitation on the outcrops in areas west of the site. Table 5.7.2-5 is a summary of the hydrogeologic units in the SSC area.

Floodplain alluvial deposits along the principal streams serve as a limited source of groundwater in Ellis County. These deposits range to 45 ft in thickness and yield small to moderate quantities of fresh water for domestic, livestock, and some irrigation use (I.W. Santry, Inc. 1975). Yields up to 75 gal/min have been reported for wells drilled in floodplain deposits of the Trinity River (Thompson 1967).

The Navarro group occurs in the extreme eastern edge of Ellis County and consists of up to 490 ft of calcareous clay and marl with some layers of fine-grained sandstone. The Navarro group is not a source of water in Ellis County (Thompson 1967).

Thick sequences of the Austin chalk, Taylor marl, and Eagle Ford shale overlie the Woodbine formation. These formations consist of shale, chalk, limestone, and marl and generally yield water in weathered zones or from small interbeds of sandstone.

The Austin chalk consists of up to 508 ft of chalk and marl (Thompson 1967). The formation is not known to yield water except in the upper weathered zone, which rarely is more than 15 ft thick. Borehole tests performed for the SSC project indicate hydraulic conductivity of the Austin chalk in the unweathered zone is 1.6×10^{-8} to 7×10^{-8} cm/s (Mason, Johnston, and Associates, Inc. 1987; Southwestern Laboratories 1987).

The Taylor marl consists of up to 706 ft of calcareous shale and sandy shale. The lower 80 ft consists of a fine-grained calcareous sandstone interbedded with sandy marl. The lower part of the formation yields small quantities of poor-quality water to a few domestic and livestock wells in the county. Borehole tests performed for the SSC project indicate hydraulic conductivity of the Taylor marl in the project area ranges from 10^{-8} to 10^{-9} cm/s. No productive groundwater beds were encountered during the drilling (Mason, Johnston, and Associates, Inc. 1987; Southwestern Laboratories 1987).

The Eagle Ford shale has a maximum thickness of 467 ft in Ellis County and contains minor sand beds that yield small quantities of water to domestic and livestock wells (Thompson 1967).

The second most important water-bearing formation in Ellis County is the Woodbine. The Woodbine formation crops out in the northwest and dips to the southeast. The top of the formation in the southeastern part of the county is about 2,000 ft below land surface. The Woodbine consists of thin- to massive-bedded sandstone interbedded with shale and sandy shale (Thompson 1967).

Table 5.7.2-5

SUMMARY DESCRIPTION OF HYDROGEOLOGIC UNITS IN ELLIS COUNTY, TEXAS

Hydrogeologic Unit	Approximate Thickness ft	Physical Description	Hydraulic Properties	Water-Bearing Characteristics
Alluvium	45	Sand, gravel, clay, and silt.	K estimated 10^{-1} to 10^{2} cm/s	Small to moderate well yields up to 75 gal/min.
Navarro Group	490	Calcareous clay and marl with some fine-grained sandstone layers.	No data	Not a source of water.
Austin Chalk	508	Chalk and marl inter-bedded with silty to sandy shale.	$K=1.6x10^{-8}$ to $7x10^{-8}$ cm/s	Not known to yield water except in weathered zone.
Taylor Marl	706	Calcareous shale to fine-grained calcareous sand or sandy shale-lower member fine-grained sandstone interbedded with sandy marl.	$K=10^{-8}$ to 10^{-9} cm/s	Yields small quantities of fresh to slightly saline water to shallow weeds for domestic and livestock uses.
Eagle Ford Shale	467	Shale containing thin beds of sandstone and limestone.	$K=1.8x10^{-8}$ cm/s	Yields small quantities of water to wells for domestic and livestock use.
Woodbine Formation	405	Thin to massive bedded sandstone with shale and sandy shale.	$K=1x10^{-3}$ to $9x10^{-3}$ cm/s T=180 to 1,500 ft^2/d	Principal aquifer in Ellis County. Well yields up to 20 gal/min common but range from 3 to 500 gal/min.
Washita Group	543	Limestone, shale and sandy to calcareous shale.	No data	Not a source of water.
Fredericksburg Group	271	Limestone shale and calcareous silty to sandy shale.	No data	Not a source of water.

Table 5.7.2-5 (Cont)

SUMMARY DESCRIPTION OF HYDROGEOLOGIC UNITS IN ELLIS COUNTY, TEXAS

Hydrogeologic Unit	Approximate Thickness ft	Physical Description	Hydraulic Properties	Water-Bearing Characteristics
Paluxy Sand	160	Fine-grained sandstone.	$K=1.5 \times 10^{-3}$ cm/s $T=420\ ft^2/d$	Yields 80 to 160 gal/min of water to few wells.
Glenrose Limestone	805	Limestone interbedded with sandstone and shale.	No data	Does not yield water in Ellis County.
Travis Peak Formation	510	Sandstone with limestone and shale.	No data	Small to moderate well yields.
Twin Mountains Formation	310	Massive sandstone containing interbeds of siltstone, shale, marl, and limestone.	$K=1x10^{-3}$ to $8x10^{-3}$ cm/s $S=8x10^{-5}$ $T=700$ to $2,200\ ft^2/d$	Principal aquifer. Yields up to 620 gal/min for municipal, industrial, domestic, and livestock uses.

Notes:

T - Transmissivity
K - Hydraulic conductivity
S - Storage coefficient

Sources: Thompson 1967; Freeze and Cherry 1979; Mason, Johnston and Associates, Inc. 1987; Southwestern Laboratories 1987; Nordstrom 1982.

Wells completed in the Woodbine, a confined aquifer, have depth to water ranging from 163 to 415 ft below land surface. Transmissivity ranges from 180 to 1,500 ft^2/d (Nordstrom 1982). Hydraulic conductivity of the formation is estimated to range from 10^{-3} to 9×10^{-3} cm/s. Reported well yields range from 3 gal/min to 500 gal/min. There are numerous small-diameter wells that have yields less than 20 gal/min in Ellis County (Thompson 1967).

Underlying the Woodbine formation are the Washita and Fredericksburg groups. Neither of these formations are considered to be water bearing in Ellis County. Both act as an aquitard in the area. The Washita group has a maximum thickness of 543 ft in Ellis County and consists of interbedded limestone, shale, and sandy to calcareous shale. The Fredericksburg group attains a maximum thickness of 271 ft in the county and consists mainly of limestone, shale, and calcareous, silty, and sandy shale (Thompson 1967).

The Paluxy sand, the upper member of the Trinity group in Ellis County, consists of up to 160 ft of fine-grained, poorly consolidated sandstone with varying amounts of clay, sandy clay, shale, lignite, and pyrite. A few wells tap the water-bearing sandstone in the Paluxy and yield small to moderate quantities of slightly saline water for domestic and livestock use (Thompson 1967). Reported well yields from the Paluxy sand in Ellis County range from about 80 gal/min to 160 gal/min (Nordstrom 1982). Transmissivity of the Paluxy sand in Ellis County is reported to be about 420 ft^2/d. Hydraulic conductivity is estimated to be 1.5×10^{-3} cm/s (Thompson 1967).

Underlying Paluxy sand are Glen Rose limestone and the Travis Peak formation, also members of the Trinity group. The Glen Rose limestone consists of medium- to thick-bedded limestone with some sandstone, sandy shale, shale, and anhydrite that reaches a maximum thickness of 805 ft in Ellis County. The Glen Rose limestone is not a source of water in Ellis County. The Travis Peak formation reaches a maximum thickness of 510 ft in Ellis County and consists of sandstone with limestone and shale. No wells are known to obtain water from this formation, therefore no hydrologic information is available for the Travis Peak in Ellis County (Thompson 1967).

The Twin Mountains formation is the lower member of the Trinity group and is the most important water-bearing formation in the area. Within Ellis County, the top of the formation ranges from about 1,800 ft below land surface in the northwest to about 4,900 ft below land surface in the eastern part. The thickness of the formation ranges from 90 ft to 310 ft. Several municipal and rural water supply wells tap the Twin Mountains formation, with some of these wells producing up to 620 gal/min. The average well yield from the Twin Mountains formation in Ellis County is 300 gal/min. Depth-to-water in wells completed in this confined aquifer ranges from approximately 440 to 880 ft below land surface (Nordstrom 1982).

The Twin Mountains formation overlies Paleozoic rocks throughout the area and is the lower member of the Trinity group. The Twin Mountains formation consists of a basal conglomerate grading upward into coarse- to fine-grained sand interspersed with shale. The sand layers are more thickly bedded in the lower part of the formation. The majority of wells completed in the Twin Mountains formation are in this lower sand member (Nordstrom 1982). Results of drawdown and recovery tests on wells completed in the Twin Mountains formation in Ellis County indicate a transmissivity ranging from about 700 to 2,200 ft^2/d. Storage coefficient was estimated to be 8×10^{-5} (Nordstrom 1982). The hydraulic conductivity of the aquifer ranges from 10^{-3} to 8×10^{-3} cm/s (Thompson 1967).

Water levels in both the Woodbine and Twin Mountains formations have been declining for years. Wells completed in the Twin Mountains formation at Waxahachie flowed at the surface until 1932. By 1987, water levels had declined a total of 685 ft. Water levels in the Woodbine formation have declined about 85 ft from 1962 to 1987 (William F. Guyton Associates, Inc. 1987).

B. Groundwater Quality

The chemical quality of the groundwater in Ellis County reflects the types of soil and rock that have been in contact with the water. Usually, as the water moves deeper, its chemical content is increased. The chemical quality of the various water-bearing units in the SSC project area is summarized and compared with various standards of water quality in Table 5.7.2-6.

The concentration of dissolved solids is reported to range from 310 mg/l in the alluvium to 3,040 mg/l in the Woodbine formation. Except for the alluvium, the majority of all water from the Paluxy, Woodbine, and Twin Mountains formations in Ellis County exceeds the EPA drinking water standard for total dissolved solids of 500 mg/l. Groundwater in the project area is of sodium-bicarbonate type (Thompson 1967).

In summary, groundwater from the Twin Mountains formation is generally of better quality than that from other aquifers in Ellis County. However, the water is generally higher in temperature (100 to 110°F) and requires cooling for domestic use. The Woodbine formation generally produces water that is more highly mineralized but is usually soft and not high in nitrates. The quality of water in the Woodbine formation deteriorates as is moves away from the area of recharge to the west. Also, the quality of water in the upper part of the Woodbine formation usually contains more dissolved solids than water from the lower part. The quality of water in the Paluxy sand also deteriorates eastward and becomes moderately saline. The quality of water from the alluvium varies locally; however, it is the source of groundwater for sustained irrigation in Ellis County (I.W. Santry, Inc. 1975). As shown on Table 5.7.2-6, water from the alluvial materials is very hard, while water from the other sources is generally soft to moderately hard.

Table 5.7.2-6

RANGE OF GROUNDWATER QUALITY IN ELLIS COUNTY, TEXAS

Source	Range of Chemical Constituents mg/l				
	Total Dissolved Solids	Chloride	Sulfate	Nitrate	Hardness* $CaCO_3$
National drinking water standards	500	250	250	45	None
Alluvium	310-1,870	2.4-240	11-1,460	1.8-231	236-965
Paluxy sands	1,250-2,063	54-85	354-930	<0.4-8.3	15-40
Woodbine formation	429-3,040	16-1,540	11-1,060	0-10	4-70
Twin Mountains formation	630-1,440	67-405	70-500	0-5	2-110

*Typical classifications of the hardness of water are as follows: 0-60 mg/l = soft to slightly hard; 60-120 mg/l = moderately hard; 120-180 mg/l = hard; >180 mg/l = very hard.

Sources: Driscoll, 1986; Nordstrom 1982; Thompson 1967; William F. Guyton Associates, Inc. 1987; Texas Water Development Board 1976; U.S. Environmental Protection Agency 1977.

C. Groundwater Use

Groundwater is used primarily for municipal and industrial supply in Ellis County. Table 5.7.2-7 is a summary of historic groundwater uses in the county and projected groundwater use to the year 2030. The projections are based on high population projections and were compiled by the Texas Water Development Board (1988).

Groundwater use has been increasing within Ellis County since 1960. Historically, approximately 65 to 70% of the water is withdrawn from the Twin Mountains formation in Ellis County, with the remaining 30 to 35% from the Woodbine formation. Municipal groundwater use in the county accounts for about 65% of the total groundwater use while industrial use is about 31% and livestock water about 4%. Irrigation is not widely practiced in the project area.

Groundwater use within Ellis County is projected to decrease by the year 1990 and remain at a constant level through the year 2020. The expected reduction results from the current trend of municipalities within the county to convert to surface water supply sources. For example, Waxahachie discontinued the use of groundwater wells in 1984 and now uses water from Lake Waxahachie and Lake Bardwell solely. Midlothian is also expected to convert to surface water supply in the near future.

Table 5.7.2-7

HISTORIC AND PROJECTED GROUNDWATER USE IN ELLIS COUNTY, TEXAS (ACRE-FT/YR)

Year	Municipal	Industrial	Mining	Livestock	Total
1960	1,440	215	---	---	1,655
1972	2,026	1,457	---	---	3,483
1980	3,765	1,805	-0-	146	5,715
1985	5,787	2,739	87	92	8,705
1990-2020	4,699	1,318	-0-	172	6,189
2030	4,234	1,105	-0-	144	5,483

Source: Texas Water Development Board 1976 and 1988.

5.7.3 Climate and Meteorology

5.7.3.1 General Description

The climate of the proposed Texas SSC site is best characterized as continental. The proximity of the site to the Gulf of Mexico, the persistent southerly and southeasterly flow of warm tropical maritime air into Texas around the westward extension of the Azores High, and the adequate rainfall combine to produce a humid subtropical climate with hot summers (National Oceanic and Atmospheric Administration 1974).

5.7.3.2 Temperature

Temperatures in the region vary from an average low of 35°F in January to an average high of 95°F in July and August. The extreme high temperature recorded, 112°F, was in August; the extreme low temperature recorded, -8°F, was in February.

The temperature drops below freezing on an average of 40 days per year. Frost penetration reaches an average of 3 inches and an extreme of 9 inches in depth (U.S. Weather Bureau 1941). Normal and extreme temperature and heating degree-day data are shown in Table 5.7.3-1.

5.7.3.3 Precipitation

Rainfall at the site varies from year to year. Rains occur most frequently in the late spring as a result of squall-line thunderstorms. Large portions of annual rain tend to occur within short periods of time, which results in excessive run-off (National Oceanic and Atmospheric Administration 1974).

The north-central Texas climatic region receives an average of 32.21 inches of precipitation per year. The peak month for precipitation is May, with an average of 4.78 inches. The month with the least precipitation is August, with an average of 1.96 inches. The region receives a mean of 3 inches of snow. Mean precipitation and snowfall data are shown in Table 5.7.3-2. Also, 1-, 2-, 5-, 10-, 25-, 50-, and 100-yr return-period extreme rainfall data are shown in Table 5.7.3-3.

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Table 5.7.3-1

NORMAL AND EXTREME TEMPERATURE DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average maximum temperature, °F	57	60	67	76	83	92	95	95	88	80	66	57
Average minimum temperature, °F	35	37	43	53	61	70	74	73	66	55	42	37
Highest maximum temperature °F	93	96	100	100	107	107	109	112	108	106	89	90
Lowest minimum temperature °F	-2	-8	10	30	34	48	56	55	40	24	19	7
Heating degree-days	630	480	350	100	10	0	0	0	0	80	350	550

Source: U.S. Environmental Science Services Administration 1968.

Table 5.7.3-2

MEAN PRECIPITATION AND SNOWFALL DATA
FOR THE NORTH CENTRAL TEXAS CLIMATIC REGION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly precipitation, inches	2.21	2.39	2.34	3.50	4.78	3.18	2.13	1.96	2.72	2.58	2.19	2.23
Mean Monthly snowfall, inches	1.0	0.50	0.50	0	0	0	0	0	0	0	0.50	0.50

Source: U.S. Environmental Science Services Administration 1968.

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Table 5.7.3-3

MAXIMUM 1-HOUR AND 6-HOUR RAINFALL
BY RETURN PERIOD

Return Period years	Rainfall (inches) 1-Hour	6-Hour
1	1.60	2.40
2	2.00	3.00
5	2.60	4.00
10	2.90	4.60
25	3.40	5.40
50	3.80	6.20
100	4.20	7.00

Source: U.S. Weather Bureau 1961.

5.7.3.4 Wind

The prevailing wind direction at the Texas SSC site is to the north at an annual average speed of 13 mi/hr. The monthly average speeds are uniform and vary from 11 mi/hr to 15 mi/hr. The fastest recorded wind speed was 77 mi/hr, which occurred in July. Average wind speed and direction data are shown, by month, in Table 5.7.3-4.

5.7.3.5 Humidity

The yearly mean relative humidity in the region of the Texas SSC site is 65%. The average humidity reaches a peak of 70% in January and has its lowest values in August at 58%. Mean and maximum dewpoint and mean relative humidity data are shown in Table 5.7.3-5.

5.7.3.6 Severe Weather

Severe weather in the region of the Texas SSC site can be best characterized as tornadoes, extreme winds, thunderstorms, and hail.

Tornadoes in the region of the site are more common than in most regions of the United States. The site is, however, outside the peak tornado risk region. The yearly probability of a point being struck by a tornado is 1.68×10^{-3}, which corresponds to a return period of 590 years (Thom 1963). For the period of record 1950-1986, 1,543 tornadoes were observed within a 100-nautical-mile radius of Waxahachie. These events caused 164 deaths and 1,687 injuries (National Severe Storms Forecast Center 1988).

Table 5.7.3-4

MONTHLY AVERAGE WIND SPEED AND DIRECTION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average wind speed, mph	13	13	14	15	13	13	12	11	12	12	13	13
Wind blowing toward:	N	N	N	N	N	NNW	N	N	N	N	N	N

Source: U.S. Environmental Science Services Administration 1968.

Table 5.7.3-5

DEWPOINT AND RELATIVE HUMIDITY DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean dewpoint temperature, °F	33	37	40	51	61	66	67	67	62	53	42	36
Maximum 12-hour 1,000 mBar dewpoint, °F	68	67	68	72	75	78	78	78	77	75	71	69
Mean relative humidity, %	70	65	63	65	68	65	62	58	62	65	62	65

Source: U.S. Environmental Science Services Administration 1968.

The highest risk months for tornadoes are April, May, and June, with 60% of the total annual occurrences. Tornado outbreaks, caused when large numbers of tornadoes are spawned in a short period of time, are associated with major hurricanes (National Oceanic and Atmospheric Administration 1974).

Extreme expected winds are shown in Table 5.7.3-6 by maximum wind speed and return period.

Table 5.7.3-6

EXTREME WIND SPEED AND RETURN-PERIOD DATA

Return Period years	Wind Speed mi/h
10	62
25	65
50	68
100	70

Source: Thom 1968

Thunderstorms occur in the region an average of 51 times per year, with peak activity in April, May, June, July, and August (National Climatic Center 1981). Hail greater than 0.75 inches in diameter is observed, on the average, 3.7 times per year (Department of Commerce, Weather Bureau 1969). Hail during April, May, and June is closely associated with squall lines of thunderstorms that form, generally move eastward, then dissipate, usually within a period of 12 hours (National Oceanic and Atmospheric Administration 1974).

5.7.4 Air Quality

5.7.4.1 Conditions Affecting Air Quality

A. Topographical

The topography of this site is generally flat to gently rolling with no major influences on air quality. In the center of the ring is Waxahachie, which may add an urban component, although it is over 5 mi from the closest point on the ring. Dallas, almost 20 mi to the north, is too far away to cause significant surface roughness or urban effects in the SSC vicinity.

B. Meteorological

The ability of the atmosphere to disperse a pollutant is categorized, in part, by its stability classification. The stability classification was described in detail in Appendix 5, Section 5.1.4. The Texas site's relative frequency of the six stability classes is shown in Table 5.7.4-1. Class A has the highest degree of dispersion. This area is well north of any influences on atmospheric stability created by the land/water interface at the Gulf of Mexico, therefore the dispersion characteristics should be very good. G. C. Holzworth's estimate of forecast days of high potential for this site is zero for air pollution, indicating excellent dispersion conditions (Holzworth 1972). Holzworth's methodology was described in Appendix 5, Section 5.1.4. The influence of wind on annual dispersion conditions is demonstrated by Table 5.7.4-2. The table is an annual summary of the frequency of wind speed and direction for the Dallas-Fort Worth first order National Weather Service Station (National Climatic Data Center (NCDC) 1988).

Table 5.7.4-1

FREQUENCY OF OCCURRENCE OF ATMOSPHERIC STABILITY CLASSES

Class	Definition	% Occurrence
A	Extremely unstable	1
B	Unstable	5
C	Slightly unstable	11
D	Neutral	55
E	Slightly stable	16
F	Stable and extremely stable	12

Source: National Climatic Data Center, Weather Station No. 03927, Dallas, Texas (Period of Record 01/82 to 12/86).

Table 5.7.4-2

ANNUAL FREQUENCY OF WIND SPEED AND DIRECTION
TEXAS SSC SITE

	Speed-Knots						
Direction	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	>21	TOTAL
N	.004788	.025071	.036488	.035826	.013289	.003379	.118842
NNE	.003815	.013677	.018176	.014225	.003585	.000708	.054186
NE	.003391	.012056	.010412	.005343	.003639	.000023	.031865
ENE	.003219	.012992	.009453	.003357	.000251	.000046	.029317
E	.006254	.019614	.013769	.004384	.000114	.000046	.044181
ESE	.005236	.017947	.016577	.005046	.000228	.000069	.045103
SE	.00437	.023610	.024729	.010344	.000571	.000114	.064804
SSE	.004175	.017924	.039776	.030392	.005297	.000594	.098158
S	.006701	.031510	.091563	.105195	.037653	.008311	.280933
SSW	.002578	.012992	.025688	.021578	.006371	.001165	.070371
SW	.001608	.007878	.011599	.006508	.001005	.000160	.028757
WSW	.001371	.004886	.005686	.002580	.000365	.000137	.015026
W	.001302	.004316	.005571	.004430	.002845	.000274	.016737
WNW	.00715	.002809	.005549	.005503	.002124	.000434	.017132
NW	.000998	.004521	.011097	.010412	.004475	.001690	.033193
NNW	.001639	.007649	.016760	.015527	.007284	.002535	.051393
Total	.0053225	.219454	.342893	.280648	.084096	.019663	

Source: National Climatic Data Center, Weather Station 03927, Dallas, Texas (Period of Record 1/82 - 12/86).

5.7.4.2 Air Quality

A. Applicable Standards

The National Ambient Air Quality Standards (NAAQS) (40 CFR 50) function as the applicable regulatory levels in the State of Texas. The primary standards are shown in Table 5.7.4-3. The Texas Air Control Board (TACB) has also established regulations that relate more directly to air quality impacts of an industrial source. Table 5.7.4-4 lists allowable increments for industrial sources for total suspended particulates (TSP) and sulfur dioxide (SO_2) (TACB 1988). These increment requirements are in addition to Prevention of Significant Deterioration (PSD) source requirements (40 CFR 52.21).

B. Background Concentrations

A portfolio of values was assembled to quantify ambient air pollutant concentrations in the region. For air pollutant concentrations with averaging times of less than 1 year, the highest representative regional value is shown. These values are delineated, along with the applicable standard for each pollutant, in Table 5.7.4-3. Selected ambient air quality monitoring stations are plotted in Figure 5.7.4-1.

C. Compliance Status

The noncompliance or nonattainment status for the counties in the region of influence of the Texas SSC site is as follows. All of Dallas and Tarrant counties are nonattainment for ozone (O_3) (U.S. EPA 1985).

D. Proximity to Sensitive Areas

The Texas SSC site is proposed for a PSD Class II area, which allows for moderate growth in air pollutant emissions. The closest PSD Class I area, which permits minimal air quality deterioration, is Wichita Mountains Wilderness, which is 125 mi northwest of the Texas SSC site.

5.7.4.3 Regional Air Pollution Sources

Air pollution sources in the site vicinity include cement plants, metal production and fabrication facilities, and electronics manufacturers. Permitted or actual emissions for these sources are shown in Table 5.7.4-5 and the sources are plotted in Figure 5.7.4-1.

Table 5.7.4-3

AMBIENT AIR POLLUTANT ALLOWABLE
CONCENTRATIONS AND BACKGROUND LEVELS

Pollutant Averaging Time	NAAQS Standard $\mu g/m^3$	Background Concentration $\mu g/m^3$	Point Measured at
TSP-24-hr	260	55[a]	Palmer, Ellis County, 1986
TSP-annual geo. mean	75	32	Palmer, Ellis County, 1986
SO_2-3-hr	1300	416[a]	Fort Worth, Northwest, 1986
SO_2-24-hr	365	50	Fort Worth, Northwest, 1986
SO_2-annual	80	8	Fort Worth, Northwest, 1986
NO_2-annual	100	28	Fort Worth, Northwest, 1986
CO-1-hr	40,000	11,110[a]	Fort Worth, Downtown, 1986
CO-8-hr	10,000	8,360[a]	Fort Worth, Downtown, 1986
O_3-1-hr	235	295[a]	Dallas, North, 1986
Pb-calendar quarter	1.5	0.69[a,b]	Baton Rouge, Louisiana, 1986

Notes:

[a]. Highest representative value is given.
[b]. TACB did not report P_b monitoring data.

Sources: 1986 Network Data Summaries, Continuous Air Monitoring, Texas Air Quality Control Board 1987.
Ambient Air Quality Data, Annual Report, 1986, Louisiana Department of Environmental Quality 1987.

Table 5.7.4-4

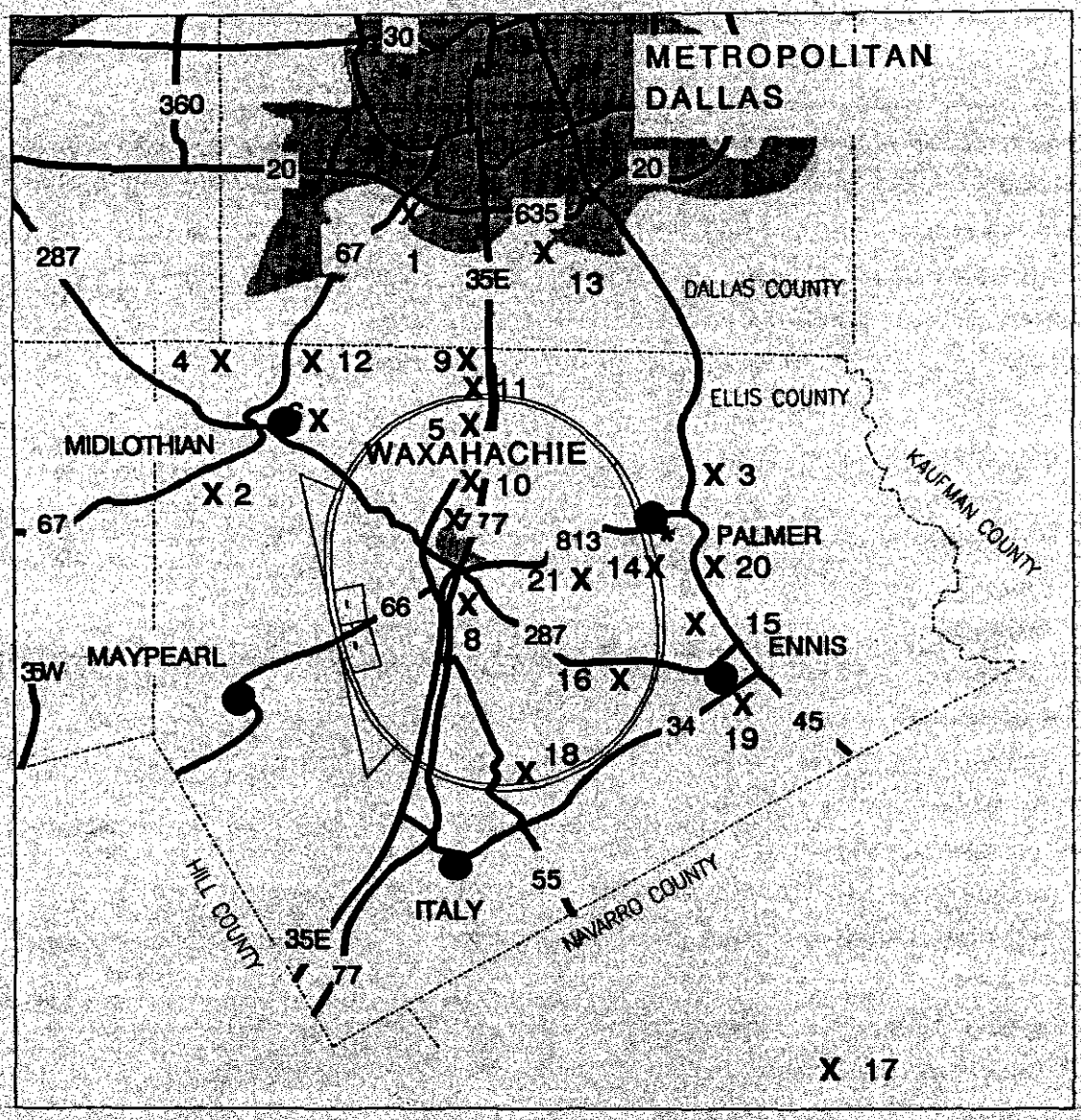
STATE OF TEXAS AMBIENT
SO_2 AND TSP INCREMENT STANDARDS
INDUSTRIAL SOURCES

Pollutant - Averaging Period	Increment, $\mu g/m^3$
SO_2 - 30 minute	1,021
TSP - 1 hour	400
TSP - 3 hour	200
TSP - 5 hour	100

TSP - Total Suspended Particulates
SO_2 - Sulphur Dioxide
Source: Texas Air Control Board 1988.

Figure 5.7.4-1

AMBIENT AIR QUALITY MONITORING STATIONS AND
REGIONAL AIR POLLLUTION SOURCES
TEXAS SSC SITE



X = Air Pollutant Source

* = Ambient Air Quality Monitoring Station

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Table 5.7.4-5

REGIONAL AIR POLLUTANT SOURCES
TEXAS SSC SITE

Source Name	Location	Permitted or Actual Emissions (ton/yr)				
		SO_2	TSP	NO_x	CO	VOC
La Farge Corp.	Dallas County	1,532	-	890	-	-
Chaparral Steel	Midlothian	73	83	-	653	-
Elk Corporation	Ennis	4	2	2	0.5	8
Gifford Hill Cement	Midlothian	1,072	162	1,158	310	32
Owens Corning Fiberglass	Waxahachie	-	134	-	-	-
Texas Industries	Midlothian	8,325	440	3,050	-	-
Eubank Ready Mix	Waxahachie	-	5	-	-	-
City of Waxahachie	Waxahachie	0.2	10	2	-	-
Southwest Aluminum	Red Oak	-	0.4	0.1	-	-
International Extrusion	Waxahachie	-	5	4	4	.6
City of Waxahachie	Red Oak	-	6	2	-	-
Boxcrow Cement	Midlothian	762	56	1,090	-	-
Dixie Metal	Dallas County	465	-	-	-	-
Koch Materials	Ennis	-	7	-	72	2
Industrial Metals	Ennis	-	1	1	-	-
RW McKinney and TL Jones & Company	Ennis	-	48	-	-	-
Gourdian Industries	Navarro County	-	-	600	-	-
Chemical Reclamation Services	Italy	7	-	12	16	0.8
Universal Tank and Iron Works	Ennis	-	-	-	-	17
Flinkote	Ennis	-	-	-	-	0.2
Cargill Inc.	Ennis	-	-	-	-	2

Source: Texas Air Control Board 1988.

5.7.5 Noise and Vibration

This section describes background noise and vibration conditions in the region of the proposed SSC site.

5.7.5.1 Ambient Noise Levels

A. Applicable Standards

Applicable noise abatement criteria in the region of the SSC site have been established by the State of Texas, the Federal Highway Administration (FHWA), and the Department of Housing and Urban Development (HUD). The criteria in the State of Texas regulations match those set forth in 23 CFR 772 by the FHWA. FHWA and HUD noise abatement criteria are discussed in Section 5.1.5.

B. Background Levels

Existing noise levels are typical of areas in agricultural use and should range from 35 to 45 dBA. The day-night sound level is expected to average 40 dBA (EPA 1982).

C. Proximity to Sensitive Areas

The primary sensitive noise receptors in the region are residences. Approximately 25 residences are located within 3,000 ft of the near cluster facilities. Approximately 108 residences are located within 3,000 ft of service area F3, and an additional 37 residences are located within 3,000 ft of the remainder of the service areas. Sensitive receptors in the project vicinity are shown on Figure 5.7.5-1.

5.7.5.2 Other Noise Sources

Primary sources of noise in the region include farm equipment, road traffic, and trains. Noise levels produced by roads (as measured 50 ft from the road) range from a high of 75.8 dBA for Interstate Highway 35E to a low of 54.2 dBA for Farm Road 876. Sound levels produced by trains (as measured 100 ft away), range from 61 dBA to 71 dBA (Ebasco Services 1987).

5.7.5.3 Ambient Vibration Levels

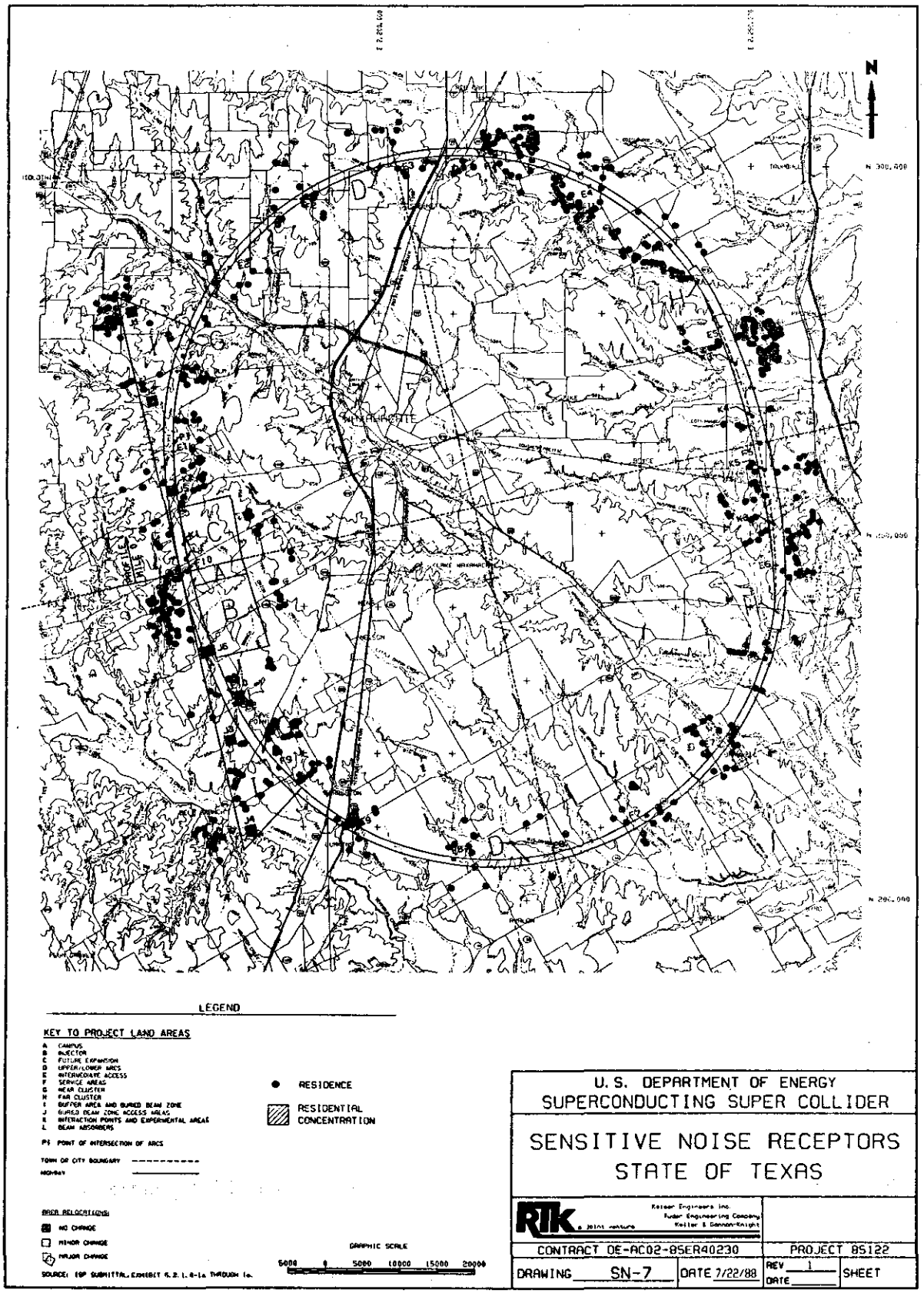
Ambient vibration levels in the site vicinity are highly dependent on the proximity to man-made sources. Naturally occurring vibrations, which result from weather phenomena exciting vibrations that travel long distances in the earth, are of low frequency (1 Hz or less). Vibrations from large, distant earthquakes will also produce vibrations at the site.

5.7.5.4 Other Vibration Sources

Major man-made vibration sources include railroads, highways, and quarries. The sources discussed below are plotted in Figure 5.7.5-2.

Figure 5.7.5-1

**SENSITIVE NOISE RECEPTORS
TEXAS SSC SITE**



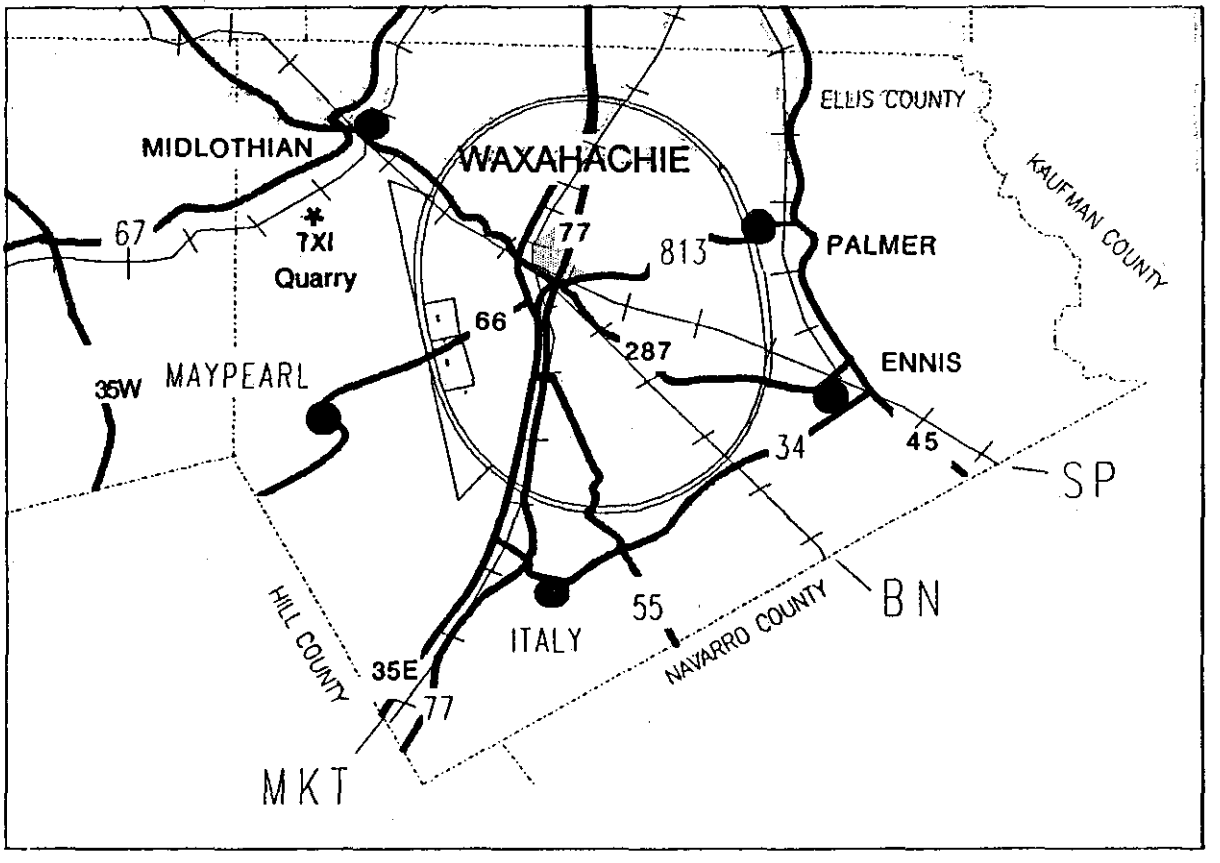
Railroads cross the collider ring at five points. The ring is crossed twice by M-K-T, twice by Burlington Northern, and once by Southern Pacific lines. The Southern Pacific passes within 2,400 ft of an interaction point (K5). The shallowest crossing of the ring by a railroad occurs at E2 at a depth of 25 ft.

Major highways in the vicinity include Interstate Highways 35E and 45, U.S. Route 287, State Highway 34, and U.S. Route 67. None come closer than 600 ft to an interaction point.

The only quarry which is a vibration source in the region is west of the proposed ring (see Figure 5.7.5-2). Measurement of the vibrations produced by the quarry is shown in Table 5.7.5-1.

Figure 5.7.5-2

REGIONAL VIBRATION SOURCES
TEXAS SSC SITE



MKT - Missouri-Kansas-Texas
BN - Burlington Northern
SP - Southern Pacific
SF - Santa Fe

Table 5.7.5-1

REGIONAL VIBRATIONS
TEXAS SSC SITE

Source	Location of Measurement Point Relative to Source: Horizontal ft	Vertical ft*	Measured Vibrations: Displacement inches	Frequency Hz
Railroad	500	123	NM	NM
Railroad	500	135	NM	NM
Railroad	500	60	NM	NM
Quarry	6,600	60	0.4×10^{-4}	0.5

* Feet below ground level.

NM Not measured.

Source: Stafford 1988

5.7.6 Environmental Radiation

5.7.6.1 Natural Radioactivity

A. Radon

Indoor radon levels reported by the University of Pittsburgh Radon Project (Cohen 1988) are presented in Table 5.7.6-1. The average level for the state was 5.5 pCi/l. Indoor radon levels were not reported for Ellis County.

The Ra-226 concentrations in rock cores at the proposed tunnel depth ranged from 0.27 to 1.26 pCi/g with an average of 0.62 pCi/g.

There are no identified uranium deposits in the proposed area.

B. Soil/Rock

Soil samples from three locations near boreholes on the proposed SSC site were collected in June 1987 and analyzed by Alpha Nuclear Laboratories (Alpha 1987). Gross alpha activities ranged from 6.07 to 10.3 pCi/g with an average of 8.3 pCi/g. The gross beta activity varied from 11.7 to 23.6 pCi/g with an average of 19 pCi/g. The Ra-226 concentration ranged from 0.40 to 1.06 pCi/g averaging 0.75 pCi/g. The thorium 232 daughters ranged from less than 0.06 to 1.52 pCi/g with an average of 0.93 pCi/g.

Additional soil samples were collected in February 1988 during ground surveys. Soil samples underlain by similar geologic strata were composited prior to gamma spectrometry and gross alpha and beta analyses by the Texas Department of Health Laboratories (Texas 1988). Samples from the proposed campus area were also composited. The gross alpha activity varied from 8.4 to 11 pCi/g with an average of 9.1 pCi/g. The beta activity ranged from 7.4 to 19 pCi/g with an average of 12.5 pCi/g. Four samples had Ra-226 concentrations less than the lower level of detection (LLD) of 2.1 to 3.5 pCi/g, but one sample was reported as 4.3 pCi/g. The U-238 concentrations were less than the lower level of detection (1.7-2.9 pCi/g). The reported concentrations for Cs-137, K-40, and Pb-214 averaged 0.3 pCi/g, 7.5 pCi/g, and 0.8 pCi/g, respectively.

In June 1987, 28 core samples from seven locations, representing the three geological strata in which the proposed tunnel would be sited were collected. Alpha Nuclear Laboratories (Alpha 1987) composited and analyzed the core samples.

Average concentrations and ranges of Ra-226, Th-232, uranium, and gross alpha and beta activities for each stratum are presented in Table 5.7.6-2. The average gross alpha activity for the three strata was 10 pCi/g and for gross beta 25.3 pCi/g. The Ra-226 averaged 0.62 pCi/g; and Th-232, 1.02 pCi/g. Uranium-238 is assumed to be in equilibrium with Ra-226.

Table 5.7.6-1

RADON LEVELS

Location	Number of Samples	Geometric Mean pCi/l	Average pCi/l	Percentage of Homes with Radon Levels <4 pCi/l	4-20 pCi/l	>20 pCi/l
United States						
Living space	49,659	1.76	4.01	80	18	2
basement	23,984	3.37	7.87	59	34	7
Texas						
Living space	167	1.57	5.54	85	14	1
basement	8	3.47	5.76	38	62	0
Ellis County	6	NA	NA	NA	NA	NA

NA - not available.
Source: Cohen 1988.

Table 5.7.6-2

AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN PROPOSED TUNNEL LOCATION

Geologic Stratum	No. Samples	Depths ft	Gross Alpha pCi/g	Gross Beta pCi/g	Ra-226 pCi/g	Th-232 daughters pCi/g	U-238* pCi/g
Taylor marl	10	60-180					
(Avg)			(11.4)	(29.5)	(0.57)	(1.24)	(0.57)
Range			10.3-13.1	2.65-31.6	0.27-0.87	1.07-1.36	0.27-0.87
Austin chalk	17	50-280					
(Avg)			(6.7)	(8.6)	(0.61)	(0.38)	(0.61)
Range			<LLD-17.4	0.75-18.2	0.31-1.26	<0.06-1.55	0.31-1.26
Eagle Ford shale	1	204	11.9	37.7	0.68	1.44	0.68

*Calculated
< LLD indicates that the activity is not discernible because lower than the lower limit of detection of the instrument.
Source: Alpha Nuclear Laboratories 1987.

C. Water

In June 1987, seven water samples were collected, three from surface water, two from shallow wells in the alluvium along creek bottoms, and two from deep aquifers. No samples were obtained from the Austin chalk or the Taylor marl since they are dry aquitards (Alpha 1987). In February 1988, five additional surface water samples were collected and analyzed (Texas 1988).

In surface water samples, the gross alpha activity ranged from 0.21 to 46 pCi/l with an average of 7.3 pCi/l. The gross beta activity varied from 3.7 to 51 pCi/l with an average of 10.9 pCi/l. The Ra-226 concentrations ranged from 0.26 to 0.48 pCi/g with an average of reported values of 0.38 pCi/l. Tritium was less than the LLD of 1,000 pCi/l. The U-238 concentrations were less than the LLD (27-53 pCi/l).

Shallow groundwater had reported gross alpha activities of 0.43 and 1.3 pCi/l; gross beta activities of 6.3 and 7.1 pCi/l; and Ra-226 concentrations of 0.38 and 0.72 pCi/l.

Deep groundwater from 944 ft and 2,500 ft yielded gross alpha activities of less than 10 pCi/l; gross beta activities of 3.6 and 3.8 pCi/l; and Ra-226 concentrations of 0.39 and 0.59 pCi/l.

D. Measured Consideration

Borehole and water radioactivity levels were based on a limited number of samples. These samples may or may not be representative of the radioactivity expected at the site.

5.7.6.2 Man-Made Radiation

Based on the profile of state and local radiation control programs for FY 1985 published by the Conference of Radiation Control Program Directors, Inc. (CRCPD 1987), the State of Texas issued 723 medical licenses, 1,289 industrial licenses, and 64 academic licenses to authorize the use of radioactive materials (RAM) in the state. Twenty-four licenses were granted to authorize the use of RAM for other than the above-named categories. Authorization was also awarded to 41 licensees in the use of source materials, and 4 licensees in the use of special nuclear materials. RAM were used in medical institutions, private clinics, eye applications, nuclear medicine, teletherapy, veterinary medicine, nuclear pharmacy, medical products, and in-vitro laboratory analysis by the medical licensees. For the industrial licensees, the RAM were used for well logging, measuring systems other than gauge, industrial radiography, irradiation, RAM distribution or manufacture of the equipment containing RAM, research and development, or other purposes. Some licensees were authorized to perform leak tests for radioactive sealed sources and to manage the radioactive waste for their clients. Nuclear reactors and federal facilities, excluding DOE facilities, are currently regulated by the Nuclear Regulatory Commission (NRC). In Texas, 86 RAM licensees are under the NRC's jurisdiction in accordance with 10 CFR 30, 40, and 70.

The proposed SSC site is in a rural area that does not contain any of the licensed operations listed above. The site does not encompass any government facilities possessing radioactive materials nor are there any milling or mining activities which would enhance the natural background levels.

5.7.6.3 Background Radiation

The proposed collider ring was surveyed in February 1988 to determine the background radiation levels by the Radiation Control Division of the Texas Department of Health (Texas 1988). The measurements were made by using a Ludlum 12S micro-R meter held at 1 meter above the land surface at 59 locations. The measured values range from 26 to 53 mrem/yr. Because of the dinectional sensing characteristics of the instrument, the measured values reflect the terrestrial contribution. If one adds the cosmic contribution of 28 mrem/yr (NCRP 75) to these values, the values for external radiation range from 54 to 81 mrem/yr.

5.7.7 Nonradioactive Environmental Hazards

5.7.7.1 Hazardous/Toxic Materials

Land title and photo searches of the proposed SSC area around Waxahachie revealed no former waste sites. Historically, the area has been used for agricultural purposes and there is no evidence of former industrial activity other than what currently exists.

A review of the EPA's Resources Conservation and Recovery Act (RCRA) treatment, storage, and disposal facility listings showed a total of five permitted facilities located in Ellis County. None is within the ring area. The closest one in Ennis, about 5 mi southwest of the SSC ring. The others are well beyond the SSC area in Midlothian and Avalon. Other RCRA disposal facilities are also located near Dallas and near Tyler.

5.7.7.2 Biological Hazards

No biological hazards are known to exist in the region of the proposed SSC site.

5.7.8 Existing Waste Management Facilities

5.7.8.1 Sewage Facilities

Figure 5.7.8-1 shows the approximate location of the existing sewage treatment plants in the Texas SSC site region. Table 5.7.8-1 presents sewage treatment plants near the SSC site, their current average daily flow rate, current permitted average daily flow rate, current daily maximum flow rate, current permitted daily maximum flow rate, and projected capacity increases.

5.7.8.2 Solid Waste Facilities

Figure 5.7.8-2 shows the approximate location of the existing solid waste disposal facilities. Table 5.7.8-2 lists the existing solid waste disposal facilities in Dallas, Ellis, Johnson, Kaufman, Navarro, Parker, Rockwell, and Tarrant counties. It shows the name of the landfill operator, approximate distance from the SSC site, total acreage, current use, remaining capacity, and estimated closing year of the landfills.

Industrial wastes such as oil, grease, and cutting oil would be disposed of at oil and grease recycling centers.

5.7.8.3 Hazardous Waste Disposal Facilities

Several commercial hazardous waste disposal facilities are located in Texas and are available for disposal of SSC wastes. These include:

- Chemical Waste Management, Inc., Port Arthur, Texas
  Landfill and proposed incinerator
  Accepts Class I hazardous and nonhazardous wastes

- Rollins Environmental Services, Deer Park, Texas
  Incineration and landfill
  Accepts Class I hazardous waste

- Gulf Coast Waste Disposal, Houston, Texas
  Landfill
  Accepts Class I waste

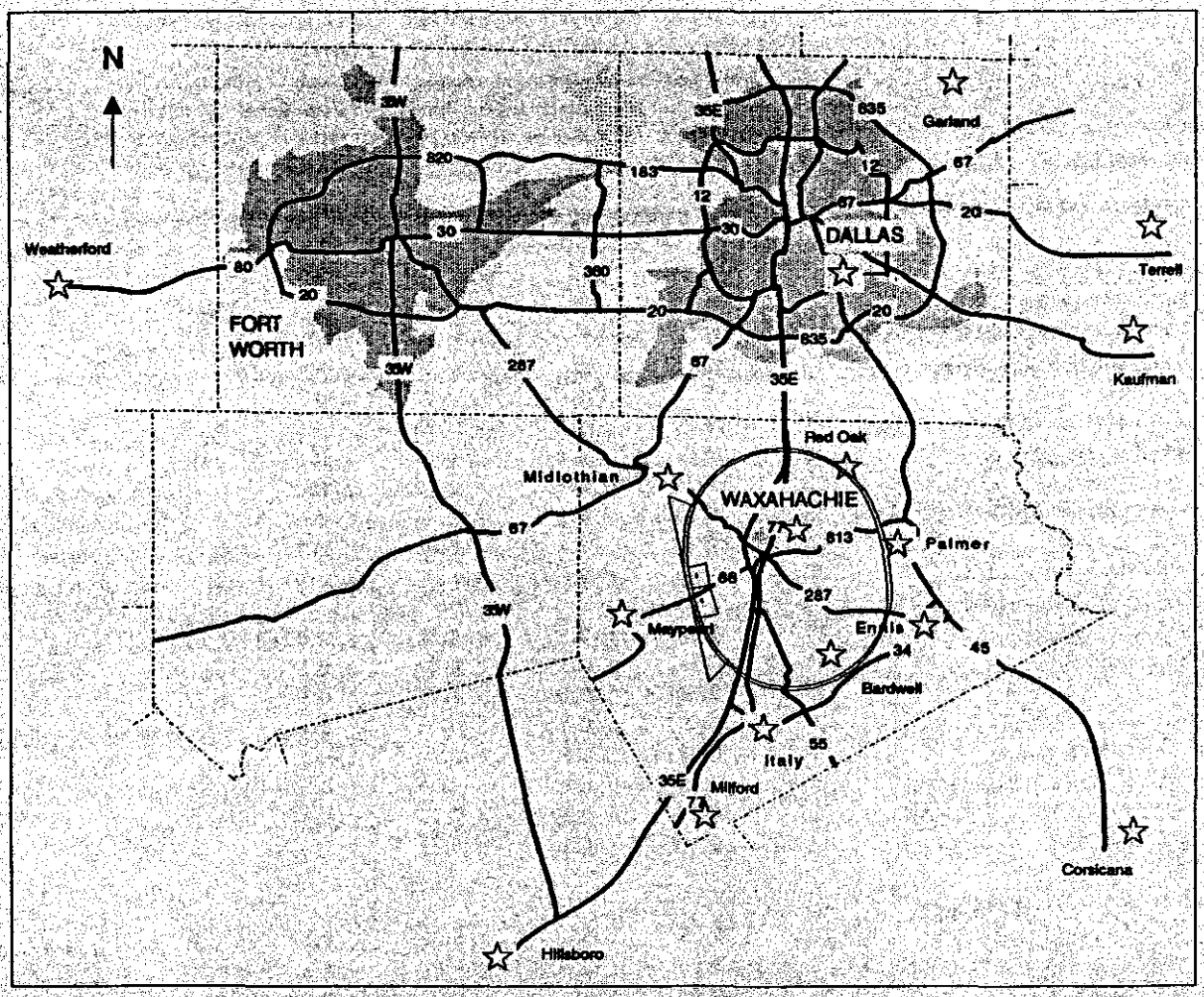
- Texas Ecologists, Robstown, Texas
  Landfill
  Accepts Class I hazardous waste

- Ellis County Disposal Company, Ellis, Texas
  Landfill
  Accepts Class II waste

The Ellis County waste disposal site is located outside the proposed SSC ring location, just east of Interstate Highway 45.

Figure 5.7.8-1

APPROXIMATE LOCATION OF EXISTING SEWAGE TREATMENT PLANTS WITHIN THE TEXAS SSC REGION



☆ Approximate Location of Existing Sewage Treatment Facilities in the Texas SSC Area

Table 5.7.8-1

EXISTING SEWAGE TREATMENT PLANT CAPACITIES

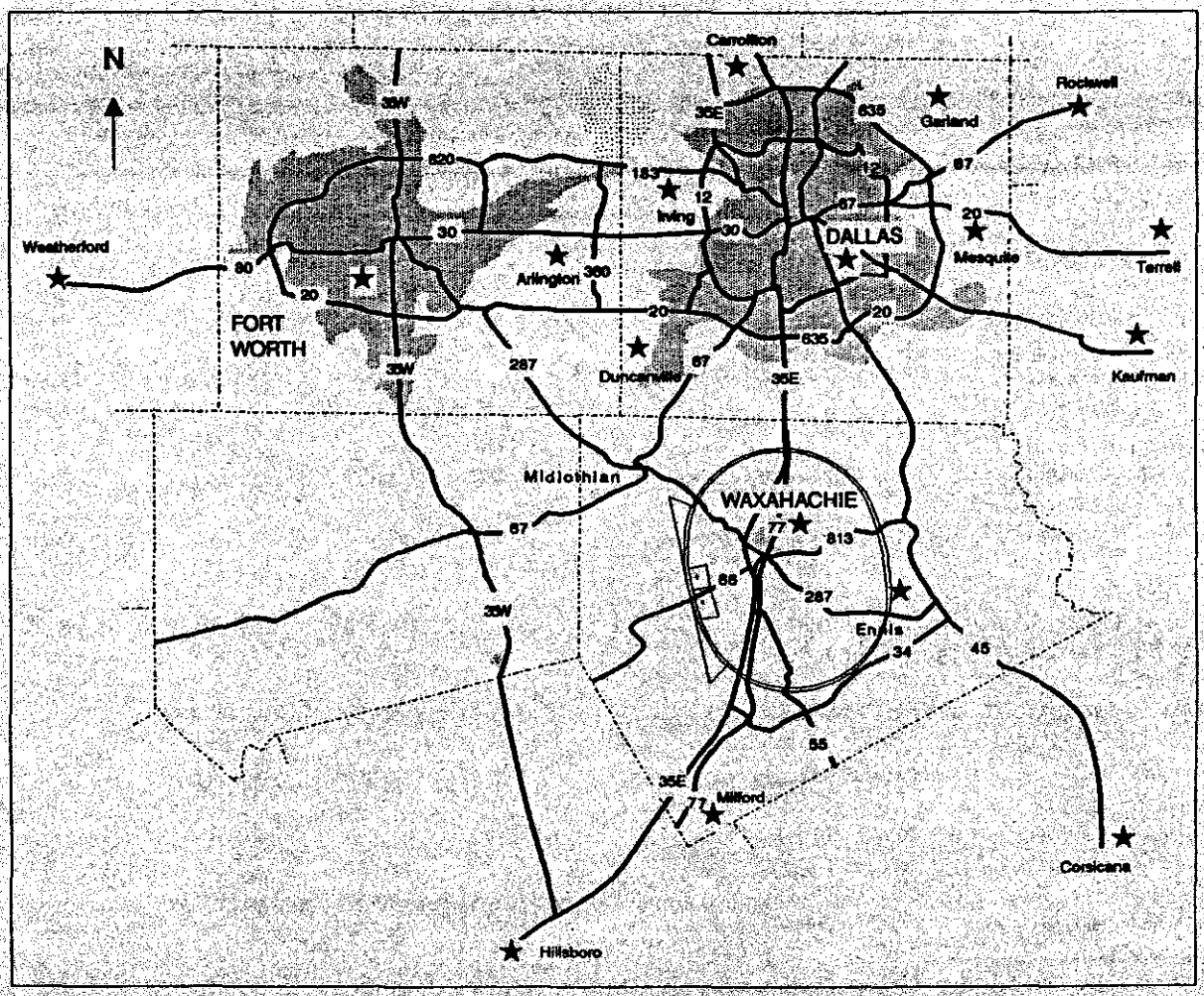
Treatment Plant	Approximate Distance from SSC Site mi	Current Daily Average Flow Rate million gal/d	Permitted Daily Average Flow Rate million gal/d	Current Daily Maximum Flow Rate million gal/d	Permitted Daily Maximum Flow Rate million gal/d
Dallas-Central[1]		14.50	150	252.50	---
Dallas-Southside[1]	32	31.10	30	62.15	75
Fort Worth-Village Creek[2]	25	109.2	120	244.70	---
Garland-Duck Creek	30	21.58	30	32.00	---
TRA-Central		85.75	100	157.08	150
TRA-Ten Mile		10.60	15	27.85	---
Bardwell[1]	18	0.01	0.02	0.08	0.04
Corsicana	35	2.36	3.50	7.50	8.75
Corsicana-Overland	35	0.78	1.0	1.40	2.50
Ennis	20	1.55	2.5	3.48	5.0
Garland, Rowlett[2]	40	11.60	6.0	25.7	12.0
Hillsboro[1]	25	1.02	0.96	2.37	2.81
Italy[1]	12	0.14	0.23	0.33	0.57
Kaufman	40	0.14	0.69	1.42	0.57
Maypearl[1]	12	0.04	0.1	0.09	0.20
Midlothian	15	0.48	0.90	1.44	---
Milford[1]	15	0.05	0.06	0.24	0.12
Palmer[1]	20	0.18	0.07	0.78	0.14
Red Oak[1]	18	0.18	0.20	0.47	--
Terrell	50	1.65	3.00	5.35	6.00
Waxahachie	6	1.90	2.20	7.21	4.40
Weatherford	55	1.55	2.12	2.94	3.06

1. Not enough excess capacity based on daily average flow rate.
2. Full but will be expanded.

Source: Texas Water Commission, Wastewater Enforcement Section

Figure 5.7.8-2

APPROXIMATE LOCATION OF EXISTING SOLID WASTE DISPOSAL SITES WITHIN THE TEXAS SSC REGION



★ Approximate Location of Existing Solid Waste Disposal Facilities in the Texas SSC Area

Table 5.7.8-2

EXISTING SOLID WASTE DISPOSAL FACILITIES

Service	Operator/Permittee	Approximate Distance from SSC Site mi	Total Acreage	Current Use ton/yr	Remaining Capacity acres	Estimated Closing Year
Dallas County						
Carrolton (#750)	City of Carrolton		123	66,500	48	2001
Dallas (#62)	City of Dallas		2040	750,000	844	2025
Dallas CBD (#57)	City of Dallas		107	19,000	40	1989
NE Dallas (#1236)	BFI		101	644,000	29	1992
Garland and Rowlett (#1062A)	City of Garland		214	171,000	75	2001
Irving (#1394)	City of Irving	25	227	73,000	74	2001
Mesquite (#556)	City of Mesquite		76	102,000	57	2001
Ellis County						
Duncanville (#1261)	City of Duncanville		105	53,000	62	2001
Ellis Co./Avalon (#1209)	Linda Elliott		70	51,000	15	1990
Ennis (#947)	City of Ennis	20	123	2,660	35	2000
Milford and IS (#1089)	City of Milford		1	740	0.5	2010
Waxahachie (#1464)	City of Waxahachie	6	incinerator	15,000	incinerator	incinerator
Hillsboro (#1414)	City of Hillsboro	25	93	9,200	67	2015
Waxahachie (#1468)	City of Waxahachie		25	3,300	0.7	2003
Johnson County						
Cleburne (#534)	City of Cleburne		125	43,000	15	1999
Johnson Co. (#1417)	Johnson County		92	24,000	45	2012
Cleburne (#1784)	City of Cleburne		incinerator	12,000	incinerator	2015
Forney (#21)	City of Forney		52	3,300	6	1988
Kaufman County						
Kaufman (#508)	City of Kaufman	40	25	5,000	12	1995
Terrell (#1473)	City of Terrell	50	78	26,000	47	2006
Navarro County						
Frost (#143)	City of Frost		59	320	20	2002
Barry (#286)	City of Barry		10	130	8	2008
Dawson (#437)	City of Dawson		16	234	3	2000
Corsicana Area (#1467)	City of Corsicana		38	48,000	15	1990
Parker County						
Weatherford	City of Weatherford		112	14,000	20	2007
Rockwall County	City of Rockwall		91	18,000	51	1994

Table 5.7.8-2 (Cont)

EXISTING SOLID WASTE DISPOSAL FACILITIES

Service	Operator/Permittee	Approximate Distance from SSC Site mi	Total Acreage	Current Use ton/yr	Remaining Capacity acres	Estimated Closing Year
Tarrant County						
NW Ft. Worth (#217)	City of Ft. Worth		91	16,000	3	1990
Ft. Worth (#1004)	Waste Management		167	283,000	unknown	1990
Ft. Worth (#1019)	Waste Management		unknown	54,000	unknown	unknown
Area Counties (#1232)	H.H. Fraser		37		14	1990
Ft. Worth (#1241)	Bruce & Sharon Fentress		93	0	88	unknown
Arlington (#358)	City of Arlington		551	247,000	316	2008
Euless, Bedford and Hurst (#1716)	SEGO Company/ Clyde Godfrey		60	90,000	38	1990
Fort Worth (#1664) (Sludge only)	City of Fort Worth	30	158	0	130	2012
WSW Fort Worth (#208)	WM Crow and Sons, Inc.		79	95,000	54	2043
SW, SE Fort Worth (#218)	City of Fort Worth		195	129,000	20	1991
Tarrant County (#464)	David Hildreth/ GSX Corp. of Texas		177	587,000	60	1993
West Tarrant County and East Parker Co. (#1156)	Laidlaw Waste System		35	82,000	3	1989

Source: State of Texas, Texas Department of Health.

5.7.8.4 Low-Level Radioactive/Mixed Waste Disposal Facilities

There are no commercial low-level radioactive/mixed disposal facilities operating in Texas.

In Texas, 124 m^3 (3,094 curies) LLRW were generated by the industrial facilities (35.3%) and government (64.7%). There was no commercial nuclear power reactor in Texas in 1986. This LLRW waste included 96.0% class A, 3.1% class B, and 0.9% class C.

5.7.9 Ecological Resources

5.7.9.1 Regional Ecological Characteristics

A. Definition of Drainage Basin and Boundaries of Ecological Resources Potentially Impacted by the SSC

The Texas SSC site is in the central part of the Trinity River Basin. The Trinity River passes approximately 10 mi east of the project site. Major drainage systems within the project site include Red Oak Creek, Waxahachie, Big Onion, and Chambers creeks. The major drainages flow through the site from the northwest to the southeast, and ultimately discharge into the Trinity River. In addition to the various streams transecting the SSC ring area, other major surface water features of the project area include Lake Waxahachie and Lake Bardwell, located on Waxahachie Creek; several floodwater-retarding structures of the Soil Conservation Service, located on tributaries of Waxahachie and Chambers creeks; and numerous small surface water impoundments. Figure 5.7.9.1 illustrates the major drainages affecting the site.

B. Relationship of Ecological Resources with Other Resources

The proposed site has been extensively developed for agricultural use over many decades. The naturally occurring blackland prairie has largely been replaced with cropland and pastures. Man-made lakes have resulted in the introduction of vegetation and animal species dependent on this new source of water.

C. Classification of Ecosystem Types and Distribution

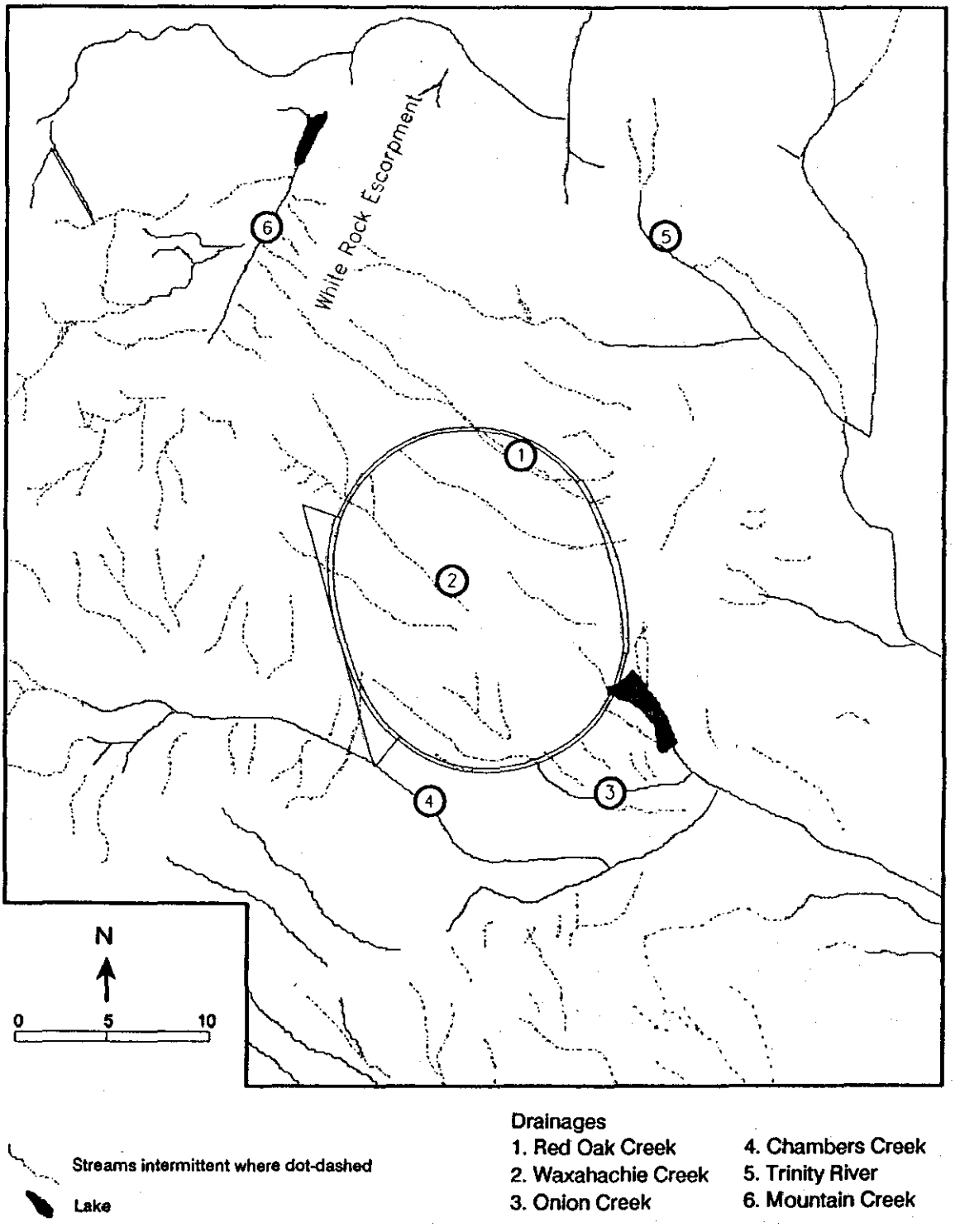
The productive clay loam soils of the central Texas prairies, commonly referred to as the Blacklands because of the soil color, support extensive agricultural development. Blackland prairie occupies a narrow band up to 60 mi wide oriented along a north-south axis from roughly Dallas in the north to San Antonio in the south.

Most of the upland areas of the SSC site are in cropland or pasture, or an area in some stage of secondary succession associated with past cultivation. Lowlands are typically cultivated or in pasture. Successional communities in the uplands are typically dominated by mesquite. Lowlands in succession, especially those along Waxahachie, Mustang, Grove, and Red Oak creeks, are dominated by an elm-sugarberry forest.

Native blackland prairie is rare, and the increasing pressures of urbanization in the area are causing the remaining examples to diminish. No intact prairie remnants are present in the area proposed for the SSC, although several examples are found in the county.

Figure 5.7.9-1

RIVER BASINS AT TEXAS SSC SITE



5.7.9.2 Terrestrial Ecosystems Characteristics and Dynamics

A. Plant Community Composition

1. Elm-Sugarberry Woodlands

Elm-sugarberry woodlands occupy about 10% of the project area. These areas primarily result from natural succession on retired cropland last used as pasture. This plant community is fairly common along streams where grazing pressures continue. In such locations, soils are typically poorly drained.

2. Mesquite Woodlands and Grasslands

Mesquite woodlands and grasslands grow on nearly 50% of the Texas SSC site vicinity. These areas are primarily retired cropland that have been planted with bermuda grass and bluestem for pasture. Where hay production occurs, the hay meadows remain open; however, without periodic hay mowing, pastures are encroached by mesquite or a mixture of mesquite, elm, and juniper. The resulting mesquite woodland is characterized by an open canopy with many species different from the species in the grasslands. In reality, the actual vegetation present in many areas of the SSC site may be an intergrade of any of the three communities described here or above. The species composition depends upon soil moisture, time since crop production ceased, grazing pressure intensity, and a number of other factors.

3. Native Blackland Prairie Grasslands

Native Blackland prairie grasslands are quite rare. No remnants exist in the site vicinity, although several exist in the county. In the vegetative climax, this tall-grass prairie is dominated by little bluestem (Schizachyrium scoparium), big bluestem (Andropogon gerardii), indiangrass (Sorghastrum avenaceum), switchgrass (Panicum virgatum), sideoats grama (Bouteloua curtipendula), tall dropseed (Sporobolus asper), and Texas wintergrass (Stipa leucotricha) (Gould 1969). Of these potentially occurring dominant species, only tall dropseed and Texas wintergrass are reported as dominant in the SSC project area (Texas National Research Laboratory Commission 1987).

4. Agricultural Systems

Timber is not produced as a marketable resource in Ellis County. This is typical throughout the Blackland prairie vegetation region. Locally harvested wood use is restricted to fenceposts and firewood, primarily made from mesquite, red cedar, and bois d'arc.

Important crops currently produced in Ellis County include: wheat, hay, grain sorghum, corn, and upland cotton. Additionally, pecans, oats, and peaches take a lesser role in the local economy. Vegetables such as bell peppers, cabbage, sweet potatoes, beets, snapbeans, spinach, and tomatoes are produced on a very limited basis.

The total area devoted to crop production in Ellis County varied over the period 1975 to 1985, but it began and ended with approximately 240,000 acres of harvested land (Texas Crop and Livestock Reporting Service (TCLRS) 1975 to 1985). During the study period, upland cotton and grain sorghum decreased significantly, while wheat production showed a large increase.

5. Wetlands (Riparian Forests)

Riparian forests account for about 6% of the plant communities in the project vicinity. The elm-sugarberry forest predominates in lowlands as primary or secondary growth along the major creeks of the area or as isolated pockets over poorly or moderately drained soils. Emergent vegetation is limited because of large water-level fluctuations. Important species include cedar, elm, sugarberry, pecan, American elm, Texas oak, bois d'arc, and chinaberry.

Based on the National Wetland Inventory maps, wetlands in the vicinity of the Texas SSC site are confined to ephemeral streams and impoundments. No large swamps or marshlands occur in the project vicinity. Locally, most small streams flow intermittently. The exceptions are Waxahachie, Mustang, and Red Oak creeks, which have water flowing all or most of the year. Stock grazing or crop tillage frequently occupies or disturbs zones in the area. Thus, wetland vegetation, other than some tree species, are frequently absent.

The study area includes 1,631 acres of wetlands.

B. Animal Community Composition

1. Terrestrial Animal Populations

Numerous reptile and amphibian species are present in the area surrounding the site. (Tables 5.7.9-1 and 5.7.9-2).

Most of the larger herbivores that once roamed the blackland prairie were extirpated in the mid-1800s when horses and cattle were introduced and the vast rangeland was converted to agricultural use. Numerous species of wildlife, however, still exist in the vicinity of the SSC site. Common mammals are listed in Table 5.7.9-3. Birds and waterfowl are presented in Tables 5.7.9-4 and 5.7.9-5.

2. Agricultural/Livestock

Trends in livestock and dairy industries reflect an increase in dairy cattle and a significant decrease in beef cattle over the period 1975 to 1985 (TCRLS 1975 to 1985). Approximately 200,000 to 250,000 acres are devoted to livestock pasture in Ellis County. Currently, 25,000 to 30,000 head of beef cattle and 2,000 to 2,500 dairy cattle are raised. Additionally, 1,500 horses and 1,500 goats and sheep are currently being raised in Ellis County.

Table 5.7.9-1

REPTILE SPECIES COMMON TO THE TEXAS SSC SITE

Scientific Name	Common Name
Habitat available over most site area:	
Coluber constrictor	Racer
Sonora semiannulata	Ground snake
Diadophis punctatus	Ringneck snake
Elaphe guttata	Corn snake
Elaphe obsoleta	Rat snake
Tropidoclonion lineatum	Lined snake
Opheodrys aestivus	Rough green snake
Pituophis melanoleucus	Pine-gopher snake
Regina grahamii	Graham's crayfish snake
Masticophis flagellum	Coachwhip
Nerodia erythrogaster	Plain-bellied water snake
Nerodia fasciata	Southern water snake
Nerodia rhombifera	Diamondback watersnake
Cnemidophorous sexlineatus	Racerunner
Sistrurus catenatus	Western massasauga
Thamnophis marcianus	Checkered garter snake
Thamnophis proximus	Western ribbon snake
Thamnophis radix	Plains garter snake
Thamnophis sirtalis	Common garter snake
Virginia striatula	Rough earth snake
Agkistrodon piscivorus	Cottonmouth
Crotalus atrox	Western diamondback rattlesnake
Trionyx spiniferus	Spiny softshell
Anolis carolinensis	Green anole
Lampropeltis calligaster	Prairie king snake
Phrynosoma cornutum	Texas horned lizard
Sceloporus undulatus	Eastern fence lizard
Terrapene ornata	Western box turtle
Sternotherus odoratus	Stinkpot
Habitat available between 10 and 50% of site:	
Virginia valeriae	Smooth earth snake
Leptotyphlops dulcis	Blind snake
Leptotyphlops dulcis dissectus	New Mexico blind snake
Rhinocheilus lecontei	Texas longnose snake
Crotalus horridus	Timber rattlesnake
Storeria dekayi	Brown snake
Tantilla gracilis	Flat-headed snake
Tantilla nigriceps	Plains black-headed snake
Heterodon platyrhinos	Eastern hognose snake
Lampropeltis getulus	Common king snake
Agkistrodon contortrix	Copperhead
Eumeces septentrionalis	Prairie plains skink
Eumeces fasciatus	Five-lined skink
Eumeces laticeps	Broad-headed skink
Sceloporus olivaceus	Texas spiny lizard
Ophisaurus attenuatus	Slender glass lizard
Holbrookia maculata	Lesser earless lizard
Chrysemys scripta	Pond slider
Graptemys kohni	Mississippi map turtle
Terrapene carolina	Eastern box turtle
Kinosternon flavescens	Yellow mud turtle
Kinosternon subrubrum	Mud turtle
Sternotherus carinatus	Razor-backed musk turtle

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Table 5.7.9-1 (Cont)

REPTILE SPECIES COMMON TO THE TEXAS SSC SITE

Scientific Name	Common Name
Habitat available over <10% of site:	
Heterodon nasicus	Western hognose snake
Hypsiglena torquata	Night snake
Lampropeltis triangulum	Milk snake
Sistrurus miliarius	Pigmy rattlesnake
Micrurus fulvius	Coral snake
Scinella lateralis	Ground skink
Eumeces obsoletus	Great plains skink
Cophosaurus texanus	Greater earless lizard
Crotaphytus collaris	Collared lizard
Alligator mississippiensis	American alligator
Cnemidophorus gularis	Texas spotted whiptail
Chelydra serpentina	Snapping turtle
Trionyx muticus	Smooth softshell
Chrysemys concinna	River cooter

Source: Behler and King 1979.

Table 5.7.9.2

AMPHIBIAN SPECIES COMMON TO THE TEXAS SSC SITE

Scientific Name	Common Name
Habitat available over most of the site area:	
Gastrophyrne carolinensis	Eastern narrow-mouthed frog
Gastrophyrne olivacea	Great plains narrow-mouthed frog
Ambystoma tigrinum	Tiger salamander
Scaphiopus holbrooki	Eastern spadefoot
Pseudacris streckeri	Strecker's chorus frog
Rana catesbeiana	Bull frog
Rana clamitans	Green frog
Bufo woodhousei	Woodhouse's toad
Acris crepitans	Northern cricket frog
Habitat available over 10-50% of the site area:	
Rana sphenocephala	Southern leopard frog
Hyla chrysoscelisl Hyla versicolor	Gray treefrog
Hyla cinerea	Green treefrog
Pseudacris clarki	Spotted chorus frog
Habitat available over <10% of site area:	
Rana palustris	Pickerel frog
Rana areolata	Crawfish frog
Notophthalmus viridescens	Eastern newt
Amphiuma triactylum	Three-toed amphiuma
Ambystoma texanum	Small-mouthed salamander

Source: Behler and King 1979.

Table 5.7.9-3

MAMMALS COMMON TO THE TEXAS SSC SITE

Scientific Name	Common Name
Habitat available over most of the site area:	
Didelphis virginiana	Opossum
Cryptotis parva	Least shrew
Scalopus acquaticus	Eastern mole
Pipistrellus sublavus	Eastern pipistrelle
Eptesicus fuscus	Big Brown bat
Tadarida brasiliensis	Brazilian free-tailed bat
Dasypus novemcinctus	Nine-banded armadillo
Sylvilagus floridanus	Eastern cottontail
Mephitis mephitis	Striped skunk
Procyon lotor	Raccoon
Mustela frenata	Long-tailed weasel
Mustela vison	Mink
Geomys bursarius	Plains pocket gopher
Perognathus hispidus	Hispid pocket mouse
Reithrodontomys fulvescens	Fulvours harvest mouse
Baiomyns taylori	Pygmy mouse
Peromyscus leucopus	Deer mouse
Mus musculus	House mouse
Rattus rattus	Black rat
Rattus norvegicus	Norway rat
Sigmodon hispidus	Hispid cotton rat
Canis latrans	Coyote
Odocoileus virginianus	White-tailed deer
Habitat available over 10-50% of site area:	
Castor canadensis	Beaver
Spirogale putorius	Eastern spotted skunk
Lasiurus cinereus	Hoary bat
Lasiurus borealis	Red bat
Nycticeius humeralis	Evening bat
Peromyscus maniculatus	White-footed mouse
Peromyscus gossypinus	Cotton mouse
Spermophilus tridecemlineatus	Thirteen-lined ground squirrel
Sciurus carolinensis	Eastern gray squirrel
Sciurus niger	Fox squirrel
Lynx rufus	Bobcat
Habitat available over <50% of site area:	
Vulpes vulpes	Red fox
Urocyon cinereoargenteus	Gray fox
Glaucomys volans	Southern flying squirrel
Microtus pinetorum	Woodland vole
Bassariscus astutus	Ringtail
Sylvilagus aquaticus	Swamp rabbit
Peromyscus attwateri	Texas mouse
Reithrodontomys montanus	Plains harvest mouse
Neotoma floridana	Eastern woodrat
Myocastor coypus	Nutria
Lepus californicus	Black-tailed jack rabbit

Sources: Whitaker 1980; Davis 1974.

Table 5.7.9-4

BIRD SPECIES COMMON TO THE TEXAS SSC SITE

Scientific Name	Common Name
Habitat available over 50% of the site area:	
	Eastern phoebe
	Great crested flycatcher
	Western kingbird
	Eastern kingbird
	Scissor-tailed flycatcher
	Ruby-crowned kinglet
	Horned lark
	Pine siskin
	Purple martin
	Dickcissel
	Rufous-sided towhee
	Cassin's sparrow
	Chipping sparrow
	Field sparrow
	Vesper sparrow
	House sparrow
	Harris sparrow
	Dark-eyed junco
	Rock dove
	Mourning dove
	Eastern meadowlark
	Western meadowlark
	Yellow-billed cuckoo
	Greater roadrunner
	Barn owl
	Eastern screech-owl
	Great horned owl
	Barn swallow
	Chestnut collared longspur
	Blue jay
	American crow
	White-throated sparrow
	Carolina chickadee
	Tufted titmouse
	Northern flicker
	Common nighthawk
	Chuck-will's-widow
	Northern parula
	Orange-crowned warbler
	Chimney swift
	Yellow-bellied sapsucker
	Ruby-throated hummingbird
	Northern cardinal
	Blue grosbeak
	Indigo bunting
	Swainson's hawk
	Red-tailed hawk
	Downy woodpecker
	American kestrel
	Merlin
	Great-tailed grackle
	Common grackle
	Brown-headed cowbird
	Northern bobwhite

Table 5.7.9-4 (Cont)

BIRD SPECIES COMMON TO THE TEXAS SSC SITE

Scientific Name	Common Name
Habitat available over 50% of the site area:	
	Loggerhead shrike
	White-eyed vireo
	European starling
	American robin
	Eastern bluebird
	Northern mockingbird
	Gray catbird
	Brown thrasher
	Yellow-breasted chat
	Northern harrier
	Killdeer
	Black vulture
	Turkey vulture
	Osprey
	Mississippi kite
	Short-eared owl
Habitat available over 10-50% of the site area:	
	American goldfinch
	Red-Wing blackbird
	McCown's longspur
	Orchard oriole
	Purple finch
	House finch
	Burrowing owl
	Barred owl
	Common yellowthroat
	Lark sparrow
	Savannah sparrow
	Fox sparrow
	Song sparrow
	Belted kingfisher
	House wren
	Winter wren
	Golden-fronted woodpecker
	Red-bellied woodpecker
	Ladder-backed woodpecker
	Hairy woodpecker
	Easter wood-peewee
	Golden-crowned kinglet
	White-crowned sparrow
	Painted bunting
	Summer tanager
	Brewer's blackbird
	Blue-gray gnatcatcher
	Red-eyed vireo
Habitat available over <10% of site area:	
	Solitary vireo
	Golden-cheeked warbler
	Black and white warbler
	Black-chinned hummingbird

Table 5.7.9-4 (Cont)

BIRD SPECIES COMMON TO THE TEXAS SSC SITE

Scientific Name	Common Name
Habitat available over <10% of site area:	
	Hermit thrush
	Red-breasted nuthatch
	Northern rough-winged swallow
	Cliff swallow
	Marsh wren
	Curve-billed thrasher
	Sharp-shinned hawk
	Coopers hawk
	Red-shouldered hawk
	Broad-winged hawk
	Bell's vireo
	Black-capped vireo
	Sprague's pipit
	Lesser goldfinch
	Cedar waxwing
	Red-headed woodpecker
	Wild turkey

Sources: Farrand 1983; Oberholser 1974; Peterson 1963; Texas Park and Wildlife Department 1987; U.S. Fish and Wildlife Service 1987.

Table 5.7.9-5

WATERFOWL COMMON TO THE TEXAS SSC SITE

Scientific Name	Common Name
Habitat available over most of the site area:	
	Gadwall
	American wigeon
	Canvasback
	Redhead
	Lesser scaup
	Bufflehead
	Ruddy duck
	Water pipit
	Spotted sandpiper
	Common snipe
	Ring-billed gull
	Canada goose
	Green-winged teal
	Mallard
	Northern pintail
	Double-crested cormorant
	Pie-billed grebe
	Eared grebe
Habitat available over 10-50% of the site area:	
	Great blue heron
	Northern shoveler
	King rail
	Common moorhen
	American coot
Habitat available over <10% of the site area:	
	Great egret
	Snowy egret
	Little blue heron
	Cattle egret
	Yellow-crowned night heron
	Black-crowned night heron
	American bittern
	Least bittern

Sources: Farrand 1983; Oberholser 1974; Peterson 1963; Texas Parks and Wildlife 1987; U.S. Fish and Wildlife Service 1987.

Table 5.7.9-6 identifies common fish species present in these diverse streams.

5.7.9.3 Aquatic Ecosystems

A. Lotic Ecosystems

Area streams and rivers provide diverse habitats for biological communities. Variations in stream vegetation are related to the differences in stream bed substrates and surface water flow regimes.

Table 5.7.9-6

FISH SPECIES COMMON TO RIVERS, CREEKS, AND STREAMS AT THE TEXAS SSC SITE

Scientific Name	Common Name
Ample habitat available:	
Micropterus punctulatus	Spotted bass
Labidesthes sicculus	Brook silverside
Lepomis macrochirus	Bluegill
Lepomis humilis	Orangespotted sunfish
Pomoxis annularis	White crappie
Moderate habitat available:	
Ictibus bualus	Smallmouth buffalo
Zygonectes notatus	Blackstripe topminnow
Lepomis auritus	Redbreast sunfish
Menidia beryllina	Inland silverside
Morone chrysops	White bass
Lepomis punctatus	Spotted sunfish
Moxostoma congestum	Gray redhorse
Percina sciera	Dusky darter
Percina caprodes	Logperch
Notropis buchanani	Ghost shiner
Campostoma anomalum	Central stoneroller
Etheostoma spectabile	Orangethroat darter
Limited to minimal habitat available:	
Opsopoedus emiliae	Pugnose minnow
Hybopsis aestivalis	Speckled chub
Notropis potteri	Chub shiner
Notropis venustus	Blacktail shiner
Notropis volucellus	Mimic shiner
Ictalurus punctatus	Channel catfish
Pylodictis olivaris	Flathead catfish
Ictalurus melas	Black bullhead
Percina macrolepida	Bigscale logperch
Aplodinotus grunniens	Freshwater drum
Notropis oxyrhynchus	Sharpnose shiner
Notropis shumardi	Silverband shiner
Fundulus zebrinus	Plains killfish
Lepisoteus osseus	Long gar
Ample habitat available:	
Dorosma cepedianum	Gizzard shad
Lepomis gulosus	Warmouth
Lepomis Machrochirus	Bluegill
Lepomis humilis	Orangespotted sunfish
Pomoxis annularis	White crappie
Labidesthes sicculus	Brook silverside
Moderate habitat available:	
Micropterus salmoides	Largemouth bass
Morone saxatilis	Striped bass
Pomoxis nigromacculatus	Black crappie
Lepomis microlophus	Redear sunfish
Lepomis auritus	Redbreast sunfish
Notropis buchanani	Ghost shiner
Campostoma anomalum	Central stoneroller

Table 5.7.9-6 (Cont)

FISH SPECIES COMMON TO RIVERS, CREEKS, AND STREAMS AT THE TEXAS SSC SITE

Scientific Name	Common Name
Ample habitat available:	
Limited habitat available:	
Lepisosteus oculatus	Spotted gar
Noturus gyrinus	Tadpole madtom
Aplodinotus grunniens	Freshwater drum
Ictalurus melas	Black bullhead

Sources: Hubbs 1982; Lee et al. 1980.

B. Lentic Systems

Lake Bardwell is the largest lake in Ellis County. A survey conducted in 1979 identified 26 species of fish (Sellers 1980). Lake Waxahachie is 4 mi northwest of Lake Bardwell. There are also numerous floodwater retarding impounds in the area.

Twenty-one fish species were identified in Lake Waxahachie in a 1986 survey (Inman 1987). Table 5.7.9-7 indicates fish species common to lakes, ponds, and other impoundments in the SSC site vicinity.

5.7.9.4 Economically, Recreationally, and Culturally Important Species

Both Lake Waxahachie and Lake Bardwell are used for sport fishing. Lake Waxahachie provides the following game fish: channel catfish, largemouth bass, and white crappie. Major sport fish in Lake Bardwell include white crappie, channel catfish, blue catfish, largemouth bass, white bass, striped bass, and sunfish.

Principal game species in the region are the northern bobwhite, rabbit, squirrel, and mourning dove. Commonly hunted waterfowl include green-winged teal, gadwall, and mallard. White-tailed deer are hunted in the area, as are bullfrogs. Raccoon, opossum, striped skunk, gray fox, and spotted skunk are trapped and or hunted in the area.

5.7.9.5 Threatened and Endangered Species

A. Federally Listed and Candidate Species

Four federally listed animal species are known to occur in the vicinity of the site. (Table 5.7.9-8). The bald eagle, black-capped vireo and whooping crane are listed as endangered species. The Arctic peregrine falcon is classified as a threatened species (Fish and Wildlife Service 1988). Two additional endangered species, the wood stork and the interior least tern are also possible inhabitants, although their presence is unconfirmed.

Additional species, listed as Category 2 by the U.S. Fish and Wildlife Service, that have some or ample habitat in the SSC vicinity (none have any special status with the State of Texas) include: Swainson's hawk (*Buteo swainsoni*), western snowy plover (*Charadrius alexandrinus nivosus*), mountain plover (*Charadrius montana*, long-billed curlew (*Numenius americanus*), western yellow-billed curlew (*Coccyzus americanus occidentalis*), migrant loggerhead shrike (*Lanius ludovicianus migrans*), and golden-cheeked warbler (*Dendroica chrysoparia*).

No federally listed plant species are known to occur in this vicinity.

Table 5.7.9-7

FISH SPECIES COMMON TO LAKES AND PONDS IN THE AREA OF THE TEXAS SITE

Scientific Name	Common Name
Ample habitat available:	
Dorosma cepedianum	Gizzard shad
Lepomis gulosus	Warmouth
Lepomis machrochirus	Bluegill
Lepomis humilis	Orangespotted sunfish
Pomoxis annularis	White crappie
Labidesthes sicculus	Brook silverside
Moderate habitat available:	
Micropterus salmoides	Largemouth bass
Morone saxatilis	Striped bass
Pomoxis nigromacculatus	Black crappie
Lepomis microlophus	Redear sunfish
Lepomis auritus	Redbreast sunfish
Notropis buchanani	Ghost shiner
Campostoma anomalum	Central stoneroller
Limited habitat available:	
Lepisoteus oculatus	Spotted gar
Noturus gyrinus	Tadpole madtom
Aplodinotus grunniens	Freshwater drum
Ictalurus melas	Black bullhead

Sources: Hubbs 1982; Lee et al. 1980.

Table 5.7.9-8

SPECIES PROTECTED BY THE STATE OF TEXAS IN ELLIS COUNTY

Identification by Common Name (Scientific Name)	Regulatory Status Federal	Regulatory Status State	Habitat(s) Utilized	Occurrence in Ellis County	Texas Parks and Wildlife Department County Status
Wood Stork (Mycteria americana)	Endangered	Threatened	Wet meadows; swamps and marshes	Non-breeding, casual visitor	Probable
Arctic Peregrine Falcon (Falco peregrinus tundrius)	Threatened	Threatened	Winters on coast, Gulf of Mexico	Migrates through area	Confirmed
Bald Eagle (Haliaeetus leucocephalus	Endangered	Endangered	Winters in Texas along rivers and reservoirs	Winter resident	Confirmed
Whooping Crane (Grus americana)	Endangered	Endangered	Winters in isolated wetlands along Texas coast (Gulf of Mexico)	Migrates through area	Probable
Interior Least Tern (Sterna antillarum anthalassos)	Endangered	Endangered	Barren or sparsely vegetated alluvial islands or sandbars	Not verified but potential visitor or breeder	Potential
Black-capped Vireo (Vireo atricapillus)	Endangered	Endangered	Open oak/juniper woodlands	Historic breeding without recent records. Habitat, if any, in western edge of county.	Confirmed
White-faced Ibis (Plegadis chihi)	Category 2 Review	Threatened	Marshes and wet meadows	Casual visitors - breeds coastal areas of Texas and SE U.S.	Probable
American Swallow-tailed Kite (Elanoides forficatus)	Category 2 Review	Threatened	Mature riparian near wet prairie/ shrub lands	Breeding currently restricted to Florida	Probable
Golden-cheeked Warbler (Dendroica chrysoparia)	Category 2 Review	Threatened	Mature juniper-oak woodlands. Nests in trees on steep slopes of canyons, scarps and creek beds	Historic records in adjacent counties. Habitat, if any, in western edge of county.	Potential
Timber Rattlesnake (Crotalus horridus)	None	Threatened	Riparian woodlands	Recent records in county; resident population level unknown	Confirmed
Texas Horned Lizard (Phrynosoma cornutum)	None	Threatened	Dry, open areas with loose and sandy soils	Population levels and distribution in county unknown	Confirmed

Source: Texas Parks and Wildlife Department 1988.

B. State Listed Species

Eleven species of animals that exist in Ellis County are listed as threatened or endangered species by the State of Texas. Table 5.7.9-8. No state listed plant species are known to occur in Ellis County (Martin 1988).

5.7.9.6 Unique Ecosystems and Communities Potentially Affected

Figure 5.7.9-2 illustrates the locations of unique natural areas.

A. Statutorily Protected Areas

Two man-made lakes, Lake Waxahachie and Lake Bardwell, are used for flood control, water supply, and recreation.

B. Remnant Communities, Virgin Stands, and Unique Assemblages

There are several unique riparian woodland areas in the vicinity of the ring for the proposed SSC alignment. While these areas are not unique in the true sense of the word, they are very uncommon and of key importance to many wildlife species for food and cover, and are the habitat for a number of the less common plant species in the area.

The White Rock Escarpment, west of the Texas SSC site, has been known to serve as a unique habitat for several endangered species.

C. Marginal Range Association and Transition Zones

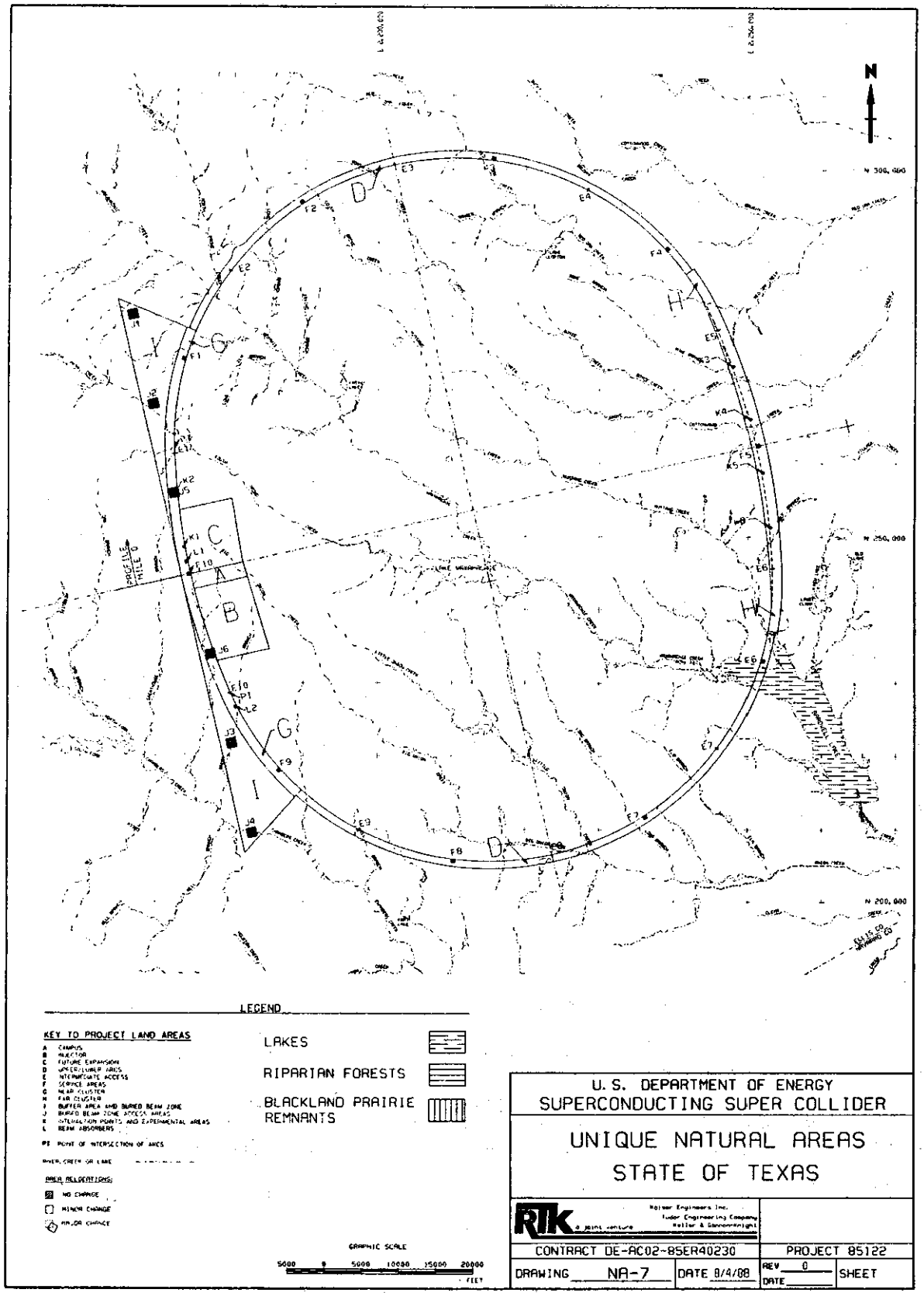
The site vicinity falls within the Texas Biotic Province (Blair 1950). The Texas Biotic Province is a transition zone between eastern mesic forests and northern and western arid grasslands. On a more local level, the majority of the Texas site vicinity is agricultural land. Transition zones which can be expected in the vicinity include agricultural/woodlands, agricultural/wetlands, and woodlands/wetlands.

D. Prime Farmlands, Wildlife Refuges, and Other Management Areas

There are no wildlife refuges in the project vicinity. Lake Bardwell and Waxahachie are managed for flood control and water supply. Prime farmland is further discussed in Section 5.7.10.

Figure 5.7.9-2

UNIQUE NATURAL AREAS



5.7.10 Land Resources

A. Jurisdictional Setting

5.7.10.1 Regional Setting

The proposed Texas SSC site is approximately 10 mi south of Dallas and 25 mi southeast of Fort Worth in Ellis County. Ellis County was established in 1849, with its county seat in Waxahachie (Kane 1972). The county covers approximately 939 mi^2, the vast majority of which is classed as unincorporated territory. The site is represented at the federal, state, and local levels of government by the following elected officials (Texas Legislative Council 1988):

- United States Senate
  Lloyd Bentsen
  William Philip Gramm
- United States House of Representatives
  Joe Linus Barton, 6th District
- State Senate
  Chet Edwards, 9th District
- State House of Representatives
  Keith Oakley, 4th District
- Ellis County Board of Commissioners

B. Ownership Patterns

Land ownership in the SSC project area of Ellis County is predominantly private, with a limited number of small scattered parcels under federal, state, or local government ownership, including the U.S. Army Corps of Engineers-regulated Lake Bardwell. This is consistent with the land ownership patterns of northeastern Texas.

C. Historic Land Use

The growth of northcentral Texas is intimately linked to its physical geographic/natural setting. The area is part of the Coastal Plains physiographic province (Fenneman 1931). The area is characterized by low relief, with topographic features ranging from relatively flat to slightly rolling prairie terrain at the area's few incised drainages, such as Waxahachie Creek. Drainage patterns are trellised, with many of the area's creeks being ephemeral. The area's dominant land cover type is suitable for either dry cropland farming or rangeland, which has made agriculture and ranching the historic economic base of the region. (Texas Department of Water Resources 1977). Communities, such as Waxahachie and Ennis developed as centers of commerce, when agricultural markets opened up with the extension of the Houston and Texas Central Railroad into North Texas in the 1870s (City of Ennis

1985). Dallas and Fort Worth established themselves as unrelated primary urban centers.

Dallas and Fort Worth grew separately as a result of oil and natural gas exploration and extraction activities. However, as a result of the construction of a series of major waterworks projects in the region, an abundant water supply was ensured, thereby making it possible for the two cities to merge as nodes in a bi-polar urban region, known as Dallas-Fort Worth Metroplex.

D. Existing Land Use Plans, Policies, and Controls

Land use planning in northcentral Texas is conducted primarily at the regional and municipal levels of government, since Texas state law pro-hibits its counties from performing any comprehensive planning func-tions other than the review of proposed municipal subdivision plans for consistency with county-established subdivision, road, utility, and septic tank standards (Texas National Research Lab Commission 1988).

Land use planning at the regional level is conducted by the North Central Texas Council of Governments (NCTCOG), for a 16-county area, centered around Dallas and Fort Worth (North Central Texas Council of Governments 1986). The organization was established in 1966 as a voluntary association of cities, counties, school districts, and special districts for the purpose of: 1) strengthening both the individual and collective power of local governments, by helping them to recognize regional opportunities, resolve regional problems, eliminate unnecessary duplication, and make joint regional decisions; and 2) developing the means to assist in the implementation of those decisions. The North Central Texas COG is composed of 16 counties, 148 municipalities, 19 independent school districts, and 15 special purpose districts, for a total of 198 member governments. Its current planning activities include population estimating and forecasting, economic forecasting, regional transportation planning, land use analyses, water quality management planning, air resources management, and information clearinghouse functions (Grady 1988).

Key North Central Texas COG plans include: 1984 Land Use Study and 1980-1984 Land Use Trends (1985); 1986 Annual Report, Metroplex Transactions (1986); Mobility 2000, Regional Transportation Plan (1986); Population and Employment Forecasts, 1990-2010 (1987); and 1987 Current Population Estimates (1987) (Grady 1988).

Under Texas state law, incorporated municipalities, i.e., General Law Cities and Home Rule Cities, can control land use within their city limits through the implementation of zoning ordinances, and can regulate development outside their city limits, but within their extra-territorial jurisdictions by enforcing their subdivision regulations (Texas National Research Lab Commission 1988). General Law Cities are classified as those municipalities with populations under 5,000 persons, who have extraterritorial jurisdiction over lands located

one-half mile beyond their city limits. As such, they are prohibited from annexing land by force. Home Rule Cities are classified as those municipalities with populations over 5,000 persons, who have extraterritorial jurisdiction over lands located one mile beyond their city limits. Home Rule Cities can annex property by force, up to an equivalent of 10% of their current land area. Home Rule Cities may annex up to an equivalent of 30% of their current land area, if the area in question asks to be included within the city limits. The SSC collider arc intersects areas under the planning control of two General Law Cities: Red Oak and Palmer; and two Home Rule Cities: Waxahachie and Ennis. While the General Law City of Bardwell is close by, it does not enforce its extraterritorial jurisdictional rights, thereby being of no direct concern from a land use planning standpoint. Communities, such as Rockett, Forreston, and Boz, which are located in the interior of the collider arc region are all unincorporated areas because of their small population size (Texas National Research Lab Commission 1988). Comprehensive land use plans are in effect for the cities of Waxahachie (1983), Ennis (1985), Palmer (1986), and Bardwell (1987). The City of Red Oak is currently preparing a comprehensive master plan, which is scheduled for completion by Fall 1988 (Texas National Research Lab Commission 1988). All five cities have joining ordinances and/or subdivision regulations in effect.

E. Existing Land Use

Existing land use in northcentral Texas continues to build on the area's historically developed land use patterns. The City of Waxahachie is the largest municipality in the SSC project study area and has annexed quite a bit of land toward the northwest, north, and northeast of the city proper to accommodate new development that flanks Interstate-35 East north toward the City of Red Oak. The City of Red Oak is growing as well, and has recently annexed land to the south of its center, thereby causing overlapping extraterritorial jurisdictions with the City of Waxahachie.

F. Future Planned Land Uses

Future land use growth and development in the SSC project study area is expected to occur in and around the well established incorporated municipalities since it is presumed that each government has the respective ability to finance the necessary physical infrastructure and community services needed to support an increased population, and can do so the most easily of any type of community.

G. Community Values/Attitudes Towards Development

There is a strong development ethic that prevails at all levels of government. These energies are being channeled toward the creation and implementation of well conceived comprehensive development plans that address the broader issue of accomplishing economic revitalization and growth with finite resources available.

5.7.10.2 Local Setting

A. Project Level

The proposed SSC project site is located in southern Ellis County on lands that are largely unincorporated (see Figure 5.7.10-1). The SSC project study area contains no federal parklands, such as national parks, monuments, preserves, rivers, scenic or historic trails, historic sites, recreation area, and parkways; no federal- or state-designated wilderness areas; and no wild and scenic rivers.

Located in a largely rural portion of the county, dryland crop agriculture and ranching are roughly co-dominant land uses that are beginning to compete for space with urbanized land use (Texas Department of Water Resources 1977).

Community values and attitudes toward the SSC project are positive, given the dearth of letters received from the public as part of the DOE public scoping process (see Volume III: Methodology for Site Selec-tion). Of the 35 letters received by the DOE as of mid-May, 1988, 13 letters were opposed to the project; 11 letters were in favor of the project; and 11 letters offered no opinion about the project. The types of issues raised in these letters included general population disturbance, residential relocation, road and congestion problems, the taking of agricultural land, labor supply effects, tax base changes, increased demand for water and electricity, increased demand for medical services, impacts to the educational system, effects on community cohesion, health and safety concerns, groundwater withdrawals, geologic hazards, and the disposal of radioactive waste.

B. Facility Level

Table 5.7.10-1 presents land use data for each of the major SSC project facilities. This includes information on county locations, ownership, existing zoning designations, existing land use, and future planned land use. Narrative descriptions are provided below.

1. SSC Project Near Cluster Quadrant

The near cluster quadrant is entirely in unincorporated Ellis County and is generally under agricultural use as cropland, pasture, or open range with associated rural residences. The community of Boz, with approximately 25 homes, is in the central portion of the site. Croplands are concentrated in the central and southern areas, while the northern portion is predominantly pasture and range. South Prong and Chambers creeks and Baker Branch are significant drainages crossing the site and are associated with areas of wooded/shrub cover. Several overhead transmission lines, two natural gas pipelines, one oil pipeline, and several roads also traverse the area. The land is privately owned and not affected by any land use plans or zoning controls.

Figure 5.7.10-1

THE PROPOSED TEXAS SSC SITE REGION

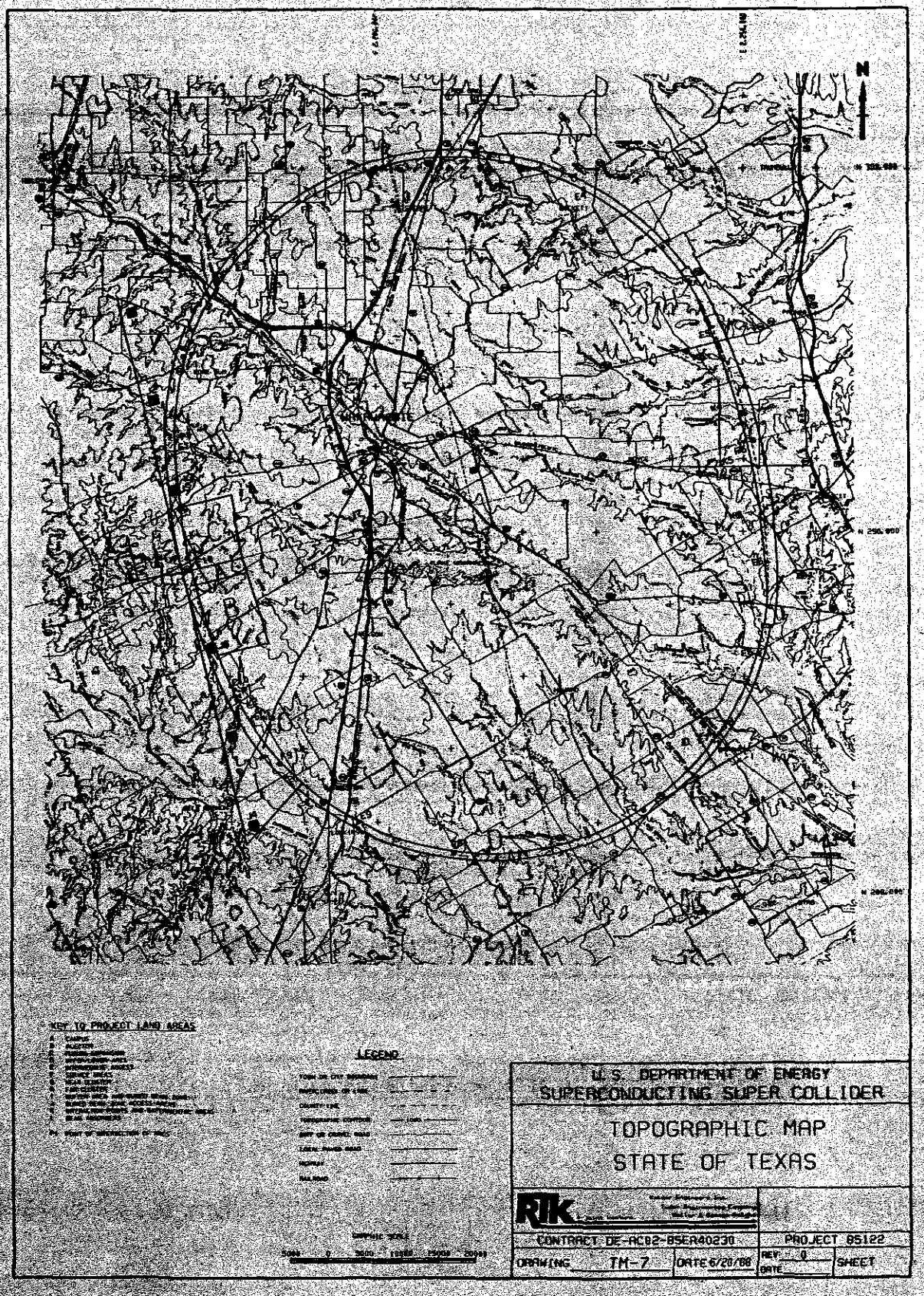


Table 5.7.10-1

LAND USE DATA TEXAS SSC SITE

SSC Project Facility	County Location	Ownership Patterns	Existing Zoning	Existing Land Use	Future Planned Land Use
Near Cluster Quadrant					
Campus area A	Ellis	Private	None	Agr/rural	None
Injector area B	Ellis	Private	None	Agr/res	None
Future exp. area C	Ellis	Private	None	Agr/rural	None
BABBZ area I	Ellis	Private	None	Rural	None
J1	Ellis	Private	None	Range	None
J2	Ellis	Private	None	Range/wooded	None
J3	Ellis	Private	None	Agr/range	None
J4	Ellis	Private	None	Wooded/wetland	None
Near Cluster Ring G	Ellis	Private	None	Agr/rural	None
E1	Ellis	Private	None	Wooded	None
E10	Ellis	Private	None	Pasture	None
F1	Ellis	Private	None	Pasture	None
F9	Ellis	Private	None	Agr	None
F10	Ellis	Private	None	Agr	None
J5	Ellis	Private	None	Range/res	None
J6	Ellis	Private	None	Rural res	None
K1	Ellis	Private	None	Agr	None
K2	Ellis	Private	None	Pasture/range	None
Far Cluster Quadrant					
Far Cluster Ring H	Ellis[1]	Private/public	None/R-4	Rural	None
E5	Ellis	Private	None	Range	None
E6	Ellis	Private	None	Pasture/wetland	None
F5	Ellis	Private	None	Range	None
K3	Ellis	Private	None	Range	None
K4	Ellis	Private	None	Range	None
K5	Ellis	Private	None	Pasture	None
K6	Ellis	Private	None	Pasture	None
Lower Arc Quadrant					
Lower Arc Ring D	Ellis	Private/public	None	Agr/rural	None
E7	Ellis	Private	None	Agr	None
E8	Ellis	Private	None	Range/wetland	None
E9	Ellis	Private	None	Agr/wetland	None
F6	Ellis	75% public	None	Range/wetland	None
F7	Ellis	Private	None	Agr	None
F8	Ellis	Private	None	Agr	None
Upper Arc Quadrant	Ellis	Private	None	Agr/rural	None
Upper Arc Ring D	Ellis[2]	Private	None/AG/HI	Agr/rural	None
E2	Ellis	Private	None	Pasture	None
E3	Ellis	Private	None	Agr	None
E4	Ellis	Private	None	Agr	None
F2	Ellis	Private	None	Pasture/range	None
F3	Ellis[3]	Private	AG	Agr	None
F4	Ellis	Private	None	Agr	None
Roads and rail	Ellis	Private	None	Rural	None
Utilities	Ellis	Private	None	Rural	None

Notes: 1. Includes a small portion in the City of Palmer.
2. Includes small areas in the cities of Red Oak and Waxahachie.
3. Located in the City of Red Oak.

a. Campus Area A

Campus area A is used for cropland agriculture with two farm residences on the southeastern portion of the area. Cropland extends for 1,000 ft around the site, with four more residences/farm complexes noted. About one-half of the area is prime farmland and a small wetland is located in the east-central section.

b. Injector Area B

Injector area B consists largely of cropland and agricultural uses and includes the eastern half of Boz with several rural residences and neighboring pastures. Four other farm residences are scattered within the site. Two small wetlands and limited wooded/shrub cover are found in the south and west. A 1,000-ft buffer zone around the area encompasses more residences both in and outside of Boz and continued cropland outside the community. Approximately one-half of the area is designated as prime farmland.

c. Future Expansion Area C

Future expansion area C is under use largely as cultivated cropland with several farm residences along farm-to-market Route 66, which runs east-west through the site.

Some pasture, range wooded/shrub, and wetland areas are found along the northern edge. Surrounding uses are of the same type and about 40% of the area is considered prime farmland.

d. Buffer Area and Buried Beam Zone I

1) North Buffer Area and Buried Beam Zone I, Including Buried Beam Zone Access Areas J1 and J2

The north buffer area and buried beam zone I consist almost entirely of rangeland and pasture with some wooded areas near South Prong Creek and a smaller drainage in the north. A few farm residences are on site, and just beyond to the northwest lies substantial rural residential development. Other neighboring uses are basically the same as those within, and small portions of the area are designated as prime farmland, including parts of J1 and J2.

Site J1 consists of open rangeland with some wooded/shrub cover in a drainage to the northeast. West of the site is a larger drainage, beyond which lies a rural residential development. The remaining surrounding areas are open rangeland.

Site J2 is approximately 60% open space/range and 40% wooded/shrub that is associated with the South Prong Creek drainage that crosses the site. Surrounding uses within a 1,000-ft buffer area are similar.

2) South Buffer Area and Buried Beam Zone I, Including Buried Beam Zone Access Areas J3 and J4

Land use of the south buffer area and buried beam zone I is mostly cropland agriculture with large patches of pasture and range. Two drainages cross the site: Chambers Creek and its Baker Branch tributary, producing wetlands and wooded areas. Several farm residences are in the cultivated southern section, and the northern tip intersects at least one residence in the community of Boz. Surrounding uses are of the same character, and prime farmlands are found in the east-central portion.

Site J3, crossed by the Baker Branch of Chambers Creek, is near the high water line of a dam downstream. The remaining land is cropland and open range. Surrounding uses are the same with a dammed lake to the south. The eastern portion of the site is prime farmland.

Site J4, crossed through the center by meandering Chambers Creek, is contained entirely within the wooded and wetland area associated with this drainage. Surrounding areas are the same with some cropland to the north and open range to the south, both at about a 500-ft distance.

3) Near Cluster Ring G, Including Intermediate Access Areas E1 and E10, Service Areas F1, F9, and F10, Buried Beam Access Areas J5 and J6, and Interaction Points and Experimental Areas K1 and K2

Land use of the near cluster ring consists largely of cropland agriculture and pasture, with scattered farm residences and rural residences in the community of Boz. Several drainages, including South Prong Creek, cross the site, and these areas are predominantly open areas with wooded/shrub cover. Most of the roadways and utility lines mentioned for the near cluster quadrant cross the arc as well. The land is privately owned and portions of it are designated as prime farmland, mostly in the central and southern sections. While entirely on unincorporated land, a small portion of the ring between E1 and F1 lies within the extraterritorial jurisdiction of the City of Waxahachie. This jurisdiction provides the city with regulatory powers over subdivisions.

Site F1 is located entirely on pastureland with some wooded areas to the north and two farm residences approximately 1,000 ft to the south. Two parallel pipelines, one crude oil and one natural gas, run about 600 ft northeast of the site. Some open rangeland is located to the west about 800 ft beyond a small wooded area.

Site E1 is located on wooded/scrub covered open land associated with a tributary drainage of South Prong Creek. This continues north of the site, while pasture uses are found to the south and east.

Site J5 includes one farm residence and a portion of a second farmhouse lot. A minor road accessing these homes crosses the site; to the north is pastureland and to the south is open rangeland. Two fingers of woodland/scrub cover are located to the north and east, while the remaining surrounding areas are under the same pasture or range use.

Site K2 is entirely within the J5 site area, located between the two farm residences mentioned and on the border of the open rangeland and pastureland.

Site K1 lies entirely within cultivated cropland and no other uses are found within 1,000 ft. Portions of the site area are designated as prime farmland.

Site F10 also consists of cropland agriculture with several farm residences located along farm-to-market Route 66 to the north. Much of the area is designated as prime farmland, and a wooded section lies 600 ft to the west.

Site J6, located near the center of the community of Boz, consists of rural residences, cultivated cropland, and small wooded/shrub areas. Surrounding uses are the same with more residences located to the north and southeast. Croplands, and some pasture use fills in the remaining surrounding area. Portions of the area are designated prime farmland and no local restrictions apply to the property because of the unincorporated status of Boz.

Site E10 is located entirely on open pastureland, and no other land use types are found within 1,000 ft. A 36-inch gas pipeline runs east-west about 1,000 ft to the south and one farm residence is found just beyond that distance to the southeast.

Site F9 is on cultivated cropland with some pasture use located approximately 800 ft to the northeast. Other surrounding areas are all croplands, portions of which are designated as prime farmland.

2. <u>SSC Project Far Cluster Quadrant</u>

<u>Far Cluster Ring H, Including Intermediate Access Areas E5 and E6, Service Area F5, and Interaction Points and Experimental Areas K3, K4, K5, and K6</u>

The far cluster quadrant is located almost entirely in unincorporated areas of Ellis County, with some small areas under the extraterritorial jurisdictions of Ennis and Palmer. A small portion of the ring area between sites E5 and K3 is within the city limit of the City of Palmer, and zoned R-4 (single-family residential). All acreage is privately owned, except the southern tip that is part of the COE Bardwell Reservoir. Land use is predominantly pasture and rangeland, with a scattering of wetlands and farm/rural residences. Several roadways, a Southern Pacific rail lines, utility lines, and gas and water pipelines cross the site, as well as Red Oak Creek and the wetland where Mustang Creek meets Bardwell Reservoir. Tree/shrub cover is associated with some of the drainages and wetlands, and patches of prime farmland are found throughout the area.

Site E5 is located in an area of open rangeland, with some pasture and cropland located immediately to the west. No other types of land use lie within 1,000 ft, but beyond that to the east are rural residential

developments in Palmer and three farm residences along Road 878 to the south. The site is also just within the extraterritorial jurisdiction of Palmer where subdivision developments are regulated.

Site K3 is located on open rangeland with a drainage and wooded area located approximately 300 ft to the southeast. Remaining surrounding uses are rangeland, and the areas to the north and east are within the extraterritorial jurisdiction of Palmer.

Site K4 is also on open rangeland with cropland agriculture to the north and west about 400 ft from the site. A small wetland area to the northwest and two large water pipelines to the south are the only other land use features located within 1,000 ft.

Site K5, also located on pastureland, is intersected by Road 870 and a parallel telephone line. Uses within 1,000 ft include two farm residences, three small wetlands, and the remainder is open pastureland.

Land use of site K6 is also pasture, although within 1,000 ft are six farm residences, two small wetlands, and some cultivated cropland. Residences are relatively concentrated here along Road 1722 and an overhead transmission line passes through the area.

Site E6 lies in unincorporated Ellis County, although within the extraterritorial jurisdiction of the community of Ennis. Land use is pasture with a scattering of a few small wetlands. This continues on and within 1,000 ft of the site.

3. SSC Project Lower Arc Quadrant

Lower Arc Quadrant D, Intermediate Access Areas E7, E8, and E9, and Service Areas F6, F7, and F8

Lower arc quadrant D, located entirely in unincorporated Ellis County, is privately owned, excluding the Bardwell Reservoir area, which is public property. A majority of the arc is used as cropland agriculture, with patches of pasture, range, wooded/ shrub cover, and wetland. The arc is crossed by several transmission lines and gas and water pipelines, I-35, M-K-T rail lines, several minor roads, and drainages. A small portion of the ring near site E7 is in the extraterritorial, though, jurisdiction of the small incorporated community of Bardwell, and there is some industrial/commercial use near the ring along the Chicago-Rock Island and Pacific rail lines and the Fort Worth and Denver rail lines that cross here. There are no zoning or land use plans affecting the area, portions of which are designated as prime farmland.

Site F6 is located on a broad peninsula on the north side of the Bardwell Reservoir. Most of the site area, and much of the land around the lake, is property of the Corps of Engineers. Private lands lie on the northwest corner of the site and beyond. Aside from the reservoir and its attendant recreational use, the surrounding area consists of open range with a few small wetlands.

Site E7 is located in the extraterritorial, though unregulated jurisdiction of Bardwell, 600 ft southwest of the Chicago-Rock Island-Pacific and the Fort Worth and Denver rail lines on agricultural cropland. There are no other land uses located within a 1,000-ft buffer area. Industrial and residential development in Bardwell lies approximately 1,500 ft to the southeast. No zoning or land use plans affect the site, but the town of Bardwell does have subdivision authority should it exercise its right. Most of the immediate area is designated as prime farmland.

Site F7 is located 400 ft north of State Route 34 and 200 ft west of a gas pipeline. Land use on and surrounding the site is cropland agriculture. Areas east of the site are designated as prime farmland.

Site E8 is located on open rangeland with some wetland to the west, wooded areas and pasture to the north. No other uses are noted within a 1,000-ft area.

Site F8 is located on an area of cropland agriculture with a minor road situated 700 ft to the north, beyond which lies open range. No other uses are found within 1,000 ft of the site.

Site E9 is located on cropland with some tree/shrub cover to the west and south, and wetland to the southeast. Beyond the wooded area to the west are two overhead transmission lines. A farm residence lies just beyond 1,000 ft to the north. The remaining surrounding areas are all cropland agriculture, most of which is designated as prime farmland.

4. SSC Project Upper Arc Quadrant

Upper Arc Quadrant D, Including Intermediate Access Areas E2, E3, and E4 and Service Areas F2, F3, and F4

The upper arc quadrant D consists mostly of cultivated croplands and pasture use with a scattering of farm residences. The incorporated areas of Red Oak and Waxahachie intersect small parts of the central area near the crossing of Interstate Highway 35 and the M-K-T rail line. Industrial and commercial uses are located around these transportation corridors. Zoning for the intersecting areas of Waxahachie and Red Oak in HI (Heavy Industrial) and AG)(Agricultural District), respectively. Just to the east are several large rural residential developments in the extraterritorial jurisdictions of Waxahachie and Red Oak. Several transmission lines, telephone lines, and gas and water pipelines cross the arc at various locations, and Red Oak Creek is found in the Red Oak/Waxahachie area. A Southern Pacific/Burlington Northern rail line crosses the arc between Site FI and E2. Zoning in Waxahachie and Red Oak follows the existing use with industrial/commercial uses permitted along the railroad and I-35, with low-density residential uses allowed to the east. Future land use plans call for a continuation of this development pattern, with an intensification of the rural residential use. Land ownership is basically private; most of the areas outside Red Oak and Waxahachie are designated as prime farmland.

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Site E2 is located on pastureland, with three small wooded/shrub areas within 1,000 ft to the north and west. The remaining surrounding area is pastureland. The site is within the extraterritorial jurisdiction of Waxahachie.

Site F2 is located approximately 200 ft northwest of a farm residence in an area of pasture and open rangeland. Cultivated croplands are found east and west of the site, with range to the north and pasture to the south. No other uses are located within 1,000 ft, except for a minor road that crosses the north corner of the site. The site area is part of Waxahachie's extraterritorial jurisdiction where only subdivision regulations are in effect. There are no zoning restrictions or land use plans affecting the site.

Site E3 is located approximately 400 ft north of the Waxahachie-O'Brien Airpark on agricultural cropland. Croplands extend east and west of the site and a large pasture area is found 300 ft to the north. No other uses are found within 1,000 ft. The site lies within the extraterritorial jurisdiction of the City of Waxahachie.

Site F3 is located in the City of Red Oak in a developing rural residential area on cultivated cropland 800 ft located northeast of Red Oak Creek. Farm residences are found immediately to the south and west of the site and a large rural residential development is situated beyond a narrow wooded area to the east. The agricultural cropland use continues to the north. Zoning for the area is AG (Agricultural District). The site has been recently annexed by the city and the AG zone is the default category for newly annexed territories.

Site E4 is located in an area of agricultural cropland use with one farm residence just beyond 1,000 ft to the west. The remaining surrounding use is all cropland agriculture.

Site F4 is located in an area of agricultural cropland, with one farm residence located just beyond 1,000 ft to the west. The remaining surrounding land use is all cropland agriculture, and a minor roadway is located along the northwestern edge of the site.

5. Planned SSC Project Roads and Railroad Networks

Locational descriptions of planned SSC project road improvements are provided in Section 1.2.1.2. Adjacent land use patterns for the road network are no different than those generally described for the area. There are no future plans that constrain these areas from further improvements. The existing railroad network is adequate for the project, with no improvements deemed necessary.

6. Planned SSC Project Utility Improvements

Locational descriptions of planned SSC project utilities are provided in Section 1.2.1.2. Adjacent land use patterns grades for these utility

upgrades are no different than those generally described for the area. There are no future plans that constrain these areas from further improvements.

5.7.10.3 Soils and Prime Farmland Resources

A. Factors of Soil Formation and the Resulting Soil Cover

Ellis County, which hosts the proposed Texas SSC site, is part of the Blackland prairies with a nearly level relief on floodplains and sloping to moderately steep surfaces on terraces and benches.

The parent material of the soil cover is represented in Ellis County by four formations referred to as Austin chalk, Taylor marl, Eagle Ford shale, and alluvium. The shale is widespread in the western part of the county and has a limited impact on the soil cover at the SSC site. The Austin chalk covers a considerable area in the central part of the county and represents the parent material for such soils as Austin, Brackett, Eddy, Houston Black, and Stephen soil series. Soils developed over chalk are highly calcareous and have a surface horizon that tends to be granular (thus in a state of good tilth), provided the textural makeup is conducive to such a structure. Marl produces soils of good tilth but also soils of limited productivity because of the presence of a claypan in the upper profile (Wilson series). The Taylor marl generated clayey soils like the Burleson, Houston, and Houston Black series. The alluvial soils are represented in the SSC region by the Frio and Lewisville soil series covering areas where the Austin formation sediment was deposited.

Estimates of characteristic soil temperatures based on air temperatures (Soil Taxonomy 1975) indicate that soils located at the SSC site have a thermic temperature regime. The relatively high precipitation of the region should have resulted in soils with an udic moisture regime, i.e., a moisture regime in which crops utilize the soil water throughout the summer without reaching the condition of water deficiency. However, although the total amount of rainfall is not small, many of the soils experience a shortage of water in late summer because of their textural makeup. The high concentration of clay and especially of montmorillonitic clay gives them a high water retentivity and thus a low capacity for releasing the stored water. Consequently these soils can be dry at a relatively high moisture content.

The generalized soil map of the United States (Soil Taxonomy 1975) indicates that the most likely soil suborders to be found in Ellis County are Usterts, associated with Ustolls (among other suborders) and Ustalfs associated with Ustolls (among other suborders). The inventory of soils in the SSC region identifies 3,620.2 acres covered by Ustolls and 2,513.7 acres covered by Usterts. These two suborders represent 81% of the fee simple area soil cover. Ustolls are soils characterized by a surface horizon of good to excellent properties for plant growth. Austin and Lewisville soil series (formerly classified as rendzinas) are members of the Ustoll suborder. They represent some of the most fertile and productive agricultural lands in the investigated perimeter.

Usterts are represented by Branyon, Burleson, Ferris, Heiden, Houston Black, and Leson soil series. These soils are characterized by a high clay concentration in excess of 30%. Moreover, since the clay is dominantly montmorillonitic, it has peculiar characteristics such as its well known high tendency for volume change (shrink/swell). Because of this property of the clay fraction Usterts develop cracks at least 1 cm wide that can remain open for more than 5 months each year (Keys to Soil Taxonomy 1987). This dominant feature gives Usterts a particular surface hydrology: during a storm the rainwater penetrates into the cracks and runoff is reduced. During and subsequent to the storm, water infiltrates into the soil along wetting fronts that move laterally from the crack inside the soil block surrounded by a net of cracks. This mechanism assures the recharge of these soils. Without it even Usterts with minimal slopes would generate large runoffs and the recharge of these soils would be drastically hindered.

The investigation of the fee simple soil cover identified 18 soil series covering 31 soil phases. Table 5.7.10-2 presents all phases grouped by soil family and corresponding acreages. Soils on slopes greater than 3% and eroded soils amount to 2,748.1 acres. This represents a high 36% of the fee simple soil acreage indicating that the slope is one important element that eliminates large surfaces from qualifying as good agricultural land.

Table 5.7.10-2

SOILS AT THE FEE SIMPLE SSC PROPOSED SITE AND AFFECTED ACREAGES

Soil Families	Included Soil Phases	Affected Acreages
Fine-silty, carbonatic, thermic Entic Haplustolls	Austin silty clay, 1-3% slope	1,836.0
	Austin silty clay, 3-5% slope	756.2
Clayey, mixed, thermic shallow Entic Haplustolls	Stephen-eddy complex, 1-3% slope, eroded	179.7
	Stephen-eddy complex, 3-5% slope, eroded	120.2
	Stephen silty clay, 1-3% slope	679.6
Fine, montmorillonitic, thermic Cumulic Haplustoll	Frio silty clay, frequently flooded	27.5
Fine-silty, mixed, thermic Typic Calciustolls	Lewisville silty clay, 1-3% slope	13.9
	Lewisville silty clay, 5-8% slope, eroded	6.2
	Lewisville soils, 5-8% slope, severely eroded	0.6
	Lewisville Association, 3-5% slope, ended	0.3
Fine, montmorillonitic, thermic Udic Paleusterts	Branyon clay, 0-1% slope	28.0
	Branyon clay, 1-3% slope	78.4
	Burleson clay, 0-1% slope	0.9
	Burleson clay, 1-3% slope	101.9
	Houston Black clay, 0-1% slope	89.5
	Houston Black clay 1-3% slope	950.1
	Leson clay, 1-3% slope	0.9

Table 5.7.10-2 (Cont)

SOILS AT THE FEE SIMPLE SSC PROPOSED SITE AND AFFECTED ACREAGES

Soil Families	Included Soil Phases	Affected Acreages
Fine, montmorillonitic, thermic Udic Chromusterts	Heiden clay, 1-3% slope	175.1
	Heiden clay, 3-5% slope, eroded	538.3
	Heiden clay, 5-8% slope, eroded	379.3
	Heiden-Ferris complex, 5-8% slope, severely eroded	74.7
Fine, montmorillonitic, thermic Udorthentic Chromustert	Ferris clay, 5-12% slope, severely eroded	96.6
Very-fine, montmorillonitic, thermic, Typic Paleuderts	Trinity clay, frequently flooded	266.7
Fine, montmorillonitic, thermic Vertic Haplustalf	Normangee loam 0.2% slope	3.7
Fine, montmorillonitic, thermic Vertic Ochraqualfs	Wilson clay loam, 1-3% slope	43.6
	Wilson clay loam, 1-3% slope, eroded	1.0
Fine-loamy, carbonatic, thermic Typic Ustochrept	Brackett and Austin soils, 2-5% slope, eroded	49.1
Loamy-skeletal, carbonatic, thermic Shallow Typic Ustorthents	Eddy gravelly clay loam, 1-3% slope	560.3
	Eddy soils, 3-8% slope, eroded	516.6
	Eddy soils, 8-20% slope	30.3
	Total Acreage 7,605.2	

B. Farming Potential of Soils

A widely used procedure for assessing the general suitability of soils for agricultural use is their ranking according to the capability classification. This is a system that ranks soils by considering their limitations, their risk of damage when used, and their response to management practices. Soils are grouped at three levels of which only the first two are pertinent for this discussion. The most general level is the capability class, with eight classes, I through VIII. Class I represents soils that have few if any limitations. Class II are soils that can be brought to a satisfactory level of productivity with only moderate management operations. Class III represents soils severely restricted in their use and requiring special management practices to become farmable for a limited number of crops. Classes V through VII represent soils with so many characteristics inappropriate to farming that their use is confined to pasture or woodland only. Class VIII represents surfaces unfit to produce any commodities.

The subclass, or second classification level, indicated by a small letter, identifies the main limitation of the soil: for example the letter e means a high erosion hazard; the letter w means excess water in the soil or above it disturbing crop development and farming operations; and s means farming limitations caused either by a shallow solum or a droughty and stony surface soil. Table 5.7.10-3 presents the proportion of soil corresponding to different capabilities and indicates acreages for each of the three possible limitations (erosion hazard, excessive wetness, and shallow solum/droughty, or stony soil).

A mean weighted soil capability was calculated to provide an estimate of the general level of suitability for all soils taken together. It was calculated using the total fee simple acreage (7,605.2 acres) and the capability class, which was represented in this calculation by the numerical value corresponding to the roman figure used to describe the capability classes. The mean weighted capability figure thus obtained for the Texas SSC proposed site was 3.1. Assuming that a class III soil, as defined in the Soil Survey of Ellis County, has a capability value of 3, the 3.1 figure reveals a mediocre overall farming suitability. Table 5.7.10-3 shows that only 3,173 acres at the Texas site, or 42% of all fee simple soils, are of capability class II, i.e. soils that can be easily brought to a satisfactory level of productivity with moderate management measures. This leaves over half the area less suitable for farming, especially since few of the class III soils could be brought up to a satisfactory productivity level. Table 5.7.10-3 also shows that the main limitation of the soils at the site is the erosion hazard, which is not an intrinsic soil deficiency but rather a consequence of the sloping topography.

Table 5.7.10-3

ACREAGE OF SOILS CORRESPONDING TO DIFFERENT CAPABILITY CLASSES AND TO DIFFERENT CAPABILITY SUBCLASSES/LIMITATIONS

Capability Classes	Affected Acreage
II	3,172.8
III	2,303.3
IV	1,116.1
V	294.2
VI	688.5
VII	30.3

Capability Subclasses	Affected Acreage
e - erosion hazard	6,583.2
s - shallow solum/ droughty/stony	727.8
w - excessive wetness	294.2

Sources: Keys to Soil Taxonomy 1987. SMSS Technical Monograph #6.
Soil Survey of Ellis County, Texas 1984. USDA-Soil Conservation Service in Cooperation with Texas Agricultuaral Experiment Station.
Soil Taxonomy 1975. USDA Soil Conservation Service, Agricultural Handbook No.436.

C. Prime, Unique, and Important Farmlands

Criteria to be considered when assessing prime or unique farmlands are established in 7 CFR Section 657.5, "Prime and Unique Farmlands." For the case of soils encountered at the Texas SSC site, it is important to consider first the one criteria that eliminates a considerable proportion of the fee simple acreage. Fifty-eight percent of the Texas site soils have slopes in excess of 3% and thus fail to meet the criteria that the product of K (erodibility factor) and the percent slope be less than 2.0. In calculating farmland acreage, one should include in the group of prime farmlands the capability class II soils. Such a grouping will be overwhelmingly represented by Austin silty clay, 1 to 3% slope; Heiden clay; 1 to 3% slope, and Houston Black and Branyon clays, 0 to 3% slope. The total area associated with these soils equals 3,157.1 acres, representing 41.5% of all fee simple lands.

5.7.11 Socioeconomics and Infrastructure

5.7.11.1 Socioeconomics

Eight north-central Texas counties (Figure 5.7.11-1) could provide a sizable portion of the project-related workforce. Encompassing virtually all settlement opportunities within approximately 1-hour driving time from the site, these counties would likely house most inmigrant workers as well. Therefore, for economic, demographic, and housing issues the region of influence (ROI) is defined as the entire eight-county area.

Ellis County, in which the entire project would be located, is where many project-related workers would probably reside and where most goods and services would be purchased. It is designated as the primary impact county for this analysis and is thus the focus of study for public services and finance impacts. Communities in the southern half of Dallas County, currently a rapidly growing suburban extension of Dallas, would also be convenient to the SSC. Characteristics of its population and housing opportunities are therefore discussed along with those in Ellis County.

A. Economic Activity, Labor Force, and Income

1. Regional Setting

The economy of the Texas ROI has grown steadily for the past two decades (Table 5.7.11-1). The employment base expanded faster than the average national rate. Total employment growth in the ROI averaged 3.8% annually between 1969-1984, compared with the U.S. annual average of 1.9% (U.S. Department of Commerce, Bureau of Economic Analysis 1986).

Annual employment growth in the Texas ROI exceeded national average growth rates in ten of eleven principal industrial sectors from 1969 to 1984. The mining sector experienced the largest percentage growth, an average annual rate of 8.8%, more than double the national average of 4.1% percent in that sector. Other leading sectors in ROI employment growth were the agricultural services, the forestry, and fishing sector, which grew 8.0% annually, and the finance, insurance, and real estate sector, which grew annually at a rate of 5.6%.

Farming was the only ROI sector to experience an overall decline in employment during the 16-yr period. With a 1.5% average annual loss in employment, this decline was consistent with the national trend which experienced an average annual loss of 1.0%. The manufacturing sector, on the other hand, experienced an average annual loss in employment of 0.2% nationally but grew in the Texas ROI at a 1.2% annual rate.

Figure 5.7.11-1

COUNTIES FOR SOCIOECONOMIC ANALYSIS
IN THE TEXAS SSC ROI

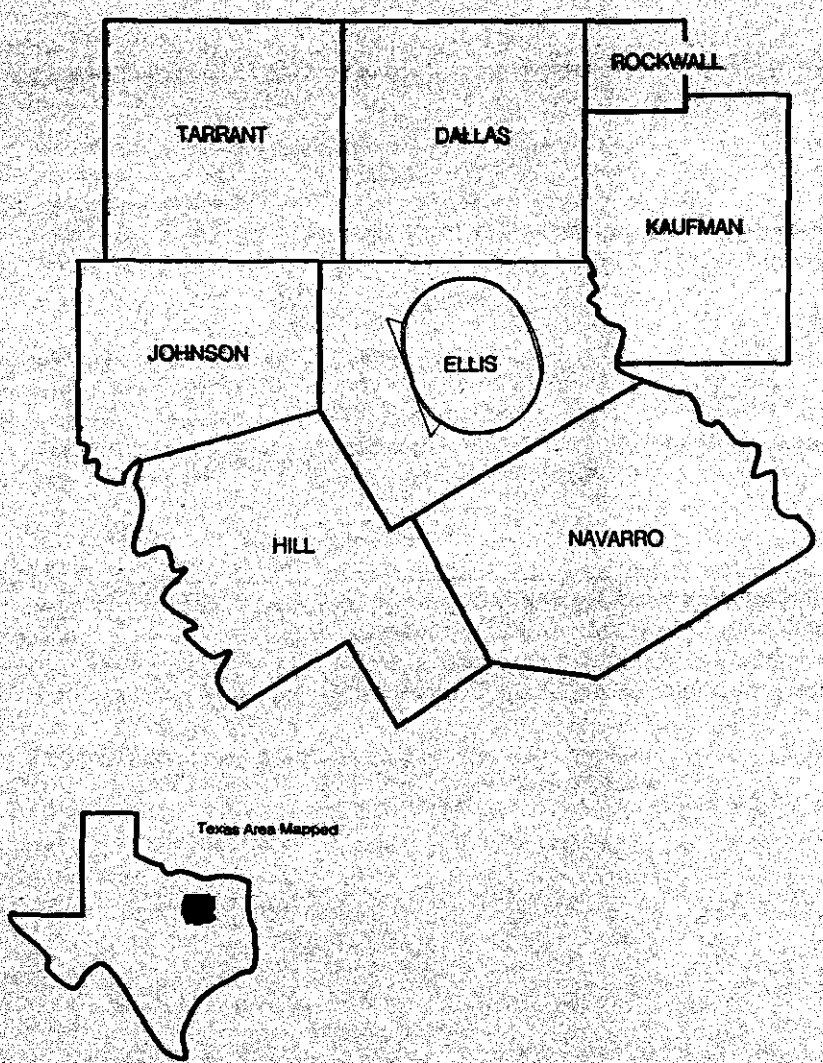


Table 5.7.11-1

HISTORIC ECONOMIC INDICATORS FOR THE TEXAS ROI AND ELLIS COUNTY

	1969	1974	1979	1984	1987	Average Annual Growth Rate
TEXAS ROI						
Total employment[1]	1,107,742	1,254,035	1,551,912	1,928,700	NA[2]	3.8%
Earnings per worker[3]	$22,782	$22,477	$23,574	$24,026	NA	0.4%
Labor force	NA	NA	NA	1,720,816	1,892,155	4.4%[4]
Per capita personal income[3]	$13,433	$14,224	$16,129	$17,405	NA	1.7%
Unemployment rate	NA	%	%	3.8%	%	NA
ELLIS COUNTY						
Total employment	17,447	19,522	22,801	26,990	NA	3.0%
Earnings per worker	$13,967	$15,266	$17,755	$17,284	NA	1.4%
Labor force	NA	NA	NA	34,892	41,513	5.8%[4]
Per capita personal income	$ 9,460	$10,585	$12,810	$14,637	NA	3.0%
Unemployment rate	NA	NA	NA	4.8%	8.6%	NA

Notes: 1. Employment is by place of work.
2. NA - data not available or not applicable.
3. Earnings and income are in constant 1988 dollars.
4. Labor force average annual growth rates are for 1980-1987.

Sources: U.S. Department of Commerce 1986; Texas Employment Commission 1988.

Figure 5.7.11-2 shows the distribution of employment in the eleven major industrial sectors in 1984. The dominant sectors of the ROI economy, in terms of employment, were services (with 23.7% of ROI jobs), retail trade (17.2%), manufacturing (16.5%), and government (9.8%).

Average earnings per worker exceeded the national average in 1984. Average earnings per worker in 1984 were greatest in the transportation, and public utilities ($36,159), wholesale trade ($37,278), and in mining ($31,692) (FY88 dollars).

From 1980-1986, average annual unemployment rates in the ROI remained below the national average; however, in 1987, the unemployment rate (6.1%), surpassed the national average of 6.1% (Texas Employment Commission 1988; U.S. Council of Economic Advisors 1988). The labor force in the ROI was 1,900,000 in 1987 and has been growing at an average rate of 4.4% annually since the beginning of the decade.

Per capita personal income in the Texas ROI has remained consistently above the national average (although it has expanded at an unsteady pace) since 1969. In 1984 it was $17,405, which exceeded the national average.

Between 1988 and 2000, employment in the ROI by place of work is expected to grow at an average annual rate of 2.0%, from an estimated 2 million jobs to over 2.5 million. This level of growth exceeds the 1.3% national annual growth projection for employment between 1988 and 2000 (U.S. Department of Labor, Bureau of Labor Statistics 1987).

2. Ellis County

Ellis County plays a small role in the ROI because of the dominance of Dallas and Tarrant counties. In 1984, Ellis County provided 1.4% of ROI employment and collected 1.9% of total personal income in the ROI. Total employment growth in the county averaged 3.0% annually between 1969 and 1984.

From 1969 to 1984 average annual employment in the 11 industrial sectors in Ellis County grew at rates exceeding the average national rates in seven sectors and the average ROI rates in six sectors. As with the ROI, employment in mining grew fastest from 1969 to 1984 at a rate of 11.9%, followed by construction (6.7%) and finance, insurance, and real estate (5.8%).

Farming was the only sector in the county to experience an overall decline in employment during the 16-yr period. With a 1.7% average annual loss in farm employment in the county, this decline is consistent with

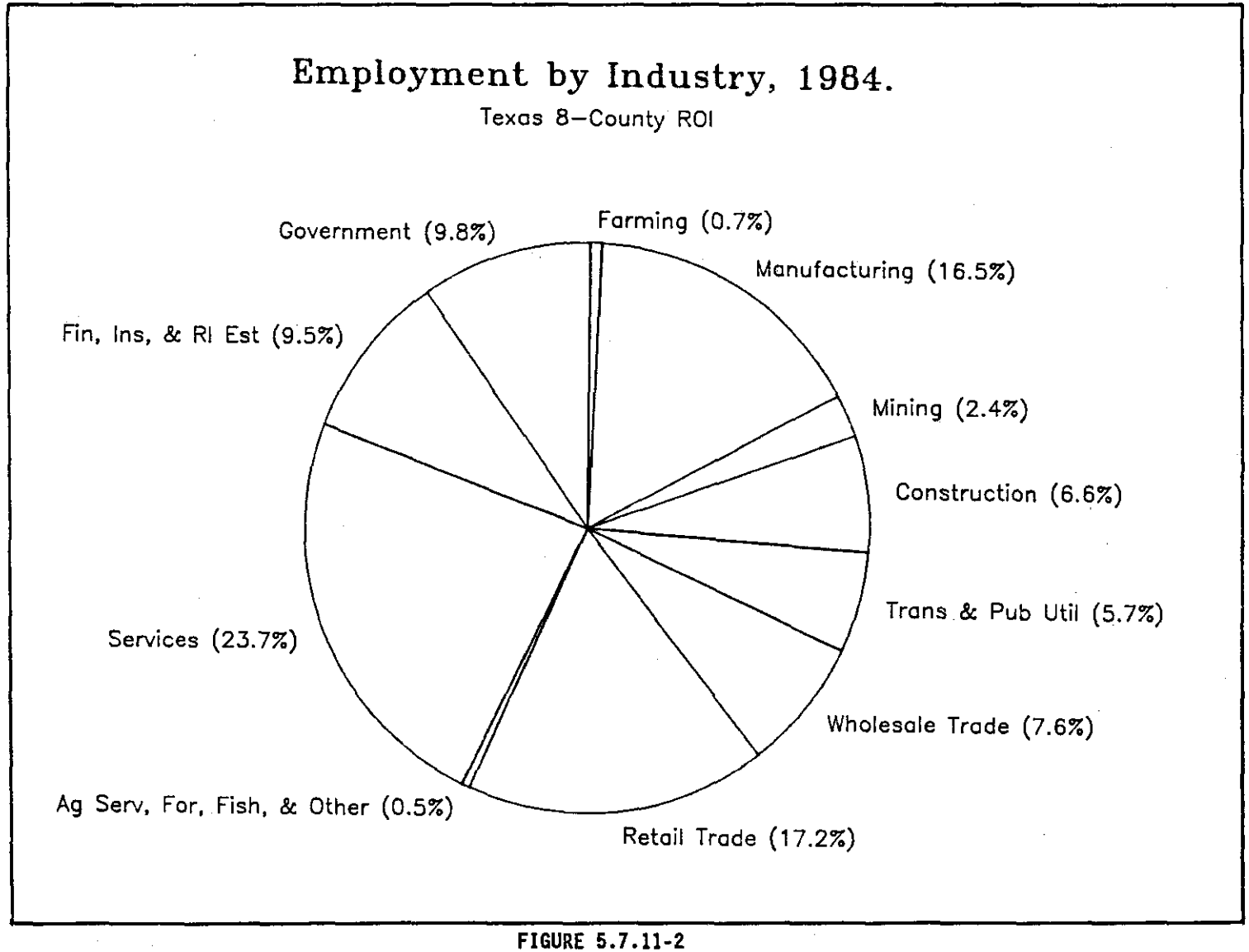


FIGURE 5.7.11-2

EMPLOYMENT BY INDUSTRY IN THE TEXAS SSC ROI

the national and ROI trends for that period. The distribution of employment in the 11 major industrial sectors in Ellis County in 1984 was similar to that of the Texas ROI. The strongest sectors were manufacturing (with 28.5% of total county jobs), services (17.8%), retail trade (13.8%), and government (10.2%).

Average 1984 earnings per worker in Ellis County were $17,284, lower than both the national and ROI averages. The highest average earnings per worker were paid in the transportation and public utilities sector at $30,327.

For the past 8 years, average annual unemployment rates in Ellis County have been consistently higher than those for the Texas ROI. Until 1985, however, these rates were also lower than the national average; since then in 1986 and 1987, the average annual unemployment rates in the county (7.4 and 8.6% in 1986 and 1987, respectively) surpassed those nationwide (Texas Employment Commission 1988). The labor force in the county grew at an annual rate of 5.8% during the 1980s, and reached more than 41,500 in 1987.

Per capita personal income in the county typically was below both the national and ROI averages between 1969 and 1984. In 1984, per capita personal income in Ellis County ($14,637) was below the ROI average ($17,405) and slightly less than the national average ($14,746).

B. Demographics and Housing

1. Regional Setting

The Texas ROI is dominated by Dallas County (the location of the City of Dallas) and Tarrant County (the location of Fort Worth), which together contained over 90% of ROI inhabitants in 1980 (U.S. Bureau of the Census 1982b). This concentration of regional population in two counties persisted throughout the last half century, masking certain subregional trends. For example, the six ROI counties, excluding Dallas and Tarrant, have all lost population at times during this period, in general contributing little to regional population growth. By 1980, the population of the ROI had reached 2.7 million persons, having grown at a 1.8% percent average annual rate from the 2.2 million recorded in 1970 (U.S. Bureau of the Census 1982b). Regional population appears to have grown more rapidly during the first half of the 1980s, increasing at a 3.5 % annual rate as population exceeded 3.1 million persons in 1985 (U.S. Bureau of the Census 1988).

Projections of ROI population suggest continued regional growth. In 1990, the region is expected to contain over 3.4 million persons, the result of 2.6% average annual growth throughout the entire decade of the 1980s. By the turn of the century, a population of 3.9 million is projected for the region, average annual growth having slowed to 1.3% after 1990. At the end of the projection series in 2030, the population

of the Texas ROI is expected to exceed 5.1 million persons, with average annual growth having slowed further to 0.8% over the final 2020-2030 decade (Table 5.7.11-2).

Table 5.7.11-2

KEY DEMOGRAPHIC INDICATORS FOR THE TEXAS ROI

	1970	1980	1990	2000	2010	2020	2030
Population (millions)	2.23	2.66	3.42	3.90	4.30	4.70	5.10
Avverage Annual Change over preceding decade	3.0%	1.8%	2.6%	1.3%	1.0%	0.9%	0.8%
			Age Distribution				
≤ 4 years	9.3%	7.6%	7.8%	7.3%	6.9%	6.7%	6 4%
5 - 19 years	29.4%	24.9%	21.4%	21.6%	21.1%	20.6%	19.0%
≥ 65 years	7.6%	8.6%	9.8%	10.4%	12.5%	14.7%	17.7%

Sources: U.S. Bureau of the Census 1982b.

Changes in age distribution are expected to accompany the growing population in the Texas ROI between 1980 and 2030. In 1980, roughly 7.6% of the ROI population was younger than 5 years, 24.9% were 5 to 19 years, and 8.6% were 65 and older (U.S. Bureau of the Census 1982b). By the year 2000 the proportional representation of the two younger age groups is projected to decrease to 7.3 and 21.6%, respectively, with persons in the older age group having increased to 10.4% of regional population. This trend of decreasing representation of younger persons and increasing representation of older persons is expected to continue through the year 2030: persons younger than 5 years and persons aged 5 to 19 years are projected to compose 6.4 and 19.0% of the population, and persons 65 and older are expected to represent 17.7% of the regional total.

Reflecting the regional population, more than 90% of the year-round housing units located in the Texas ROI are found in Dallas and Tarrant counties. Statistics from 1980 indicate that the total number of year-round housing units in the region exceeded 1 million, nearly one-fifth of the state total (U.S. Bureau of the Census 1982a). Of these units, 57.6% were occupied (or available for occupancy) by owners, 40.1% were occupied (or available for occupancy) by renters, and the remaining 2.4% were not available for occupancy since they were under transfer of ownership or deemed uninhabitable.

Of the total year-round housing units in the ROI, 92.2% were occupied in 1980. Considering just year-round units available for occupancy in the ROI, the 1980 census indicated vacancy rates were 2.5% for owner units and 10.2% for rental units. From 1981 to 1986, building permits were issued for the construction of more than 330,000 units in the ROI, an average of more than 55,000 per year. Issuance of permits peaked in 1983 with nearly 100,000 and has since declined to 31,000 in 1986 (U.S. Bureau of the Census 1983, 1985, 1987a).

2. Ellis and Southern Dallas Counties

The primary impact area of the Texas ROI is Ellis County, the proposed location of the SSC. In addition, a number of people associated with the project are likely to live in the southern portion of Dallas County, particularly in the communities of Cedar Hill, DeSoto, Duncanville, and Glenn Heights, all within 30 min of the proposed SSC site.

The population of Ellis County declined at a slow, steady rate between 1930 and 1960. More recent demographic trends in the county have been toward increasingly rapid growth; the 47,000-person population recorded for Ellis County in 1970 grew to nearly 60,000 by 1980, the result of 2.5% average annual growth over the decade (U.S. Bureau of the Census 1982b). Growth has continued through 1985, with a 4.3% annual increase since 1980, yielding an estimated mid-decade population of nearly 74,000 persons (U.S. Bureau of the Census 1988). The recent trend of growing population in Ellis County is anticipated to continue through 2030, both as a consequence of continued southerly expansion of suburban Dallas and through continued growth of communities such as Midlothian, Ennis, and Waxahachie within Ellis County itself.

Populations in 1980 for the southern Dallas County communities of Cedar Hill, DeSoto, Duncanville, and Glenn Heights were 6,800, 15,500, 27,800, and 1,000 (U.S. Bureau of the Census 1982b). All have grown markedly by 1987, their respective populations estimated at 15,000 in Cedar Hill (12.4% average annual growth), 26,900 in DeSoto (8.5% average annual growth), 34,900 in Duncanville (3.4% average annual growth), and 4,300 in Glenn Heights (23.5% average annual growth) (North Texas Council of Governments 1987b).

The total number of year-round housing units in Ellis County exceeded 21,000 in 1980, of which 70.4% were owner units, 25.5% were rental units, and 4.1% were in transition or uninhabitable at the time (U.S. Bureau of the Census 1982a). Vacancy rates in Ellis County in 1980 were 1.4% for owner units, 6.2% for rental units, and 6.7% for these units combined.

Of the total year-round housing units available for occupancy in Dallas County in 1980, roughly 2,260 were in Cedar Hill (3.9% total vacancy), 5,060 were in DeSoto (3.2% total vacancy), 9,140 were in Duncanville (3.3% total vacancy), and 390 were in Glenn Heights (8.7% total vacancy).

Building permits issued for the construction of housing units in Ellis County between 1981 and 1986 numbered more than 3,200 (averaging 532 per year). Issuance of permits rose steadily through 1983, leveled off through 1985, and fell dramatically in 1986, roughly paralleling the trend observed in this variable for the ROI as a whole (U.S. Bureau of the Census 1983, 1985, 1987a).

A 1987 survey of housing units in Ellis County by the North Central Texas Council of Governments (1987a) revealed a distribution of 71.2% single-family units, 21.9% multifamily units, and 6.8% mobile homes, with a combined vacancy rate similar to that of the 1980 Housing Census. Sampling of the southern Dallas County communities of Cedar Hill, DeSoto, Duncanville, and Glenn Heights in 1987 indicated increases in total vacancy rates for these communities compared to 1980 levels. Several housing developments currently are planned for the Cedar Hill area, slightly east of the newly completed Joe Pool Reservoir.

Hotels and motels provide 630 rooms of temporary lodging in Ellis County; recreational vehicle parks and campgrounds supply an additional 127 spaces. In neighboring Dallas County, an additional 37,590 hotel, motel, and resort rooms and 135 recreation vehicle/camping spaces are available.

C. Public Services

Levels of public service provided by local governments within the Texas ROI were analyzed using October 1982 employment data (U.S. Bureau of the Census 1984) and 1986-1987 school year statistics (Texas Education Agency 1987).

Police and fire protection, provision of health care, and public educational instruction were examined in detail. The levels of general public service were determined by the ratio of employees to regional population and by student/teacher ratios at the primary and secondary public school levels.

1. Regional Setting

Level of service ratios for key public services (police and fire protection, health care, and education) of each component county of the Texas ROI, the ROI as a whole, the State of Texas, and the United States are presented in Table 5.7.11-3. With the exception of health care, ROI levels of service in all key public services exceed the corresponding national averages. The ROI level of service for public health care, indicated by 3.11 full-time equivalent (FTE) employees per 1,000 population, falls somewhat below the national average of 3.84. The predominantly urbanized counties of Dallas and Tarrant with high levels of public services tend to influence these ROI statistics.

Table 5.7.11-3

LEVELS OF PUBLIC SERVICE FOR TEXAS SSC SITE[1]

Area	Police Protection	Fire Protection[2]	Health and Welfare	Public Education General Education	Public Education Student/ Teacher Ratio	All Other	Total
Dallas County	2.81	1.67	4.09	20.39	18.2	10.40	39.36
Ellis County	2.13	0.92	0.12	23.05	15.6	5.49	31.70
Hill County	1.64	0.44	2.20	21.02	14.5	5.87	31.17
Johnson County	1.49	0.67	5.43	20.74	16.7	5.14	33.47
Kaufman County	1.72	0.23	0.03	24.43	16.2	7.02	33.42
Navarro County	1.76	1.05	0.00	24.54	14.5	8.41	35.76
Rockwall County	2.41	0.00	0.00	22.78	17.8	6.19	31.39
Tarrant County	2.41	1.30	1.70	20.36	18.0	8.80	34.58
Region of Influence	2.59	1.46	3.11	20.58	18.0	9.50	37.23
Texas	2.24	1.10	3.16	23.60	16.1	9.05	39.15
United States	2.34	1.02	3.84	18.44	18.0	8.71	34.35

Notes: 1. All table values represent full time equivalent (FTE) employees per 1000 population <u>except</u> student/teacher ratio.
2. Low values indicate counties served primarily by volunteer fire departments.

Sources: U.S. Bureau of the Census 1984; Texas Education Agency 1987; U.S. Department of Education 1987.

Over 80 medical facilities in the ROI provide general hospital care with nearly 16,000 beds. Although 70 of these facilities are concentrated in Dallas and Tarrant counties, access is facilitated by air ambulance capabilities and close driving distances from other points within the ROI.

2. <u>Ellis County</u>

Since all components of the Texas SSC facility are proposed to be situated in Ellis County, public services and facilities here would likely experience the most direct impacts associated with SSC development in the ROI.

The key facilities of the proposed Texas SSC project, all of which are situated in unincorporated portions of Ellis County, fall within the jurisdiction of the Ellis County Sheriff's Office. The Sheriff's Office currently operates one station with 24 sworn officers and 25 vehicles. Together with the ten municipal police departments in the county, law

enforcement services and facilities are provided to county residents at a level of service slightly below the ROI, state, and national averages.

Fire protection at the proposed SSC site, as with the majority of Ellis County, is provided by rural volunteer fire departments. Only the incorporated cities of Ennis and Waxahachie maintain paid professional fire protection forces.

In addition to medical facilities in nearby Dallas and Fort Worth, Ellis County offers the public general hospital care with two community facilities containing more than 120 beds.

Ten independent school districts in Ellis County provide public education to more than 16,000 students. The county's student/teacher ratio of 15.6 is lower than the average rates for ROI, state, and nation (Texas Education Agency 1987).

D. Public Finance

1. Texas State Government Finances

a. State Government Finances

Texas has several sales tax sources and a corporate franchise tax. Motor fuel taxes and motor vehicle sales taxes and fees are substantial. Severance taxes on oil, gas, sulfur, and cement are a significant revenue source. Owing in part to reductions in this source in 1987, the State Legislature broadened the base and increased the rate of the sales and use tax. A brief discussion of the major taxes indicates their importance. All dollar values in the public finance discussion are current dollars for the fiscal years cited.

The sales and use tax rate is 6% and includes retail sales and rentals of tangible personal property used in the state as well as selected services including cleaning and repairs. This has been the largest tax revenue source with 38.90% of receipts for Texas in FY 86 (Table 5.7.11-4). With a broadened base and rate increase since October 1, 1987, this source will probably increase its share in the near future.

The corporate franchise tax, which is levied at $6.70 per $1,000 of capital including undivided profits, was temporarily increased for 1988 and 1989 from $5.25 due to a recent state deficit crisis. In FY86, this source contributed 8.31% of Texas tax revenues.

Oil is taxed at 4.6 cents per barrel plus three-sixteenths of one cent per barrel. Natural gas is taxed at 7.5% of market value. Sulfur is taxed at $1.03 per long ton. Cement is taxed at 2.75 cents per hundredweight distributed in the state. These taxes provided 13.95% of Texas tax revenues in FY 86.

Table 5.7.11-4

TEXAS STATE GENERAL REVENUES AND EXPENDITURE - 1986

Revenue/Expenditures	Amount in thousands	Per Capita
REVENUE		
Total intergovernmental	$ 4,558,617	$ 273
Federal	4,546,954	273
Total taxes	$ 11,124,708	$ 667
Sales and gross receipts	7,669,750	460
General Sales	4,327,698	259
Selective sales, gross receipts	3,342,052	200
Alcohol	348,660	21
Insurance	424,962	25
Motor Fuels	1,011,478	61
Public Utilities	234,990	14
Tobacco	378,715	23
Individual income	---	---
Corporate net income	---	---
License	1,783,357	107
Corporate license tax	924,291	55
Motor vehicle	643,590	39
Occupations and business licenses	94,995	6
Documentary and stock transfer fees	---	---
Property tax	13	0
Charges and misc. general revenue	4,221,044	253
Current charges	1,547,117	93
Total general revenue	$ 19,904,369	$1,193
EXPENDITURE		
Total general expenditure	$ 18,917,786	$1,134
Direct capital outlay	2,504,997	150

Notes: Population, 1986: 16,682,000
Source: U.S. Bureau of the Census 1987b.

Gasoline, liquefied gas, and diesel fuel are taxed at 15 cents/gal. This was a recent increase from 10 cents on January 1, 1987. These taxes yielded 9.09% of tax revenues in FY 86.

The sales tax on motor vehicles was raised from 5% to 6% of the price on September 1, 1987. Interstate carriers pay only in proportion to the Texas mileage share of total mileage. This tax produced 7.31% of Texas revenue in FY86.

License fees for passenger vehicles vary from $40.50 to $58.50 if gross weight is 6,000 lbs or less. If over 6,000 lbs, the fee is $25 plus 60 cents per hundredweight. Trucks and combinations also pay on a sliding weight scale. Diesel vehicles pay 11% more. These fees provided 6.25% of 1986 Texas tax revenues.

Other taxes which produced substantial revenues include insurance company taxes, public utilities taxes, cigarette and tobacco taxes, and alcoholic beverage licenses and taxes. The largest revenue source of these was the insurance companies tax, which accounted for 3.94% of Texas tax revenues in FY 86.

b. State Revenues and Expenditure

Texas general revenue and expenditure for FY 86 are presented in Table 5.7.11-4. Taxes, intergovernmental revenues, and charges are the major revenue categories. General sales taxes were the predominant source; there are no income taxes in Texas. General revenue exceeded general expenditures by 5%; direct capital outlay was 13% of general expenditures.

c. Local Government Organization and State Payments to Local Governments

There were 254 county, 1,121 municipal, and 1,124 school district governments in Texas at the time of the 1982 Census of Governments. There were no dependent school systems, despite enabling legislation.

There were also 1,681 special district governments. Important among these are municipal power agencies, water districts, and rural fire prevention districts as well as subordinate county road districts. Many of these can charge fees, levy taxes, and issue bonds, under appropriate conditions.

The largest Texas intergovernmental expense is the State Foundation School Program which provides an equalization apportionment to fund school district operations. Other categorical programs are funded as well.

After a modest set-aside for the county and road district fund, 25% of motor fuel tax revenues are granted to counties, one-fifth by area, two-fifths by rural population, and two-fifths by lateral road mileage. Other units receive some appropriations.

The alcoholic beverage sales tax is divided 30% to local governments, with half going to cities and half to counties of origin.

2. Texas Local Government Finances

Ellis County and the City of Waxahachie comprise the primary impact area for the public finance analysis.

a. Ellis County

Revenues and expenditures for FY86 are given for Ellis County in Table 5.7.11-5. The major revenue sources are property taxes and various fines, fees, charges, and transfers. A small deficit of about 5% of total expenditures occurred in 1986. Capital projects were about 3% of total expenditures.

Ellis County property tax levies for all jurisdictions in 1986 were as follows:

Jurisdiction	Tax Levy
County government	$4,228,688
Cities	4,286,757
School districts	15,406,370
Special districts	1,533,536
Total Ellis County	$25,455,351

Total 1987 assessed value was $2,327,291,406.

b. Waxahachie

Financial data for 1987 for Waxahachie are presented in Table 5.7.11-6. Taxes, including property taxes, sales taxes, and franchise taxes, licenses and fees, and water sales, as well as investment income provided the major shares of revenues. When capital projects are included, 32% of total expenditures in 1987 a deficit equal to about 25% of total expenditures result.

Table 5.7.11-5

ELLIS COUNTY, TEXAS
COUNTY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1986

Revenue/Expenditure	Amount (in thousands)	Per Capita
REVENUE		
Taxes		
Ad valorem	$ 3,722,238	$ 48
Mixed drink tax	31,225	0
Licenses and permits	2,190	0
Fees	172,452	2
Fines	823,956	11
Motor vehicle fees	671,300	9
Intergovernmental		
Federal	203,261	3
State	213,708	3
Interest	361,707	5
Charges for services	577,093	7
Sale of material	109,914	1
Sheriff	213,039	3
Transfers from road & bridge reserve	1,741,705	22
Transfers from various funds	827,965	11
Other revenues	275,897	4
Total Operating Revenue	$ 9,947,650	$ 128
EXPENDITURE		
Operations	$ 10,216,383	$ 131
Capital projects	297,197	4
Total Expenditures	$ 10,513,580	$ 135

Note: Population, 1986: 77,800

Sources: For financial data: Ellis County Finances 1987a; Ellis County, April 1987b.
For population figures: U.S. Bureau of the Census 1988.

Table 5.7.11-6

WAXAHACHIE (ELLIS COUNTY), TEXAS
CITY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1987

Revenue/Expenditure	Amount (in thousands)	Per Capita
REVENUE		
Taxes	$ 4,799,281	$ 263
Permits	72,570	4
Licenses and fees	1,032,478	57
Fines and forfeitures	210,030	12
Cemetary	25,827	1
Other revenues	114,074	6
Intergovernmental (com. dev. blk. grant)	201,200	11
Investment income	939,138	52
Water sales	1,300,000	71
Assessments	9,043	0
Pension plan contributions	97,661	5
Capital cost recovery	29,362	2
Total Operating Revenue	$ 8,830,664	$ 484
EXPENDITURE		
Operations	$ 8,246,592	$ 452
Capital Projects	3,956,524	217
Total Expenditures	$ 12,203,116	$ 669

Note: Population, 1986: 18,230,000.

Sources: For financial data: City of Waxahachie 1987; for population figures: U.S. Bureau of the Census 1988.

5.7.11.2 Infrastructure

A. Transportation

1. Roads

Major highways and roads serving the proposed SSC site are shown in Figure 5.7.11-3. Data on highways and roads are presented in Table 5.7.11-7.

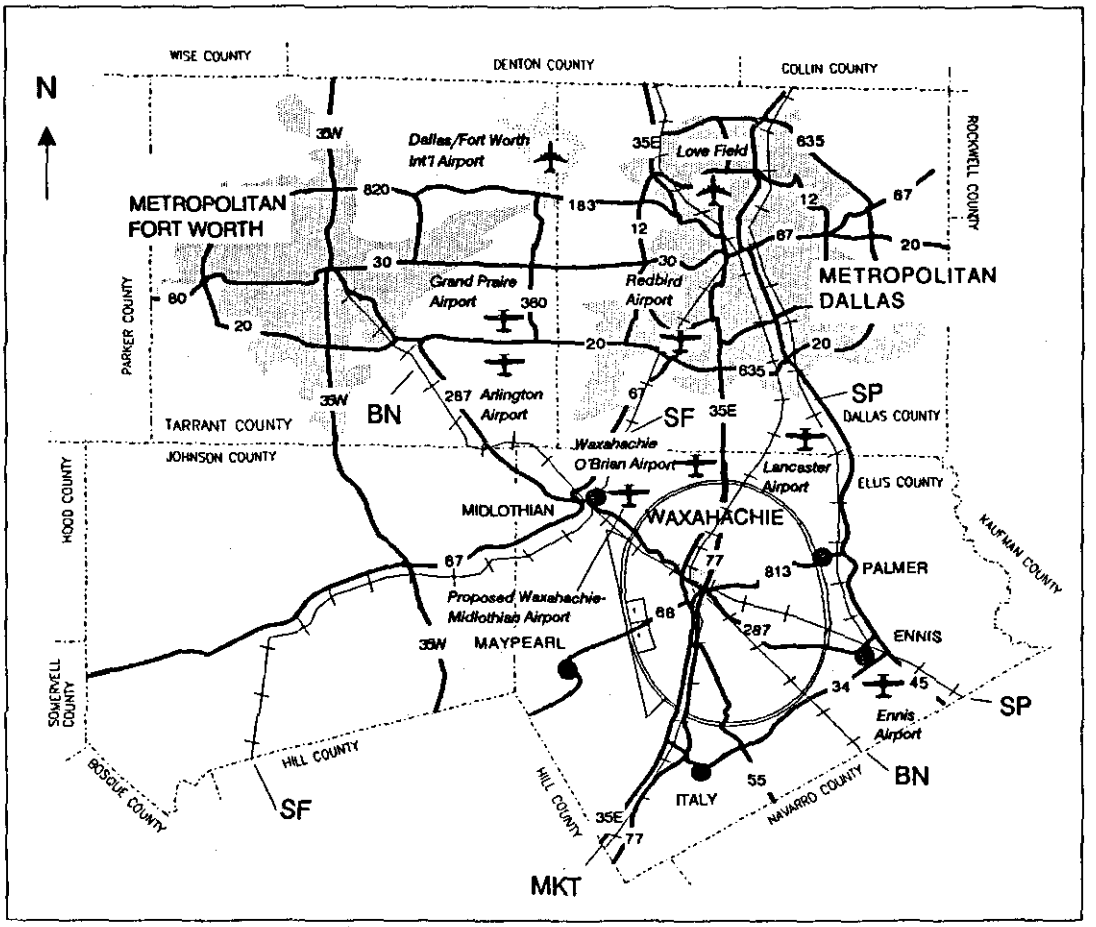
The Dallas-Fort Worth Metroplex located 32 mi to the north of the proposed site is served by a network of freeways that includes Interstate Highway 20 (I-20) extending to the east and west, I-30 extending to the east-northeast, I-35 extending to the north and south, and I-45 extending to the southeast. I-35 splits into east and west sections to serve both Dallas and Fort Worth. Additional freeways include U.S. Routes 67, 75, 175, and 287. An extensive system of arterial and bypass freeways and highways join Dallas and Fort Worth and the freeways discussed above.

The Dallas-Fort Worth Metroplex has been experiencing increasing transportation problems because of rapid growth in recent years. The North Central Texas Council of Governments developed the Mobility 2000 Regional Transportation Plan in February 1986, to solve these transportation problems. This plan calls for expansion and improvement of the freeway system in the Dallas-Fort Worth Metroplex to 4,807-lane miles by the year 2000. By comparison the metroplex freeway system included only 2,740-lane miles in 1980. Plan elements that will improve transportation to the proposed SSC site area include the widening of I-35E and U.S. Route 67 south of Dallas and the extension of State Route 360 south from I-20 to U.S. Route 287 (North Central Texas Council of Governments 1986). Contracts for the widening of I-35E and the extension of State Route 360 are scheduled to be let by the Texas State Department of Highways and Public Transportation during the 4-yr letting period ending in August 1991 (Texas Department of Highways 1986a; 1987).

The proposed site is served by a network of interstate, U.S., state, and county roads. These include I-35E which passes north to south through Waxahachie in the center of the ring and I-45, which passes to the east of the proposed site area. U.S. Route 287 crosses the proposed site connecting the area to Fort Worth and Midlothian on the northwest and Ennis on the southeast. U.S. Route 67 passes to the northwest connecting Dallas and Midlothian. U.S. Route 77 crosses the site from north to south paralleling the route of I-35E. State Highway 34 passes to the south of the proposed site connecting I-35E and I-45. Farm-to-market Route 66 extends west from Waxahachie to the proposed campus location, while farm-to-market Route 878 extends east from Waxahachie to the proposed far cluster location and I-45. Additional county paved and unpaved roads provide access to most of the proposed locations for surface facilities.

FIGURE 5.7.11-3

MAJOR TRANSPORTATION SYSTEMS SERVING THE TEXAS SITE



MKT - Missouri-Kansas-Texas
BN - Burlington Northern
SP - Southern Pacific
SF - Santa Fe

Table No. 5.7.11-7
PRESENT HIGHWAYS AND ROADS SERVING THE PROPOSED TEXAS SSC SITE

ROAD SEGMENT	Length Mi	Lanes	Capacity pcph[1]	Peak Hour Volume pcph	LOS[2]
I-35E: I-20 to U.S. Route 77	10	4	8,000	4,200	b[4]
I-35E: U.S. Route 77 to State Route 34	22	4	8,000	1,850	a
I-45: I-20 to F.M. Route 878[3]	17	4	8,000	3,050	b
I-45: F.M. Route 878 to U.S. Route 287	9	4	8,000	2,450	a
U.S. Route 67: I-20 to U.S. Route 287	15	4	8,000	2,600	a[5]
U.S. Route 287: I-20 to Ellis County Line	12	4	8,000	1,850	a
U.S. Route 287: Ellis County Line to U.S. Route 67	5	2	2,800	900	c
U.S. Route 287: U.S. Route 67 to F.M. Route 528 (West of Waxahachie)	8	2	2,800	1,100	d
U.S. Route 287: F.M. Route 528 to I-45	21	4	8,000	850	a
U.S. Route 77: I-35E to U.S. Route 287	6	2	2,800	800	c
U.S. Route 77: F.M. Route 66 to State Route 34	14	2	2,800	200	b
F.M. Route 66: U.S. Route 77 to Maypearl	11	2	2,800	200	b
F.M. Route 878: U.S. Route 287 to Palmer	10	2	2,800	150	b
State Route 34: U.S. Route 77 to Ennis	19	2	2,800	200	b
F.M. Route 55: U.S. Route 77 to State Route 34	11	2	2,800	100	a

Table No. 5.7.11-7 (Cont)

PRESENT HIGHWAYS AND ROADS SERVING THE PROPOSED TEXAS SSC SITE

Notes: 1. pcph - passenger cars per hour

2. LOS: Level of Service

a. Free flow with individual users virtually unaffected by the presence of others in the traffic stream

b. Stable flow but the presence of other users in the traffic stream begins to be noticeable.

c. Stable flow but operations of individual users becomes significantly affected by interactions with others in the traffic stream.

d. High density, but stable flow with speed and freedom to maneuver severely restricted and the driver experiences a generally poor level of comfort and convenience.

e. Unstable flow at near capacity level with speeds reduced, maneuvering difficult and extremely poor level of comfort and convenience.

f. Forced or breakdown flow with traffic demand exceeding the capacity, unstable stop and go traffic.

3. F.M.: Farm to Market (State road)

4. Portions of I35E close to I-20 experience LOS C

5. Portions of U.S. Route 67 close to I-20 experience LOS B

Sources: Transportation Research Boards 1985; Texas Department of Highways 1986b; Texas Department of Highways 1986c

Future state plans call for the upgrading of U.S. route 287 in the proposed site area (Texas Department of Highways 1986a; 1987).

2. Rail

The proposed SSC site area is served by a network of rail lines that are operated by Southern Pacific Transportation Company, Burlington Northern Railroad Company, Missouri-Kansas-Texas Railroad Company, and Santa Fe Railway Company as shown in Figure 5.7.11-3. A Missouri-Kansas-Texas main line crosses the proposed site area from the north to the south connecting Dallas with San Antonio and Houston. A Burlington Northern main line crosses the site area from northwest to southeast connecting Dallas with Houston. This line carried a traffic density of approximately 10-million gross ton mi/yr in 1983. A Southern Pacific branch line crosses the site from northwest to east connecting Fort Worth to a north-south Southern Pacific main line east of the site. The Southern Pacific main line connects Dallas with Houston and San Antonio. The main line traffic density exceeded 13-million gross ton mi/yr in 1983. Finally, a Santa Fe branch line passes to the northwest of the site connecting Dallas to its east-west main line at Brownwood, Texas. The closest siding is at Waxahachie 6 mi northeast of the proposed campus location. These rail lines connect the proposed site area with most other U.S. cities through connections to other railroads (Railroad Commission of Texas 1986).

Amtrak provides passenger rail service between San Antonio, Texas, and Chicago serving the cities of Dallas, Fort Worth, and Cleburne within the proposed SSC site region. This service is only provided three times a week. Total passengers served at these cities in FY84 were 26,300, 12,600, and 2,700, respectively (Railroad Commission of Texas 1986).

3. Air

Airports serving the proposed SSC site are shown in Figure 5.7.11-3. The principal airport providing passenger and freight service is the Dallas-Fort Worth International Airport. This publicly owned and operated airport is located approximately 16 mi west-northwest of downtown Dallas, 20 mi northeast of downtown Fort Worth, and 39 mi north of the proposed campus location. The airport is a major hub in the U.S. transportation system. It is the largest airport in the U.S. in land area and the second largest in the world. Operations in 1987 included approximately 21 million passenger enplanements, the handling of more than 185,000 tons of cargo, and more than 625,000 aircraft landings and takeoffs. Airport operations are currently congested with 75,000 hours of delays experienced by scheduled airline operations in 1986. Delays are forecasted to increase to 90,000 hours in 1996 (Yatzeck 1988). Operations at the airport have been forecasted to more than double the current level within the next 20 years. The Dallas-Fort Worth airport is currently updating its 20-yr master plan to address this growth. Phase I of the plan addresses a major expansion of the American Airlines terminal facilities, including additional runways. Phase II will address

terminal facilities for other airlines and other airport facilities (Dallas-Fort Worth 1987).

Love Field could also provide passenger and freight service to the proposed SSC site. This airport, owned and operated by the City of Dallas, is located approximately 5 mi northwest of downtown Dallas and approximately 35 mi north of the proposed campus location. The airport serves regional and commuter airline traffic as well as general aviation traffic. Airport operations in 1987 included more than 2 million passenger enplanements and approximately 225,000 aircraft landings and takeoffs (City of Dallas 1987). The airport is currently operating below its capacity; however, its capacity may be exceeded in the 1995-2000 time period (North Central Texas Council of Governments 1984).

The principal general aviation field that would serve the proposed SSC site is the Redbird Airport. This airport, owned and operated by the City of Dallas, is located approximately 8 mi south-southwest of downtown Dallas and approximately 24 mi north of the proposed campus location. It is capable of handling corporate jet aircraft. It is currently operating at below its capacity (North Central Texas Council of Governments 1984). Future plans call for an extension of the main runway by 1,000 ft and the development of additional taxiways (City of Dallas 1987).

The closest general aviation field to the proposed campus location is the Waxahachie-O'Brian Airport. This privately owned and operated airport is located approximately 11 mi north-northeast of the proposed campus location. It is capable of handling only small piston engine aircraft (North Central Texas Council of Governments 1984).

Other general aviation airports in the proposed SSC site area include the Arlington, Ennis, and Lancaster municipal airports and the Grand Prairie private airport. The Lancaster Municipal Airport located 21 mi northeast of the proposed campus location currently handles corporate jet aircraft. Peak operations at the Arlington Municipal airport occasionally exceed its capacity (North Centra Texas Council of Governments 1984).

The cities of Waxahachie and Midlothian are planning to build a new general aviation airport in the near future. This airport will be located between the cities adjacent to U.S. Route 287 approximately 5.8 mi from Waxahachie and 5.1 mi from Midlothian. The airport will be located near the proposed location of intermediate access shaft E2 approximately 8 mi north of the proposed campus location. Plans call for the initial construction of a 4,200-ft-long runway with extension to 5,000 ft in Phase II. It will be capable of handling corporate jet aircraft after the extension of the runway (Willis 1987). When completed, the airport will be the closest general aviation field to the proposed campus location.

4. Waterways

There are no waterways serving the proposed SSC site. The closest port is at Houston approximately 210 mi to the southeast. Both rail and interstate highway access is available to the Port of Houston.

5. Public Transit

a. Bus and Transit Service

Bus and transit service in the Dallas-Fort Worth metroplex are provided by Dallas Area Rapid Transit (DART) and the Fort Worth Transportation Authority. Neither of these provide service to the proposed SSC site area.

DART provides bus service to 16 member cities and towns in the Dallas metropolitan area. DART uses approximately 850 buses and provides service to approximately 160,000 passengers per day (DART 1988). The closest bus line is an express line to the community of Glen Heights, approximately 16 mi to the north-northeast of the proposed campus location. DART has just completed its Immediate Action Program in which its bus fleet was nearly doubled. Currently DART is establishing ten transit centers throughout the service area. These transit centers will provide parking and express bus service to downtown locations (Dallas Area Rapid Transit 1987).

The Fort Worth Transportation Authority (FWTA) provides bus service in the Fort Worth metropolitan area on over 32 routes with 105 peak-hour operating buses. In addition, subscription commuter bus service is provided to two major employers in the Fort Worth area. The system carried more than 5.1 million passengers in 1986 (Forth Worth Transportation Authority 1988).

DART has plans to develop a rail rapid transit system that will consist of 93.7 mi of rail lines following the Dallas area's most heavily traveled corridors. The first stage of construction calls for completion of approximately 30 mi of rail lines by the end of 1997. The entire system is scheduled to be in operation by 2010 (Dallas Area Rapid Transit 1988).

The Mobility 2000 Regional Transportation Plan developed by the North Central Texas Council of Governments calls for the establishment of commuter rail service between the Dallas and Fort Worth central business districts. This will include service over two lines utilizing former Rock Island and Missouri-Pacific rail lines (North Central Texas Council of Governments 1986).

b. Taxi Service

Privately operated taxi, shuttle, and limousine service is provided throughout the Dallas-Fort Worth Metroplex. In addition, the Fort Worth

Transit Authority provides bus service from several locations in the Fort Worth area to the Dallas-Fort Worth International Airport (Fort Worth Transportation Authority 1988).

c. Rental Car Service

Privately operated rental car services are provided at the Dallas-Fort Worth International Airport, Love Field, and other locations within the Dallas-Fort Worth Metroplex. Additional rental car services are located at the Red Bird and Lancaster general aviation fields (Flight Guide 1986).

d. Para-Transit Services

DART provides transportation for mobility-impaired persons throughout the 16 towns and cities in its service area. This service, called "HandiRides," is provided curb-to-curb using taxis and lift-equipped vans. Services are currently provided to more than 7,000 certified customers. In addition DART charges reduced fares to senior citizens on the regularly scheduled bus lines.

The FWTA also operates mobility-impaired transportation services within its service area. This service provides demand-responsive door-to-door transportation for qualified citizens (Fort Worth Transportation Authority 1988).

Both DART and the FWTA provide assistance in coordinating ridesharing programs. In addition both provide park and ride lots (Dallas Area Rapid Transit 1988; Fort Worth Transportation Authority 1988).

B. Utilities

1. Electricity

a. Ownership

The area in the vicinity of the proposed Texas SSC site is served by the transmission network of the Texas Utilities Electric Company (TU Electric, TU Electric is the principal subsidiary of the Texas Utilities Company. (TU Report 1987).

b. Delineation of Service Territory

TU Electric's three operating divisions, Dallas Power and Light, Texas Electric Service, and Texas Power and Light provide electric service to over 5 million people, about one-third of the state's population. The service territory extends 600 mi from west Texas eastward to Louisiana and 250 mi, from the Oklahoma border southward into Central Texas (TU 1986).

Service is provided in 87 counties to 361 incorporated cities, including Dallas, Fort Worth, Wichita Falls, Arlington, Plano, and Waco (TU 1986).

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c. Interrelationship with Other Electric Utilities

The TU Electric system is part of the interconnected Electric Reliability Council of Texas (ERCOT). ERCOT is one of nine regional councils that make up the North American Electric Reliability Council (NERC). ERCOT is comprised of 20 municipalities, 49 cooperatives, 6 investor-owned utilities, and 1 state agency. These systems operate 85% of the electric generating capacity in Texas and serve approximately 200,000 mi^2, 73% of the state (NERC 1987).

The ERCOT transmission system is directly interconnected with the transmission system of the Southwest Power Pool (SPP), another NERC Regional Council (NERC 1987).

d. Existing Network

The TU Electric system includes 23 generating stations, combining a mix of gas and lignite-fired, and diesel electric units for a total present capacity of approximately 19,000 MW (TU 1986; Watson 1987). The ERCOT system, to which TU Electric is interconnected, has approximately 44,000 MW of installed generating capability (NERC 1987).

e. Planned Upgrades/Additions

New generating capacity scheduled for installation and connection to the ERCOT system during the period 1987-1996 is approximately 12,500 MW. This includes 5,400 MW of coal-fired capacity, 2,800 MW of combustion turbines, and 4,800 MW of nuclear generation. ERCOT members expect to install approximately 1,300 circuit miles of 345-kV lines during the next 10 years (NERC 1987).

Plans are currently being developed for expansion of ERCOT to SPP interconnect ties with capacities of 100 to 600 MW. Completion dates are tentatively scheduled for 1989 to 1990 (NERC 1987).

TU Electric projects a total system capacity increase to approximately 24,000 MW by 1997. ERCOT forecasts an installed capacity increase to approximately 56,000 MW by 1996-1997 (Watson 1987; NERC 1987).

TU Electric has plans for substantial transmission line construction projects, upgrades, and renovations between 1988 and 1997 (TU Plan 1987).

2. Natural Gas

a. Ownership

The area in the vicinity of the proposed Texas site is served by the natural gas transmission systems of the Lone Star Gas Company (Lone Star) and the Valero Energy Corporation (Valero).

The Lone Star Gas Company is a utility division of ENSERCH Corporation (Bryan 1987). ENSERCH Corporation is a diversified energy, engineering, and construction company incorporated under Texas law in 1942.

Valero Energy Corporation is a publicly-owned corporation incorporated under the laws of the State of Delaware.

The portion of the transmission system that would serve the site vicinity is jointly owned and operated by Valero and the Texas Utilities Fuel Company (TUFCO) (Juenger 1987). The Texas Utilities Fuel Company, a wholly owned subsidiary of the Texas Utility Company, owns a natural gas pipeline system; acquires, stores, and delivers fuel gas; and provides other services for generating electric energy by TU Electric (TU Report 1987).

b. Delineation of Service Territory

Valero's natural gas pipeline systems are located primarily along the Texas Gulf Coast and throughout South Texas and extend westward to Pecos, Texas. The company also jointly owns and operates pipelines that extend from Waha, Texas, to the Dallas-Fort Worth area and from Waha to San Antonio (Juenger 1987; Valero Report 1987).

Lone Star's natural gas system primarily services a 120,000 mi^2 area of northeast Texas and southern Oklahoma. Its network stretches north-south from Norman, Oklahoma, to Houston, Texas, and east-west from Abilene, Texas, to the Louisiana border (Lone Star 1985).

c. Interrelationship with Other Natural Gas Utilities

Valero purchases natural gas under approximately 2,500 long-term and short-term contracts from numerous producers and pipeline companies then gathers, processes, delivers, and sells the gas to customers. Valero's pipeline system has 20 interconnections with 9 interstate pipelines and 54 interconnections with 17 intrastate pipelines (Juenger 1987).

d. Existing Network

Valero's pipeline system includes approximately 7,300 miles of mainlines, lateral lines and gathering lines and 1,400 miles of lines for retail distribution. Additionally, the company leases and operates several pipelines, including a stretch of line extending from Dallas to Houston. These integrated systems include 40 mainline compressor stations, gas processing, dehydration and treatment plants, and numerous measuring and regulating stations (Juenger 1987).

Valero jointly owns and operates with TUFCO a 395-mile, 36-inch pipeline extending from Waha, Texas, to the Dallas-Fort Worth area. This pipeline extends into east Texas in a joint venture with TUFCO and Lone Star Gas Company (Juenger 1987).

Lone Star currently operates 32,000 mi of interconnected natural gas pipelines that transport and deliver gas to over 1.25 million customers in 600 Texas and Oklahoma cities. Total transmission pipeline capacity is over 2.7 billion ft^3/d. Lone Star's existing pipelines in the vicinity of the proposed site area have a cumulative capacity of approximately 350 million ft^3/d (Bryan 1987).

e. Planned Future Upgrades/Additions

Lone Star has eleven underground gas storage projects in depleted oil or gas fields with a working capacity of 65 billion ft^3. A new storage area is presently under construction near Bethel, Anderson County, Texas. This facility will have a working gas capacity of 3.5 billion ft^3 by the end of 1989, with a planned ultimate capacity of 10.5 billion ft^3 (Bryan 1987).

3. Telecommunications

a. Ownership

Southwestern Bell Telephone Company is the primary provider of telecommunications services in the vicinity of the proposed site. There are also communication lines belonging to CONTEL that serve the Waxahachie area.

Southwestern Bell Telephone Company (Southwestern Bell) is one of the six principal subsidiaries of the Southwestern Bell Corporation.

b. Delineation of Service Territory

Southwestern Bell provides a variety of telecommunications services to customers in Arkansas, Kansas, Missouri, Oklahoma, and Texas (Bell 1987).

Southwestern Bell currently serves the towns of Waxahachie, Midlothian, Red Oak, and Ennis with digital switch service and is scheduled to provide similar service to Italy, Texas, in 1989.

c. Interrelationship with Other Telecommunications Systems

Insufficient information concerning system interrelationships was available for review.

d. Existing Network

Insufficient information concerning the existing network was available for review.

e. Planned Future Upgrades/Additions

Southwestern Bell is currently installing a fiber-optic run from Dallas to San Antonio that will generally follow the alignment of Interstate Highway 35. The installation from Dallas to Waxahachie is presently complete and is expected to reach San Antonio by the end of 1988.

Also, Southwestern Bell is introducing a new technology in integrated services digital network (ISDN), which will be available in the equipment and planned digital switches. The technology allows simultaneous voice and data transmission over the same two-wire facilities.

5.7.12 Cultural and Paleontological Resources

5.7.12.1 Cultural Resources

A. Cultural History and Scientific Basis

Although the Paleo-Indians are considered to have been the first inhabitants of the project region during Late Pleistocene to Early Holocene times, there is little information available as to the date of their local occupation, life-style, or settlement patterns. Their presence is known from the rare finds of Clovis or Folsom projectile points.

The Archaic Period (5000 B.C. - 800 A.D.) is also lacking in data. Although sites have been recorded for this general time period within the project vicinity, comprehensive research for the region does not exist at the present time, and there is only a poor understanding of the economy, settlement pattern, or social organization of these people. Much of what is known relates to stylistic elements of artifacts, which have enabled archaeologists to identify the Carrollton and successive Elam cultures. The diagnostic tools of the Carrollton focus are the Carrollton axe; Trinity-notched, Wheeler leaf, Edgewood, Wells, Martindale and Castroville projectile points; Waco net sinkers; and an assemblage of gravers, scrapers, burins, and drills. Site types from the Archaic Period are found at the confluence of streams and rivers, where seasonal camps were established, and special activity sites also associated with waterways but focused on hunting, fishing, or other specialized tasks. The Elam Period which follows appears to be a continuation of the Carrollton; there is an increase in the numbers of grinding stones and a trend towards smaller projectile points, including the Elam type. The Carrollton axe and Waco net sinker are phased out and there is an increase in the number of turtle back scraper forms (Brown 1982; Raab et al. 1982a).

The formative Late Prehistoric (Neo-American) stage seems to have been established, in the project area, by around 800 A.D. and continues until 1600 A.D. Subsistence shifted to an agricultural base and more complex social systems developed. Introduction of the bow and arrow, ceramics, and cultigens was the principal indicator of the shift from the Archaic Period. The Southern Cult, a religious tradition, spreading from eastern Oklahoma to southwestern Arkansas and east Texas. Interregional trade became widespread and large mounds were constructed. Sites recorded in the project area appear to have belonged to the Wylie focus, possibly representing small satellite sites to the large classic Wylie sites that covered many acres. Wylie sites feature large pits often 20 meters in diameter, and dense middens. Small sites are located at terrace margins, or are buried in the floodplains of creeks and may be small seasonal camps (Brown 1982; Raab et al. 1982a).

Development of the historically known tribes, the Hasinai Caddo Confederacy and the Wichita, has not as yet been traced. The northeast region has two archaeologically established historic cultures, the Allen and the Glendora; however, neither of these is documented as being present in the project area.

The first historic contact recorded is probably by the French explorer, LaSalle, who reportedly reached the Middle Trinity River during his expedition of 1687. He was followed between 1690 and 1716 by Spanish expeditions. The Spanish presence in Texas (1659-1836) was mainly military and religious with the settlement pattern determined by the Spanish effort to defend its territories. Around 1750, Euro-American hunters and trappers entered the area, but settlement did not begin until around 1840 because of ongoing disputes between Texas and Mexico. Details of the early settlement patterns by various ethnic groups or economic development are generally lacking. From 1840 to 1870, there was a shift from what was essentially a frontier society to one based on the production of cotton. Tenant farmers growing this cash crop increased throughout the period from 1870 to 1940, with populations in the rural communities probably reaching their highest populations during this time period. The boom period for the small towns and settlements was from around 1890 to the early 1920s. Development was spurred by the expanding railroad system and by a healthy cotton market. Ellis County became the largest cotton producer in the nation with Waxahachie as the cotton ginning and marketing center. Ennis saw a great deal of growth when it became the headquarters of the railroad (Hardy, Heck, and Moore 1985a, 1985b).

After the Civil War construction of the railroad opened up markets to the north and east for cotton and cattle, and also brought in new settlers, doubling the population between 1890 and 1900. The result was an increase in the numbers of small family farms and tenant farms, many located in marginal agricultural lands. Cotton production boomed and by 1900 cotton gins were to be found in almost every small town.

In 1894 oil was discovered at Corsicana, southeast of the proposed SSC project area. From 1900 to around 1945 the oil industry in the region had several periods of major growth, causing periodic booms in the local economy.

Agriculture underwent major changes early in the twentieth century as the cotton market dropped and the boll weevil ravaged crops, many farms were apparently abandoned at this time (Bruseth and Moir n.d.)

The oil industry dominated the economy of the project area in the first half of the 20th century and is significant in the regional history and development (Raab et al. 1982b).

B. Known National Register Sites/Sacred Sites

No currently listed National Register sites are located within the facilities boundaries of the proposed Texas SSC site. National Register sites are located in Waxahachie and Ennis. Some of the archaeological sites recorded during field reconnaissance procedures require additional evaluation to determine if they are eligible for the National Register.

Based on site reconnaissance and archival study conducted by the State Historic Preservation Officer, no Native American sacred sites have been recorded in the study area (State of Texas 1988). Burial sites, however, have been located during field study. The Texas Indian Commission along with the chairmen of the Caddo and Wichita tribes have stated that to the best of their knowledge, no Native American sacred sites are recorded in Ellis County (State of Texas 1988).

C. Previously Recorded Sites and Research in the Project Area

Approximately 30 minor archaeological investigations have been completed in Ellis County. These studies were undertaken in relation to channel and floodway improvement work of the Soil Conservation Service (SCS) and roadway construction by the DOHPT. No sites were identified during these studies. The Texas Archaeological Salvage Project conducted archaeological studies before the construction of Lake Bardwell. Fifteen sites were located and designated 41 EL2 through 41 EL16. At least six of the sites were affiliated with the Archaic Period, some of which also contained Late Prehistoric Period materials (Shafer 1964). Several of these sites are near the proposed SSC site and are listed on Table 5.7.12-1.

Archaeological studies (Raab et al. 1982a) were undertaken pertaining to the construction of Lake Lakeview, a Corps of Engineers reservoir located principally in Dallas County but involving portions of Ellis County. Seventeen prehistoric sites and 25 historic sites were located. Five prehistoric sites belonging to the Archaic and Neo-American stages were evaluated as significant. Eleven historic sites, identified with the Antebellum Period, the Civil War and Reconstruction Period, and the Late Victorian Period, were determined to be eligible for the National Register.

A similar study (Raab et al. 1982b) was conducted pertaining to construction of the Richland Creek reservoir located in Navarro and Freestone counties approximately 55 mi southeast of the proposed SSC project area. A total of 447 archaeological sites were recorded representing the Middle and Late Archaic and Late Prehistoric stages. A total of 488 historic sites were recorded, including dwellings, barns, bridges, wells, and cemeteries. A total of 77 sites within project impact areas were considered significant.

Two historic sites (41 EL35 and 41 EL36), a partially destroyed farmhouse dating to about 1881 and another farmhouse dating to the 1920s, were identified during an archaeological survey of the proposed Waxahachie-Midlothian Airport (Westbury 1986).

The Texas State Historic Preservation Office has conducted a literature search and a reconnaissance survey of the proposed SSC project area (State of Texas 1988). Table 5.7.12-1 lists previously recorded sites within the vicinity of the proposed SSC site, including 17 prehistoric archaeological sites. Historic structures located include several houses and farmsteads (ca. 1890), a cemetery, a truss bridge (ca. 1910), and a cotton gin/weigh station (ca. 1920). None of these are expected to be affected by SSC site activities.

Several communities in the vicinity of the proposed SSC site feature a number of historic buildings associated with the cotton boom era. From 1890 to 1910, Waxahachie was the cotton ginning and marketing center of Ellis County, the largest cotton-producing county in the nation. A 1985 historical survey of the city identified 1,988 structures that predate 1935 (Hardy, Heck, and Moore 1985a); 85 of these buildings have been listed on the National Register. In 1983, Waxahachie was chosen by the state as a Main Street Project City. The Main Street Program was initiated by the National Trust for Historic Preservation.

Ennis similarly features a number of historic structures associated with the cotton and railroad industries (Hardy, Heck, and Moore 1985a). A 1985 survey identified 1,286 historic structures; several have been listed on the National Register.

D. Characterization of Known Resources and Scientific/Educational Potential and Significance

Relatively few archaeological studies have been completed in Ellis County. Information indicates that archaeological site density is low in upland prairie environments such as the project vicinity. However, all prehistoric cultural periods are likely to be represented. Those sites which have been identified are usually situated along the banks of larger streams such as Mustang, Waxahachie, and Chambers creeks or adjacent to perennial springs. None of the previously recorded archaeological sites in the proposed project area have been evaluated regarding their eligibility for the National Register.

Other communities in the area such as Ferris, Forreston, Italy, Maypearl, Midlothian, Milford, and Palmer possess residences, commercial buildings, and railroad depots from the Victorian and early 20th-century periods.

Table 5.7.12-1

CULTURAL RESOURCES RECORDED WITHIN THE VICINITY OF THE PROPOSED TEXAS SSC SITE

Property	Chronological/ Cultural Period	Description
41EL2	Unknown Prehistoric	Open campsite
41EL4	Unknown Prehistoric	Open campsite
41EL5	Archaic	Midden and campsite
41EL6	Late Prehistoric	Campsite; burials
41EL7	Archaic; Late Prehis.	Campsite
41EL8	Unknown Prehistoric	Open campsite
41EL9	Unknown Prehistoric	Open campsite
41EL10	Unknown Prehistoric	Open campsite
41EL11	Archaic; Late Prehis.	Campsite; burials
41EL12	Archaic	Campsite
41EL13	Unknown Prehistoric	Open campsite
41EL14	Unknown Prehistoric	Midden, campsite
41EL15	Archaic	Open campsite
41EL16	Unknown Prehistoric	Open campsite
41EL21	Archaic; Late Prehis.	Midden, campsite
41EL23	Unknown Prehistoric	Midden, campsite
41EL24	Unknown Prehistoric	Open campsite
House (FM 342)	ca. 1890	Farmhouse
House N of Bell Chapel Cemetery	ca. 1890	Farmhouse
Farmstead N of Rockett	ca. 1890	Farm: frame house, outbuildings, 2-room gabled home
1988 historic properties of Waxahachie	1850-1935	Various historic structures associated with development
House N of Palmer	ca. 1910	4-tenant frame house
Historic resources of Palmer	1850-1935	Residences, commercial properties
Pratt through truss bridge	ca.1910	Historic bridge
1300 historic resources of Ennis	1850-1935	Various historic associated with development
Five Points Community	ca. 1920	Residences, cotton gin/weigh station
Bethel Cemetery	1970-Present	

Source: State of Texas 1988.

Historical resources in the rural setting of the project vicinity are represented by a variety of historical structures. Historic farmsteads dating from 1850 to 1935 are present within the project vicinity and may contain a variety of structural types such as single or double pen log cabins, L-plan and I-plan frame houses, and outbuildings. Other rural historical resources include mid-19th or early 20th-century cotton gins and weighing stations, early 20th century churches, cemeteries, and bridges, and early 20th century gas stations and grocery stores. A brief field reconnaissance of the project vicinity indicates that rural historic resources are more densely concentrated in the north, east, and central sections of the project vicinity (State of Texas 1988). Historical resources in urban settings are also present in the project vicinity, specifically Waxahachie, Ennis, and Palmer.

E. Unknown but Potential Resources

Intensive surveys of the proposed SSC project area have not been undertaken. Relatively little of the surrounding area has been systematically studied. It can be expected, however, that previously unrecorded prehistoric archaeological sites will be located, although perhaps not as frequently as within the reservoir study areas mentioned above.

Also, no information is available pertaining to historic archaeological sites. Field studies in consort with archival research could identify such resources pertaining to historic farming and the oil industry.

Considering the large number of significant historic resources in the surrounding communities, it is likely that important rural historic and architectural resources exist. Additional historic cemeteries could be identified.

No data are currently available about potential Native American sacred sites. Requests for information from descendants of Native American groups, that traditionally occupied the proposed project area, could produce information about such locations.

5.7.12.2 Paleontological Resources

A. Scientific Basis

For a description and discussion of the geological stratigraphy of the proposed SSC site, reference should be made to Section 5.7.1.2.

Although little paleontological research has been completed in the vicinity, nearby Pleistocene and Cretaceous deposits are documented as fossiliferous (Slaughter and Thurmond 1965). Quaternary alluvium and terrace deposits have produced mammoth and an assortment of molluscan fauna. The Cretaceous Austin chalk has produced numerous teleast and elasmobranch fish as well as a specimen of marine reptile.

B. Known Paleontological Localities

A 1964 survey of Lake Bardwell (Slaughter and Thurmond 1965) is the only systematic paleontological survey conducted in Ellis County. Other paleontological sites that have been identified have resulted from chance encounters during, for example, gravel and quarry operations. Two Ellis County finds, cataloged in the collection of the University of Texas, Department of Vertbebrate Paleontology, including a bison ankle bone and a mammoth wrist bone located along Pleistocene stream terraces of tributaries of the Trinity River.

The Shuler Museum of Paleontology, Southern Methodist University, has recorded a number of Ellis County localities from which fossil shark teeth were obtained from the Cretaceous Austin chalk/Taylor marl. The Shuler collection also contains a skeleton of the Cretaceous fish Pachyrhizodus from the Midlothian limestone (Austin chalk/Eagle Ford group contact).

The systematic paleontological survey in Ellis County was conducted in 1964 by the Shuler Museum before the building of Lake Bardwell by the Army Corps of Engineers (Slaughter and Thurmond 1965). The objectives of the survey were to map Quaternary deposits of Waxahachie Creek and to prospect natural terrace exposures for recovery of Cretaceous and Quaternary vertebrate and molluscan fossils. From bedrock deposits, researchers recovered the lower jaw of a marine reptile (mosasaur), two species of teolost fishes, and seven species of elasmobranch fishes. The presence of the pelecypods was noted. Floodplain terraces were also examined along Big Mustang Creek. These Pleistocene sediments produced numerous molluscan species. Only fragmentary identifiable vertebrate fossils were found, including a fragment of a leopard frog mandible and a mammoth tooth.

C. Characterization of Geological Strata and Paleontological Potential

It could be expected that paleontological resources are present in Ellis County formations of the Pleistocene and recent epochs, particularly along stream terraces. The likelihood of significant land-dwelling or marine vertebrate paleontological finds in the older Austin chalk and Taylor marl (Cretaceous) is not very great. It is more likely that scattered Cretaceous marine creatures (molluscs, clams, shark teeth, fishes) would be encountered (State of Texas 1988).

5.7.13 Scenic and Visual Resources

5.7.13.1 Visual Character of the Region

The proposed SSC site is located in the Western Gulf Coast section of the Coastal Plain physiographic province (Fenneman 1931), an area typically low in topographic relief, with altitudes generally less than 500 ft. Flat to rolling lands are broken by several low, west-facing escarpments. Less than 80 mi to the west and southwest, respectively, lie the Osage Plains section of the central lowlands and the central Texas sections of the high plains. These areas and the Western Gulf Coast section are similar in being nearly featureless, topographically. The nearest area of any significant relief is the Ouachita Province 150 mi to the northeast. This region is a lowland surmounted by long, narrow, even-topped mountain ridges.

The region includes parts of Louisiana, Arkansas, the southern margin of Oklahoma, and much of Texas. Native vegetation varies from broadleaf deciduous forests, grading to mixed deciduous needleleaf evergreen forests along the eastern edge of the region, to grasslands along the coast and prairies to the west. Today, grasslands are dominated by croplands and pasture, and trees are mostly confined to the valleys along drainages.

The region is along the western margin of a broad area of the United States characterized by a humid-subtropical climate (White 1979). Conditions get progressively more arid to the west and southwest, reflected in the distribution of vegetation noted. There are a great many lakes and reservoirs in the central, northern, and eastern portions of the region, with several major rivers, including the Sabine and the Trinity rivers.

There are four major population centers in the region, these being Dallas Fort Worth, Houston, Austin, and San Antonio. However, the region is generally a lightly populated agricultural area.

5.7.13.2 Visual Character of the Site

A. Topography

As is the case generally with the region, topography is gently rolling to nearly flat, and is essentially featureless. The site slopes to the southeast, elevations within the collider ring ranging from just over 800 ft near the northwest quadrant, to 360 ft where Waxahachie and Onion creeks cross the southeast quadrant. Local relief on the flatter portions of the prairie is slight, generally 40 to 50 ft across 1 to 2 mi. However, along Waxahachie Creek, the streambed is 80 to 120 ft below the adjacent prairie surface. Along the northwest quadrant near this stream, the terrain is noticeably dissected and hilly. The White Rock escarpment west of the site, rising to 840 ft, is the only locally prominent feature in the surrounding prairies.

B. Vegetation

Pastures and croplands dominate nearly all of the lands enclosed by the collider ring, extensive flat to rolling fields being broken with occasional woodlots, small parks, and riparian areas. The lands along Waxahachie Creek in the vicinity of the northwestern quadrant, and along the White Rock escarpment, are distinguished by heavily wooded hills and valleys, along with pastures and croplands. Creek bottoms along the western portion of the site present red oak, pecan, green ash, American elm, and eastern red cedar. Along the east side, creek bottoms support mesquite, sugarberry, cedar, and elm.

C. Water Features

The main drainages in the area are Waxahachie, Big Onion, Chambers, and Red Oak creeks. Waxahachie, Mustang (tributary to Waxahachie Creek), and Red Oak creeks all have reaches with water flowing all or most of the year. However, most of the area creeks and streams are intermittent or ephemeral. None are visible unless viewed close-up. The principal lakes in the area are Lake Waxahachie and Lake Bardwell. Both are man-made, serving for flood control, water supply, and recreation.

D. Cultural Modifications

The site vicinity is best described as agricultural in character. The proposed site encloses land that primarily is extensively flat to rolling pastures and croplands, with occasional woodlots and fencerows. Sparsely distributed farm houses and rural residences are common beyond the outskirts of the several small communities in and around the collider ring. All but one of the proposed SSC facilities not in fee simple areas would be in rural/agricultural lands. Subdivisions occur only along the northern part of the collider ring, specifically near F3.

E. Viewshed Definition

Within the collider ring, views tend to be distant, not being defined by the flat to rolling topography so much as by woodlots, fencerows, and riparian vegetation. Because of the expanse of cultivated fields and pastures, the tree-lined skyline appears distant and low in profile. Occasionally the horizon is nothing more than the subtle swell of pastures or fields. In sum, the landscape is best described as horizontal, unenclosed, and panoramic. Except within communities or near areas of commercial and industrial development, vertical relief is afforded only by occasional woodlands and agricultural structures. Views tend to be enclosed along the western part of the collider ring near major drainages. Riparian vegetation and topographic relief is more pronounced here; views are characteristically confined to the foreground.

5.7.13.3 Sensitivity

A. Travel Routes

There are three major transportation routes in the site vicinity: Interstate Highway 35E, Interstate Highway 45, and U.S. Route 287. The first passes north-south through Waxahachie in the center of the ring. Interstate 45 passes to the east of the proposed site area. U.S. Route 287 crosses the middle of the site northwest-southeast. Secondary transportation routes are the many county roads.

Visual sensitivity in the project vicinity relative to road-based views is generally low. There are no formally designated scenic highways or roads near the site. About 30 mi to the south of Waxahachie, there are several routes shown on state road maps as being scenic (informal designation): State Highway 171 from Covington to Hubbard; State Highway 31 from Hubbard to Trinity River; and Routes 67 and 933 near Lake Whitney (H.M. Gousha Co. Texas road map). Although some of the public may be highly sensitive to impacts on views from these routes, the project would not be visible from these roads.

Segments of roads near to and serving subdivisions, primarily serving other destinations are considered moderately sensitive. One subdivision is near the proposed site for F3. In addition, State Highway 34 crosses Lake Bardwell, which is considered to be highly sensitive because of the recreation facilities there. The stretch crossing the lake would be considered moderately sensitive because it is a primary access route to the lake; it would be within two miles of facilty F6.

B. Public Use Areas

Apart from Lake Bardwell, there are no designated areas of aesthetic, recreational, cultural, or scientific significance from which project facilities would be visible. Lake Bardwell is within 2,000 ft of F6 and the impact on views in the direction of this facility need to be considered. This lake has 25 mi of shoreline, five boat launches, and six public parks, two of which have camp sites. The recreation opportunities at Lake Bardwell are probably regionally important, being relatively close to Waxahachie. Other lakes are comparatively distant. Most in the region are north of Dallas and Fort Worth. In the opposing direction, Lake Whitney is about 37 mi to the southwest (six recreation areas with campsites) and Navarro Mills Lake is about 30 mi to the south (three recreation areas with campsites).

The balance of public use areas considered sensitive include one subdivision, several rural residential areas, and a church and cemetery noted above. Facility F3 is proposed to be sited adjacent to several residences that would be acquired in fee simple estate. However, there is a subdivision 2,000 ft to the north, and views from there would include this structure. Facilities E4, F4, and K5 would be within 0.25 to 0.50 mi of rural residential areas. Facility E10 is 1,000 ft from the cemetery and church noted, and the facility access road would be near the cemetery.

Laws, Plans, Policies, and Regulations

There are no laws, plans, policies, or regulations that indicate a sensitivity for scenic or visual resource protection in the site vicinity.

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