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DRAFT
ENVIRONMENTAL IMPACT STATEMENT

SUPERCONDUCTING SUPER COLLIDER

Volume IV
Appendix 5b

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VOLUME IV

APPENDIX 5B

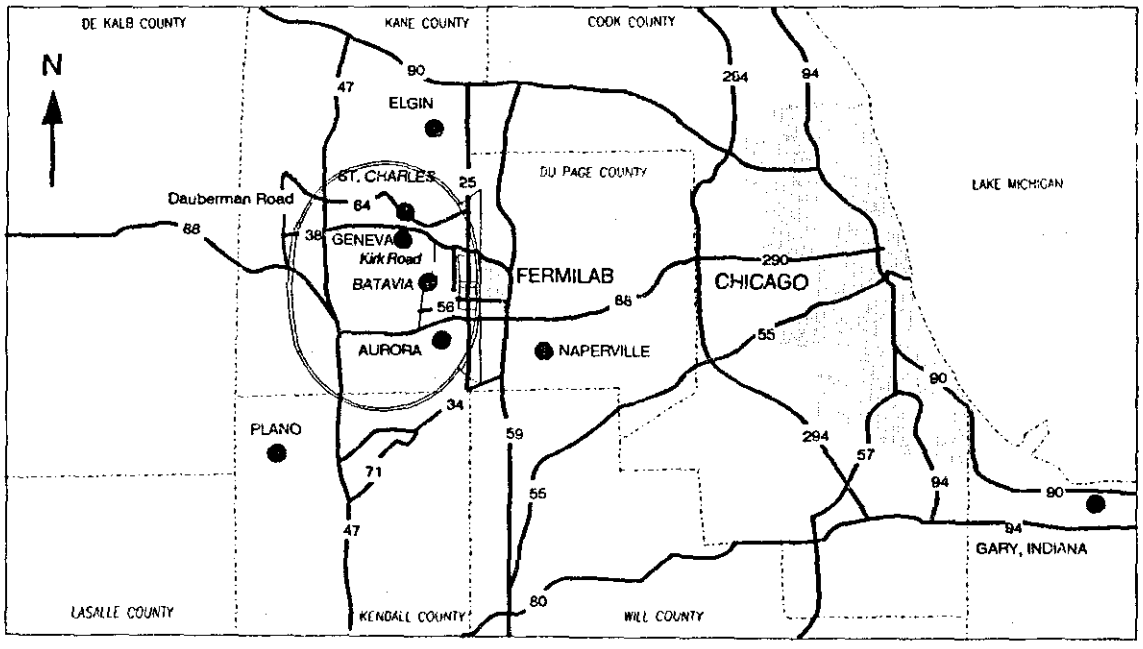
AFFECTED ENVIRONMENTS
AT ALTERNATIVE SITES

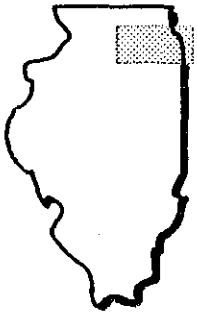
5.3 ILLINOIS

5.4 MICHIGAN

Affected Environments at Site Alternatives

I L L I N O I S





Illinois - **The proposed site is located approximately 40 miles west of Chicago in the northeastern portion of Illinois and includes portions of Kane, DuPage, and Kendall Counties. The entire tunnel would be constructed by tunneling techniques in dolomite below the water table.**

CONTENTS

			Page
5.3	**ILLINOIS**		1
	5.3.1	**Earth Resources**	1
	5.3.1.1	Physiography and Topography	1
	5.3.1.2	Stratigraphy	1
	5.3.1.3	Geologic Structure	9
	5.3.1.4	Geoengineering Conditions	13
	5.3.1.5	Geologic Hazards	16
	5.3.1.6	Economic Geologic Resources	17
	5.3.2	**Water Resources**	21
	5.3.2.1	Surface Water Hydrology, Quality, and Use	21
	5.3.2.2	Groundwater Hydrology, Quality, and Use	31
	5.3.3	**Climate and Meteorology**	40
	5.3.3.1	General Description	40
	5.3.3.2	Temperature	40
	5.3.3.3	Precipitation	40
	5.3.3.4	Wind	43
	5.3.3.5	Humidity	43
	5.3.3.6	Severe Weather	43
	5.3.4	**Air Quality**	47
	5.3.4.1	Conditions Affecting Air Quality	47
	5.3.4.2	Air Quality	50
	5.3.4.3	Regional Air Pollution Sources	50
	5.3.5	**Noise and Vibration**	53
	5.3.5.1	Ambient Noise Levels	53
	5.3.5.2	Other Noise Sources	53
	5.3.5.3	Ambient Vibration Levels	58
	5.3.5.4	Other Vibration Sources	58
	5.3.6	**Environmental Radiation**	62
	5.3.6.1	Natural Radioactivity	62

CONTENTS (Cont)

		Page
5.3.6.2	Man-Made Radiation	67
5.3.6.3	Background Radiation	71
5.3.7	**Nonradioactive Environmental Hazards**	72
5.3.7.1	Hazardous/Toxic Materials	72
5.3.7.2	Biological Hazards	72
5.3.8	**Existing Waste Management Facilities**	74
5.3.8.1	Sewage Facilities	74
5.3.8.2	Solid Waste Facilities	76
5.3.8.3	Hazardous Waste Disposal Facilities	78
5.3.8.4	Low-Level Radioactive/Mixed Waste Disposal Facilities	78
5.3.9	**Ecological Resources**	80
5.3.9.1	Regional Ecological Resources	80
5.3.9.2	Terrestrial Ecosystem Characteristics	82
5.3.9.3	Aquatic Ecosystems	92
5.3.9.4	Economically, Recreationally, and Culturally Important Species	92
5.3.9.5	Threatened and Endangered Species	97
5.3.9.6	Unique Ecosystems and Communities Potentially Affected	97
5.3.10	**Land Resources**	103
5.3.10.1	Regional Setting	103
5.3.10.2	Local Setting	110
5.3.10.3	Soil and Prime Farmland Resources	121
5.3.11	**Socioeconomics and Infrastructure**	125
5.3.11.1	Socioeconomics	125
5.3.11.2	Infrastructure	149

CONTENTS (Cont)

		Page
5.3.12	Cultural and Paleontological Resources	163
	5.3.12.1 Cultural Resources	163
	5.3.12.2 Paleontological Resources	170
5.3.13	Scenic and Visual Resources	174
	5.3.13.1 Visual Character of the Region	174
	5.3.13.2 Visual Character of the Site	174
	5.3.13.3 Sensitivity	176
REFERENCES		178

TABLES

		Page
5.3.1-1	Lithologic Descriptions	4
5.3.1-2	Summary of Fault Characteristics	13
5.3.1-3	Geotechnical Properties of Overburden Soils	14
5.3.1-4	Geotechnical Characteristics - Rock	15
5.3.2-1	Channel and Floodplain Characteristics at the Collider Ring	24
5.3.2-2	Gauge Data in Project Vicinity	26
5.3.2-3	Surface Water Quality Data in Project Vicinity	28
5.3.2-4	Summary Description of Hydrogeologic Units, DuPage and Kane Counties, Illinois	32
5.3.2-5	Approximate Range of Groundwater Quality in Kane and DuPage Counties, Illinois	36
5.3.2-6	Recent and Projected Groundwater Use in Kane County and the Western Portion of DuPage County, Illinois	38

TABLES (Cont)

		Page
5.3.3-1	Normal and Extreme Temperature Data	41
5.3.3-2	Mean Precipitation and Snowfall Data for the Northeast Illinois Climatic Region	42
5.3.3-3	Maximum 1-Hour and 6-Hour Rainfall by Return Period	43
5.3.3-4	Monthly Average Wind Speed and Direction	44
5.3.3-5	Dewpoint and Relative Humidity Data	45
5.3.3-6	Extreme Wind Speed and Return Period Data	46
5.3.4-1	Frequency of Occurrence of Atmospheric Stability Classes	47
5.3.4-2	Annual Frequency of Wind Speed and Direction Illinois SSC Site	48
5.3.4-3	Ambient Air Pollutant Allowable Concentrations and Background Levels	49
5.3.4-4	Regional Air Pollution Sources - Illinois SSC Site	51
5.3.5-1	Allowable Daytime Octave Band Sound Pressure Levels (dB) of Sound Emitted to Any Receiving Class A Land from Class A, B, or C Land	54
5.3.5-2	Allowable Nighttime Octave Band Sound Pressure Levels (dB) of Sound Emitted to Any Receiving Class A Land from Class A, B, or C Land	55
5.3.5-3	Allowable Nighttime Octave Band Sound Pressure Levels (dB) of Sound Emitted to Any Receiving Class B Land from Class A, B, or C Land	56
5.3.5-4	Regional Vibrations, Roads and BN Railroad - Illinois SSC Site	61
5.3.6-1	Radon Levels	63

TABLES (Cont)

		Page
5.3.6-2	Mean Concentrations of Potassium, Uranium, and Thorium in Major Bedrock Units in the Proposed SSC Siting Area	65
5.3.6-3	Concentrations of Radon-222 and Uranium-238/234 in Groundwater from Various Wells	66
5.3.6-4	Radiation Dose Equivalent to the General Public as a Result of the Fermilab Activities	69
5.3.6-5	Summary of Radioactivity Released to the Environment from Fermilab	70
5.3.8-1	Existing Sewage Treatment Plants	74
5.3.8-2	Existing Landfills in Cook, Kane, Kankakee, Livingstone, and Ogle Counties	76
5.3.8-3	Hazardous Waste Storage, Treatment, and Disposal Facilities Permitted by the Illinois EPA in Northeastern Illinois	79
5.3.9-1	Dominant Woodland Species in the Proposed Illinois SSC Site	84
5.3.9-2	Remnant Prairie Dominant Species in the Proposed Illinois SSC Site	85
5.3.9-3	Agricultural Production at Proposed Illinois SSC Site	86
5.3.9-4	Reptiles and Amphibians Common to the Proposed Illinois SSC Site	88
5.3.9-5	Livestock Production Trends at the SSC Site	89
5.3.9-6	Common Mammals in the Proposed Illinois SSC Site	90
5.3.9-7	Birds of the Proposed Illinois SSC Site by Their Season(s) of Residence	91
5.3.9-8	Common Fish in the Proposed Illinois SSC Site	93
5.3.9-9	Game Birds Common of the SSC Site	95

TABLES (Cont)

		Page
5.^.9-10	Sports and Commercial Fish Species - Illinois SSC Site	96
5.3.9-11	Migratory Freshwater Fish in the Proposed Illinois SSC Site	96
5.3.9-12	Federally Listed or Candidate Threatened and Endangered Species Potentially at the Proposed Illinois SSC Site	98
5.3.9-13	Illinois State Listed Threatened and Endangered Species in DuPage, Kane, and Kendall Counties	99
5.3.10-1	Land Use Data - Illinois SSC Site	111
5.3.10-2	Soil Subgroups and Series with Corresponding Acreages	123
5.3.10-3	Acreages per Capability Subclasses and Main Limitations at the Illinois SSC Site	124b
5.3.11-1	Historic Economic Indicators for the Illinois ROI, and DuPage, Kane, and Kendall Counties	127
5.3.11-2	Key Demographic Indicators for the Illinois ROI	133
5.3.11-3	Levels of Public Service for the Illinois SSC Site	137
5.3.11-4	Illinois State General Revenue and Expenditure - 1986	140
5.3.11-5	DuPage County, Illinois - County Revenue by Source and Total Expenditure - 1986	143
5.3.11-6	Kane County Illinois - County Revenue by Source and Total Expenditure - 1986	144
5.3.11-7	Aurora (Kane County), Illinois - City Revenues by Source and Total Expenditure - 1986	146
5.3.11-8	Kaneville Township (Kane County), Illinois - Township Revenues by Source and Total Expenditure - 1986	147

TABLES (Cont)

		Page
5.3.11-9	Kendall County, Illinois - County Revenues by Source and Total Expenditures - 1986	148
5.3.11-10	Present Highways and Roads Serving the Proposed Illinois SSC Site	151
5.3.11-11	Commonwealth Edison Generating Plants and Primary Energy Sources in Service	160
5.3.12-1	Recorded Archeological Sites in the Proposed Illinois SSC Site	167
5.3.12-2	Pre-World War II Standing Structures in the Proposed Illinois SSC Site	169
5.3.12-3	Recorded Fossil Localities in the Vicinity of the Proposed Illinois SSC Site	172

FIGURES

		Page
5.3.1-1	Topographic Setting of Illinois Site	2
5.3.1-2	Stratigraphic Column of Bedrock and Overlying Glacial Sediments at the Illinois Site.	3
5.3.1-3	Bedrock Geology	10
5.3.1-4	Surface Distribution of Glacial Materials Over the Area Surrounding the Proposed Site	11
5.3.1-5	Cross Section Along the Proposed Ring	12
5.3.1-6	Mines and Prospects in the Proposed Site	18
5.3.2-1	Major Watershed in Illinois	22
5.3.2-2	Hydrologic Features - Illinois Site	23

FIGURES (Cont)

		Page
5.3.4-1	Ambient Air Quality Monitoring Stations and Regional Air Pollution Sources - Illinois SSC Site	52
5.3.5-1	Sensitive Noise Receptors - Illinois SSC Site	57
5.3.5-2	Regional Vibration Sources - Illinois SSC Site	60
5.3.7-1	Locations of TSD Facilities and Potential Chemical Releases	73
5.3.8-1	Approximate Locations of the Existing Wastewater Sewage Treatment Plants Near the Illinois SSC Region	75
5.3.8-2	Approximate Locations of existing Solid Waste Facilities in the Illinois SSC Region	77
5.3.9-1	River Basins of Illinois Site Vicinity	81
5.3.9-2	Vegetation Map for the Proposed Illinois Site	83
5.3.9-3	Locations of Wetlands in the Proposed Illinois SSC Site	87
5.3.10-1	The Proposed Illinois SSC Site Region	111
5.3.11-1	Counties for Socioeconomic Analyses in the Illinois ROI	126
5.3.11-2	Distribution of Employment in the Major Industrial Sectors in the Illinois ROI	128
5.3.11-3	Roads and Airports Serving the Illinois Site	150
5.3.11-4	Railroads and Waterways Serving the Illinois SSC Site	156
5.3.11-5	Commonwealth Edison Company System Interconnections	158

5.3 ILLINOIS

5.3.1 Earth Resources

5.3.1.1 Physiography and Topography

The proposed Illinois site is located in a transitional area between the eastern lake and till plain sections of the interior lowlands physiographic province (Fenneman 1938). The eastern lake section, to the northeast, is a lowland with hummocky or linear glacial moraines (Lineback 1979), lacustrine plains, and frequent lakes. The till plain section, to the west and south, is also a lowland area and is dominated by young, broadly rolling till plains, with little morainic topography and no lakes.

Elevations in the site vicinity range from 600 ft along the Fox River at the southern edge of the collider ring (U.S.G.S. 1973), to 970 ft atop a morainal ridge that crosses the northwestern edge of the ring (U.S.G.S. 1980b). Over much of the area, the rolling to hummocky topography has low relief, 30 to 60 ft (U.S.G.S. 1972b, 1973, 1975a and b, 1980c), although locally, morainal ridges may reach 200 to 220 ft in height (U.S.G.S. 1971, 1972a and b, 1980a, b, and c).

The topographic setting of the Illinois site is shown in Figure 5.3.1-1. The drainage pattern in the site area is controlled by the glacially-produced land forms, with streams flowing around and between moraines and along glacial outwash channels in a glacially-deformed dendritic pattern. Site-vicinity drainage is dominated by the Fox River and two of its tributaries, Mill Creek and Blackberry Creek. The tributary creeks, like most creeks in the area are only slightly incised, 5 to 10 ft, into the rolling surface (U.S.G.S. 1972a and b, 1973, 1980b). However, the Fox River, following a major glacial outwash channel (Lineback 1979), meanders within a flat floodplain that lies 50 ft below the adjacent rolling surface. (U.S.G.S. 1972b, 1973, 1980c and d).

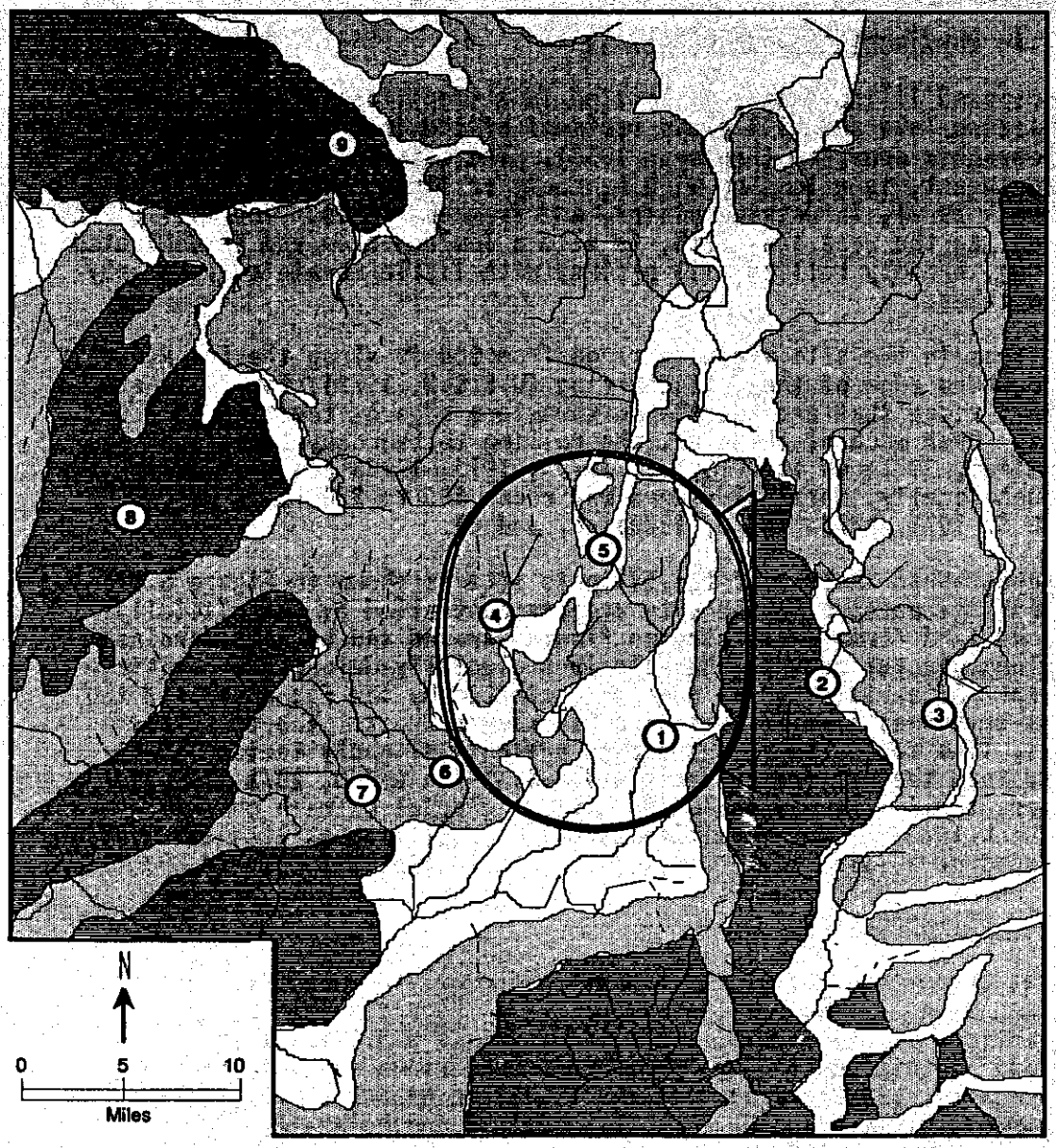
5.3.1.2 Stratigraphy

A stratigraphic column of the bedrock and overlying glacial sediments in and around the Illinois site is depicted in Figure 5.3.1-2. Lithologic descriptions of these units are given in Table 5.3.1-1. Information provided in this section was obtained from various sources including Graese et al. (1988), Hansel et al. (1986), Lineback (1979), Willman et al. (1975), Willman and Frye (1970), Willman and Kolata (1978), and Kolata and Graese (1983). The time scale used to approximate the ages of the rock units is the "Decade of the North American Geology 1983 Geologic Time Scale" (Palmer 1983).

The bedrock of Illinois is almost completely covered by glacial drift. Drift deposits consist chiefly of till, outwash, loess, and lacustrine sediments. Uppermost bedrock units in the site area are Silurian (421- to 438-million-yr-old) dolomites, which overlie the Ordovician (438- to 468-million-year-old) dolomites and shales of the Maquoketa and Galena

Figure 5.3.1-1

TOPOGRAPHIC SETTING OF ILLINOIS SITE



Glacial morraine with elevated hummocky topography

Ground morraine area of low relief

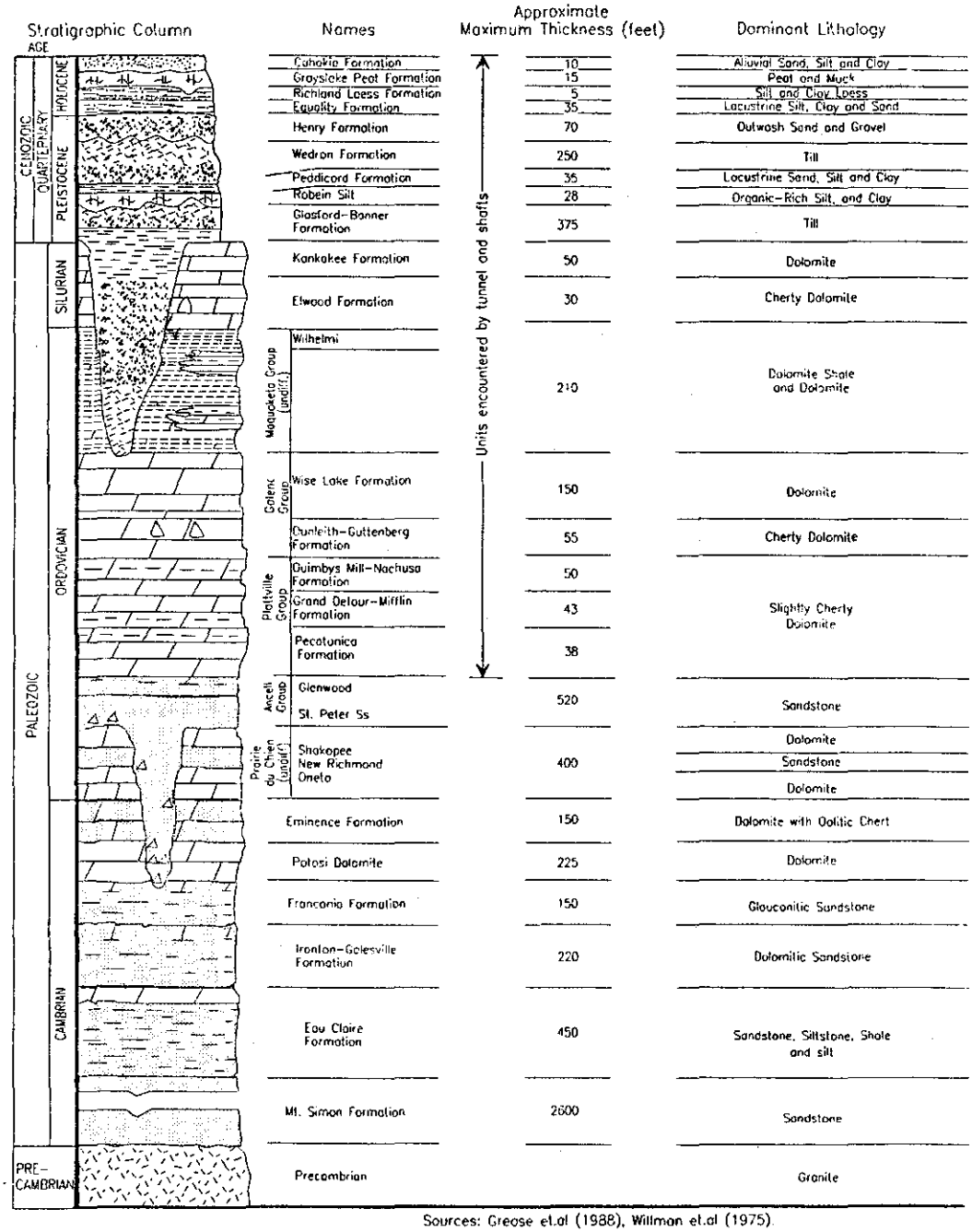
Glacial outwash channels

Stream intermittent flow where dashed

Streams
1. Fox River
2. West Branch Dupage River
3. East Branch Dupage River
4. Blackbery Creek
5. Mill Creek
6. Big Rock Creek
7. Little Rock Creek
8. Kishwaukee River South Branch
9. Coon Creek

Figure 5.3.1-2

STRATIGRAPHIC COLUMN OF BEDROCK AND OVERLYING GLACIAL SEDIMENTS AT THE ILLINOIS SITE



Sources: Grease et.al (1988), Willman et.al (1975).

Table 5.3.1-1

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Cahokia Alluvium	Silt loam to silty clay loam, to poorly sorted sand, silt or clay, with discontinuous sand and gravel lenses, deposited in modern floodplains and stream and river channels.	
Grayslake Peat Formation	Dominantly organic deposits (peat, sandy and silty peat, muck, and marl) interbedded locally with silt and clay.	Occurs principally as a filling of ponds and poorly drained areas.
Richland Loess Formation	Massive tan silt, locally calcareous and fossiliferous.	Equivalent to the upper Peoria loess. Mantles over much of the site area are characterized by gentle slopes.
Equality Formation	Fine-grained silt and clay with minor sand from a deep-water lacustrine environment, and coarser grained sand, pebbly sand, and local gravel, with minor beds of silt and clay, representing lacustrine beaches, bars, spits, and deltas.	Typically overlies sand and gravel.
Henry Gravel	Glacial outwash of sand with local, thin beds of silt. May vary from thin, well-sorted, sandy, sheetlike deposits to poorly sorted silt, sand, and gravel.	Extensive deposits formation located in eastern and southern portions of site area.

Table 5.3.1-1 (Cont)

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Wedron Formation	Thick sequence of chiefly till with interbedded outwash sand and gravel and lacustrine silt and clay. Subdivided into five distinct members of varying degrees of heterogeneity. General constituents include loam to clay loam, discontinuous to thick layers of gravel, sand, clay, and silt, and thick sequences of bouldery and cobbly sand and gravel.	The individual members of the Wedron cover most of the site area.
Robein Silt Formation	Brown, gray, dark gray to black, leached silt, with abundant organic material. Silt is locally derived and deposited by sheetwash. Contains some loess.	Considered a likely source of methane in drift gas
Peddicord Formation	Gray and pinkish tan, calcareous, lacustrine silts.	Overlain by the Robein silt or Wedron formation.
Kankakee Formation	Greenish to pinkish gray, fine- to medium-grained, slightly cherty, glauconitic dolomite, commonly in thin beds separated by green clay.	Missing or partly eroded in large portions of the site area.
Elwood Formation	Slightly argillaceous, massive light brownish gray, fine-grained dolomite with nodules and layers of dense, white chert in upper portions of unit.	

Table 5.3.1-1 (Cont)

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Maquoketa Group	Interbedded shale, dolomite, and limestone. Upper portion of unit is typically oxidized (slightly weathered). The shales, which are dominant in the basal portions of the unit, are dolomitic (hard) to friable, olive gray to dark greenish gray and silty. The carbonates are dominantly dolomitic, fossiliferous, medium-bedded, fine- to coarse-grained, and pure to argillaceous. The dolomite beds also contain some silty laminae and pyrite, and are locally calcitic, and vuggy and porous.	Lithologies are highly variable laterally within the site area.
Galena Group	Divided into the following three formations in the site area:	
Wise Lake Formation	Relatively pure, light brown, medium- to thick-bedded, stylolitic and slightly vuggy dolomite. Beds separated by wispy, slightly argillaceous partings and contain some secondary pyrite. Grades laterally to a very fine- to coarse-grained limestone.	Slightly oil stained in upper parts; upper most unit potentially encountered in tunnel.
Dunleith Formation	Medium-grained, vuggy (more than Wise Lake), thick-bedded dolomite. Relatively pure except for upper 5 - 10 ft which are cherty, and for thin slightly clayey laminae between beds.	

Table 5.3.1-1 (Cont)

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Guttenberg Formation	Medium-grained, vuggy, pure dolomite beds separated by reddish brown silty laminae.	Sometimes absent in the site area. Otherwise, about 2 ft thick beneath Dunleith.
Platteville Group	Divided into the following three general formational groupings:	
Quimbys Mill-Nachusa Formation	Fine- to medium-grained, light tan, dense to locally vuggy, variably cherty, pure to argillaceous, dolomite with well-defined beds separated by thin shalely calcareous partings.	
Grand Detour-Mifflin Formation	Gray to light tan, predominantly fine-grained dolomite, in moderately thin and wavy beds separated by green to dark gray calcareous shale partings.	
Pecatonica Formation	Brown, fine- to medium-grained, relatively pure, medium-bedded dolomite. Locally cherty and either dense or finely vesicular.	
Ancell Group		
Glenwood Formation	Poorly sorted sandstone with interbedded shale and silty dolomite. Highly variable in composition.	Lowest formation potentially encountered in experimental hall. Regional aquifer.
St. Peter Sandstone	Fine- to medium-grained, white, friable sandstone.	
Prairie du Chien Group	Cherty dolomite with some interbedded sandstone.	

Table 5.3.1-1 (Cont)

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Eminence Formation	Light gray to pink or brown, fine- to medium-grained, sandy dolomite with oolitic chert and thin beds of sandstone.	
Potosi Dolomite	Pure to slightly argillaceous, brown to pinkish gray, finely crystalline dolomite.	
Franconia Formation	Glauconitic, argillaceous sandstone and dolomite.	
Ironton-Galesville Formation	Poorly sorted, fossiliferous sandstone overlying clean, unfossiliferous sandstone.	
Eau Claire Formation	Dolomite, dolomitic sandstone, siltstone, and shale.	
Mt. Simon Formation	Coarse-grained, partly conglomeratic sandstone.	Basal bedrock aquifer

Sources: Graese et al. 1988; Hansel et al. 1986; Lineback 1979; Quaternary Formations - Glasford-Banner through Cahokia; Willman et al. 1975; Willman and Frye 1970; Willman and Kolata 1978; and Kolata and Graese 1983.

groups. The underlying portion of the Paleozoic (225- to 570-million-yr-old) column consists of dolomites and sandstones, the lowermost of which is a regional basal aquifer overlying Precambrian (greater than 570-million-yr-old) granite.

5.3.1.3 Geologic Structure

The proposed Illinois site has various types of glacial drift deposits which overlie fairly uniform, nearly flat-lying Paleozoic bedrock. The bedrock was deformed by movement and associated uplift along the Sandwich Fault zone southwest of the site, during Paleozoic time. In general, the bedrock units dip between 10 and 15 ft/mi to the southeast; dips may increase locally along some minor folds (Graese et al. 1988). The bedrock geology is shown in Figure 5.3.1-3. The surface distribution of glacial materials over the area surrounding the proposed site in Illinois is shown in Figure 5.3.1-4.

A cross section along the proposed ring is presented in Figure 5.3.1-5. Erosion and glaciation in Quaternary time resulted in deposition of a layer of glacial material over an eroded bedrock surface, burying valleys and stream channels.

Known fault characteristics in the vicinity of the Illinois site are summarized in Table 5.3.1-2. The Sandwich Fault Zone, 6 mi southwest of the site, is described as a narrow belt of high-angle faults (Kolata et al. 1978). The fault zone trends N50-60W and extends about 85 mi across Will, Kendall, DeKalb, and Ogle counties. Maximum cumulative displacement along the zone is estimated at about 800 ft (Kolata et al. 1978). The Sandwich Fault offsets units as Young as Silurian, but does not offset overlying glacial deposits.

High-resolution seismic surveys performed along the northern half of Dauberman Road on the western portion of the ring indicate the possibility of two minor vertical faults with up to 13 ft of displacement (Vaiden 1988). A subsequent survey south of the first two indicates normal faulting resulting in about 35 ft of displacement within the Galena-Platteville Group (Walker 1988).

With the exception of the Oswego syncline just south of the area in Northern Kendall County and the Aurora syncline in southeastern Kane County, no other structural features have been identified in the area (Graese et al. 1988).

Joints and fractures have been noted in the various bedrock units. In general, the joints are rough, wavy, nonweathered, tight, and sound; they infrequently contain clay filling (Curry et al. 1988). The primary joint sets are oriented at N47E and N50W, with dips of 70° or greater observed in 84% of the joints encountered (Graese et al. 1988). Joint spacing for the three major formations in the study area are 20 to 25 ft for the Silurian rocks, and 8 ft in the Maquoketa units; joint spacings in the Galena range from 2.3 to 2.6 ft for relatively discontinuous joints, and up to 100 ft for more continuous joints (Graese et al. 1988, Kempton et al. 1987a).

Figure 5.3.1-3

BEDROCK GEOLOGY

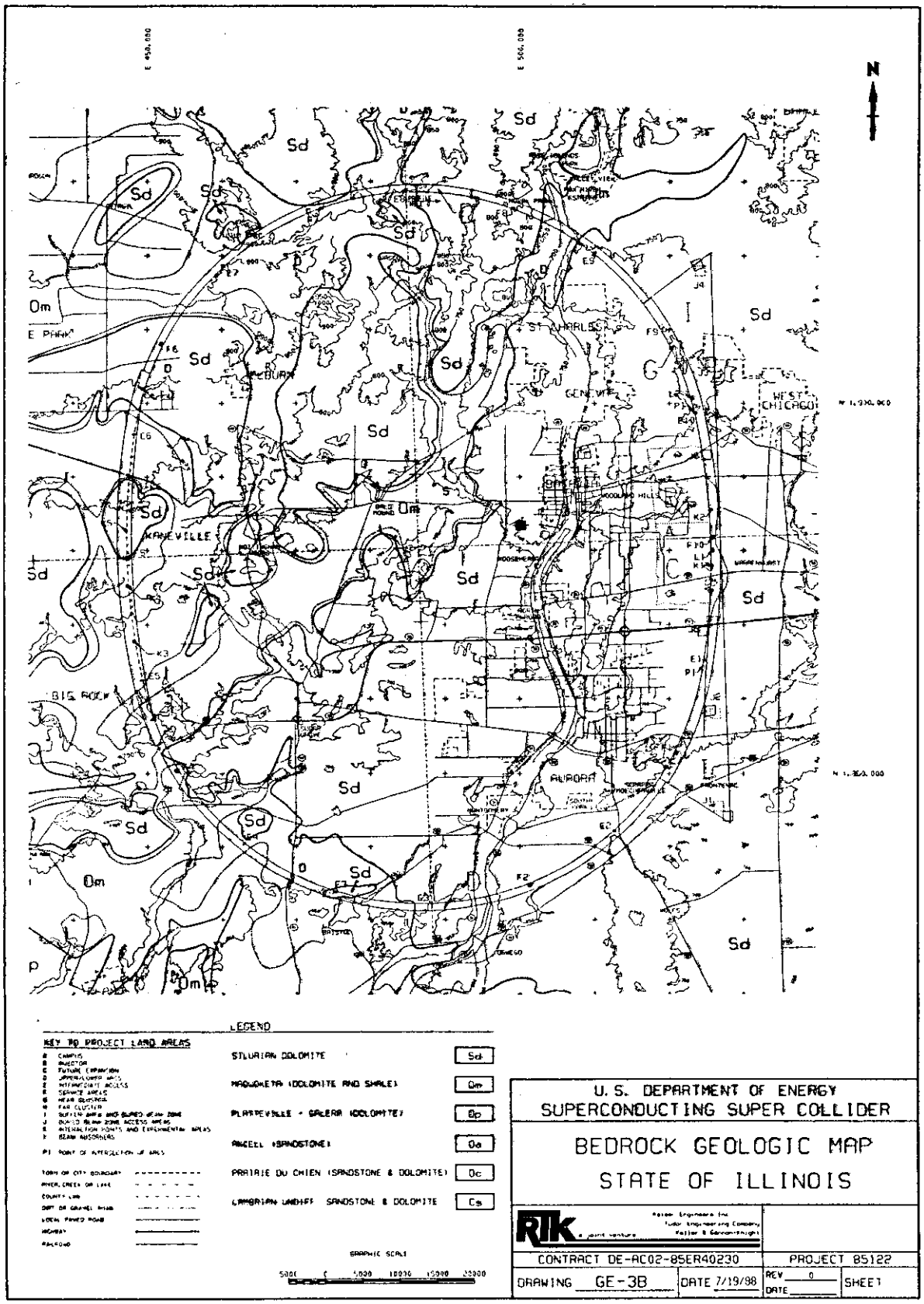
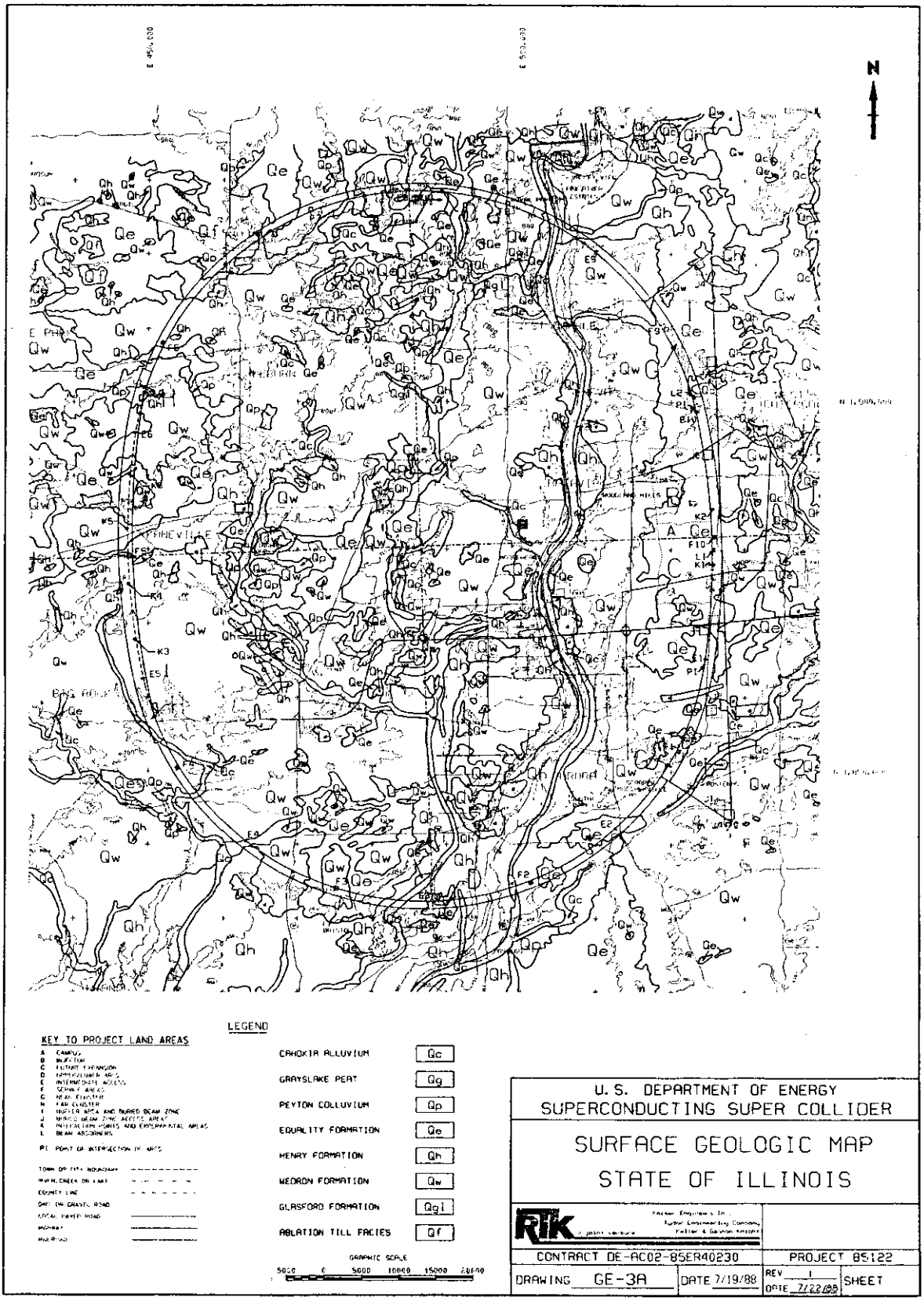


Figure 5.3.1-4

SURFACE DISTRIBUTION OF GLACIAL MATERIALS OVER THE AREA SURROUNDING THE PROPOSED SITE



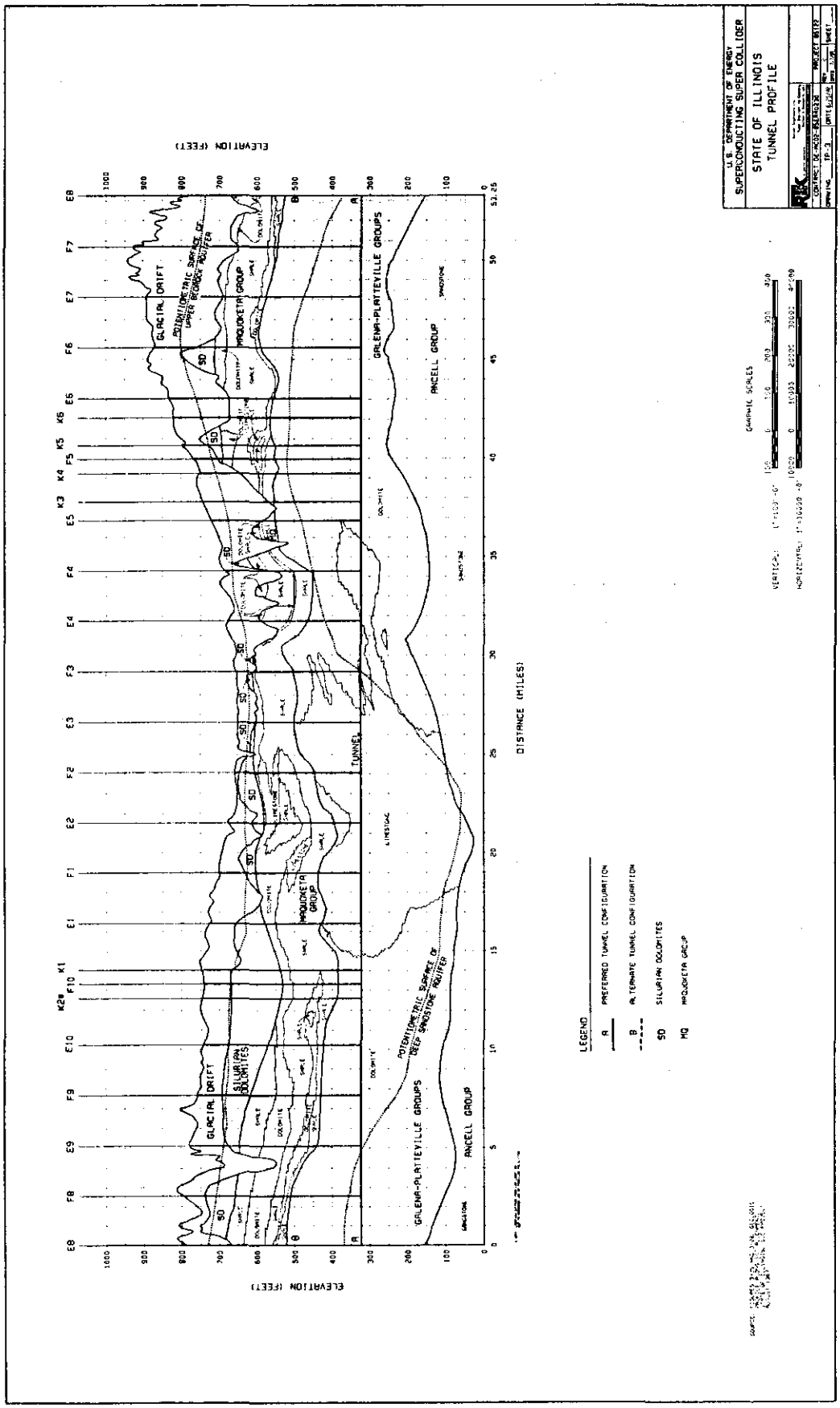


Figure 5.3.1-5

CROSS SECTION ALONG THE PROPOSED RING

Table 5.3.1-2

SUMMARY OF FAULT CHARACTERISTICS

Fault	Location	Strike	Dip	Thickness	Displacement/Age
Sandwich fault zone	6 mi SW	N50-60W	Steep	0.5-2 mi	Up to 800 ft/Late Paleozoic
Two minor offsets	Western Arc	--	--	---	13 ft/Pre-Pleistocene
Minor Arc	Western	--	--	---	35 ft/Pre-Pleistocene offset

5.3.1.4 Geoengineering Conditions

The geoengineering materials at the SSC site in Illinois include:

- o Glacial drift (soils)
  - Till
  - Outwash
  - Lacustrine deposits
  - Loess
  - Organic rich sediments
- o Dolomite
- o Limestone with very thin shale beds.

The overburden soils are glacial drift, including subunits of till, lacustrine, outwash, and loess deposits. Table 5.3.1-3 presents the geotechnical properties of these soils. The soils represented are mainly CH, CL, MH, and ML, with several occurrences of GW, SW, and SP based on the Unified Soil Classification System (USCS) designation. The rocks at the proposed Illinois site consist of dolomite and limestone with thin shale beds. Engineering properties of these rocks are presented in Table 5.3.1-4. The rock units at tunnel depth are those of the Galena-Platteville group, which are predominantly medium-bedded dolomites with thin beds of limestone and shale and locally dispersed chert nodules.

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

- o Soils overlying bedrock are mostly inorganic clays of low to high plasticity with local occurrences of largely unconsolidated gravelly, sandy, silty lean clays, and silty sand.

Table 5.3.1-3

GEOTECHNICAL PROPERTIES OF OVERBURDEN SOILS

Deposit	Soil Description USCS	Dry Density lb/ft^3	Moisture Content %	Liquid Limit Plasticity Index LL/PI	Unconfined Compressive Strength lb/ft^3
Till	CL, Rare SM	137 (136-172)	12	30/14 (12+48/1-29)	ND
Peat	OH and OL	52	112	ND	ND
Outwash	GW, SW, SP, Rare CL, ML	ND	17	ND	ND
Lacustrine deposits	CL, ML, SM, Rare CH, MH	125	8	ND	ND
Loess	MH and ML	94 (183-114)	24	41/22 (22-70/4-50)	ND
Buried organic-rich sediment	CH and CL, Rare MH, ML	ND	29	ND	ND

Notes: Data is presented as averages with range in parentheses.
ND = No data

USCS Soil Designations:

GW - Well-graded gravels, gravel-sand mixtures, little or no fines.
SW - Well-graded sands, gravelly sands, little or no fines.
SP - Poorly graded sands, gravelly sands, little or no fines.
SM - Silty sands, sand-silt mixtures.
ML - Low plasticity inorganic silt.
CL - Inorganic clays of low to medium plasticity.
OL - Organic silts and organic silt-clays of low plasticity.
MH - Elastic inorganic silts.
CH - Inorganic clays of high plasticity.
OH - Organiz clays of medium to high plasticity.

Source: Curry 1988; Kempton et al. 1987a,b

Table 5.3.1-4

GEOTECHNICAL CHARACTERISTICS - ROCK

Unit	Seismic Velocity Ratio*	Unconfined Compressive Strength lb/inch^2	Tensile Strength lb/inch^2	Young's Modulus psi x 10^6	Poisson's Ratio*	Bulk Density lb/ft^3	Triaxial Test* Friction Angle	Triaxial Test* Cohesion lb/inch^2	Tabor* Hardness	Total* Hardness
Silurian	0.725	16,065 (13,859-20,918)	1,159 (1,002-1,578)	7.13 (4.55-11.56)	0.28	ND	48°	1,640	-	-
Maquoketa shale	0.463	4,405 (3,480-6,737)	523 (401-727)	0.77 (0.49-1.12)	0.20	ND	32°	996	0.304	15.38
Dolomite	0.532	8,998 (4,955-10,083)	817 (579-1,314	3.13	0.22	ND	-	-	-	-
Galena Group										
Wise Lake Dolomite	0.765	10,034 (6,800-12,237)	841 (614-1,023)	5.62 (3.37-7.73)	0.28	ND	49°	1,555	0.897	30.74
Wise Lake	ND	16,148	1,089	11.72	ND	ND	53°	2,842	1.153	36.19
Dunleith	0.767	7,600 (6,406-11,267)	635 (207-1,125)	4.63 (1.56-8.08)	0.27	ND	42°	1,161	0.900	32.28
Platteville Dolomite	0.764	12,169 (10,045-14,798)	1,034 (835-1,205)	6.56 (2.76-8.49)	0.28	ND	53°	1,1884	0.841	37.20
Limestone	ND	22,775	1,411	6.30	ND	ND	53°	3,054	-	-

Notes: Data presented as averages, with range in parentheses.
ND = No data available.

* More than 10 samples tested; laboratory versus in-situ velocity squared.

Sources: Graese et al. 1988; Harza Engineering Company 1987.

- Good quality dolomite rocks with calcite and limestone and occasional veins of shale comprise much of the bedrock. The rocks frequently have vuggy porosity, because of casts of fossils.

- The deeper rocks are stylolitic. Stylolites are more common in parting surfaces than bedding.

- Shale, particularly that interbedded in the Maquoketa formation, has a tendancy to slake.

- Rock quality designation (RQD) at tunnel depth ranges from very good to excellent.

- The rocks have occasional near vertical and a few horizontal joints; some of these show signs of weathering and dissolution.

- Only traces of deleterious accessory minerals, such as pyrite, are found.

- Results of in-situ stress measurements indicate the presence of a highly anisotropic stress field with the horizontal stress greater than vertical (overburden) pressure (Haimson 1987).

- Unconfined compressive strength for shale averages 4,400 $lb/inch^2$; for dolomite 10,400 $lb/inch^2$; for limestone 19,460 psi. Youngxs modulus values range between 0.77×10^6 $lb/inch^2$ and 11.72×10^6 $lb/inch^2$.

- There is a potential for methane in the glacial drift.

5.3.1.5 Geologic Hazards

The proposed Illinois site is in the tectonically stable central area of the U.S. where seismicity is very low. The site is within Zone 1 of the Uniform Building Code seismic risk map (International Conference of Building Officials 1988); Zone 1 is characterized as having a potential for minor damage from earthquakes with modified Mercalli intensities up to V and VI. Hadley and Devine (1974) show 13 widely-scattered earthquakes within 100 mi of the SSC site between 1800 and 1972. Earthquakes nearest the site were a 1985 earthquake of modified Mercalli intensity III to IV, and a 1912 event of intensity V-VI about 10 and 15 mi from the site, respectively. The largest earthquake within 100 mi was a 1909 event of intensity VII. The great earthquakes that occurred in 1811 and 1812 near New Madrid, Missouri, over 400 mi from the site, generated shaking of intensities about V to VI in the SSC site area (Heigold 1972), i.e., similar to shaking caused by more local earthquakes. Algermissen et al. (1982) calculated a 90% probability that peak ground accelerations in the SSC area will not exceed 0.045g in 50 years. There are no potentially active faults known in proximity to the site (Howard et al. 1978).

The site region is covered by non-indurated glacial sediments that are commonly saturated. These materials could be susceptible to liquefaction if they were weakly consolidated; but generally they are dense and liquefaction is not likely.

Occurrences of "drift-gas" have been noted in the till (drift) in a number of wells in Illinois, including several wells near the northwestern portion of the site and a few wells near the southern portion of the site (Kempton 1988b). No gas was encountered in 19 borings made for the SSC project (Kempton 1988b). Drift gas is primarily methane, but also contains small amounts of nitrogen and carbon dioxide. Gas pressure in the deposits averages 13 $lb/inch^2$ (range <0 to 64 $lb/inch^2$) (Coleman 1976). Drift gas occurrences correlate relatively well with occurrences of Robein silt, an organic-rich member within the till; the gas occurs below the silt. C-14 ages analyzed from the gas are generally 20,000 to 30,000 years, which indicates that the Robein silt (age-dated at 22,000 to 28,000 years) is the likely source and that the gas is not derived from a bedrock source.

No other geologic hazards are expected at the site. Ground subsidence, caused by withdrawal of water or hydrocarbons, is not expected because hydrocarbons are not being produced in the area and because the deep aquifer beneath the ring, a cemented sandstone, is relatively incompressible; there is no volcanic activity in the region; the site topography is sufficiently subdued so that landslides are not expected; and stress in the bedrock, although reflecting a high horizontal deviatoric stress (Haimson 1987), is not high enough to result in a hazardous condition.

5.3.1.6 Economic Geologic Resources

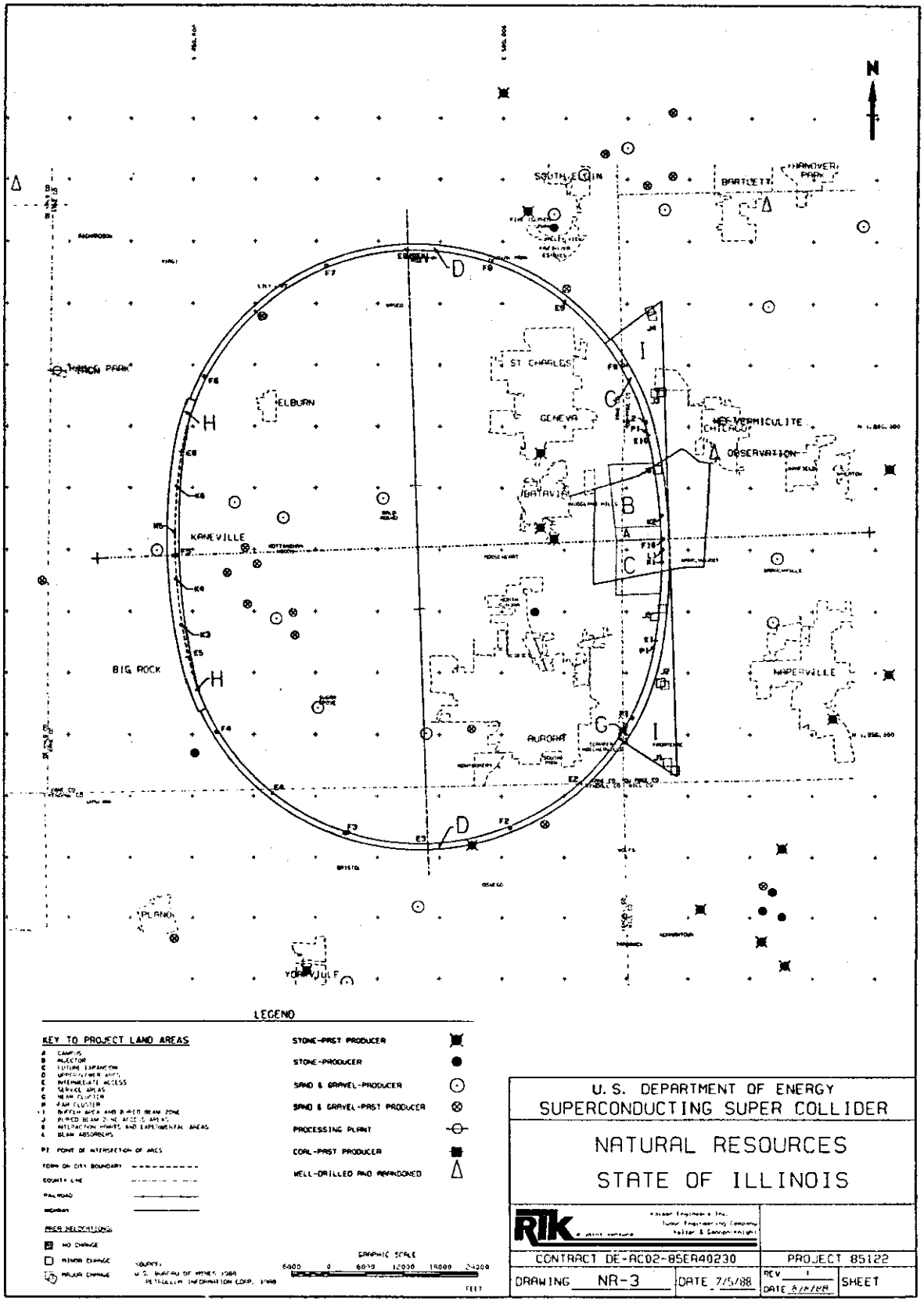
Sand and gravel deposits are abundant and along with the underlying carbonate strata, represent the principal geologic resources of the area. Mines and prospects surrounding the proposed site are shown in Figure 5.3.1-6, which is based on data from the Bureau of Mines' Mineral Industry Location System (MILS) database. Data on oil and gas wells from the Petroleum Information Corp. are also included in the figure. Oil and gas reserves are generally confined to the Illinois basin, south of the site; no production has been recorded within the site area. Other proven and potential resources include natural gas, peat, coal, and base metals, but none occur in significant quantities.

A. Earthen Construction Materials

High-quality aggregate resources are available from the abundant deposits of sand and gravel within the glacial materials present over most of Illinois. Terminal and ground moraines, outwash plains, valley trains, and other landforms as well as the calcareous rocks they overlie, have provided sources of aggregate to Chicago and northeastern Illinois

Figure 5.3.1-6

MINES AND PROSPECTS IN THE PROPOSED SITE



throughout most of this century. In particular, Pleistocene (10,000- to 1.8-million-year-old) outwash deposits such as portions of the Henry formation and shallow Silurian dolomite formations have been especially important sources in the region of the proposed site (Masters 1983; Goodwin 1983). A total of 19 listed producers of sand and gravel and eight producers of stone resources are present in the vicinity of the site. Seven of these operations are located inside the ring, and 12 are within 0.5 mi of the ring. In addition, 17 past producers of sand and gravel and 14 past producers of stone have also been located.

About 4.6 billion tons of sand and gravel reserves and about 3.8 billion tons of dolomite reserves exist within the 16 townships comprising the vicinity of the proposed SSC site (Curran 1988). In 1983, about 22 million tons of limestone, dolomite, and lime were produced in 14 counties of northeastern Illinois, and about 15 million tons of sand and gravel and industrial sand were produced in 1984 (Bureau of Mines 1983 and 1984). In addition, 0.9 million tons of Portland cement were produced in these counties in 1984.

B. Energy Resources

The known oil and gas reserves of Illinois appear confined to the sediments of the Illinois basin, the northernmost part of which lies approximately 10 mi south of the proposed site (Howard 1987; Curran 1988). In addition, 90% of the oil reserves within the basin are associated with the New Albany shale, which lies over 100 mi south of the site (Barrows and Cluff 1984). Wildcat drilling of at least five wells in the vicinity of the site, including one well within 0.5 mi of the ring (see Figure 5.3.1-6) has proven unsuccessful to date (Petroleum Information Corp. 1988). Data from Gilkenson et al. (1984) indicate increasing amounts of total dissolved solids in groundwater toward the center of the basin, which suggests that any potential oil accumulations near the site have been flushed out by fresh water.

Occurrences of natural gas (drift gas) composed primarily of methane with minor nitrogen and carbon dioxide have been noted in areas overlain by the Robein Silt (Coleman 1976). Deposits of gas detected in wells in northeastern Illinois usually contain very small volumes of gas that, at best, are suitable only for home use. As a whole, these deposits are not considered a significant regional resource.

C. Metallic Resources

No record of metallic mineral exploitation or exploration in the vicinity of the proposed site is contained in the MILS database (Bureau of Mines 1988). Sulfide mineralization (primarily pyrite with some sphalerite and galena) in fractures and joints was noted in at least one of the project boreholes (Curry et al. 1988); no deposits of significant size were encountered.

218-829 0 - 88 - 2 (BOOK 4)

D. Other Resources

Peat deposits are associated with some of the surficial units in the region (see Section 5.3.1.2), and one past producer of peat inside the proposed ring (see Figure 5.3.1-6) is listed in the MILS database (Bureau of Mines 1988). However, present production of peat as well as clay and silica is from deposits outside the area immediately surrounding the proposed ring (Samson and Masters 1987). Coal reserves in the state are confined to Pennsylvanian (280-million to 320-million-year-old) sediments in the Illinois Basin (over 10 mi away) in the central and southern portions of the state (Damberger et al. 1984).

5.3.2 Water Resources

5.3.2.1 Surface Water Hydrology, Quality, and Use

A. Surface Runoff and Flooding

Most of the project site is situated in the Fox River drainage basin in northeastern Illinois (Figure 5.3.2-1). The Fox River originates northwest of Milwaukee, Wisconsin, about 75 mi north of the Illinois-Wisconsin border. It enters Illinois northwest of Antioch and flows southerly through the project site then turns to the southwest and joins the Illinois River near Ottawa. With a drainage area of 2,658 mi^2 at its confluence with the Illinois River, it is the third largest tributary of the Illinois River (Army Corps of Engineers 1984). From Ottawa, the Illinois River flows west about 25 mi through Peru then southwest through Peoria to Beardstown, and then generally south to join the Mississippi River north of St. Louis.

Hydrologic features of the Illinois site and major tributaries to the Fox River within the project area are shown in Figure 5.3.2-2. Their drainage area and floodplain characteristics as they cross the collider ring, are given in Table 5.3.2-1. The drainage area of the Fox River where it crosses the northern collider ring is 1,592 mi^2; and 1,738 mi^2 where it crosses the south collider ring.

A small portion of the project site along the eastern edge drains to the east into the West Branch of the DuPage River near West Chicago. The West Branch flows south and joins the DuPage River north of Plainfield. The DuPage River continues south to the DesPlains River southeast of Joliet and, finally, into the Illinois River at the confluence with the Kankakee River.

Figure 5.3.2-1

MAJOR WATERSHEDS OF ILLINOIS

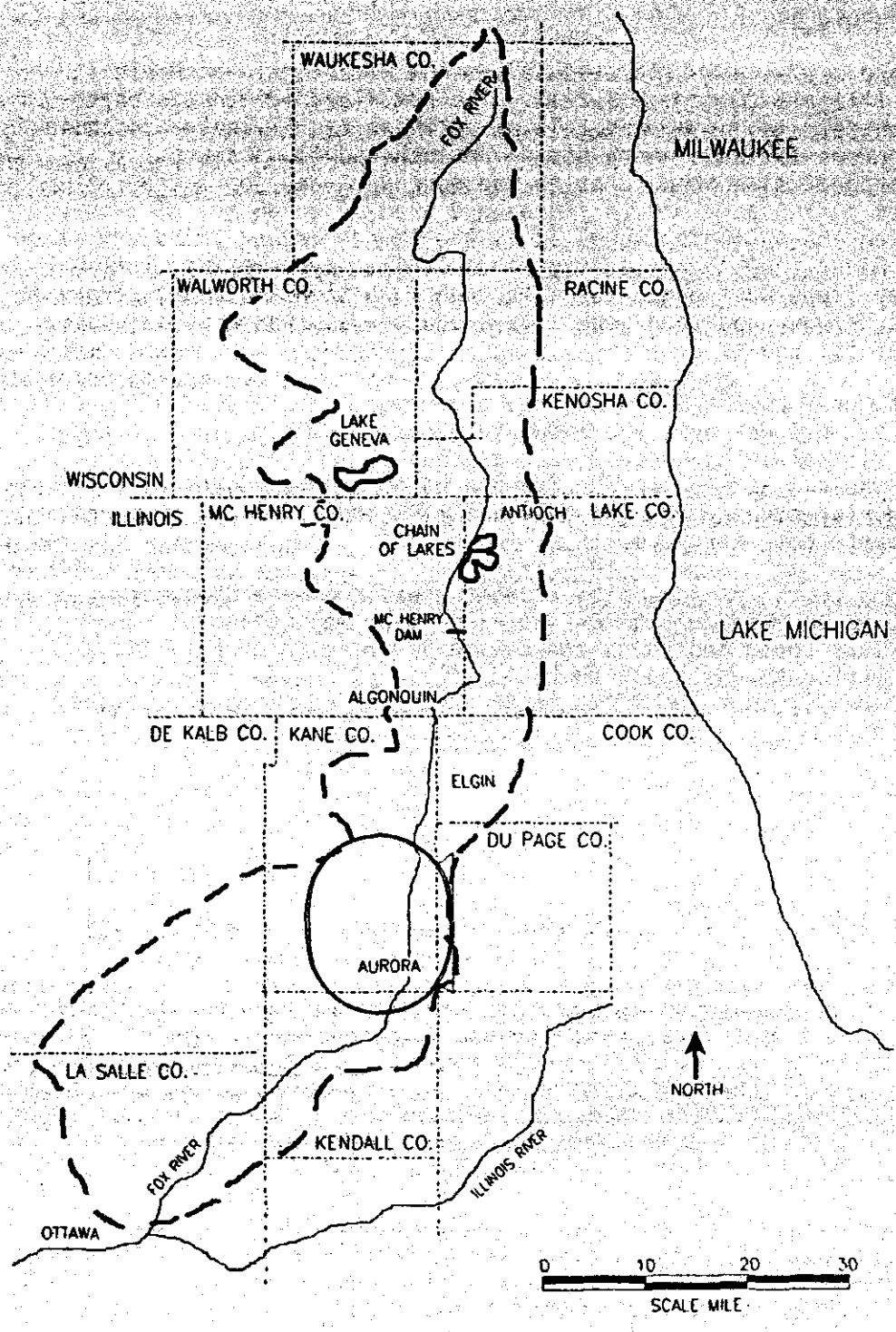


Figure 5.3.2-2

HYDROLOGIC FEATURES - ILLINOIS SITE

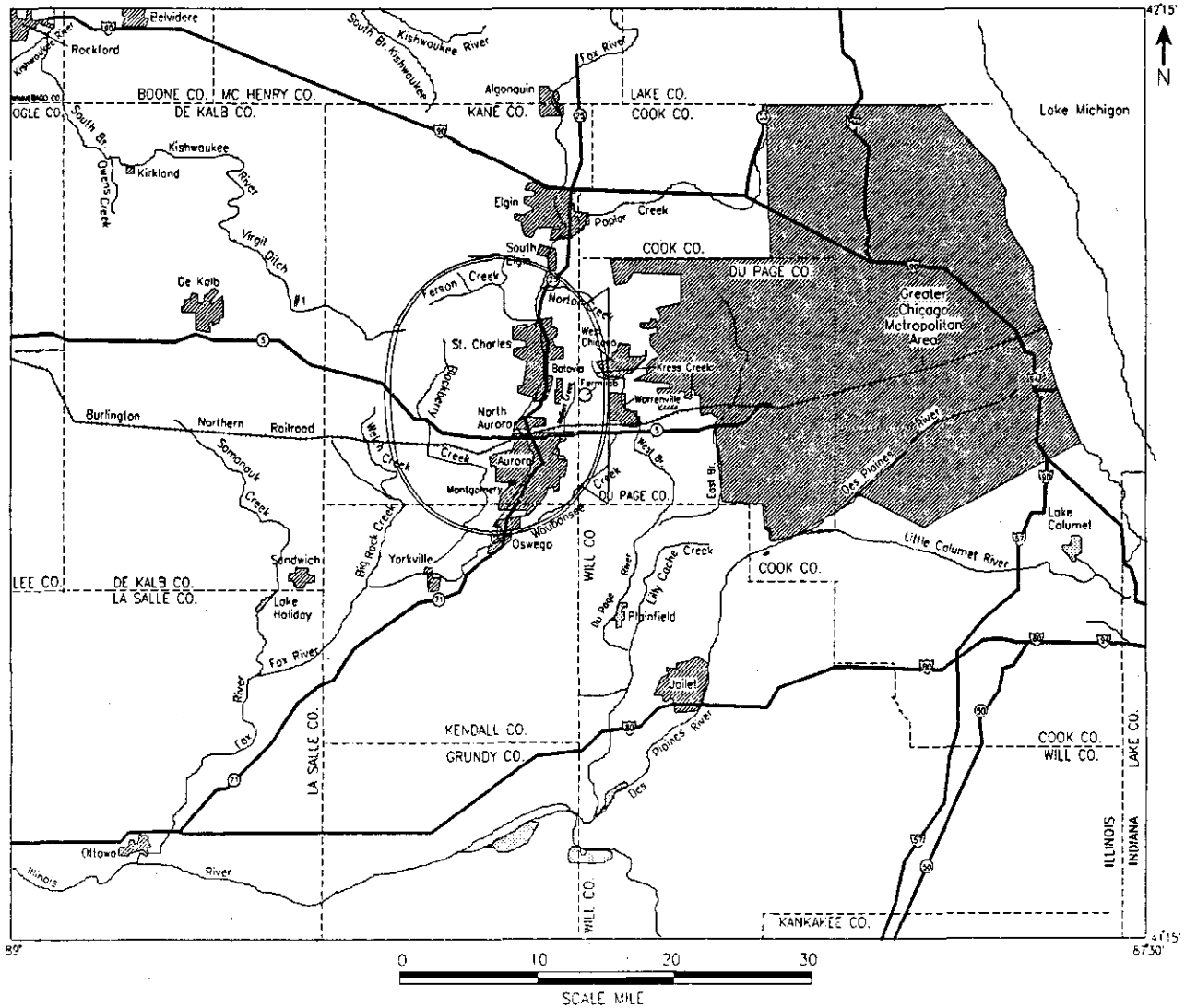


Table 5.3.2-1

CHANNEL AND FLOODPLAIN CHARACTERISTICS AT THE COLLIDER RING

Drainage Channel	Drainage Area mi^2	Bankfull Channel Width ft	Bankfull Channel Depth ft	Floodplain Width ft
Welch Creek near K5	9.91	25	9	700
Welch Creek near F5	12.07	25	8	600
Welch Creek near K4	13.59	25	7	1,000
Welch Creek near F4	37.37	38	4	300
Blackberry Creek near F3	64.51	35	4	700
Fox River near F2	1,737.88	400	4	800
Waubansee Creek near F2	20.28	34	7	600
Waubansee Creek near E2	18.44	30	6	1,700
Kress Creek near J6	12.55	20	7	1,200
Kress Creek near E10	10.09	18	7	800
Kress Creek near J3	10.09	18	7	2,500
Norton Creek near E9	11.50	35	3	400
Fox River near F8	1,592.21	500	4	1,400

Sources: Singh 1988; Federal Emergency Management Agency 1981a and 1981b.

Another small portion of the project site along the northwestern edge drains west into the South Branch of the Kishwaukee River. The South Branch flows northwest and joins the Kishwaukee River southeast of Rockford; the Kishwaukee joins the Rock River southwest of Rockford. The Rock River then flows to the southwest through Dixon and Sterling, and joins the Mississippi River at Davenport, Iowa.

Records of stream discharge have been maintained in the Fox River and adjacent tributary streams for various periods since 1915 (Fitzgerald et al. 1987). These records provide indicators of potential instantaneous flood flow rates in the project vicinity; flow-duration data from those records provide indications of flow variability throughout the year. This information is given in Table 5.3.2-2. The selected stations include: the Fox River, at a site about 18 mi upstream from the collider ring, three tributary streams, and two stations in the West Branch DuPage River, directly east from the project site. Locations of the selected stations are shown in Figure 5.3.2-2 (Fitzgerald et al. 1987).

With a maximum discharge of 6,610 ft^3/s into the Fox River from a drainage area of 1,403 mi^2, the table shows the flood retention effect of the Chain-of-Lakes on flood flows in the river. The smallest watershed represented in the table is West Branch DuPage River near West Chicago. Its peak flood flow was 984 ft^3/s from a drainage area of 28.5 mi^2, more than seven times the flow per square mile of drainage area of the Fox River (Fitzgerald et al. 1987).

Damaging floods have occurred in the Fox River basin and its major tributaries during all seasons of the year. In general, floods usually result from heavy thunderstorms following a period of prolonged rainfall that has saturated the ground, or from a severe storm during conditions of snowmelt. The greatest recorded flood in the area occurred in April 1962 (Federal Emergency Management Agency (FEMA) 1981b).

Indian Creek is a tributary to the Fox River with drainage boundaries almost entirely confined within the collider ring. It originates on Fermilab property north of the accelerator ring near Batavia Road, flows generally south to southwest to the Burlington Northern Railroad, and then west to the Fox River. Indian Creek joins the Fox River about 5 mi upstream from the Fox River crossing of the south collider ring. The drainage area of Indian Creek at the Fox River confluence is about 14.7 mi^2. The channel flows through property owned by the Department of Energy, private interests, and the City of Aurora (U.S. Department of Agriculture 1986). Flooding has been a significant problem in the Indian Creek watershed and, with continued development, the flooding problem is expected to intensify. The most recent major flood occurred in July 1983 and damaged many residences and businesses. Local citizens are concerned about the flooding problem and they have recommended a no-growth policy for the City of Aurora and Kane County until the problem is solved (U.S. Department of Agriculture 1986).

Table 5.3.2-2

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%	Q20%	Q50%	Q78%	Q95%
Ferson Creek near St. Charles (No. 0555 1200)	51.7	1,970	2-20-71	0.1	41.3	136.2	54.0	20.0	11.0	1.7
Blackberry Creek near Yorkville (No. 05551700)	70.2	2,060	7-3-83	0.1	52.7	164.0	70.0	29.0	18.0	7.0
Poplar Creek at Elgin (No. 05550500)	35.2	896	4-22-73	0	24.6	97.0	34.0	8.9	3.4	0.7
Fox River at Algonquin (No. 05550000)	1,403.0	6,610	4-6-60	12.0	858	2,560.0	1,300.1	540.1	329.1	123.0
West Branch DuPage River near West Chicago (No. 05539900)	28.5	984	12-3-82	0.2	33	101.1	44.0	19.0	12.0	2.0
West Branch DuPage River near Warrenville (No. 05540095)	90.4	2,160	12-3-82	7.8	100	331.2	137.1	58.0	35.0	16.0

* All flow values are in cubic feet per second (ft^3/s)
Sources: Fitzgerald et al. 1987; Illinois Water Survey 1988.

Flood insurance studies have been completed for all major streams in the project area. Detailed studies, complete with flood profiles, were completed for the Fox River and Norton, Kress, Waubansee, Blackberry, and a portion of Ferson creeks. Approximate studies were completed for the headwaters of Indian Creek, Waubansee Creek, a tributary to Kress Creek, and for Welch Creek, Virgil Ditch and the remaining portion of Ferson Creek. Flood boundaries, developed as part of the flood insurance studies, were superimposed on a map of the project site and the width of flooding near appropriate project facilities was measured (FEMA 1981a and 1981b). Flooding widths are tabulated in Table 5.3.2-1.

B. Surface Water Quality

Section 13 of the Illinois Environmental Protection Act authorizes the State Pollution Control Board to issue regulations to restore, maintain, and enhance the purity of the waters of the state. In conjunction with those regulations, the board adopted water quality standards for the various waters of the state in conformance with the projected uses of those waters (EPA 1987).

At this time, the streams within the project site have no specific designated uses and therefore, the general use water quality standards apply. The general use standards were developed to protect water for aquatic life, agricultural use, primary and secondary contact use, most industrial uses, and to ensure the aesthetic quality of the aquatic environment. Surface water quality data for selected parameters in the project vicinity are shown in Table 5.3.2-3.

General use standards for pH, dissolved oxygen, and fecal coliform are described as follows:

- The pH shall be within the range of 6.5 to 9.0 except for natural causes.

- Dissolved oxygen shall not be less than 6.0 mg/l during at least 16 hours of any 24-hour period, nor less than 5.0 mg/l at any time.

- Based on a minimum of five samples taken over less than a 30-day period, fecal coliform shall not exceed a geometric mean of 200 counts per 100 ml, nor shall more than 10% of the samples during any 30-day period exceed 400 counts per 100 ml.

Water quality data have been collected from streams close to the project site since 1974 by the EPA and U.S.G.S. In the Fox River, data were collected at two locations on the main stem and on the Blackberry tributary just south of the collider ring. In the DuPage River, data were collected at three sites located directly east from the project site. Data for the sampling sites on the Fox River, Blackberry Creek, and the West Branch DuPage River near West Chicago are shown in Table 5.3.2-3.

Table 5.3.2-3

SURFACE WATER QUALITY DATA IN PROJECT VICINITY

Parameter	Unit	Standard	Maximum	Minimum	Average
Stream: Fox River at South Elgin, 1981-85					
Flow	cfs		5,180	315	1,471
Fecal Coliform	#/100 ml	≤200	2,200	10	430
pH		6.5-9.0	8.3	6.8	7.7
Temperature	°C			-	
Dissolved Oxygen	mg/l	<5	17.3	4.1	10.2
Dissolved Solids	mg/l	<1,000	520	326	441
Turbidity	FTU		49	1	16
Chloride	mg/l	<500	84	29	51
Sulfate	mg/l	<500	66	40	52
Nitrate(N)	mg/l		10	0.3	2.1
Lead	µg/l	<100	100	0	47
Mercury	mg/l	<0.0005			
Stream: Fox River at Montgomery, 1981-85					
Flow	cfs		6,420	300	1,688
Fecal Coliform	#/100 ml	≤200	8,500	91	1,338
pH		6.5-9.0	8.7	6.6	7.9
Temperature	°C			-	
Dissolved Oxygen	mg/l	>5	14.7	7.2	10.9
Dissolved Solids	mg/l	<1,000	486	222	384
Turbidity	FTU		100	1	21
Chloride	mg/l	<500	87	36	60
Sulfate	mg/l	<500	76	35	53
Nitrate(N)	mg/l		12	0.2	1.9
Lead	µg/l	<100	100	0	49
Mercury	mg/l	<0.0005			

Table 5.3.2-3 (Cont)

SURFACE WATER QUALITY DATA IN PROJECT VICINITY

Parameter	Unit	Standard	Maximum	Minimum	Average
Stream: Blackberry Creek near Yorkville, 1981-85					
Flow	cfs		918	9	92
Fecal Coliform	#/100 ml	≤200	12,000	9	1,072
pH		6.5-9.0	8.2	6.8	7.6
Temperature	°C			-	
Dissolved Oxygen	mg/l	>5	15.5	6.5	10.1
Dissolved Solids	mg/l	<1,000	562	280	466
Turbidity	FTU		110	1	23
Chloride	mg/l	<500	53	8	33
Sulfate	mg/l	<500	95	52	80
Nitrate(N)	mg/l		6.8	1	3.3
Lead	µg/l	<100	100	0	47
Mercury	mg/l	<0.0005			
Stream: West Branch DuPage River near West Chicago, 1981-85					
Flow	cfs		813	11	58
Fecal Coliform	#/100 ml	≤200	53,000	10	2,792
pH		6.5-9.0	8.5	6.8	7.5
Temperature	°C			-	
Dissolved Oxygen	mg/l	>5	15.8	4.6	9.5
Dissolved Solids	mg/l	<1,000	1,000	504	702
Turbidity	FTU		140	2	23
Chloride	mg/l	<500	300	72	164
Sulfate	mg/l	<500	210	68	119
Nitrate(N)	mg/l		12	3.1	7.3
Lead	µg/l	<100	100	0	46
Mercury	mg/l	<0.0005			

Sources: Budd 1988; EPA 1987.

The table indicates that both maximum and average concentrations of fecal coliform exceeded state standards in both rivers. Minimum concentrations of dissolved oxygen failed to meet state general use standards in the Fox River at South Elgin, and West Branch DuPage River. The maximum concentrations of lead equaled the state standard at each of the four sampling points.

There are a total of 117 National Pollutant Discharge Elimination System (NPDES) permits issued for the stream channels located close to the project site. These permits establish limitations on discharges into the surface streams to ensure that the state water quality standards are satisfied.

There are no state standards for turbidity; however, Table 5.3.2-3 indicates moderate concentrations. Turbidity will tend to be higher during the late spring-early summer period of relatively sustained runoff from spring rains. As storm flows recede in the stream channels to average seasonal discharge, the concentrations of turbidity also diminish.

C. Surface Water Use

The Fox River and its major tributaries in the project area flow throughout the year. However, in the small tributary channels during late fall and for much of the winter, the flow becomes minimal and unrecoverable. In 1970, total water use in the Fox River basin was estimated to be more than 40 billion gal/yr, with 97% of that supplied by groundwater (Corps of Engineers 1984).

In 1986, the total use of surface water by public and self-supplied industrial users in DuPage, Kane, Will and Kendall counties was estimated to be only 1.16 million gal/d (Illinois State Water Survey 1988). All of this surface water was supplied by the Fox River and it was used by the Fermilab for cooling water and other purposes. Average annual discharge in the Fox River at Algonquin, located about 18 mi north of the collider ring, is about 540 million gal/d. Current water use in the SSC project area is, therefore, only a fraction of the average annual flow in the river. Overpumpage of the aquifers east of the project area has resulted in substantial declines in water levels causing users of the local groundwater resource to seek alternative sources of supply. To meet this current and projected future demand, local users have contracted for the delivery of Lake Michigan water to the area. In the area west of the Fox River significant water level declines have not yet occurred. If future water levels in the area decline to unacceptable levels, an alternative source of water supply for the SSC project could be the Fox River.

5.3.2.2 Groundwater Hydrology, Quality, and Use

A. Groundwater Hydrology

The Illinois SSC site is characterized by glacially deposited material overlying Paleozoic bedrock. The bedrock is typical of the mid-continent, consisting primarily of limestone, dolomite, sandstone, and shale. Five major hydrogeologic units are differentiable: 1) the glacial drift, 2) the upper bedrock or Silurian aquifer, 3) the Ordovician aquitard, 4) the Cambrian-Ordovician or Midwest Bedrock aquifer and, 5) the Basal Bedrock or Mt. Simon aquifer (Schicht et al. 1976; Visocky et al. 1985; Sasman et al. 1986; and Visocky and Schulmeister 1988). Table 5.3.2-4 summarizes characteristics of these hydrogeological units. These units and the general hydrogeologic conditions in the vicinity of the Illinois SSC site are described in the following sections.

1. Glacial Drift

The glacial drift consists of unconsolidated glacial deposits--pebbly clay or till, silt, and gravel, and alluvial silts, sands, and gravel. A thin layer of windblown silt or loess commonly overlies the drift. The drift varies in thickness from 0 to greater than 400 ft but is typically 100 to 200 ft thick (Visocky and Schulmeister 1988). Because of the variable lithology, the glacial drift is locally both an aquifer and an aquitard. Again, because of the lateral and vertical variation in lithology, aquifers are both water table and confined. Resulting water levels and depth to water is complex, but the water table is typically encountered within 5 to 20 ft below land surface. Groundwater movement within the glacial drift is controlled by topography and lithology (Kempton and Cartwright 1984). Within the vicinity of the proposed site, all recharge to underlying bedrock units must occur through the glacial drift. Recharge is highest in upland areas. Recharge to glacial aquifers (sands and gravels) varies from 110 up to 400 acre-ft/yr/mi^2, depending on location, depth, and extent of interbedded low permeability layers (Kempton and Cartwright, 1984; Schicht et al. 1976).

As indicated, the sands and gravels in the glacial drift are aquifers on a local scale. Well yields are highly variable, but have been reported from as high as 1,000 to as much as 3,000 gal/min. Small well yields are typical, but yields from 50 to 500 gal/min are common in DuPage and Kane counties in areas of significant thickness of sand and gravel deposits. Reported specific capacities range from about 0.1 to 5,600 gal/min/ft of drawdown (Visocky et al. 1985; Woller et al. 1986; and Woller and Sanderson 1978).

Hydraulic conductivity of drift is highly variable. Till materials in the vicinity of the Illinois site have hydraulic conductivities ranging from 10^{-6} to 10^{-9} cm/s, dependent primarily on the percentage of clay present. Glacial sands and gravels have hydraulic conductivities ranging from 10^{-2} to 10^{-5} cm/s (Booth and Vaugt 1986; Jennings 1987; Williams and Farvolden 1967).

Table 5.3.2-4
SUMMARY DESCRIPTION OF HYDROGEOLOGIC UNITS, DUPAGE AND KANE COUNTIES, ILLINOIS

Hydrogeologic Unit	Approximate Thickness ft	Physical Description	Hydraulic Properties	Water-Bearing Characteristics
Glacial Drift	0-400	Till, silt, and gravel and alluvial silt, sand and gravel; loess over glacial deposits	Till: $K = 10^{-6}$ to 10^{-9} cm/s Sand and gravel: $K = 10^{-2}$ to 10^{-5} cm/s	Local discontinuous aquifers; well yields from small up to 3,000 gal/min.
Upper Bedrock Aquifer	0-130	Silurian dolomites, cherty dolomites, argillaceous dolomites and shale - the latter only where overlying dolomites are absent and the Maquoketa group is part of the upper bedrock aquifer.	Silurian dolomites: $K = 10^{-2}$ to 10^{-4} cm/s Maquoketa dolomites: $K = 10^{-4}$ to 10^{-6} cm/s	Productive only in upper 50 to 100 feet of unit with joints/fractures dissolution. Well yields to 500+ gal/min.
Ordovician Aquitard	200+	Shales and argillaceous dolomites of the Maquoketa group and locally dolomites and cherty dolomites of the Galena-Platteville group.	$K = 10^{-3}$ to 10^{-6} cm/s	Generally not water-yielding except where dolomites at surface or directly underlie glacial drift and joints/fractures subject to dissolution.
Cambrian-Ordovician Aquifer	200-600 (Major Sandstone Units Only)	Major aquifer units are sandstones (Glenwood-St. Peter and Ironton-Galesville); other geologic units include dolomite, siltstone, shale, and less permeable sandstones.	For major sandstone units: $K = 2 \times 10^{-3}$ to 5×10^{-4} cm/s $T = 1{,}300$ to $2{,}800$ ft^2/d $S = 0.0002$ to 0.0004	Sandstones are major producing units but all formations yield some water. Well yields typically from less than 50 to over 700 gal/min.
Basal Bedrock Aquifer	2,000-2,600	Sandstones at the base of the Eau Claire and of the Mt. Simon formations.	One measured K value $K = 8 \times 10^{-4}$ cm/s $T = 130$ to $1{,}300$ ft^2/d $S = 0.0001$ to 0.0005	Quality deteriorates with depth. Wells only in upper few hundred feet of unit. Typical well yields are 200 to 1,600 gal/min.

Sources: Hughes et al. 1966; Visocky et al. 1985; Booth and Vaugt, 1986; Jennings, 1987; Kempton et al. 1987a and 1987b; Curry et al. 1988; Vaiden et al. 1988; and Visocky and Schulmeister, 1988.
Notes: K = Hydraulic Conductivity; T = Transmissivity; S = Storativity

2. Upper Bedrock Aquifer

The Upper Bedrock aquifer includes the sequence of Silurian dolomite formations and, in areas where overlying bedrock is absent, dolomites of the Ordovician Maquoketa group and the upper portions of the Galena-Platteville group. The Silurian dolomites vary from very pure to very silty. Thin shales and argillaceous beds commonly occur at the base of the section. Thickness of the Silurian dolomites varies from 0 to approximately 130 ft. The Silurian dolomites are generally absent in the western portion of the Illinois site where the Maquoketa dolomite and shale is the uppermost bedrock formation (Woller and Sanderson 1978; Visocky and Schulmeister 1988).

Recharge to the Upper Bedrock aquifer in northeastern Illinois has been estimated by Walton (1965) to range from about 60 up to 250 acre-ft/yr/mi^2 and to average about 150 acre-ft/yr/mi^2. Groundwater movement and production in the Upper Bedrock aquifer occurs predominantly in the upper 50 to 100 ft where dissolution has occurred, enlarging the joints and fractures in the rock and increasing its permeability (secondary permeability). Well yield is highly variable, being dependent on the number and extent of joints and fractures penetrated by an individual well bore. Typical yields are from 0 to 500+ gal/min. Specific capacity ranges from 0.01 to 0.23 gal/min/ft of drawdown (Schicht et al. 1976; Visocky et al. 1985). The potentiometric surface or water level in the Upper Bedrock aquifer is typically at, or slightly above, the bedrock surface and within the overlying glacial drift. Groundwater flow is generally from the northwest to the southeast (Visocky and Schulmeister 1988).

Hydraulic conductivity of the Upper Bedrock aquifer ranges from 10^{-2} to 10^{-4} cm/s in the eastern portions of the site (Silurian dolomites) and from 10^{-4} to 10^{-6} cm/s in the western and northern portions of the site (Maquoketa dolomite and shale) (Kempton et al. 1987a and 1987b; Curry et al. 1988; and Vaiden et al. 1988).

3. Ordovician Aquitard

The Ordovician Aquitard consists primarily of the shales and dolomites of the Maquoketa shale group. The underlying Galena-Platteville group is sometimes considered part of the confining unit, although it is also locally productive where exposed at the surface, or overlain directly by glacial deposits. In the Illinois site vicinity, the Galena-Platteville is overlain by the Maquoketa shales and is generally not water yielding (Visocky et al. 1985).

The Maquoketa consists of shales and argillaceous dolomites over 200 ft thick. The Galena-Platteville is pure, partially cherty dolomite. The Galena is typically medium-bedded, while the Platteville is fine-grained and more thinly bedded. The Galena-Platteville is of relatively uniform thickness in Kane County, ranging from about 300 to 350 ft (Woller and Sanderson 1978).

Shales in the Maquoketa are generally not water yielding, while the dolomites may yield small supplies locally where fracturing and dissolution have occurred. Within the Illinois site, where the Galena-Platteville is overlain by shales, well yields are very small (Sasman et al. 1986).

Water levels in the Maquoketa fall between those of the overlying and underlying aquifers, indicating a downward vertical flow gradient. Recharge through the Maquoketa to underlying units is estimated to be on the order of 2 to 4 acre-ft/yr/mi^2. Water levels from wells and piezometers in the Galena-Platteville show a west to east flow direction. The existence of a well-defined groundwater gradient to the east within the Galena-Platteville although the unit is not locally a significant water producer, suggests hydraulic connection with the underlying aquifer units.

Hydraulic conductivity of the Ordovician aquitard (Maquoketa shales and Galena-Platteville) ranges from 10^{-3} to 10^{-6} cm/s or less (Kempton et al. 1987a and 1987b; Curry et al. 1988; and Vaiden et al. 1988).

4. Cambrian-Ordovician Aquifer

The Cambrian-Ordovician aquifer generally includes all bedrock units from the Galena-Platteville down to the Cambrian Eau Claire formation. Within the Illinois site, because of the overlying Maquoketa, the Galena-Platteville may be more properly associated with the Ordovician aquitard.

Major water producers within the Cambrian-Ordovician aquifer are the Glenwood and St. Peter sandstones (Ancell group), which occur just below the Galena-Platteville, and the Ironton-Galesville sandstone. The Glenwood-St. Peter sandstones range from about 200 to 400 ft in thickness in Kane County, while the Ironton-Galesville sandstone is usually about 175 ft thick. The formations between these sandstones and the basal Eau Claire formation are mixed dolomites, sandstones and shales, and may be more properly considered confining units rather than aquifers (Sasman et al. 1986; Woller and Sanderson 1978; Schicht et al. 1976). Well yields from the Cambrian-Ordovician Aquifer range from less than 50 to over 700 gal/min. Larger yields are usually derived from the Ironton-Galesville sandstone (Sasman et al. 1986; Hughes et al. 1966).

The majority of recharge to the Cambrian-Ordovician Aquifer occurs through the overlying Maquoketa and Galena-Platteville units. Recharge may also occur from the underlying Basal Bedrock or Mt. Simon aquifer. Groundwater movement in the unit is generally from west to east toward areas of large groundwater withdrawals along the Fox River Valley, and further to the east in the Chicago area. The potentiometric surface of the Cambrian-Ordovician aquifer has been lowered several hundreds of feet in some areas since groundwater pumping began in the late 1800s. Because of this, the potentiometric surface of the Cambrian-Ordovician aquifer is below that of the Galena-Platteville throughout most of Kane County (Schicht et al. 1976, Visocky and Schulmeister, 1988).

Recorded hydraulic conductivity values for the sandstone units of the Cambrian-Ordovician Aquifer range from 2×10^{-3} to 5×10^{-4} cm/s. Values of 2.7×10^{-3} and 2.8×10^{-3} cm/s have been calculated from pumping tests in wells completed in the Glenwood-St. Peter formation (Hughes et al. 1966; Visocky and Schulmeister 1988; Vaiden et al. 1988). Recorded transmissivity values for the unit range from 1,300 to 2,800 ft^2/d. Approximately 65% of this transmissivity is thought to be provided by the sandstone units. Storativity is on the order of 0.0002 to 0.0004 (Visocky et al. 1985; Vaiden et al. 1988).

5. Basal Bedrock Aquifer

The Basal Bedrock or Mt. Simon aquifer consists of the basal sandstones of Eau Claire and Mt. Simon formations. In Kane County, this aquifer occurs at depths ranging from 1,500 to 1,800 ft. The unit ranges in thickness from about 2,000 to 2,600 ft. Only the upper portion is considered a viable aquifer, since water quality deteriorates with depth. Well yields from 200 to 1,600 gal/min are obtained in the upper few hundred feet of the unit. The unit is heavily developed only in the areas of extensive pumping near Chicago (Cook County), and in eastern Kane County (Sasman et al. 1986; Woller and Sanderson 1978). In these areas, water levels have been lowered and the potentiometric surface is below that of the overlying Cambrian-Ordovician aquifer. In western Kane County, the underdeveloped Basal Bedrock aquifer water level may be on the order of 50 ft higher than in the Cambrian-Ordovician aquifer (Woller and Sanderson, 1978).

Limited data are available on the hydraulic properties of the Basal Bedrock aquifer. A hydraulic conductivity of approximately 8×10^{-4} cm/s is referenced by Hughes et al. (1966). Transmissivities ranging from 130 to about 1,300 ft^2/d and storativities from 0.0001 to 0.0005 are reported from aquifer tests (Visocky et al. 1985).

B. Groundwater Quality

The chemical quality of groundwater in the Illinois SSC site is typical of areas with a significant proportion of carbonate rock. Calcium-magnesium bicarbonate water is predominant, although sodium-chloride and sulfate-dominated waters do occur. The chemical quality of the various water bearing units in the Illinois site vicinity is summarized and compared with pertinent water quality standards in Table 5.3.2-5.

Groundwater quality is generally good in all water bearing units described in the previous section, down to and including the upper portions of the Basal Bedrock aquifer. As indicated above, calcium-magnesium bicarbonate water predominates. Total dissolved solids are typically in the range of 300 to 1,000 mg/l, while common hardness values range from about 200 to 700 mg/l, very hard water. Municipal supplies are commonly treated for iron, as its concentration may range upwards of 4 mg/l.

Table 5.3.2-5

APPROXIMATE RANGE OF GROUNDWATER QUALITY IN KANE AND DUPAGE COUNTIES, ILLINOIS

Source Units	Range of Chemical Constituents mg/l				
	Total Dissolved Solids	Chloride	Sulfate	Iron	Hardness* $CaCO_3$
National drinking water standards	500	250	250	0.3	None
Glacial drift	300-1,000	0-120	30-400	0-4	100-700
Upper bedrock	350-1,200	<1-100	30-500	0-4	100-700
Cambrian-Ordovician and Basal bedrock	300-1,500+	5-350+	6-450	0-3	150-650

*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; Schicht et al. 1976; Woller and Sanderson 1978; and Woller et al. 1986; Environmental Protection Agency, 1977.

Nitrate and fluoride do not occur in significant concentrations. Groundwater with elevated radium levels has been encountered to the east of the proposed site. The city of West Chicago has been placed on the Illinois Environmental Protection Agency's restricted list because of high radium levels in the water supply wells. The only high salinity groundwater in the area occurs at depths of more than a few hundred ft into the Basal Bedrock aquifer. Within this unit, total dissolved solids rapidly increase with depth, and water changes to a sodium chloride type (Woller and Sanderson 1978; Visocky et al. 1985; Woller et al. 1986).

C. Groundwater Use

Groundwater use is extensive in the vicinity of the Illinois site. Significant pumping occurs in all of the aquifer units discussed above, both for municipal/industrial supply and domestic use. Total withdrawals have historically been greatest in the urbanized areas along the Fox River on the eastern side of the proposed site. In this area, heavy pumpage for municipal supplies from primarily the Cambrian-Ordovician aquifer has resulted in local water level declines of up to several hundred feet (Sasman et al. 1986). Table 5.3.2-6 shows recent and projected groundwater use in Kane County and for the western portion of DuPage County.

Totals shown in Table 5.3.2-6 are for all aquifer units combined. Although municipal and industrial supplies are developed from all of the productive units, including the glacial drift, the majority pump from the Upper Bedrock aquifer, and the sandstones of the Cambrian-Ordovician aquifer. Domestic wells are generally developed in the shallower formations, the glacial drift, and Upper Bedrock aquifer, but many do tap the sandstones in the Cambrian-Ordovician aquifer.

Pumpage for municipal supply systems is by far the predominant groundwater use. Estimated and reported groundwater withdrawals for 1986 in all of DuPage and Kane counties were about 110,000 and 38,000 acre-ft, respectively (Kirk 1987). Of these totals, about 91,000 and 30,000 acre-ft (83 and 79%) were withdrawn for public supply. Approximately 15% of withdrawals in each county were for rural or domestic use. Public supply withdrawals for 1986 in DuPage County were distributed as follows: glacial drift = 1,100 acre-ft; Upper Bedrock aquifer - 53,800 acre-ft (60%); and Cambrian-Ordovician and Basal Bedrock aquifers - 34,700 acre-ft (39%). In Kane County, withdrawals between units are distributed differently reflecting the decreased occurrence of the Upper Bedrock aquifer; glacial drift = 7,800 acre-ft (25%); Upper Bedrock aquifer = 225 acre-ft (<1%); and Cambrian-Ordovician and Basal Bedrock aquifer = 22,400 acre-ft (75%) (Kirk 1987).

The present and projected groundwater use shown in Table 5.3.2-6 locally exceeds the estimated yield of the Cambrian-Ordovician aquifers, as is documented by the declining water levels. This overdraft condition is a significant groundwater issue in the area of Illinois. In response to this situation, and as assumed in the projections in the table, there

Table 5.3.2-6

RECENT AND PROJECTED GROUNDWATER USE IN KANE COUNTY AND THE WESTERN PORTION OF DUPAGE COUNTY, ILLINOIS

County	Year								
	1986	1990	1995	2000	2005	2010	2015	2020	2025
	Acre-ft x 1,000								
Kane	38.3	38.8	40.4	41.1	45.0	46.5	46.7	48.5	49.6
DuPage*	17.0	2.7	2.8	3.0	3.1	3.2	3.4	3.5	3.6

* Three townships in DuPage County only (38N9E, 39N9E, and 40N9E); data assume Lake Michigan allocations in effect by 1990.

Sources: Kirk 1987; Visocky and Schulmeister 1988.

are ongoing programs to replace a portion of local municipal groundwater usage with surface water imported from Lake Michigan. The schedule for replacement is not firmly established. Estimated yield of the shallow aquifers (glacial and upper bedrock) is generally not exceeded at present, except very locally in the immediate vicinity of public water supply withdrawals. For the area as a whole (Kane and Western DuPage counties), recharge to the glacial deposits and Upper Bedrock aquifer are approximately 150,000 and 50,000 acre-ft/yr/mi^2 respectively (estimated recharge to the glacial deposits assumes an average recharge rate of 250 acre-ft/yr/mi^2). These recharge values are compared to a 1986 use in the same area of about 55,000 acre-ft.

5.3.3 Climate and Meteorology

5.3.3.1 General Description

The climate at the Illinois SSC site is best characterized as typically continental, with cold winters, warm summers, and frequent fluctuations in temperature, humidity, cloudiness, and wind direction. Because Illinois is not protected by natural barriers such as mountains, the state experiences the full sweep of winds that bring in climates from other areas. Storm systems move through the state most frequently during the winter and spring and cause a maximum of cloudiness during those seasons. Summer storm systems, which tend to be weaker and stay farther north, leave the site with much sunshine and short-term thunderstorm situations (National Oceanic and Atmospheric Administration 1974).

5.3.3.2 Temperature

Winter temperatures at the site are extreme, with temperatures dropping below zero several times during the course of the season. Summer conditions include periods of uncomfortably hot and humid weather that are often broken after a few days by the arrival of cool air from Canada (National Oceanic and Atmospheric Administration 1974).

Temperatures in the region vary from an average low temperature of 20°F in December, January, and February to an average high temperature of 85°F in July. The highest temperature recorded was 105°F in July; the lowest temperature recorded was -23°F in December. The temperature drops below freezing on an average of 130 days per year. Frost penetration reaches an average of 30 inches and an extreme of 45 inches in depth (U.S. Weather Bureau 1941). Normal and extreme temperatures and heating degree-day data are shown in Table 5.3.3-1.

5.3.3.3 Precipitation

Precipitation patterns at the site are largely a function of wind direction. Southeast, easterly, and southerly winds bring mild and wet weather. The Gulf of Mexico serves as the dominant precipitation source for the site. Precipitation during the fall, winter, and spring tends to fall uniformly over dry areas; summer precipitation, which often occurs as thunderstorms accompanied by hail and high winds, occurs principally as brief showers affecting relatively small areas (National Oceanic and Atmospheric Administration 1974).

The northeast Illinois climatic region receives an average of 33.57 inches of precipitation per year. The peak month for precipitation is July, with an average of 4.10 inches. The month with the least precipitation is February, with an average of 1.53 inches. The region receives 36 inches of snow during the course of an average year. Mean precipitation and snowfall data are shown in Table 5.3.3-2, and 1-, 2-, 5-, 10-, 25-, 50-, and 100-year return period extreme rainfall data are shown in Table 5.3.3-3.

Table 5.3.3-1

NORMAL AND EXTREME TEMPERATURE DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average maximum temperature, °F	32	34	43	57	70	80	85	82	75	65	47	36
Average minimum temperature, °F	20	20	27	37	47	57	65	61	53	45	30	20
Highest maximum temperature, °F	67	69	82	91	98	104	105	102	101	91	81	68
Lowest minimum temperature, °F	-20	-21	-12	17	27	35	49	46	29	14	-2	-23
Heating degree-days	1200	1100	950	500	200	50	0	25	100	350	800	1200

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

Table 5.3.3-2

MEAN PRECIPITATION AND SNOWFALL DATA
FOR THE NORTHEAST ILLINOIS CLIMATIC REGION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly precipitation, inches	1.85	1.53	2.77	3.16	3.77	4.10	3.08	3.38	3.14	2.71	2.11	1.97
Mean monthly snowfall, inches	11.0	10.5	8.5	4.5	1.0	0.0	0.0	0.0	0.0	0.0	2.5	7.5

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

Table 5.3.3-3

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

Return Period Years	Rainfall (inches) 1-Hour	6-Hour
1	1.2	1.8
2	1.3	2.1
5	1.8	2.7
10	2.0	3.0
25	2.3	3.6
50	2.6	4.0
100	2.8	4.3

Source: U.S. Weather Bureau 1961.

5.3.3.4 Wind

Winds at the site are controlled by storm systems and weather fronts that move eastward and northeastward.

The prevailing wind direction at the Illinois site is toward the north-northeast at an annual average speed of 10 mph. The monthly average speeds are relatively uniform, ranging from 8.0 mph to 12.0 mph. The fastest recorded wind speed was 87 mph, which occurred in February. Average wind speed and direction data are shown by month, in Table 5.3.3-4.

5.3.3.5 Humidity

The mean relative humidity in the region of the Illinois site is 73%. The average relative humidity reaches a peak of 78% in December, and reaches its lowest values in April and May at 67%. Mean and maximum dewpoint and mean relative humidity data are shown in Table 5.3.3-5.

5.3.3.6 Severe Weather

Severe weather in the region of the Illinois SSC site can be best characterized through discussion of tornadoes, extreme winds, thunderstorms, blizzards and ice storms, and hail.

Tornadoes in the region of the site are relatively common, with peak activity in the spring. The yearly probability of a point being struck by a tornado is 1.30×10^{-3}, which corresponds to a return period of 770 years (Thom 1963). For the period of record 1950-1986, 255 tornadoes were observed within a 50-nautical mile radius of Batavia. These events caused 70 deaths and 1,688 injuries (NSSFC 1988). Although Illinois

Table 5.3.3-4

MONTHLY AVERAGE WIND SPEED AND DIRECTION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average wind speed, mi/h	11	11	12	11	11	9	8	8	9	9	11	11
Wind blowing toward	E	E	E	E	SSW	NNE	NE	NE	N	N	E	E

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

Table 5.3.3-5

DEWPOINT AND RELATIVE HUMIDITY DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean dewpoint temperature, °F	16	20	25	37	48	58	62	62	53	43	32	22
Maximum 12-hour 1,000 mbar dewpoint, °F	54	54	61	67	71	76	77	77	74	71	65	56
Mean relative humidity, %	78	75	70	67	67	70	70	70	70	70	75	78

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

holds the record for tornado-produced deaths, more than 70% of these occurred before modern forecast networks were developed (National Oceanic and Atmospheric Administration 1974).

Extreme expected winds in the region are shown in Table 5.3.3-6 by maximum wind speed and return period.

Table 5.3.3-6

EXTREME WIND SPEED AND RETURN-PERIOD DATA

Return Period Years	Wind Speed mi/h
10	60
25	65
50	74
100	82

Source: Thom 1968.

Thunderstorms occur in the region on an average of 57 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 x 0.75 observed, on the average, 0.7 times per year (Department of Commerce, Weather Bureau 1969).

Heavy snows of 4 to 6 inches or more average 1 to 2 per year. Moderate to heavy ice storms average about once every 4 to 5 years and can be quite damaging to utility lines and trees (National Oceanic and Atmospheric Administration 1974).

5.3.4 Air Quality

5.3.4.1 Conditions Affecting Air Quality

A. Topographical

The proposed site is generally flat terrain with the major features contributing to surface roughness being man-made. Nearby, the building heights range from single-story to the 15-story Wilson Hall at Fermilab.

B. Meteorological

The ability of the atmosphere to disperse a pollutant is categorized in part by its stability classification. The stability classification is discussed in detail in Appendix 5, Section 5.1.4. The sites relative frequency of occurrence of the six stability classes is shown in Table 5.3.4-1. The lower number classes have the highest degree of dispersion.

Table 5.3.4-1

FREQUENCY OF OCCURRENCE OF ATMOSPHERIC STABILITY CLASSES

Class	Definition	% Occurrence
A	Extremely Unstable	<1
B	Unstable	4
C	Slightly Unstable	10
D	Neutral	60
E	Slightly Stable	12
F	Stable and Extremely Stable	14

Source: National Climatic Data Center 1988.

The area is characterized by good dispersion conditions and low occurrences of stagnation. The SSC site is far enough from Lake Michigan to be outside the area of "lake effect" influences on atmospheric stability class. G. C. Holzworth's number of "forecast days" of high pollution potential is between 0 and 10 (Holzworth 1972) indicating good dispersion conditions. Holzworth's methodology is also discussed in greater detail in Appendix 5, Section 5.1.4.

The influence of winds on dispersion conditions on an annual basis is illustrated in Table 5.3.4-2. The table is an annual summary of the frequency of wind speed and direction for the Chicago first order National Weather Service Station (NOAA 1988).

Table 5.3.4-2

ANNUAL FREQUENCY OF WIND SPEED AND DIRECTION ILLINOIS SSC SITE

	Speed - Knots						
Direction	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	Greater than 21	Total
N	.005078	.017880	.022607	.013861	.003722	.001347	.064495
NNE	.003041	.014158	.018268	.013336	.003517	.001210	.053530
NE	.002304	.012194	.029206	.017766	.002877	.000548	.064895
ENE	.001055	.006028	.018816	.010664	.001096	.000206	.037865
E	.001414	.007147	.020163	.013633	.002466	.000388	.045212
ESE	.002486	.010687	.015528	.005823	.000617	.000183	.035323
SE	.003201	.012240	.012148	.003517	.000320	.000000	.031426
SSE	.003143	.014158	.013016	.005001	.000502	.000069	.035889
S	.009802	.035349	.048000	.031353	.005503	.000982	.130988
SSW	.004180	.016510	.027334	.021762	.004247	.000731	.074764
SW	.005808	.021328	.029206	.022264	.004841	.001256	.084704
WSW	.006210	.022379	.025804	.015574	.003311	.001370	.074647
W	.009610	.035897	.039025	.029206	.007490	.002147	.123375
WNW	.004704	.018611	.017492	.011783	.001758	.000183	.054530
NW	.004686	.014500	.018862	.011029	.001393	.000206	.050676
NNW	.002057	.007421	.014135	.010824	.002626	.000617	.037680
Total	.068780	.266487	.369611	.237395	.046287	.011440	

Source: National Climatic Data Center 1988.

Table 5.3.4-3

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	130[a]	West Chicago, 1986
TSP-annual geo. mean	75	46	West Chicago, 1986
SO_2 3-hr	1,300	440[a]	Elgin, 1986
SO_2-24-hr	365	168[a]	Elgin, 1986
SO_2-annual	80	8	Elgin, 1986
NO_2-annual	100	26	Lemont, 1986
CO-1-hr	40,000	8,300*	Cicero, 1986
CO-8-hr	10,000	5,400*	Cicero, 1986
O_3-1-hr	235	218*	Elgin, 1986
Pb-calendar quarter	1.5	0.08*	Elgin, 1986

* Highest representative regional value given.

Source: Illinois EPA 1987.

5.3.4.2 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 Illinois. The primary standards are shown in Table 5.3.4-3.

B. Background Concentrations

A portfolio of values was assembled from State of Illinois ambient air monitoring stations to quantify ambient air pollutant concentrations. 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 5.3.4-3. Selected ambient air monitoring stations are plotted in Figure 5.3.4-1.

C. Compliance Status

The noncompliance or nonattainment status for the counties in the ROI of the Illinois SSC site are as follows. For ozone (O_3), all of Cook, DuPage, Kane, and Lake counties are in nonattainment status. Parts of DeKalb County are in nonattainment status for carbon monoxide (CO). For the primary total suspended particulate (TSP) standard, parts of Cook, DuPage, LaSalle, and Will counties are in nonattainment status. Parts of DeKalb, Grundy, Kane, and Kendall counties are in noncompliance with the secondary TSP standard (EPA 1985).

D. Proximity to Sensitive Areas

The Illinois SSC site is proposed for a Prevention of Significant Air Quality Deterioration (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 Mingo Wilderness, which is 300 mi southwest of the SSC site.

5.3.4.3 Regional Air Pollution Sources

Because of the proximity of the Illinois SSC site to the Chicago metropolitan area, there are a large number of air pollution sources (some large enough to require PSD permits and many smaller) that have the capability to impact air quality. The number of sources has been estimated at 15,000 (Illinois EPA 1987). The types of sources in the Chicago metropolitan area range from the steel mills in South Chicago and in Gary, Indiana, to coal-fired power plants, oil refineries, and federal and private research laboratories. Emissions from commuter traffic cause localized impacts on carbon monoxide concentrations and also contribute to the ozone noncompliance status of the area. Regional air pollution sources in DuPage, Kane, and Kendall counties are shown in Table 5.3.4-4 and are plotted in Figure 5.3.4-1.

Table 5.3.4-4

REGIONAL AIR POLLUTION SOURCES
ILLINOIS SSC SITE

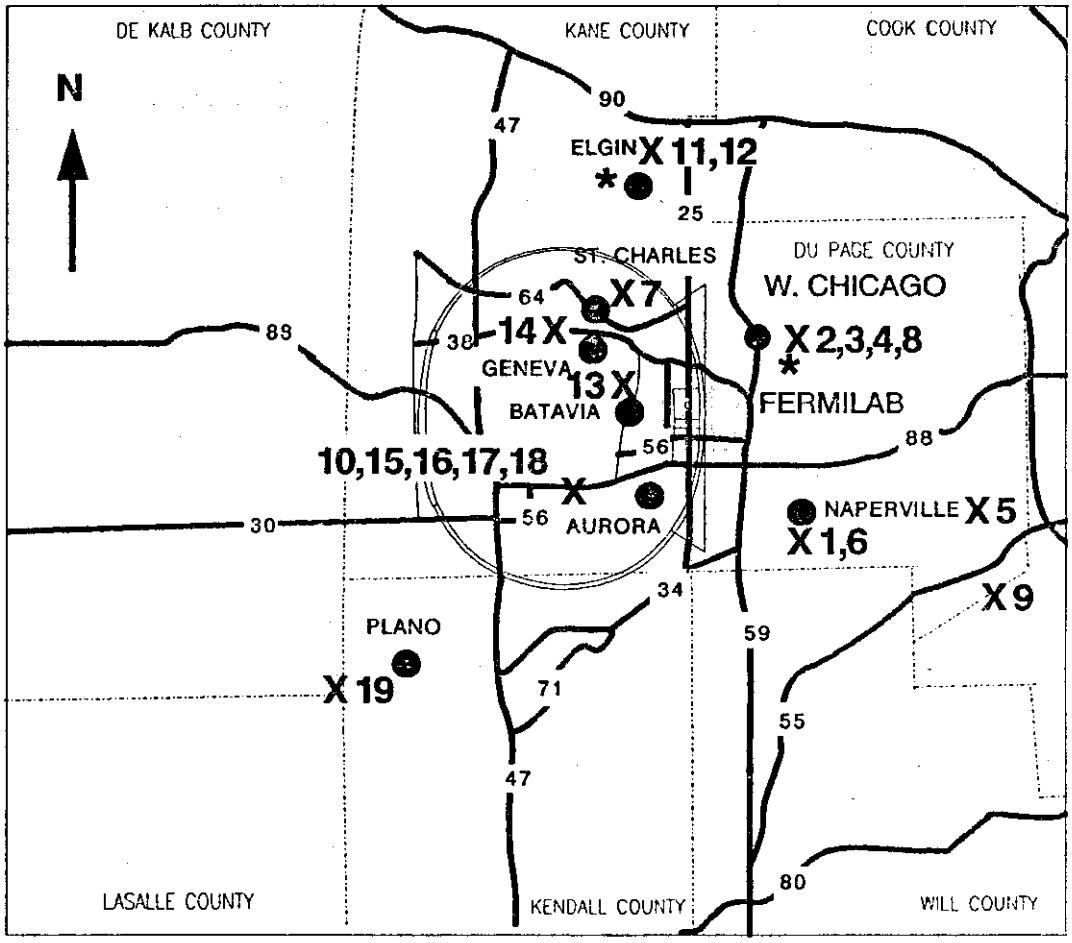
Source Name	Location	Permitted or Actual Emissions (ton/yr) TSP	SO_2	NO_x	VOC	CO
1. Nalco Chemical	Naperville	5.1	11.1	119.1	10.7	31.2
2. General Mills	West Chicago	131.8	0.	96.1	0.9	4.4
3. Mead Release Products	West Chicago	0.	0.	0.	131.8	0.
4. Lear Siegler Inc.	West Chicago	0.	0.	0.	126.9	0.
5. Micro Biotrol Co.	Willowbrook	0.	0.	0.	100.7	0.
6. Waste Management	Naperville	3.5	8.7	102.0	1.7	54.5
7. Alumax Extrusions	St. Charles	36.4	38.9	590.9	1,623.1	116.0
8. Regensteiner	West Chicago	0.	0.	4.8	322.8	0.4
9. Argonne National Lab	Argonne	3.5	319.3	476.6	8.1	30.1
10. Lyon Metal Products	Montgomery	0.7	0.	1.5	203.1	0.
11. Butler Pharmapac	Elgin	1.0	0.	0.	138.6	0.
12. Printpack	Elgin	20.9	0.	4.9	213.5	0.2
13. Guardian Packaging	Batavia	0.	0.	0.6	355.4	0.
14. Riverside Laboratories	Geneva	0.	0.	0.	312.0	0.
15. The Dial Corporation	Montgomery	31.0	0.	270.6	6.0	39.4
16. All Steel Equipment	Montgomery	6.2	0.	6.3	400.0	4.6
17. Caterpillar Tractor	Montgomery	12.4	328.1	313.9	262.6	97.0
18. AT&T Technologies	Montgomery	1.2	0.	10.2	438.9	0.9
19. Michigan Wisconsin	Sandwich	1.5	0.	707.4	8.2	84.1

Source: Illinois EPA 1988.

218-829 0 - 88 - 3 (BOOK 4)

Figure 5.3.4-1

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



X = Air Pollutant Source
* = Ambient Air Quality Monitoring Station

5.3.5 Noise and Vibration

This section describes background noise and vibration conditions in the region of the Illinois SSC site.

5.3.5.1 Ambient Noise Levels

A. Applicable Standards

Applicable noise abatement criteria in the region of the Illinois SSC site have been promulgated by the State of Illinois, the Federal Highway Administration (FHWA), and the Department of Housing and Urban Development (HUD).

The Illinois Environmental Protection Agency delineated its noise guidelines in Title 35, Subtitle H (Noise) of its rules and regulations. The regulation delineates three classes of land use: A, B, and C. Class A land uses are primarily residential, and include houses, hotels, retirement homes, and religious quarters. Class B land uses can be characterized as retail, light industrial, and offices. Allowable noise impacts for Class A and Class B land uses are shown in Tables 5.3.5-1, 5.3.5-2, and 5.3.5-3.

FHWA and HUD noise-abatement criteria are discussed in Section 5.1.5.1.

B. Background Levels

Background noise levels in the vicinity of the site are a strong function of the land use in the area of interest. Measured ambient noise levels are expected to range from a low of 42 dBA on farmlands to a high of 60 dBA in more commercialized areas. The day-night sound level (L_{dn}) would be expected to average 50 dBA (EPA 1982.

C. Proximity to Sensitive Areas

Sensitive receptors in the vicinity of SSC surface facilities include residences, schools, cemeteries, open-space recreational areas, and a forest preserve. Several of the exit/vent areas and service areas will be located close to concentrated residential developments. Specifically, F1, E2, and F2 are located close to neighborhoods in Aurora, F5 is located adjacent to residences in Kaneville, and E7 and F7 are adjacent to residential developments in Lily Lake. The Elburn Forest Preserve is located approximately 1 mi away from F6. The Pheasant Run Resort near St. Charles is located within 1/2 mi of F9. These sensitive receptors are shown in Figure 5.3.5-1.

5.3.5.2 Other Noise Sources

Predominant sources of ambient noise include freeways, highways, light and heavy industry, commerce, and railroads. Major highways and railroads in the region are shown in Figure 5.3.5-1. No measurements of noise produced by these sources are available.

Table 5.3.5-1

ALLOWABLE DAYTIME OCTAVE BAND SOUND PRESSURE LEVELS (dB) OF SOUND EMITTED TO ANY RECEIVING CLASS A LAND FROM CLASS A, B, OR C LAND

Octave Band Center Frequency (Hz)	From Class C Land	From Class B Land	From Class A Land
31.5	75	72	72
63	74	71	71
125	69	65	65
250	64	57	57
500	58	51	51
1,000	52	45	45
2,000	47	39	39
4,000	43	34	34
8,000	40	32	32

Source: State of Illinois Rules and Regulations, Title 35, Subtitle H (Noise).

Table 5.3.5-2

ALLOWABLE NIGHTTIME OCTAVE BAND SOUND PRESSURE LEVELS (dB) OF SOUND EMITTED TO ANY RECEIVING CLASS A LAND FROM CLASS A, B, OR C LAND

Octave Band Center Frequency (Hz)	From Class C Land	From Class B Land	From Class A Land
31.5	69	63	63
63	67	61	61
125	62	55	55
250	54	47	47
500	47	40	40
1,000	41	35	35
2,000	36	30	30
4,000	32	25	25
8,000	32	25	25

Source: State of Illinois Rules and Regulations, Title 35, Subtitle H (Noise).

Table 5.3.5-3

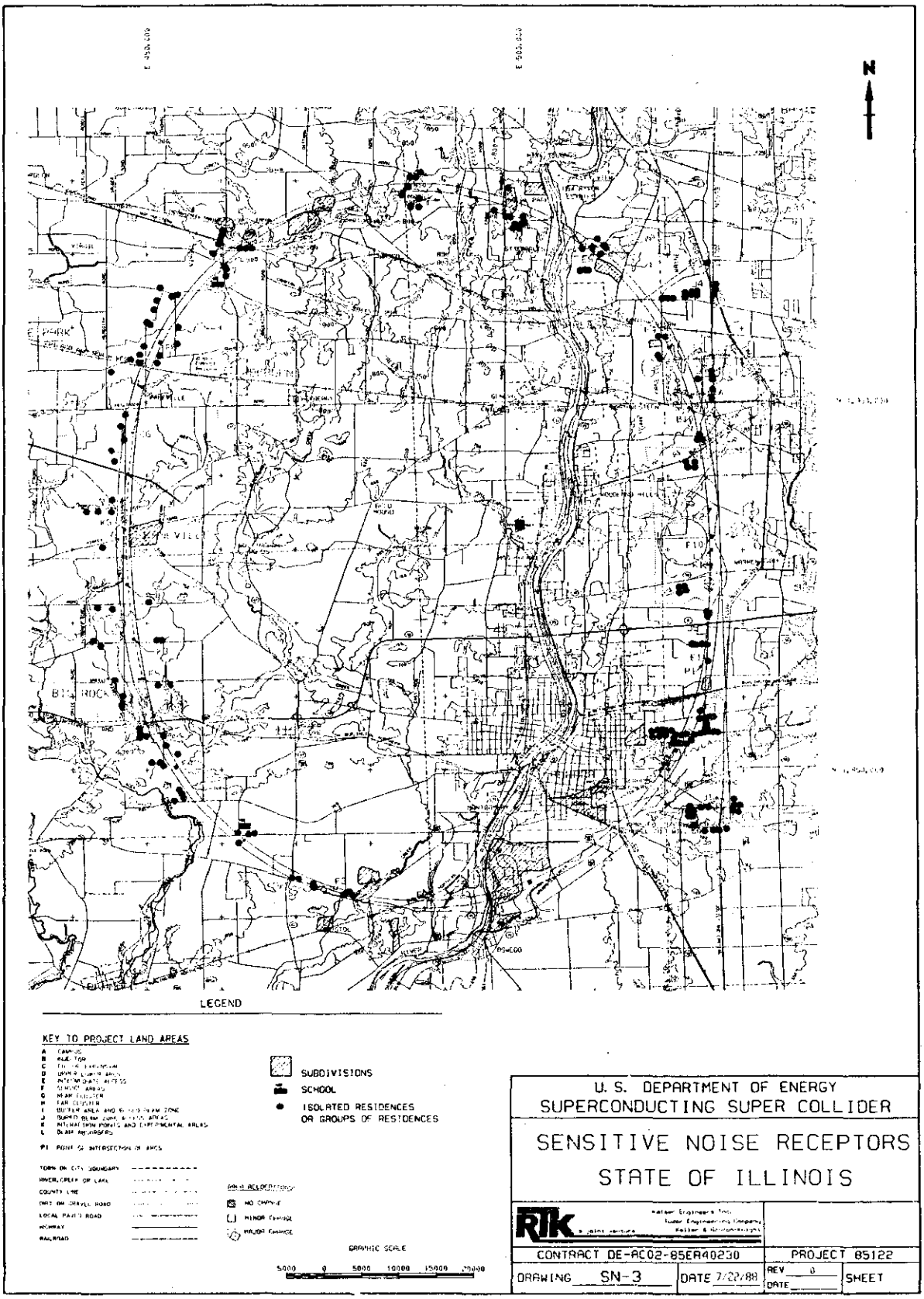
ALLOWABLE NIGHTTIME OCTAVE BAND SOUND PRESSURE LEVELS (dB) OF SOUND EMITTED TO ANY RECEIVING CLASS B LAND FROM CLASS A, B, OR C LAND

Octave Band Center Frequency (Hz)	From Class C Land	From Class B Land	From Class A Land
31.5	80	79	72
63	79	78	71
125	74	72	65
250	69	64	57
500	63	58	51
1,000	57	52	45
2,000	52	46	39
4,000	48	41	34
8,000	45	39	32

Source: State of Illinois Rules and Regulations, Title 35, Subtitle H (Noise).

Figure 5.3.5-1

**SENSITIVE NOISE RECEPTORS
ILLINOIS SSC SITE**



5.3.5.3 Ambient Vibration Levels

Ambient vibration levels in the SSC site vicinity are highly dependent on proximity to man-made vibration sources. Naturally occurring vibrations, which result from weather phenomena exciting vibrations that can travel long distances in the earth, are low frequency (1 Hz or less). Vibrations from large, distant earthquakes will also produce vibrations at the site. Man-made vibrations are discussed in further detail in the next section.

5.3.5.4 Other Vibration Sources

Vibration sources in the region, including railroads, highways, and rock and sand quarries are shown on Figure 5.3.5-2. The collider ring is crossed by the Chicago and North Western Transportation Company (C&N) railroad at three points, the Burlington Northern (BN) railroad at four points, and the Elgin Joliet and Eastern Railway Company railroad at one point. None of these railroads pass within 3,000 ft of an interaction point.

Roads crossing the collider ring at two points include routes 5, 64, 38, 47, 31, and 25. Routes 34 and 30 cross the collider ring at one point. Route 5, a major east-west-travel corridor, passes within 600 ft of interaction point K6. Route 56 passes within 700 ft of interaction point K1.

Vibrations produced by the combination of Route 5, Route 31, and the BN Railroad were monitored and the resulting displacements and frequencies are shown in Table 5.3.5-4 (I.S.G.S. 1987).

Quarry blasting is another regional source of vibrations. There are 3 rock quarries, 38 sand and gravel pits, and 5 sand and gravel pit/rock quarries in the project vicinity. The Conco Western quarry is located 19,000 ft from the collider tunnel and 21,600 ft from the nearest interaction point (K1). The Meyer quarry is located 4,000 ft from the collider tunnel and 21,000 ft from the nearest interaction point (K3). The Fox River quarry is located 7,800 ft from the collider tunnel and 53,000 ft from the nearest interaction point (K1). Vibrations produced at these quarries are not available.

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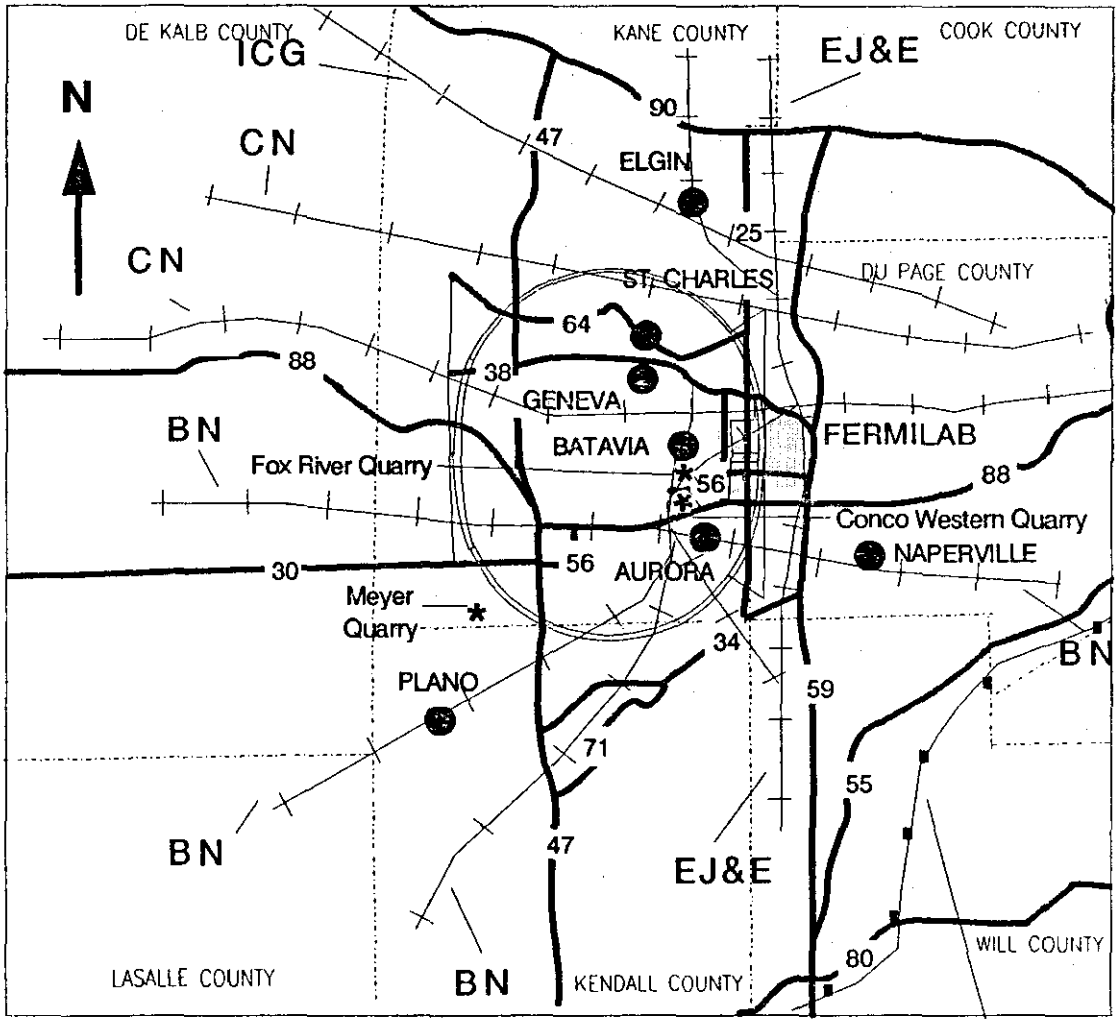
Figure 5.3.5-2

**REGIONAL VIBRATION SOURCES
ILLINOIS SSC SITE**



BN - Burlington Northern
EJ&E - Elgin Joilett & Eastern
ICG - Illinois Central Gulf
CN - Chicago and Northwestern

Table 5.3.5-4

REGIONAL VIBRATIONS
ROADS AND BN RAILROAD
ILLINOIS SSC SITE

Source	Location of Measurement Point Relative to Source Horizontal ft	Vertical ft*	Measured Vibrations Displacement in	Frequency Hz
Route 5	156	0	1.15×10^{-4} - 7.6×10^{-4}	11.9 - 23
Route 5	156	67	1.2×10^{-6} - 3.2×10^{-6}	9.7 - 17
BN Railroad	191	0	6.2×10^{-5} - 1.6×10^{-4}	38 - 42
BN Railroad	191	60	0.5×10^{-6} - 2.6×10^{-6}	9.6

* Feet below ground level.

Source: Bauer 1987.

5.3.6 Environmental Radiation

5.3.6.1 Natural Radioactivity

A. Radon

Indoor radon levels reported by the University of Pittsburgh Randon Project are presented in Table 5.3.6-1. The average indoor radon levels in DuPage and Kendall county residences averaged 2.89 pCi/l (Cohen 1988).

The proposed tunnel elevation places it in the Galena/Platteville dolomite groups. Measured uranium concentrations in these strata ranged from 0.30 to 1.50 ppm, with an average concentration of 0.78 ppm. Assuming equilibrium with Ra-226, the average Ra-226 concentration would be 0.26 pCi/g (Gilkeson et al. 1988). Radon levels in ground water in the Galena and Platteville dolomite groups were also reported by Gilkeson. The Rn-222 concentrations ranged from 162 to 510 pCi/l, with an average of 295 pCi/l.

There are no identified uranium deposits in the proposed area.

B. Soil/Rock

Twenty soil samples collected and analyzed during a survey of Fermi National Accelerator Laboratory (Fermilab) and the surrounding area (Jobst 1981) reported Th-232 concentrations ranging from 3 to 11.3 ppm with an averge of 9.4 ppm. The U-238 concentrations ranged from 1.0 to 3.7 ppm with an average of 2.8 ppm, and the K-40 concentrations ranged from 6.6 to 21 pCi/g with an average of 16.4 pCi/g.

In 1987, three 8-inch boreholes were drilled at three locations on the proposed ring footprint. In-situ measurements using a sodium iodide detector to determine the K-40 concentration and uranium and thorium equivalents were conducted at the three holes. U-238 is assumed to be in equilibrium with its decay product Bi-214 and Th-232 is assumed in equilibrium with its decay product Tl-208. Rock chips from the holes were analyzed by Instrumental Neutron Activation Analysis (INAA). The INAA analysis of 71 samples from six major rock units was reported. The majority of rock samples were from one hole with a limited number of samples from the other two borings. Samples were analyzed from 20-ft spacings at a depth of 300 to 800 ft, and also in locations where the gamma log indicated the highest activities (Gilkeson et al. 1988).

Eighteen samples of Galena dolomite and 14 samples of Platteville dolomite from the samples discussed above were analyzed by INAA (Gilkeson et al. 1988). The Galena dolomite concentration for potassium ranged from 0.03 to 0.91% with an average 0.16%. The concentration for U-238 ranged from 0.40 to 1.40 ppm with an average of 0.78 ppm. The concentration for Th-232 ranged from 0.10 to 2.00 ppm with an average of 0.44 ppm.

Table 5.3.6-1

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[a]						
Living space	49659	1.76	4.01	80	18	2
Basement	23984	3.37	7.87	59	34	7
Illinois[a]						
Living space	2358	1.52	2.32	87	13	0
Basement	1144	2.52	3.80	71	28	1
N.E. Illinois[a]						
Living space	119	---	---	87	13	0
Basement	677	---	---	65	34	1
DuPage County[a]						
Living space[a]	434	1.92	2.84	81	19	0
First floor[b]	31	---	---	87	13	0
Basement[a]	322	3.00	4.11	66	34	0
Basement[b]	134	---	---	62	36	2
Kane County[b]						
First floor	12	---	---	75	25	0
Basement	59	---	---	43	54	3
Kendall County						
Living space[a]	13	3.45	4.29	77	23	0
First floor[b]	2	---	---	100	0	0
Basement[a]	7	3.54	4.41	57	43	0
Basement[b]	26	---	---	35	65	0

Source: a. Cohen 1988.
b. Gilkeson et al. 1988.

The Platteville dolomite ranged from 0.08 to 0.94% K-40, 0.30 to 1.50 ppm U-238, and 0.30 to 1.80 ppm Th-232 with averages of 0.43%, 0.79 ppm, and 0.84 ppm respectively.

Also analyzed were samples of Silurian dolomite, Maquoketa shale, Platteville dolomite, Glenwood sandstone, St. Peter sandstone, and Kress sandstone.

Mean concentrations of potassium, uranium, and thorium in seven bedrock units are listed in Table 5.3.6-2.

A National Uranium Resource Evaluation (NURE) survey was conducted over the Aurora quadrangle (DOE 1981). Uranium concentrations were determined to be from 0.6 to 3.0 ppm in the Aurora quadrangle, with the majority of the area varying from 1.0 to 2.0 ppm. There were no indications of high concentrations of uranium or thorium.

C. Water

Concentrations of Rn-222 and U-238 and U-234 in groundwater from various wells in different geologic units are presented in Table 5.3.6-3 (Gilkeson et al. 1988).

Groundwater samples from four wells (in glacial drift) in the vicinity of the proposed SSC site were analyzed for Rn-222 and uranium. The Rn-222 concentrations averaged 568 pCi/l. Three wells open to the shallow bedrock (Silurian and/or Maquoketa) showed Rn-222 concentrations averaging 574 pCi/l. Nineteen groundwater samples from 18 wells in confined aquifers in the Maquoketa shale group and Galena-Platteville dolomite were analyzed. The Rn-222 concentrations averaged 295 pCi/l. Concentration from six wells in the confined aquifers plus three samples at different depths in a seventh well yielded uranium concentrations with an average of 0.5 pCi/l.

Between 1971 and 1976, 93 samples from public water supply wells in the proposed SSC area in DuPage, Kendall, and Kane counties were analyzed for gross beta and gross alpha activity by the Illinois Environmental Protection Agency (Gilkeson et al. 1988). Groundwater sources include sands and gravels with an average well depth of 106 ft, shallow bedrock with an average well depth of 222 ft, and Maquoketa shale with an average well depth of 241 ft. The gross alpha activity ranged from the lower limit of detection (LLD) to 4.6 pCi/l with an average of 1.2 pCi/l; the gross beta activity varied from LLD to 16.1 pCi/l with an average of 2.8 pCi/l.

Wells more than 1,000 ft deep that produce groundwater from confined sandstones in the Cambrian and Ordovician bedrock are an important source of public water supplies in the siting area. In the proposed siting area, this source of groundwater has low values of uranium and radon but commonly exceeds the U.S. EPA interim standard of 5.0 pCi/l for total dissolved radium.

Table 5.3.6-2

MEAN CONCENTRATIONS OF POTASSIUM, URANIUM, AND THORIUM IN MAJOR BEDROCK UNITS IN THE PROPOSED SSC SITING AREA

Bedrock unit	Number of Samples	K (%)	U (ppm)	Th (ppm)
Silurian dolomite	*	0.62	0.45	2.55
Maquoketa shale	7	3.02	2.45	7.2
(range)		(0.02-4.74)	(0.30-4.60)	(0.30-11.5)
Galena dolomite	18	0.16	0.78	0.44
(range)		(0.03-0.91)	(0.40-1.40)	(0.10-2.00)
Platteville dolomite	14	0.43	0.79	0.84
(range)		(0.08-0.94)	(0.30-1.50)	(0.30-1.80)
Glenwood sandstone	11	1.11	1.2	0.65
(range)		(0.15-2.16)	(0.20-4.10)	(0.24-1.90)
St. Peter sandstone	17	0.63	1.05	1.41
(range)		(0.01-4.41)	(0.30-5.10)	(0.35-5.80)
Kress sandstone	4	1.47	2.03	4.90
(range)		(0.05-2.74)	(0.60-3.90)	(0.10-16.00)

Notes: Mean concentrations determined by instrumental neutron activation analysis.

* Concentrations of potassium, equivalent uranium, and equivalent thorium determined from borehole spectral gamma radiation measurements.

Source: Gilkeson et al. 1988.

Table 5.3.6-3

CONCENTRATIONS OF RADON-222 AND URANIUM-238/234 IN GROUNDWATER FROM VARIOUS WELLS

Geologic Units		Rn-222 pCi/l	U-238/234 pCi/l
Glacial Drift			
Sand and Gravel		670	0.8
		641	-
		462	-
		499	1.1
Shallow Bedrock			
Silurian		740	0.2
		706	-
Silurian/Maquoketa		277	<0.1
Confined Aquifers			
Silurian/Maquoketa/Galena		277	-
		315	0.1
Maquoketa/Galena		286	<0.1
		448	-
		172	-
Maquoketa/Galena/Platteville		190	-
		277	<0.1
		380	-
Galena		459	-
		324	<0.1
		227	-
Galena/Platteville	183	323	
	247	346	1.4
	458	129	
			0.4
Maquoketa/Galena/Platteville/ St.Peter		162	-
St. Peter Sandstone			
Galena/Platteville/St. Peter		510	-
Well SSC	ft		
Galena	400	-	0.1
	460	-	0.56
Platteville	540	-	1.9
St. Peter	800	-	7.21

Source: Gilkeson et al. 1988.

Regionally, Ra-226 concentrations in groundwater vary from 0.5 to greater than 15 pCi/l. The Ra-226 concentrations in groundwater from the Cambrian-Ordovician bedrock at 18 different locations within the proposed ring and townships traversed by the ring ranged from 4.6 to 15.2 pCi/l with an average of 7.3 pCi/l. The regional variation of U-238 (plus U-234) concentrations range from 0.02 pCi/l to 2.5 pCi/l and are less than 0.5 pCi/l throughout most of the region (Gilkeson et al. 1988).

In general, groundwater from aquifers other than the Cambrian and Ordovician bedrock has very low concentrations of radium (Gilkeson et al 1983).

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.

5.3.6.2 Man-made Radiation

Illinois has issued 1,216 licenses authorizing possession or use of radioactive materials. More than 600 facilities currently are licensed to use and possess radioactive materials in northeastern Illinois alone. These facilities collectively hold approximately 900 radioactive material licenses distributed as follows: 370 medical applications; 366 analytical and measurement devices containing radioactive materials, 89 manufacturing processes, 58 research and development, and 21 academic institutions.

Of the facilities holding broadscope licenses for non-fixed radioactive material, three are located in the 36-township area encompassing and surrounding the proposed SSC site. They are:

- Westinghouse Electric Company owns and operates a facility located in Geneva, Illinois, that decontaminates, repairs, and maintains waste shipping containers used to transport low-level radioactive waste. The only radioactive materials present on the Westinghouse site are trace amounts that accrue during decontamination of the waste shipping containers.

- Amoco Corporation, located approximately 15,000 ft from the ring, possesses a number of radionuclides in both sealed and unsealed form for research and development.

- Northern Illinois University in DeKalb uses primarily H-3, C-14, and I-125 in small quantities (less than 10 millicuries).

The above three facilities do not contribute to the radiation background at the proposed SSC site.

There are ten commercial nuclear power reactors located at five generating stations within 50 mi of the proposed site. The stations are:

- Dresden Nuclear Power Station, 25 mi south
- LaSalle County Nuclear Power Station, 37 mi southwest

- Braidwood Nuclear Power Station, 32 mi south-southeast
- Zion Nuclear Power Station, 45 mi north-northeast
- Bryon Nuclear Power Station, 45 mi northwest.

There is one irradiated fuel storage facility, the General Electric Morris Operation, which is located about 25 mi south of the proposed site.

The aforementioned licensed facilities do not release radioactive materials that contribute to the natural radiation background at the proposed site.

Argonne National Laboratory (ANL) is located approximately 20 mi southeast of the proposed SSC site. Located approximately 2 mi east of the present ANL facility is the original ANL site, which contains some buried radioactive and hazardous or toxic waste remnants of the World War II Manhattan Project. Annual site environmental reports for both the present laboratory facility (DOE 1980-1986) and the old Manhattan Project site (DOE 1982-1987) indicate that neither facility will contribute to the background radiation of the proposed site.

There are two facilities that contribute to a very slight degree to the natural background radiation levels. They are the Fermilab which is proposed as the high energy booster part of the SSC main ring and the Kerr-McGee Chemical Corporation chemical processing plant, which is currently shut down.

Fermilab is a high-energy research facility that has both fixed target and collider programs. Tables 5.3.6-4 and 5.3.6-5 summarize the estimated dose equivalent received by the general public from Fermilab activities and the amount of radioactivity released to the environment from 1982 to 1986. The maximum fence-line annual dose equivalents for an individual were estimated based on a 24-hr/day occupancy for a full year at the fence line. The dose contributed from muon exposure was reduced to a negligible level in 1986, through effective use of operation improvements which is reflected in the lowered 1986 values.

The Kerr-McGee chemical processing plant is located approximately 1 mi northeast of the proposed site. From 1931 to 1973, the plant processed monazite ore containing thorium and rare-earth elements (Frigerio et al. 1978). Wastes from this process consisted of rare-earth elements and thorium decay products. Over the years, precipitation-induced runoff transported wastes into a nearby storm sewer and drainage ditch. The wastes were then carried into Kress Creek where they have been deposited at numerous locations downstream from the storm sewer outfall.

A foot-by-foot survey along Kress Creek and the DuPage River (Frigerio et al. 1978) found that dose rates along the banks range from background to 150 μR/h at one meter above ground. Along the DuPage River, deposits found downriver generally represented a dose rate on the order of 25 μR/h at one meter above ground. At least 80% of the total activity along both these waterways is deposited in the first third of the distance along Kress Creek.

Table 5.3.6-4

RADIATION DOSE EQUIVALENT TO THE GENERAL PUBLIC AS A RESULT OF THE FERMILAB ACTIVITIES

	Dose Equivalent				
	1982	1983	1984	1985	1986
Maximum potential radiation dose to an individual at the site boundary (millirem)*	0.5	0.04	0.8	1.5	0.0007
Total potential radiation dose to the general off-site population (person-rem)	2.6	0.1	4.5	1.2	0.003

* Includes dose equivalent from muons, neutrons, gamma rays, and airborne C-11.

Source: Baker 1983-1987.

Table 5.3.6-5

SUMMARY OF RADIOACTIVITY* RELEASED TO THE ENVIRONMENT FROM FERMILAB

Release Point	Radionuclide	Pathway	Annual Release (Curie) 82	83	84	85	86
Magnets debonding oven	^{3}H	Air	0.005	0	0.001	0.003	0.003
Total off-site, release in surface waters	^{3}H	Water	0.530	0.658	0.150	0.165	0.083
Water evaporator (at boneyard)	^{3}H	Air	0.058	0.042	ND	ND	ND
Discharge from a closed loop water system leak	^{3}H	Water	N/A	N/A	0.001	ND	0.001
	^{7}Be	Water	0.230	0.001	0.028	0.025	0.005
Other radionuclides in deep wells	Ra	Water	NC	NC	NC	NC	NC
	Th	Water	NC	NC	NC	NC	NC

Notes: ND - Nondetectable amount.
N/A - Data is not available.
NC - No Change.

* Carbon-11 is not included since it has a short half life of 20 minutes and does not accumulate in the environment.

Source: Baker 1983-1986.

The three major areas of thorium residual activity from the Kerr-McGee facility are contained within security fences. Under present conditions there are no areas that exceed the federal limits set forth in Title 10 CFR Part 20. The total population dose from all sources is estimated to be less than 30 person-rem/yr (Frame 1983).

5.3.6.3 Background Radiation

A radiological survey, which consisted of aerial measurements of gamma radiation levels and the collection and analysis of soil samples on and near the Fermilab site, was conducted by the EG&G Energy Measurements Group for the Department of Energy in 1977 (Jobst 1981). Data from the survey indicate that the dose equivalent rates from gross gamma radiation vary from 88 to 122 mrem/yr. The exposure rates include an assumed 35 mrem/year contribution from cosmic radiation.

The dose equivalent rate in the range of 88 to 122 mrem/yr is substantiated by:

- The value of 105 mrem/yr reported by Baker (Baker 1974) from Fermilab detectors.
- The range of values from 105 to 114 mrem/yr reported by Solon (Solon 1959) for the area.

Twenty soil samples collected in the survey were analyzed for moisture content and radionuclide concentrations. The sum of the dose equivalent rates from each of the identified radionuclides in the soil is 67.4 mrem/yr. If one adds this value to the assumed 35 mrem/yr contribution from cosmic radiation, the total dose equivalent rate is 102.4 mrem/yr, which compares favorably to the range of values from the aerial survey.

5.3.7 Nonradioactive Environmental Hazards

5.3.7.1 Hazardous/Toxic Materials

According to Illinois EPA records consulted, there are no known hazardous waste disposal sites within the proposed SSC area. The Illinois EPA also conducted a computer search of CERCLIS that includes both Federal NPL sites and Illinois Superfund sites. Four NPL sites (all owned by Kerr-McGee) exist in West Chicago, well outside of the SSC corridor. No state-listed sites were found in the vicinity of the proposed site.

A search of the regional U.S. EPA database revealed a total of 24 EPA-permitted TSD facilities in DuPage and Kane counties. The locations of these sites are shown in Figure 5.3.7-1. The only facility situated within the proposed ring location is Fermilab. (Stanley 1988)

In addition, the Illinois EPA conducted a review of all chemical spill incidents reported to the agency from 1980 to the present, and searched their listings of facilities that are subject to the Illinois Chemical Safety Act (requires spill contingency plans) and to the reporting requirements of SARA Title III (O'Brien 1988). The results of the incident search showed four minor spills that occurred within the SSC footprint. None of these resulted in any residual contamination after cleanup. Two gasoline spills occurred outside the ring area, one in Geneva, and the other in Naperville, with uncertain information available on the exact location and extent of cleanup.

Potential sites of chemical releases, based on the Illinois EPA listings, include two facilities on the ring (Fermilab and AT&T) and seven facilities outside the SSC footprint. These sites are shown in Figure 5.3.7-1 and are listed below.

Facilities with Chemical Release Potential per SARA Title III

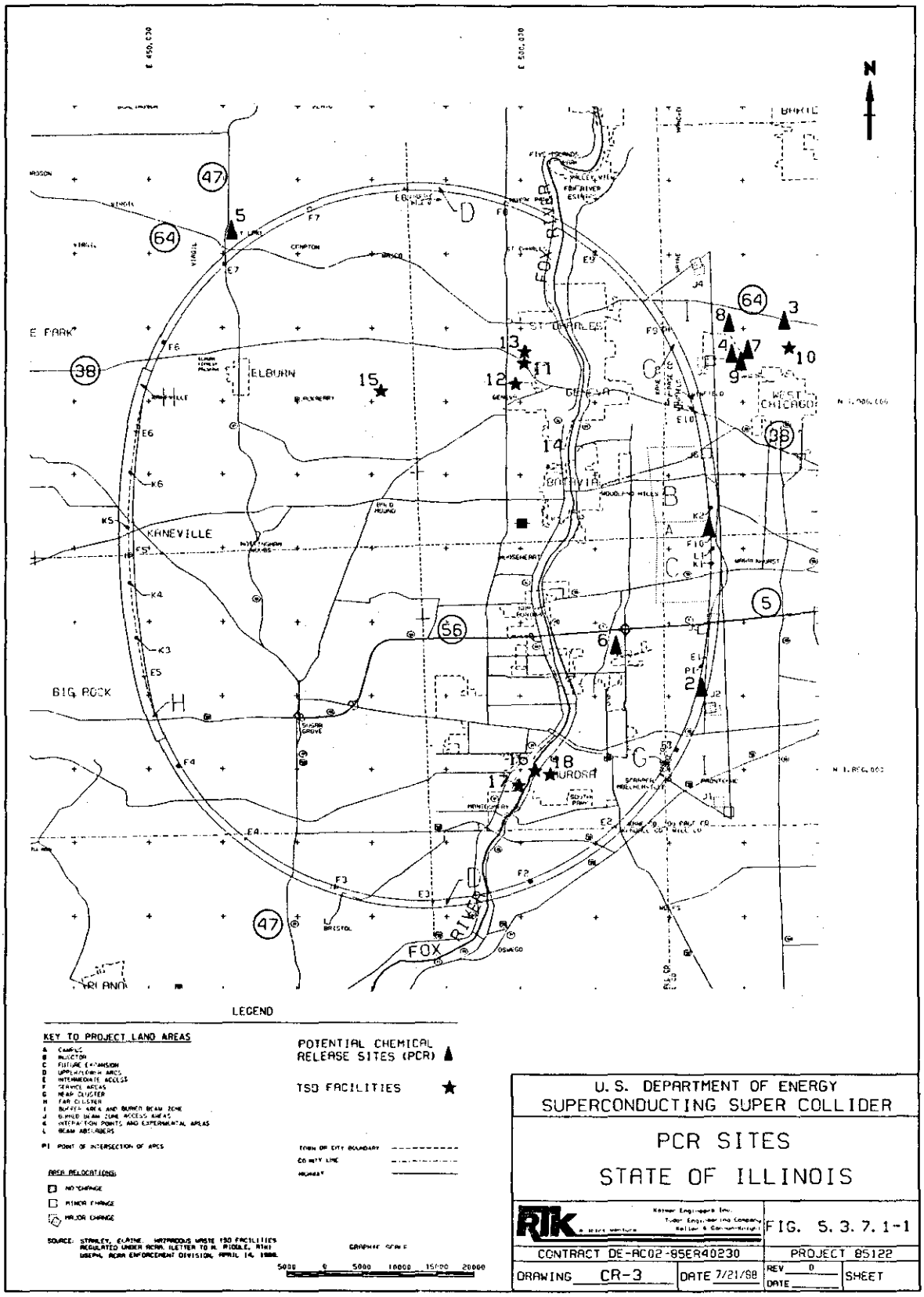
1. Fermilab--Batavia
2. AT&T--Eola
3. Valley Maid Ice Cream Corp.--Aurora
4. Camsco Produce Co.--West Chicago
5. Lear Siegler, Inc.--West Chicago
6. Griffin Wheel Co.--West Chicago
7. James River/Handi-Kup--West Chicago
8. No Sag Products Corp.--West Chicago
9. Pride Petroleum Co., Inc.--Maple Park

5.3.7.2 Biological Hazards

No biological hazards are known to exist in the region of the proposed SSC site.

Figure 5.3.7-1

LOCATIONS OF TSD FACILITIES AND POTENTIAL CHEMICAL RELEASES



5.3.8 Existing Waste Management Facilities

5.3.8.1 Sewage Facilities

Figure 5.3.8-1 shows the approximate location of the existing 14 wastewater sewage treatment plants near the SSC ring. The publicly owned treatment facilities within 30 mi of ring, their distance from the SSC site, their design capacities, existing loads, outstanding permits, and remaining capacities are listed in Table 5.3.8-1. The table shows that the existing sewage treatment plants in the area would be able to accommodate the wastewater loads generated by the SSC main campus.

Table 5.3.8-1

EXISTING SEWAGE TREATMENT PLANTS

Name of Treatment Facility	Approximate Distance From SSC Site, mi	Design Capacity million gal/d	Existing Load[2] million gal/d	Outstanding Permits[2] million gal/d	Remaining Capacity[2] million gal/d
Aurora[1]	6	32.2	23.8	0.68	7.72
Bartlett	12	2.27	0.67	0.16	1.44
Batavia[1]	3	3.00	1.83	0.23	0.94
Carol Stream	10	3.50	1.50	0.94	1.06
Downers-Grove	13	9.6	8.53	0.89	0.18
Elburn[1]	13	1.27	0.20	0.01	1.06
Geneva	4	4.0	1.82	0.24	1.94
Naperville	4	15.0	12.3	1.61	1.09
Oswego	12	0.4	0.28	0.09	0.03
St. Charles[1]	8	8.0	3.78	0.47	3.75
Sugar Grove[1]	12	0.15	0.15	0	0
West Chicago	5	7.64	2.23	0.26	5.15
Wheaton S.D.	9	8.9	5.51	0.11	3.28
Yorkville-Bristol	17	0.70	0.66	0	0.04

Notes: 1. These existing sewage treatment plants are located within the collider ring area.
2. Current data as of May 31, 1988.

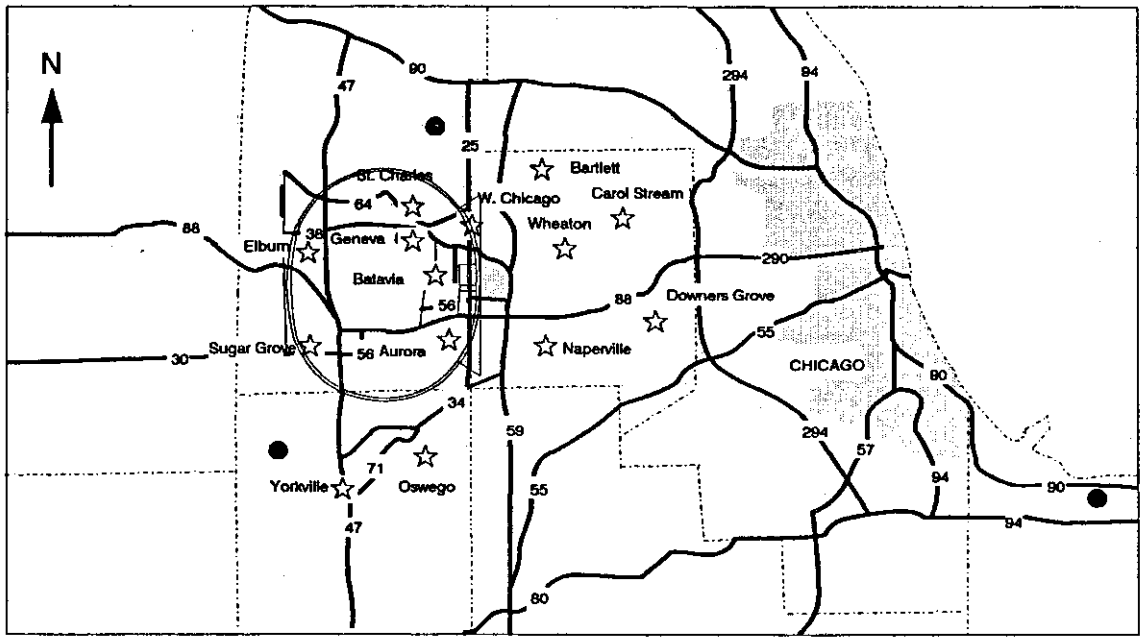
Source: DWPC, Illinois EPA.

The laboratory complex at Fermilab is currently served by the City of Batavia water treatment plant.

The Fermilab Village sewer system is connected independently to the Naperville Springbrook treatment plant via the City of Warrenville system.

Figure 5.3.8-1

APPROXIMATE LOCATIONS OF EXISTING WASTEWATER SEWAGE TREATMENT PLANTS NEAR THE ILLINOIS SSC REGION



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

The closest existing wastewater treatment facility to the proposed far experimental areas is at the Village of Elburn.

5.3.8.2 Solid Waste Facilities

Most of the SSC collider ring would be located in Kane county. The two landfills in Kane county are Settlers Hill landfill and Woodland landfill.

There are 38 landfills in nearby counties: Boone, Cook, DeKalb, DuPage, Grundy, Kankakee, Lake, Lee, Livingston, McHenry, Ogle, Stephenson, Will, and Winnebago. All but four of these landfills will be full in six years.

Figure 5.3.8-2 shows the approximate locations of the two landfills in Kane County and the landfills in Cook, Kankakee, Livingston, and Ogle counties that have more than six years remaining capacities. Table 5.3.8-2 lists the names of the landfills, approximate distance from the SSC site, remaining capacities, current deposition rate, and remaining capacities time.

Table 5.3.8-2

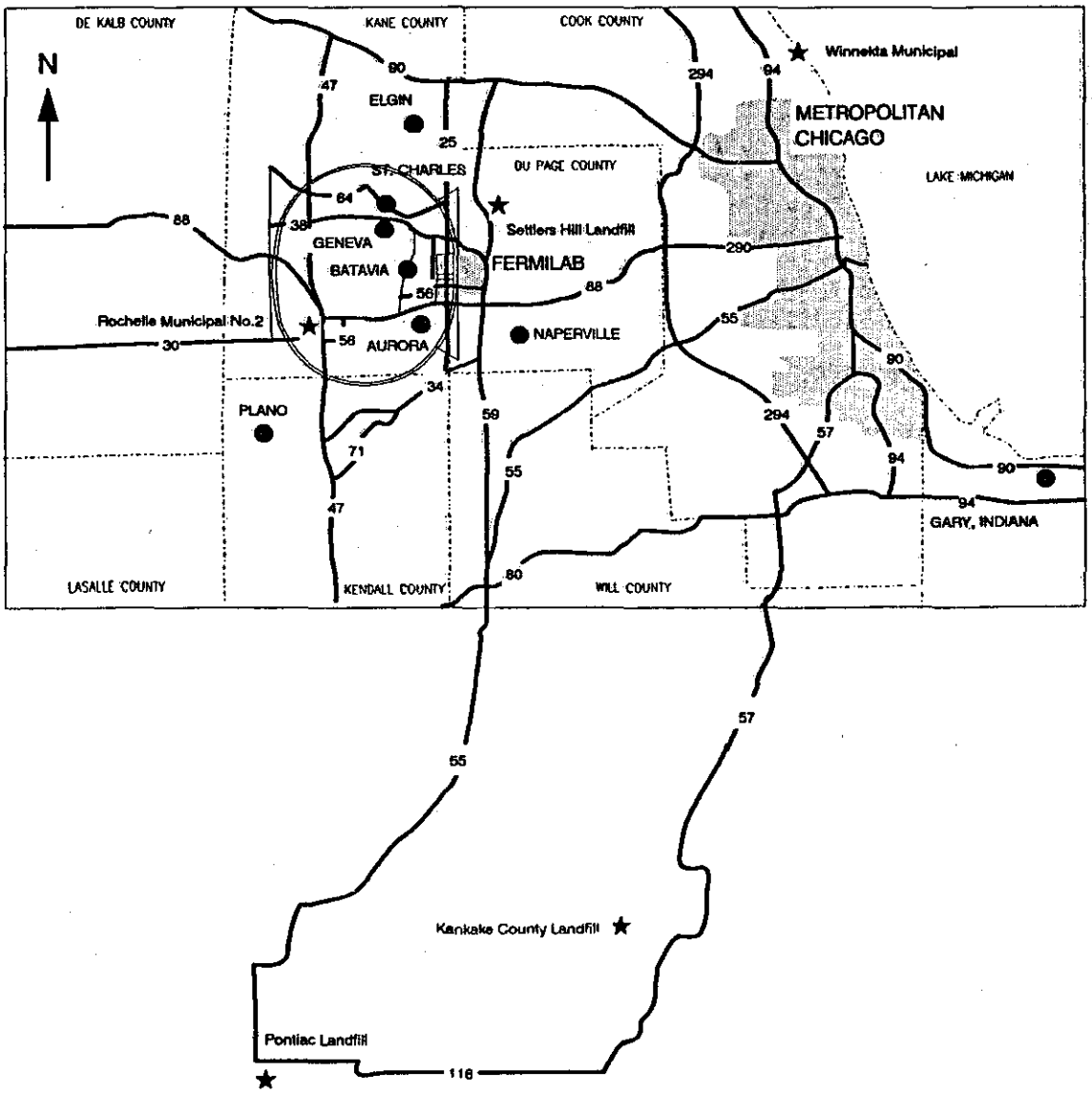
EXISTING LANDFILLS IN COOK, KANE, KANKAKEE, LIVINGSTONE, AND OGLE COUNTIES

County	Landfill	Approximate Distance from SSC site mi	Remaining Capacity yd^3	Current Deposition yd^3/yr	Time Remaining yr
Cook	Winnetka Municipal	30	600,000	44,000	14
Kane	Settlers Hill	5	23,000,000	1,842,000	12
Kane	Woodland	15	2,112,000	1,686,000	1
Kankakee	Kankakee County Landfill	65	6,400,000	253,000	25
Livingston	Pontiac Landfill	100	1,600,000	84,000	19
Ogle	Rochelle Muni No. 2	40	1,612,000	109,000	15

Source: Division of land pollution control·

Figure 5.3.8-2

APPROXIMATE LOCATIONS OF EXISTING SOLID WASTE FACILITIES IN THE ILLINOIS SSC REGION



★ Approximate Location of Existing Solid Waste Facilities in the Illinois SSC Area

In Illinois, Settlers Hill landfill accepts construction solid wastes. The Settlers Hill landfill is near Batavia and is operated by Waste Management. The site is on 150 acres of land.

5.3.8.3 Hazardous Waste Disposal Facilities

There are more than 30 hazardous waste storage, treatment, recycling, incinerating, and processing facilities permitted by the Illinois EPA in northeastern Illinois. A partial list of these facilities is shown in Table 5.3.8-3. Aqueous waste treatment facilities are located in Harvey (Envirite) and Calumet City (Chem-Clear,Inc.), both of which are south of Chicago about 35 to 40 mi from the SSC site. Solvent reclaimers are located in Elgin (Safety Kleen Corp.) and in Chicago (McKesson Chemical, Hydrosol, and Fisher Calo). The Chemical Waste Management incinerator facility located in Chicago will accept nearly any type of liquid waste. Two hazardous waste landfills are available to accept SSC waste, one in Calumet City (CID Landfill) and the other in Winthrop Harbor (BFI No.1).

5.3.8.4 Low-Level Radioactive/Mixed Waste Disposal Facilities

Currently there are no commercial low-level radioactive/mixed disposal facilities operating in Illinois.

Low-level radioactive waste (LLRW) generated in Illinois reached 6,433 m^3 (42,888 Curies) in 1986, as reported by the commercial LLRW disposal sites. Wastes were generated by the government (0.1%), industrial generators (24.6%), and utilities (75.9%). Most of these wastes were Class A LLRW (89.4%). Class B LLRW waste accounted for 9.8% of the total waste volume, and the remaining 0.8% was Class C waste (EG&G 1987).

Table 5.3.8-3

HAZARDOUS WASTE STORAGE, TREATMENT, AND DISPOSAL FACILITIES PERMITTED BY THE ILLINOIS EPA IN NORTHEASTERN ILLINOIS

Company	Location	Waste Accepted	Operation
INCINERATORS			
Chemical Waste Management	Chicago	Organics, solvents, waste oil, commercial chemical products, non-metallic inorganics, pesticides, PCBs	Incineration
SOLVENT RECLAIMERS			
Safety Kleen Corp.	Elgin	Chlorinated solvents	Treat/Store
Hydrosol, Inc.	Chicago	Flammable solvents	Treat/Store
McKesson Chemical	Chicago Heights	Chlorinated, fluorinated, and flammable solvents	Treat/Store
RECYCOL	Des Plaines	Aromatic, aliphatic and chlorinated solvents	Recycle
Fisher Calo	Chicago	Aromatic, chlorinated solvents; amides, amines, and ethers	Treat/Store
Custom Organics	Chicago	Halogenated and non-halogenated solvents	Recycle
Baron Blakeslee	Cicero	Chlorinated solvents	Recycle
WASTE OIL RECYCLERS			
Petrochem Services	Lombard	Waste oils	Recycle
MORCO	McCook	Diesel oil drainings	Recycle
Interstate Pollution Control	Rockford	Fuel, coolant and oils	Recycle
Envirite	Harvey	Commercial and industrial aqueous waste	Treat
Chem-Clear, Inc.	Chicago	Commercial and industrial aqueous waste	Treat
CID Processing	Chicago	Commercial and industrial aqueous waste	Treat

5.3.9 Ecological Resources

5.3.9.1 Regional Ecological Resources

This area is the site of a prairie restoration project that has allowed a remnant prairie community within an otherwise agricultural and suburban development west of Chicago.

A. Definition of Drainage Basin and Boundaries

The proposed Illinois site is located within a transitional zone between the eastern lake and the till plain section of the interior lowlands physiographic province (Fenneman 1936). The great majority of the proposed SSC site lies within the Fox River drainage basin (Figure 5.3.9-1). The Fox River is the third largest tributary of the Illinois River (COE 1984) and drains approximately 2,660 mi^2. A small portion of the site is drained along the eastern edge by the West Branch of the DuPage River near West Chicago. The final portion of the site, along the northwestern edge, drains west to the South Branch of the Kishwaukee River.

B. Relationship of Ecological Resources with Other Resources

The proposed Illinois site is a complex heterogeneous portion of what historically was the eastern portion of the Great Plains.

The primary resources most closely coupled to ecological resources within the proposed Illinois site are soils, plant root zone, hydrology, and land, especially prime farmlands.

In the short-term, ecological systems in the suburban/rural transition zone of the proposed site area are affected primarily by development. In the long-term they are affected by increased pollutant loading in air, water, and soil, by regional development trends, and by agricultural practices.

C. Classification of Ecotypes and Their Distribution

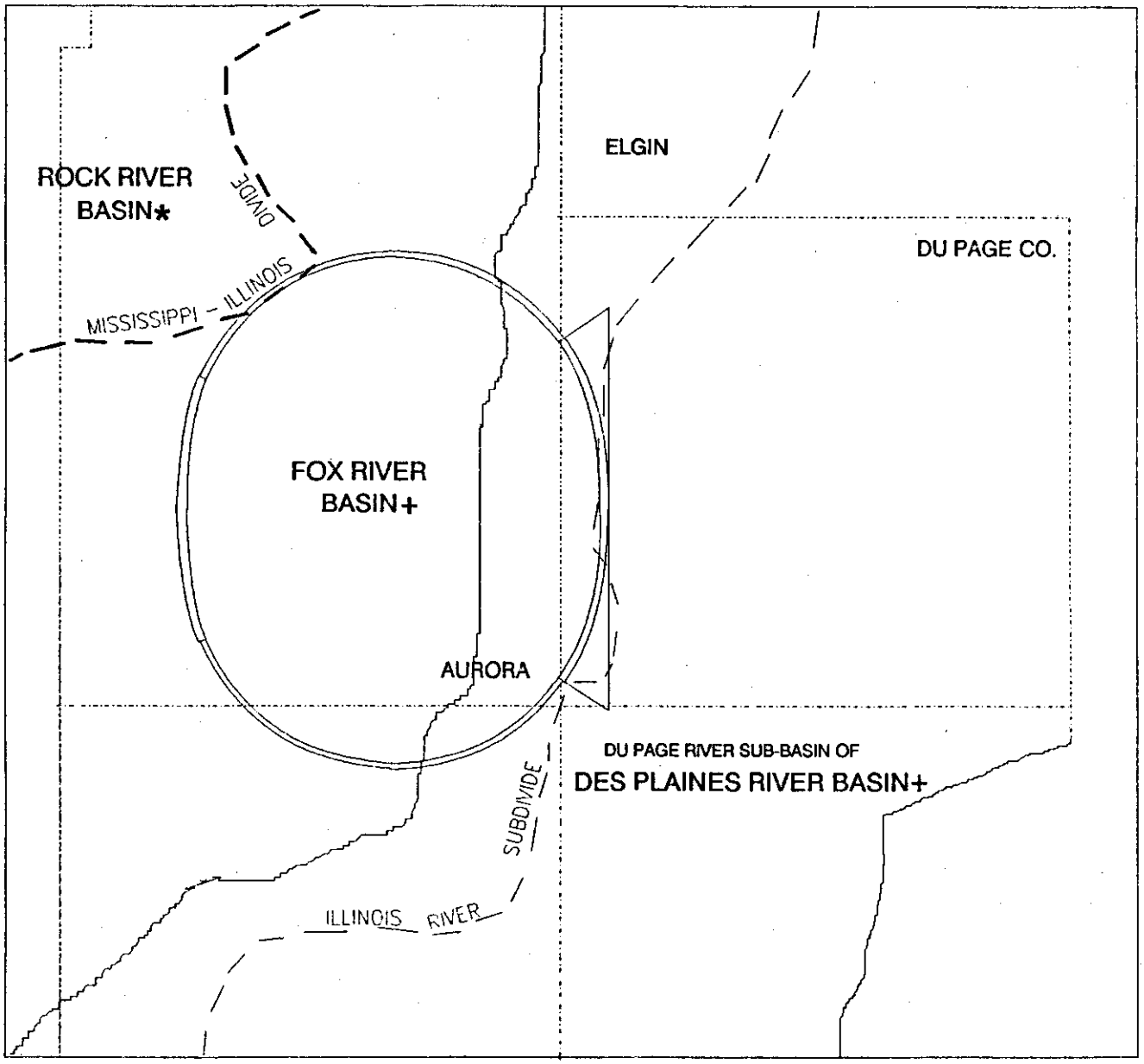
The proposed site is located within a patchwork of forest, prairie, agricultural, wetlands, and aquatic ecotypes. Both terrestrial and aquatic ecotypes in the area are diverse though not extensive.

The terrestrial ecotypes summarized in Section 5.3.9.2 include:

- Upland forests (mesic and dry)
- Floodplain forests and forested fens
- Savanna
- Mesic prairie, wet prairie, and prairie reconstruction
- Shrub wetlands
- Marshes and sedge meadows
- Agricultural systems, including timber lands, row croplands, hayfields and successional old fields.

Figure 5.3.9-1

RIVER BASINS OF ILLINOIS SITE VICINITY



+ ILLINOIS RIVER BASIN
* MISSISSIPPI RIVER BASIN

Aquatic ecotypes in the area are also diverse. They include small ponds and lakes, reservoirs, and numerous miles of first and second order streams and small rivers. The aquatic portion of the three-county area is approximately 8% and provides substantial aquatic resources.

5.3.9.2 Terrestrial Ecosystem Characteristics

A. Plant Community Composition

Seven wetland communities and nine upland communities in the area (Whilte (1978) and Cowardin et al. (1979) are identified. Figure 5.3.9-2 shows the distribution and relative proportions of the various terrestrial ecotypes found in the proposed Illinois site. These include conifer and hardwood forests/woodlands, mixed forest stands, urban/suburban associations, and agricultural systems.

1. Forests and Woodlands (Mesic)

There are numerous small forest stands in the proposed site area. They are diverse and in general represent second-growth mesic forest communities having high productivities and extensive understories. Table 5.3.9-1 summarizes the composition of the forest communities in the region.

a. Upland Forests

The upland forests in the area occur in a gradient from dry to wet but are all mesic upland sites. The dry mesic forests are primarily on sites that were predominantly savannas prior to the suppression of prairie fires by settlers. They occur mostly on level or almost level upland sites that are well drained and seasonally xeric. The canopies are fairly open and the trees young to moderately mature, usually 2 to 50 years old. Oaks usually dominate the canopy species, principally red oak, white oak, and black oak. Other oaks such as burr and chestnut occur, as do shagbark hickory, white ash, and black walnut. The understory is dominated by tree seedlings and immigrant shrubs, including box elder, sugar maple, black cherry, European highbrush cranberry, buckthorn, honeysuckle, gooseberry, and wild rose (Table 5.3.9-1).

The dry mesic forest community is generally considered climax, maintained by fire suppression techniques. Occasionally, this association may also be caused by removal to make room for housing developments.

The mesic upland forest is found on the grounds of Fermilab and near Big Rock Creek. These stands are denser than the dry mesic stands and are usually in early or mid-succession. The dominant canopy species are burr oak, sugar maple, basswood, red oak, white ash, and black maple. Understory species include sugar maple, hop hornbeam, white ash, and black cherry, bladdernut, and blue beech (see Table 5.3.9-1).

Figure 5.3.9-2

VEGETATION MAP FOR THE PROPOSED ILLINOIS SITE

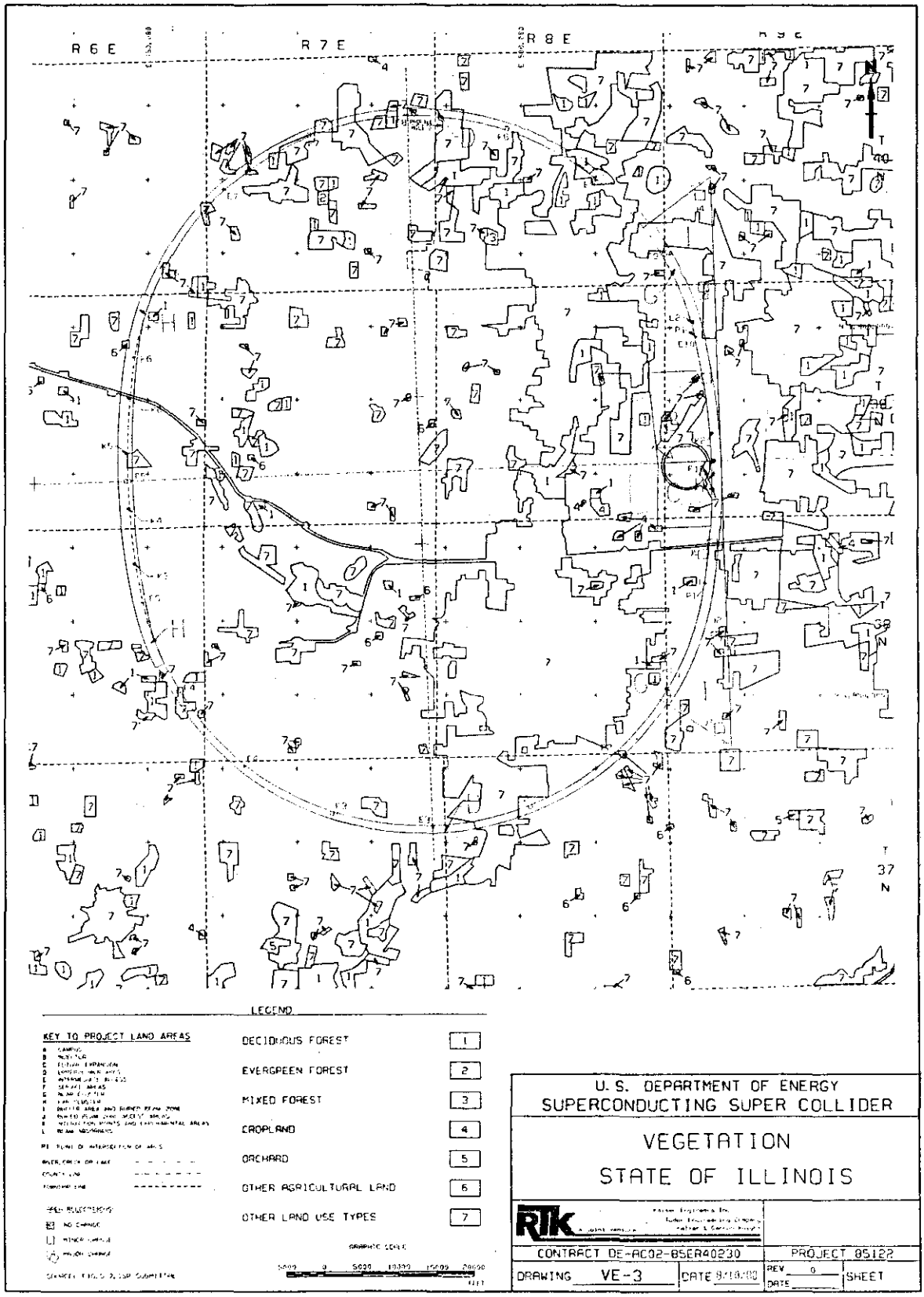


Table 5.3.9-1

DOMINANT WOODLAND SPECIES IN THE PROPOSED ILLINOIS SSC SITE

Forest Type	Canopy Dominants	Other Canopy Species	Typical Understory
Upland Forests	White oak Red oak Black oak Sugar maple Basswood American elm Slippery elm Burr oak	Shagbark hickory Other hickories Buckeye Mulberry	Hop hornbeam Black haw Blue beech Bladder nut
Savannah Remnants	Burr oak White oak Black oak	Black maple Shagbark hickory	Hazelnut Many herbs, grasses
Floodplain Forests and Fens	Sugar maple Basswood American elm Slippery elm (No real dominants)	Black walnut White ash Hackberry Green ash Swamp white oak	Box elder Slippery elm Winterberry Prickly ash

Source: White 1978; IFWIS 1988.

b. Floodplain and Fen Forests

Forested fens and floodplain forests are found near flowing bodies of water in the site area. These communities are usually in early to mid-successional stages and are heterogeneous with respect to dominant trees, especially on the wetter sites. Many of the fen sites have been degraded by historical practices of logging and livestock grazing. Characteristic understory species are skunk cabbage, marsh marigold, blue iris, and fowl manna grass, wild ginger, Virginia waterleaf, false rue anemone, and swamp buttercup.

c. Savannas

Savannas are extremely rare in the area. A degraded remnant is found along the Burlington Northern Railroad, immediately north-northeast of Bristol. Open canopy, burr oak dominates the area. Native herbs are in

the understory, including Indian grass, round-headed brush clover, rosinwood, yellow giant hyssop, and dogbane. These areas are greatly disturbed from mowing, logging, and grazing. The lack of periodic wildfires also encourages invasion of the area by woody species.

2. Prairies

There are three types of remnant prairie in the area. These are the mesic prairie, wet mesic prairie, and prairie reconstruction on Fermilab property. The mesic prairie occurs now only at the western extreme of the West Chicago Prairie Natural Area (Figure 5.3.9-1). It requires fire maintenance and is extremely diverse. Characteristic of the vegetation are big bluestem, switch grass, tall coreopsis, wild bergamot, prairie dock, and Culver's root.

The wet mesic prairie occurs in a railroad right-of-way near the proposed campus in the West Chicago Prairie Natural Area. This prairie characteristically includes tussock sedge, bluejoint grass, prairie cord grass, big bluestem, Riddell's goldenrod, and New England aster.

The prairie reconstruction project at Fermilab is located in areas formerly farmed. Dr. Robert Betz, Northeastern University, is heading the project. The plantings include native prairie grasses and forbs (ANL 1986). Table 5.3.9-2 summarizes the common remnant prairie species found in the area.

Table 5.3.9-2

**REMNANT PRAIRIE DOMINANT SPECIES
IN THE PROPOSED
ILLINOIS SSC SITE**

Common Remnant Prairie Plants
Big bluestem*
Culver's root
New England aster*
Prairie dock
Riddell's goldenrod
Switch grass
Tussock sedge*

* Dominant on wetter sites.

Source: IFWIS 1988.

3. Agricultural Systems

There are no commercial timber operations in the area. Woodlands present are diverse and are used variously for nature study and recreational activities. A few commercial nurseries and forest plantations are present and are producing nonnative conifers, ornamental shrubs, and shade trees.

Croplands are frequent, especially in the western portions of the proposed site. These are very productive systems, producing corn and soybeans, primarily. These prime farmlands have been depleted through many years of cropping, requiring large inorganic fertilizer applications to maintain productivity. Winter plantings of green manure crops are becoming more common, increasing fertility and stabilizing productivity to some degree. A summary of the trends in corn and soybean production is given in Table 5.3.9-3.

Table 5.3.9-3

AGRICULTURAL PRODUCTION AT PROPOSED ILLINOIS SSC SITE

	Bushels per Thousand Acres					
	DuPage County		Kane County		Kendall County	
Crop	1981	1985	1981	1985	1981	1985
Corn	16.9	19.5	112.3	116.9	93.5	101.3
Soybeans	16.1	11.0	65.8	59.0	61.9	63.0

Source: Illinois Department of Agriculture 1986.

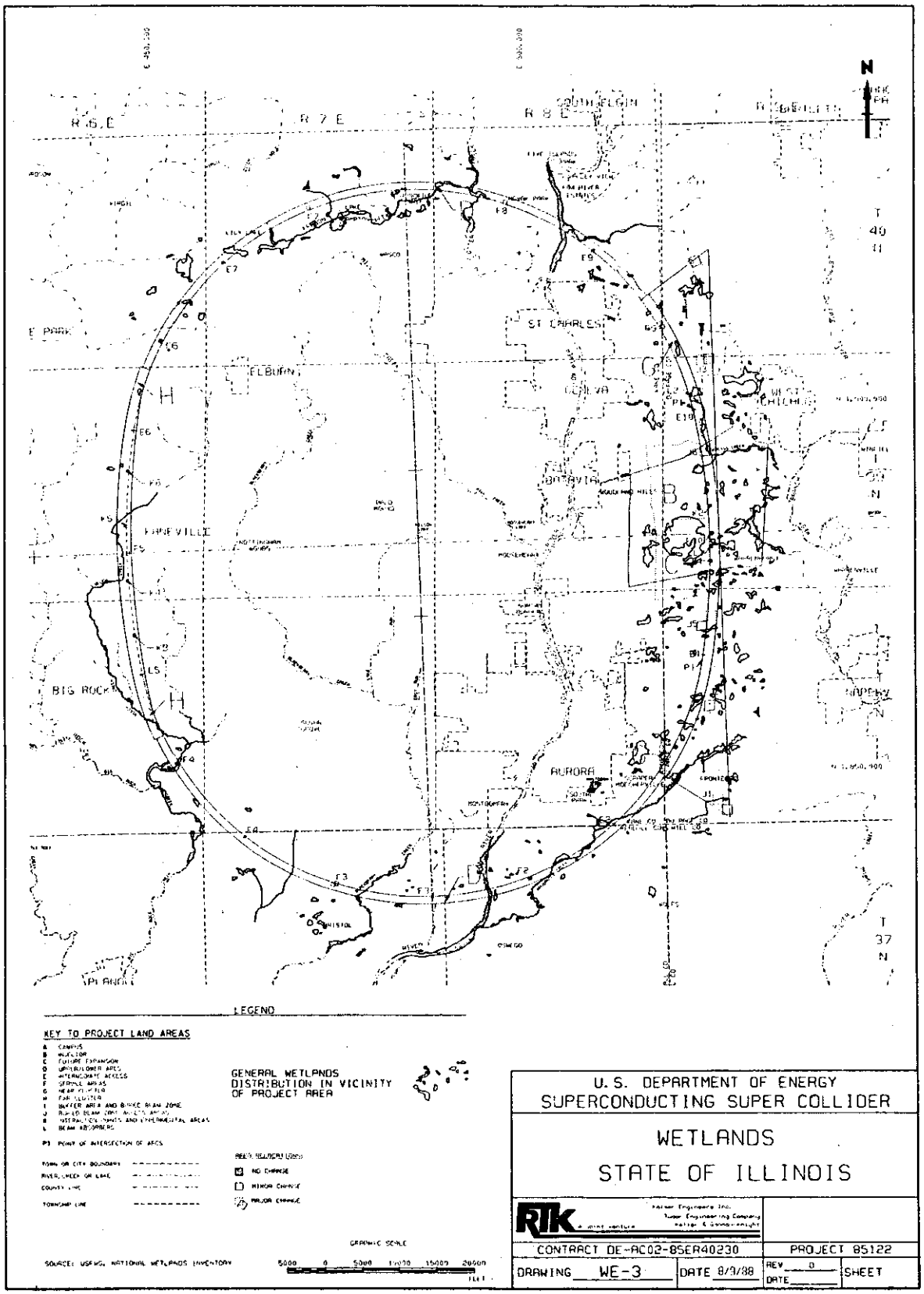
Pasture and hayfields are occasionally present on sites that were naturally burr oak savannas. These are generally planted in cool-season grasses and/or legumes. They are grazed or mowed periodically for hay or silage production.

4. Wetland Systems

In addition to the floodplain forests, there are shrub wetlands, marshes, and sedge meadows in wetlands in the area of the site (See Figure 5.3.9-3). The shrub wetlands are thickets of shrub-sized trees, shrub species, and grasses/forbs of the area, both native and introduced. Dominants include sandbar willow, black willow, cottonwood, box elder, and red-osier dogwood. In openings, marsh vegetation, including reed canary grasses, is typical. Introduced plants, including Kentucky blue grass, wild rose, and weeping willows are also found.

Figure 5.3.9-3

LOCATIONS OF WETLANDS IN THE PROPOSED ILLINOIS SSC SITE



Marshes are successional communities near waterways dominated by emergent wetland species. These include areas that have been degraded by siltation from dredging as well as diverse, high-quality marshes, such as that on the south side of the Burlington Northern Railroad in Eola. Typical dominants are reed canary grass and cattail with occasional rushes. Young willow and purple loosestrife are also found. Open water is usually found in the middle of these marshes

Sedge meadows are very rare in the area. A small one, which has been degraded by dredging, lies immediately south-southwest of Lily Lake. A higher quality meadow is located southwest of Kress Creek north of the proposed accelerator ring. The meadow is dominated by sedges with occasional swamp milkweed, common boneset, and cattail.

B. Animal Community Composition

Terrestrial animal communities are largely remnant communities that have adapted to suburban areas and the refuges offered by the nature preserves and portions of the Fermilab property. In addition, there are appreciable livestock holdings in the area of the site.

1. Invertebrates and Herpetofauna

The diversity of invertebrates in the area is high. Soil invertebrate communities are associated with the vegetation type and limited in distribution to those boundaries. Aerial invertebrates, including those common to both rural and urban areas are present in the three-county area.

Amphibians and reptiles are largely limited to pockets of suitable habitat in nature preserves, to the Fermilab properties, and to the croplands, particularly in spring and fall. Twenty-six species of reptiles and fifteen species of amphibians are reported in the site area. Table 5.3.9-4 lists the more common ones.

Table 5.3.9-4

REPTILES AND AMPHIBIANS COMMON TO THE PROPOSED ILLINOIS SSC SITE

Common Reptiles	Common Amphibians
Fox snake	Tiger salamander
Garter snake	Tree frog
Water snake	Bull frog
DeKay's snake	Leopard frog
Mud turtle	Spring peeper
Box turtle	
Gopher turtle	
Snapping turtle	

Source: IFWIS 1988.

2. Livestock

While a few sheep and dairy herds and poultry houses are in the area they have little economic impact. However, beef and pork production are significant. Trends in beef cattle and hog/pig production are given in Table 5.3.9-5.

Table 5.3.9-5

LIVESTOCK PRODUCTION TRENDS AT THE ILLINOIS SSC SITE

	Number of Heads by County					
	DuPage County		Kane County		Kendall County	
Livestock	1981	1985	1981	1985	1981	1985
Beef Cattle	300	0	1,600	1,700	1,300	1,100
Hogs/Pigs	2,300	2,400	41,400	35,600	40,700	34,200

Source: Illinois Department of Agriculture 1986.

3. Common Wildlife

Data on common as well as economically important or threatened and endangered animal species are available from the Illinois Fish and Wildlife Information System (IFWIS). The IFWIS documents 249 species of bird and 40 species of mammals in the area. Table 5.3.9-6 summarizes the most common mammals in the study area. These are typically associated with both mixed woodlands and remnant prairie, as well as rural/suburban transition zones.

Common birds in the area are summarized as summer and winter inhabitants on Table 5.3.9-7. The diversity of birds is high, and are often distributed throughout the various ecotypes of the region. In addition, the multiple ponds, reservoirs, and the Fox River serve as habitat for Canadian geese and other major migratory populations.

Table 5.3.9-6

COMMON MAMMALS IN THE PROPOSED ILLINOIS SSC SITE

Fallowdeer (confined to ANL/Fermilab)	Mink
White-tailed deer	Muskrat
Cottontail rabbit	Eastern chipmunk
Opossum	Eastern mole
Racoon	Weasel
Striped skunk	Fox
Woodchuck	Gray squirrel
Mice (several species)	Brown bat (caves)
13-lined ground squirrel	Little brown bat (caves)
Norway rat	Keen's bat (caves)
Short-tailed shrew	Silver-haired bat (trees)
Prairie vole	Big brown bat (caves)
Meadow vole	Red bat (trees)
Gray fox	Hoary bat (trees)
Red fox	Evening bat (trees)
Least weasel	
Long-tailed weasel	

Source: IFWIS 1988.

Table 5.3.9-7

BIRDS OF THE ILLINOIS SSC SITE BY SEASON(S) OF RESIDENCE

Summer Residents		Winter Residents
	High Densities	
Starling		Starling
Crow		Crow
Mallard		Mallard
Blue jay		Blue jay
Black-capped chickadee		Black-capped chickadee
Sparrows (field, song chipping, house)		Sparrows (song, tree)
		Dark-eyed junco
Grackle		
Robin		
Swallows (barn, rough-winged tree, purple martin)		
Redwing blackbird		
	Low Densities	
Redtailed hawk	Chimney swift	Redtailed hawk
American kestrel	Western meadowlark	American kestrel
American goldfinch	Nighthawk	American goldfinch
Cardinal	Brown-headed cowbird	Cardinal
Rock dove	Rufous-sided towhee	Grackle
Kingfisher	Brown thrasher	Rock dove
Horned lark	Eastern kingbird	Kingfisher
Yellow throat warbler	Rose-breasted grosbeak	Horned lark
Indigo bunting	Catbird	Mute swan
Northern oriole	Killdeer	Wild turkey
Pheasant	Mourning dove	
	Mute swan	

Source: IFWIS 1988.

C. Ecosystem Level Processes

Reclamation of disturbed areas is fairly rapid, usually dependent upon old field succession of fire cherry, grasses and rapid-growing trees such as eastern red cedar, and black locust.

5.3.9.3 Aquatic Ecosystems

1. Lotic Ecosystems

The major lotic environment in the area is the Fox River which is also the major recreational resource in the area, especially for sportsfishing. Native populations of smallmouth bass exist in the upper reaches of the river. Pools contain largemouth bass, green sunfish, pumpkinseed sunfish, orangespotted sunfish, and black and white crappie (Table 5.3.9-8).

The remaining streams, especially in the eastern portion of DuPage County, are polluted and support only rough or forage species, if any at all. Pollution sources include turbidity and siltation, leaving carp and sucker species as dominant.

2. Lentic Ecosystems

There are no appreciable lentic ecosystems in the area. The marshes and sedge meadows were discussed in Section 5.3.9.2 above. There are numerous small ponds and a few larger farm impoundments used primarily for livestock.

5.3.9.4 Economically, Recreationally, and Culturally Important Species

There are no culturally important species in the area proposed for the SSC site. Hunting and fishing are primary recreational resources in the area.

Table 5.3.9-9 lists the major game birds in the area by habitat. Table 5.3.9-10 lists the principal sports and commercial fishes. Table 5.3.9-11 lists the major migratory fishes that occur seasonally in the site area.

Table 5.3.9-8

COMMON FISH IN THE PROPOSED ILLINOIS SSC SITE

	Primary Habitats			
Fish	Lakes	Streams/Rivers	Ponds	Wetlands
Central mudminnow	X	X	-	X
Grass pickerel	X	X	X	X
Northern pike	X	X	-	-
Bigmouth shiner	-	X	-	-
Blacknose dace	-	X	-	-
Blacknose shiner*	-	X	-	-
Bluntnose minnow	X	X	X	X
Brassy minnow	-	X	-	-
Bullhead minnow	X	X	-	-
Carp	X	X	X	X
Central stoneroller	-	X	-	-
Common shiner	X	X	X	-
Creek chub	-	X	-	-
Emerald shiner	X	X	X	-
Fathead minnow	X	X	X	X
Golden shiner	X	X	X	X
Goldfish	-	X	-	-
Hornyhead chub	-	X	-	-
Largescale stoneroller	-	X	-	-
Mimic shiner	-	X	-	-
Redfin chiner	-	X	-	-
Roseyface shiner*	-	X	-	-
Sand shiner	X	X	-	-
Southern redbelly dace*	-	X	-	-
Spotfin shiner	X	X	-	-
Spottail shiner*	X	X	-	-
Steelcolor shiner*	-	X	-	-
Striped shiner	-	X	-	-
Suckermouth minnow	-	X	-	-
Bigmouth buffalo	X	X	X	-
Black redhorse*	-	X	-	-
Golden redhorse	-	X	-	-
Highfin carpsucker*	-	X	-	-
Lake chubsucker	X	X	X	-
Northern hog sucker*	-	X	-	-
Quillback	-	X	-	-
River carpsucker	X	X	-	-
River redhorse*	-	X	-	-
Shorthead redhorse	X	X	-	-
Silver redhorse	-	X	-	-

Table 5.3.9-8 (Cont)

COMMON FISH IN THE PROPOSED ILLINOIS SSC SITE

	Primary Habitats			
Fish	Lakes	Streams/Rivers	Ponds	Wetlands
White sucker	X	X	-	-
Black bullhead	X	X	X	-
Brown bullhead	X	X	X	-
Channel catfish	X	X	X	-
Flathead catfish	-	X	-	-
Slender madtom*	-	X	-	-
Stonecat	X	X	-	-
Tadpole madtom*	X	X	-	-
Yellow bullhead	X	X	X	-
Blackstripe topminnow	X	X	-	-
Brook stickleback	X	X	-	-
Brook silversides	-	X	-	-
White bass	X	X	-	-
Yellow bass	-	X	-	-
Black crappie	X	X	X	X
Bluegill	X	X	X	X
Green sunfish	X	X	X	X
Largemouth bass	X	X	X	X
Longear sunfish*	X	X	X	X
Orangespotted sunfish	X	X	X	X
Pumpkinseed	X	X	X	X
Rock bass*	X	X	X	X
Smallmouth bass	X	X	-	-
Warmouth	X	X	X	X
White crappie	X	X	X	X
Banded darter*	-	X	-	-
Blackside darter	-	X	-	-
Fantail darter	-	X	-	-
Iowa darter	-	X	-	-
Johnny darter	-	X	-	-
Least darter	X	X	-	-
Logperch	-	X	-	-
Orangethroat darter	-	X	-	-
Rainbow darter	-	X	-	-
Slenderhead darter*	-	X	-	-
Walleye	X	X	-	-
Yellow perch	X	X	-	-
Mottled sculpin*	X	X	-	-

* Intolerant species, rare except in preserve, high quality waters.
Source: Selected from IFWIS 1988.

Table 5.3.9-9

GAME BIRDS OF THE SSC SITE

	Habitat				
Game Bird	Forest	Agriculture	Prairie	Wetlands	Urban
Pied-billed goose				X	
Canada goose	X	X	X	X	X
Snow goose	X	X		X	X
Mallard		X		X	X
American black duck	X	X		X	X
Gadwall	X	X		X	X
Green-winged teal		X	X	X	X
American widgeon		X		X	
Northern pintail		X	X	X	
Northern shoveler		X		X	X
Blue-winged teal	X	X		X	X
Wood duck	X			X	
Canvasback		X		X	X
Redhead			X	X	
Ring-neck duck	X	X		X	X
Lesser scaup	X	X		X	X
Oldsquaw				X	X
Common merganser	X			X	
Hooded merganser	X	X		X	X
Red-breasted merganser				X	
American coot	X			X	X
American woodcock		X	X	X	X
Gray partridge		X	X		
Ring-necked pheasant	X	X	X		
Mourning dove	X	X	X	X	X
Crow	X	X	X	X	X

Source: IFWIS 1988.

Table 5.3.9-10

SPORTS AND COMMERCIAL FISH SPECIES ILLINOIS SSC SITE

Fish	Habitat: Lentic Systems	Habitat: Rivers/ Creeks	Habitat: Marshes
Rainbow trout	X	X	
Northern pike	X	X	
Grass pickerel		vegetated zones	
Carp	X	X	X
River carpsucker		pools	
Northern hogsucker		clear, fast riffles	
Bigmouth buffalo	X	slow flow	
Quillback carpsucker	X	X	X
White sucker	X	X	X
Lake chubsucker	vegetated, high flow		X
Channel catfish	X	X	X
Yellow bullhead		X	
Brown bullhead	vegetated high flow	X	
Black bullhead	X	X	
Yellow bass	X		
White bass	clear	clear	
Smallmouth bass		cold	
Largemouth bass	vegetated	vegetated	
Green sunfish	X	X	X
Pumpkinseed sunfish	vegetated		
Orangespotted sunfish	X	X	X
Warmouth	X	X	X
Bluegill	vegetated	vegetated	vegetated
Rock bass		clear, vegetated pools	
Black, white crappie	X	X	X
Walleye	X	X	
Yellow perch	clear, vegetated	clear, vegetated pools	

Sources: Vidal 1968, 1969; Tickacek and Wright 1971; Smith 1979.

Table 5.3.9-11

MIGRATORY FRESHWATER FISH IN THE PROPOSED ILLINOIS SSC SITE

Migratory Fishes	
Grass pickerel	Golden redhorse
Common carp	Shorthead redhorse
Quillback	Black bullhead
White sucker	White Bass
Northern hogsucker	Rock bass
Bigmouth buffalo	Smallmouth bass
River redhorse	

Source: IFWIS 1988.

5.3.9.5 Threatened and Endangered Species

A. Federally Listed and Candidate Species

No federally listed plant species are found in the immediate area of the site. Two candidate species are found, the forked aster and the lakeside daisy. However, the specific locations of these plants has not been mapped.

Three endangered species of animals are found in the area of the proposed site: the bald eagle, the peregrine falcon, and the Indiana bat. Each of these has a very large range, occupies or feeds in multiple ecotypes, and is present in low densities. None of the three is known to breed in the immediate area of the proposed site. Five animal species and two plant species present in low densities in the area have been proposed as federal candidates for listing. Table 5.3.9-12 lists these federally listed endangered species and candidate species.

B. State-Protected Species

There are many state-listed plant and animal species in the area of the proposed site. These are identified in Table 5.3.9-13. There are 57 species of plants, 37 species of birds, and three mammals thus listed.

5.3.9.6 Unique Ecosystems and Communities Potentially Affected

The area of the proposed site in Illinois is a complex of small successional ecotypes interspersed with large-scale agriculture and urban sprawl.

A. Statutorily Protected Areas

Details of the lands protected in refuges, forest preserves and parks are given in Section 5.3.10. There are substantial forest preserves in the area ranging in size from 2 acres to 1,800 acres, including:

- DuPage County 12,000 acres
- Kane County 3,400 acres, plus Fox River Trail, 6 mi; Great Western Nature Trail, 14 mi; and Prairie Path, 8 mi
- Kendall County 115 acres

There are 17 natural areas and nature preserves in the area, including the DOE Fermilab and ANL reservations.

Table 5.3.9-12

FEDERALLY LISTED OR CANDIDATE THREATENED AND ENDANGERED SPECIES POTENTIALLY AT THE ILLINOIS SSC SITE

Species: Scientific Name	Species: Common Name	Status	Habitat
PLANTS			
Aster furcatus	Forked aster	Candidate	Wooded slopes
Hynenoxys acaulis var. glabra	Lakeside Daisy	Candidate	Prairie
ANIMALS			
Simsonichonca ambigua	Salamander Mussel	Cat. II	Lakes, rivers
Osternon flavescens spooneri	Illinois Mud Turtle	Cat. II	Ponds, rivers
Clonophis kirtlandi	Kirkland Red fox's Water Snake	Cat. II	ponds, rivers
Sistrurus catenatus	Eastern Massasauga	Cat. II	Forest, field, wetlands
Buteo swainsoni	Swainson's Hawk	Cat. II	Forest, field, prairie, savanna
Haliacetus leucophalus	Bald eagle	Endangered	Forest, field, prairie, savanna
Falco peregrinus	Peregrine falcon	Endangered	Prairie, wetlands
Myotis sodalis	Indiana bat	Endangered	Caves, wetlands

Source: USFWS, Region 5, Chicago.

Table 5.3.9-13

ILLINOIS STATE LISTED THREATENED AND ENDANGERED SPECIES IN DUPAGE, KANE AND KENDAL COUNTIES

Species		Status
Scientific Name	Common Name	
PLANTS:		
Rhamnus anifolia	Alder buckthorn	Endangered
Veronica americana	American brookline	Endangered
Sparganium americanum	American burreed	Endangered
Galium labradoricum	Bog bedstraw	Threatened
Triglochin maritima	Common bog arrow grass	Endangered
Castilleja sessiliflora	Downy yellow painted cup	Endangered
Polygonatum pubescens	Down Solomon's seal	Endangered
Tofieldia glutinosa	False asphodel	Threatened
Cimicifuga racemosa	False bugbane	Endangered
Panax quinquefolius	Ginseng	Threatened
Hydrastis canadensis	Golden seal	Threatened
Calopogon tuberosus	Grass pink orchid	Threatened
Sparganium chlorocarpum	Green-fruited burreed	Endangered
Rorippa islandica var. hispida var. hispida	Hairy marsh yellow grass	Endangered
Viola incognita	Hairy white violet	Endangered
Plantago cordata	Heart-leafed plantain	Endangered
Conioselinum chinense	Hemlock parsley	Endangered
Chamaedaphne calyculata	Leatherleaf	Threatened
Petalostemum foliosum	Leafy prairie clover	Endangered
Thelypteris phegopteris	Long beach fern	Endangered
Veronica scutellata	Marsh speedwell	Threatened
Drosera intermedia	Narrow-leaved sundew	Threatened
Thelypteris noveboracensis	New York fern	Endangered
Geranium bicknellii	Northern cranesbill	Endangered
Asclepias ovalifolia	Oval milkweed	Endangered
Lathyrus ochroleucus	Pale vetchling	Threatened
Lechea intermedia	Pinweed	Endangered
Lespediza leptostachya	Prairie clover	Endangered
Lactuca ludoviciana	Prairie lattace	Endangered
Sabatria campestris	Prairie rose gentian	Endangered
Habernaria leucophaea	Praire white-fringed orchid	Endangered
Geum rivale	Purple avens	Endangered
Rubus odoratus	Purple-flowering raspberry	Endangered

Table 5.3.9-13 (Cont)

ILLINOIS STATE LISTED THREATENED AND ENDANGERED SPECIES IN DUPAGE, KANE AND KENDAL COUNTIES

Species Scientific Name	Common Name	Status
Filipendula rubra	Queen-of-the-prairie	Threatened
Oryzopsis racemosa	Rice grass	Threatened
Juncus alpinus	Richardson's rush	Endangered
Ulmus thomasii	Rock elm	Endangered
Drosera rotundifolia	Round-leaved sundew	Endangered
Ranunculus cymbalaria	Seaside crowfoot	Endangered
Carex crawei	Sedge	Endangered
Carex laxiculmus	Sedge	Endangered
Carex oligosperma	Sedge	Endangered
Carex rostrata	Sedge	Endangered
Carex viridula	Sedge	Endangered
Cypripedium reginae	Showy lady's slipper	Endangered
Triglochin palustris	Slender dog arrow grass	Endangered
Arenaria patula	Slender sandwort	Threatened
Circaea alpina	Small enchanter's nightshade	Endangered
Cypripedium calceolus var. parviflorum	Small yellow lady's slipper	Endangered
Alnus rugosa	Speckled alder	Endangered
Eleocharis rostellata	Spikerrush	Endangered
Corallorhiza maculata	Spotted choral root orchid	Threatened
Zigadenus glaucus	White camass	Endangered
Thuja occidentalis	White cedar	Threatened
Cypripedium candidum	White lady's slipper	Endangered
Aslepias lanuginosa	Woolly milkwee	Endangered
Betula lutea	Yellow birch	Endangered
Mimulus glabratus	Yellow monkey flower	Endangered
ANIMALS		
Birds		
Botaurus lentiginosus	American bittern	Endangered
Haliaeetus leucocphalus	Bald eagle	Endangered
Tyto alba	Barn owl	Endangered
Thryomanes bewickii	Bewick's wren	Threatened
Nycticorax nycticorax	Black-crowned night heron	Endangered
Laterallus jamaicensis	Black rail	Endangered
Chlidonias niger	Black tern	Endangered
Euphagus cyanocephalus	Brewer's blackbird	Threatened
Certhia familiarus	Brown creeper	Endangered

Table 5.3.9-13 (Cont)

ILLINOIS STATE LISTED THREATENED AND ENDANGERED SPECIES IN DUPAGE, KANE AND KENDAL COUNTIES

Species Scientific Name	Common Name	Status
Gallinula chloropus	Common gallinule	Threatened
Sterna hirundo	Common tern	Endangered
Accipiter cooperii	Cooper's hawk	Endangered
Phalacrocorax auritus	Double-crested cormorant	Endangered
Numenius borealis	Eskimo curlew	Endangered
Sterna forsteri	Forster's tern	Endangered
Casmerodius albus	Great egret	Endangered
Ammodramus henslowii	Henslow's sparrow	Threatened
Sterna albifrons	Least tern	Endangered
Lanius ludovicianus	Loggerhead shrike	Threatened
Asio otus	Long-eared owl	Endangered
Circus cyaneus	Marsh hawk	Endangered
Pandion halaetus	Osprey	Endangered
Falco peregrinus	Peregrine falcon	Endangered
Charadrius melodus	Piping plover	Endangered
Porphyrula martinica	Purple gallinule	Endangered
Buteo lineatus	Red-shouldered hawk	Endangered
Asio flammeus	Short-eared owl	Endangered
Bureo swainsoni	Swainson's hawk	Endangered
Limnothlypis swainsonii	Swainton's warbler	Threatened
Bartramia longicauda	Upland sandpiper	Endangered
Catharus fuscescens	Veery	Threatened
Steganopus tricolor	Wilson's phalarope	Endangered
Zanthocephalus xanthocephalus	Yellow-headed blackbird	Endangered
Corturnicops noveboracensis	Yellow rail	
Mammals		
Lynx rufus	Bobcat	Threatened
Myotis sadolis	Indiana bat	Endangered
Lutra canadensis	River otter	Threatened

Sources: Mohelenbock 1986; Natural Land Institute 1981; IENR 1988.

B. Unique Communities

The prairie reconstruction project on the Fermilab site represents a unique opportunity to redevelop an area of mesic prairie in the study area.

The small woodlands can be considered as remnant communities as can the few acres of savanna remaining in the area. Most of these communities are found in protected lands.

C. Marginal Range Associations and Transition Zones

There are no plants or animals common to the area or of economic importance or which are federally listed threatened/endangered that are at the extent of their range in the proposed SSC site.

Because of the patchwork nature of the area, there are numerous transition zones favoring successional development and diverse wildlife habitat. These include:

- Agricultural areas/woodlands transition
- Forest/wetlands transition
- Prairie/wetlands transition
- Prairie/woodlands transition
- Agricultural/urban transition
- Woodlands/urban transition.

D. Land Use Policy Implications

The major impact of land use policy on the ecological resources is caused by urban development which in turn causes urbanization of forest and prairie lands, increases pressure for draining marshes and sedge meadows, and reduces ecological diversity. Simplification of plant communities by development of prairie and forest into agricultural lands not only results in lower biological diversity but decreased stability of the nutrient-cycling capacities of the area. Erosion, and increased loss of nitrogen and other nutrients causing eutrophication, is already evident. These are largely surface disturbance effects and do not have significant implications for development of the subsurface.

E. Implications on Prime Farmlands, Wildlife Refuges, and Other Management Areas

As discussed in detail in Section 5.3.10, some conversion from prime farmland to commercial facilities is proposed. Ecological resources documented in the three-county area are distributed among the many refuge, remnant, and open areas. No preserves are found in the immediate portion of the ring. There is insufficient data to determine long-term trends of important species during the agricultural development or the suburbanization of specific locations.

5.3.10 Land Resources

5.3.10.1 Regional Setting

A. Jurisdictional Setting

The proposed Illinois SSC site is located approximately 40 mi northwest of Chicago in portions of the following three counties: western DuPage County, eastern Kane County, and northeastern Kendall County. The county seats of each jurisdiction and the year of respective establishment are as follows: Wheaton, DuPage County (1839); Geneva, Kane County (1836); and Yorkville, Kendall County (1841). The areal extent of each jurisdiction is listed below:

County	Areal Extent (mi^2)
DuPage	332
Kane	522
Kendall	324
Total:	1,178

The SSC project is located in both municipal and unincorporated areas in each of the three subject counties. The proposed Illinois site is represented at the federal, state, and local levels of government by the following elected officials (State of Illinois 1987):

- United States Senate
  - Alan J. Dixon
  - Paul Simon
- United States House of Representatives
  - Jack Davis, 4th District
  - Henry J. Hyde, 6th District
  - Harris W. Fawell, 13th District
  - J. Dennis Hastert, 14th District
- State Senate
  - Beverly Fawell, 20th Leg. District
  - Forest D. Etheredge, 21st Leg. District
  - Doris C. Karpiel, 25th Leg. District
  - John E. Friedland, 33rd Leg. District
- State House of Representatives
  - Mary Lou Cowlishaw, 41st Rep. District
  - Suzanne L. Duechler, 42nd Rep. District
  - Donald N. Hensel, 50th Rep. District
  - Delores Daederlein, 65th Rep. District
  - James M. Kirkland, 66th Rep. District

- DuPage County Board, District 5
- Kane County Board, Districts 14, 15, 25, and 26
- Kendall County Board, Districts 14, 15, 25, and 26

B. Ownership Patterns

Land ownership in the SSC tri-county area is predominantly private, the approximate 6,800-acre federally owned and contractor-operated Fermilab is the most notable exception. There are also some small scattered state and local governmental holdings. These land ownership patterns are consistent with northeastern Illinois patterns.

C. Historic Land Uses

The growth of northeastern Illinois is linked intimately to its geologic/geographic setting. Ancient geologic forces and later glaciation processes gave the region the following attributes: 1) thick limestone bedrock useful both as building material and as the raw material for cement, 2) layers of impermeable clay that create a high water table; 3) plains environment that supports agriculturally rich soils; 4) lakes interspersed among moraines that produce the important recreational Lake Geneva and Fox Lake chain, as well as wetland areas that are now part of many local forest preserves; 5) drainage channels, including two of the region's most important waterways, the Calumet Sag Channel and the Chicago Sanitary and Ship Channel; and 6) well-drained sandy strips of land, used first as Native American trails and subsequently as travel/transportation routes (Mayer and Wade 1969).

European-type settlements first appeared in the SSC tri-county area in the 1830s as part of Chicago's first suburban movement; the men and women were known as "outside settlers" who linked their fortunes with Chicago but lived beyond its municipal boundaries (Mayer and Wade 1969). They were largely farmers/homesteaders who sought to work the rich agricultural lands of the area.

This population growth was strong and widespread enough that by 1839, the area split away from Cook County and formed DuPage County. Cook County itself had been created only eight years earlier by the Illinois General Assembly. Settlements, such as Brush Hill (Hinsdale), Naperville, and Turner Junction (West Chicago) in DuPage County; Oswego in Kendall County; and Aurora, Batavia, Geneva, St. Charles, and Elgin in Kane County became magnets for commerce and later for industry. Spurred by the growth of numerous overland routes to the west, "plank roads," the area's first tollroads, and the Galena and Chicago Union Railroad were built.

Growth in DuPage County and beyond continued steadily as Chicago grew, first as a railroad capital, then as a rebuilt city after the 1871 fire, and later as a major metropolitan center after the 1893 World's Columbian

Exposition. From World War I on, as the automobile became increasingly popular and affordable and as prosperous times allowed, suburban living became the preferred lifestyle. As a consequence, agricultural conversion rates, particularly in DuPage County, accelerated as a way to accommodate this growth. It is only recently, with DuPage County as suburbanized as western Cook County, that similar development pressures have been felt in Kane County and, to a lesser extent, in Kendall County.

D. Existing Land Use Plans, Policies, and Controls

Land use planning in northeastern Illinois is conducted at the state, regional, and local levels of government; the local level includes not only county-level activities but also townships and municipalities. Land use planning at the state level is conducted by the Governor's Office of Planning as well as a number of "code" departments, including the Department of Conservation (the state's largest land management agency), Energy and Natural Resources, Agriculture (Natural Resources Division), Commerce and Community Offices, Mines and Minerals, and Transportation.

Land use planning at the regional level is conducted by the Northeastern Illinois Planning Commission (NIPC), which was created by the Illinois General Assembly in 1957 for the six-county greater Chicago region encompassing Cook, DuPage, Kane, Lake, McHenry, and Will counties. The Commission acts as an advisory source only, relying on voluntary compliance to support its mission of 1) conducting research and collecting data for planning, 2) assisting local governments, and 3) preparing comprehensive land use plans and policies for its member counties. The NICP consists of 30 commissions, 23 of which are appointed and 7 of which are elected.

Key plans include as a base document The Comprehensive General Plan for the Development of the Northeastern Illinois Counties Area (1977) and the following elements: Regional Residential Policy Plan (1978), Regional Open Space and Recreation Policy Plan (1980), Regional Land Use Policy Plan (1984), and Regional Solid Waste Management Policy Plans (1986).

Under Illinois state law, planning responsibilities are delegated to either the county government for all unincorporated private lands and municipalities where home rule has not been elected or municipalities designated as home rule units. This distinction applies to municipalities with more than 25,000 people or those who voters have elected by referendum to become a home rule unit. Except as limited by state statute, a home rule municipality has the authority to perform any function pertaining to its government, including the power to license; to tax; to incur deficit; and to regulate for the protection of public health, safety, morals, and welfare. Of the nine municipalities in DuPage county that enjoy home rule status, those closest to the SSC project are Wheaton, Naperville, and Aurora. There are no home rule municipalities located in either Kane or Kendall counties.

All three counties have long-range comprehensive land use plans in effect. They are: DuPage County Land Use Plan (1985), DuPage County Open Space Opportunities Plan (1985), Kane County Comprehensive Land Use Plan 1982/2000 (1983), and Kendall County Rural Land Policy Plan (1984). These are the key local planning documents for the SSC project.

E. Existing Land Uses

Existing land use in the northeastern Illinois region continues to build on the area's historically developed land use patterns. As a result, more intense forms of land use, including employment centers, have developed along the region's major road, rail, and waterway corridors radiating like spokes from the downtown Chicago hub. The dominant land use between these spokes is residential, with densities lowering as distances increase away from the City of Chicago (Northeastern Illinois Planning Commission 1984).

In the three primary impact counties of the SSC project area, i.e. DuPage, Kane, and Kendall counties, employment center development has occurred along the East-West Tollway (Interstate 88) to the south and east of Fermilab, and along both Roosevelt Road (Highway 38) and North Avenue (Highway 64) to the north of Fermilab and around the DuPage County Airport. Aside from Fermilab and the DuPage County Airport, this area's only other major special land use is the 1,200-acre Mooseheart, the "Child City" and school of the Loyal Order of Moose, which includes a home and school for children of deceased members, and a farm to support it (Loyal Order of Moose 1982). Mooseheart is located to the west of the Fox River and southwest of Batavia (Northeastern Illinois Planning Commission 1984; Chicago Tribune 1986).

Northeastern Illinois regional open space areas include parks and forest preserves that are generally located in water-dependent areas of critical environmental concern, paralleling the region's water courses (Northeastern Illinois Planning Commission 1984). In the SSC project area, the Fox River serves as a north-south spine along which are located forest preserves, parks, and golf courses/country clubs interspersed among the well established population centers of Elgin, St. Charles, Geneva, Batavia, and Aurora (Northeastern Illinois Planning Commission 1984; Chicago Tribune 1986). The river itself is a significant recreational resource for both active and passive leisure activities. In fact, two segments of the river, including the 32-mile reach from the Wilmot Dam near Fox River Grove south to Algonquin in McHenry County, and the 6-mile reach from the West Dundee Dam south to Elgin in Kane County, are designated by the National Park Service as having "outstandingly remarkable recreational value," and are used heavily for fishing and canoeing (National Park Service 1982).

Two greenbelt areas in DuPage County are significant recreation/open space areas. They are:

1. The Butterfield Road (Route 56) Greenbelt extending on the east from the 390-acre Hidden Lake Forest preserve in Downers Grove through the privately endowed not-for-project, 1,500-acre Morton Arboretum

in Lisle, the 765-acre Danada and the 760-acre Herrick Lane preserves south of Wheaton, to the 1,256-acre Roy C. Blackwell and 43-acre Warrenville Grove preserves near Warrenville on the west; and

2. The DuPage River, West Branch Greenbelt, stretching from the 416-acre McDowell Grove near Naperville northward through Warrenville Grove, Roy C. Blackwell Preserve, the 250-acre West DuPage Woods, and the 611-acre Timber Ridge preserve to the 1,741-acre West Branch and 928-acre Mallard Lake Preserves south of Hanover Park (Northeastern Illinois Planning Commission 1984; Forest Preserve District of DuPage County 1986; DuPage County Regional Planning Commission 1981; and Chicago Tribune 1986).

In Kane County, significant recreation/open space areas include the Fox River Greenbelt composed of a number of individual forest preserves and a number of other individual forest preserves located throughout the SSC project study area. They are:

1. The Fox River Greenbelt, extending on the north from south of Elgin and the 21-acre Fox River Shoreline facility, through the 186-acre Blackhawk Forest Preserve, the 16-acre ?????? Anderson Forest Preserve, the 245-acre Fabyan's Forest Preserve south of Geneva, the 27-acre Glenwood Park, and the 32-acre Les Arends Forest Preserve south of Batavia; and

2. Western Kane county holdings, including the 305-acre Compton Forest Preserve, the 253-acre LeRoy Oakes Forest Preserve, the 87-acre Elgin Forest Preserve that is in the vicinity of the historic Oregon Trail, the 185-acre Johnson's McLand, the 201-acre Nelson Lake which is also a state designated Illinois State Nature Preserve, the 117-acre Bliss Woods, and the undeveloped 117-acre Aurora West Forest Preserve. Recreational opportunities include hiking, picnicking, and the like (Kane County Forest Preserve District 1896).

Other important recreational/open space areas in the SSC which makes the facility eligible as a proposed National Environmental Research Park; project area include the restored prairie portions of Fermilab itself; the 55-mile long Illinois Prairie Path which is used as a hiking, biking, equestrian, and nature trail that occupies the former Chicago, Aurora and Elgin Railway (The Illinois Prairie Path); the 25-mile Fox River bike trail which is also used for jogging, hiking, and cross-county skiing; the 18-mile Great Western Nature Trail that occupies the abandoned portions of the Chicago and Northwestern Railroad right-of-way and used for similar purposes; and the 11-mile Virgil Gilman Nature Trail, used for similar purposes that occupies the abandoned portions of the Elgin, Joliet, and Eastern (E, J & E) Railroad right-of-way paralleling Lincoln Highway (Route 30) (The Illinois Prairie Path; Illinois Department of Conservation; Kane County Forest Preserve District).

Agricultural lands in the three primary impact counties of the SSC project area are located to the west of the settlements along the Fox River Valley in central and western Kane County (Northeastern Illinois Planning Commission 1984). There is also some small-scale agricultural activity occurring to the north and west of the DuPage County Airport on what are considered country estates by the Northeastern Illinois Planning Commission (1984).

F. Future Planned Land Uses

The Northeastern Illinois Planning Commission has set forth in its Regional Land Use Policy Plan (1984) five goals upon which all functional regional plans are to be based. They are:

- Access for all to the cultural, social, and economic resources of the region without regard to race, creed, national origin, sex, age, or physical state of health.
- Expansion of economic opportunities for all and improvement of the region's ability to maintain its share of economic growth.
- Enhancement of the quality of personal and community life.
- Balanced development patterns reflecting the limitations of the region's natural resources and the need to preserve and improve environmental quality for present and future generations.
- Effective representative government, responsive and accountable to the region's citizens.

With these principles set as a base, specific goals and objectives have been identified for the following five areas of concern:

- Critical environmental areas
- Urban conservation and development
- Regional scale developments and opportunity areas
- Major public investments
- Land use management.

These five areas of concern have been analyzed, with baseline data mapped and areas that need careful attention in the formulation of future land use plans indicated. For the primary impact counties in the SSC project area the following issues are of particular concern: protection and/or enhancement of the Fox River as a key waterway area; the areas currently used as agricultural land in central and western Kane County as protection areas, including the state-designated agricultural conservation and protection area north of Elburn; several small areas in the vicinity of North Aurora, Batavia, and Elburn for proposed regional open space areas; and designation of two opportunity areas: the Fermilab/DuPage County Airport/East-West Tollway Corridor (Illinois Research and Development Corridor), and the Fox Valley Villages area located west of Highway 59 in the southwestern corner of Naperville Township in DuPage County.

Each of the three counties directly affected by the SSC project have developed their own individual future land use plans that seek to address the same generalized set of concerns identified by the Northeastern Illinois Planning Commission. The DuPage County Planning Commission has employed a growth node concept in its DuPage County Land Use Plan (1985) as a way to focus future growth and development. This growth node provides the following advantages:

- Existing activity centers are recognized and strengthened.
- Efficient multi-modal transportation system potential is preserved and enhanced.
- The distribution and sizing of community facilities and services can be effectively predetermined.
- Visual, environmental, and recreational buffers are provided between individual growth nodes.
- "Urban sprawl" potential is diminished by encouraging new growth centers to occur only where transportation and other public services can be provided efficiently.

The Kane County Development Department has in effect its Comprehensive Land Use Plan 1982/2000 (1983) that identifies proposed open space, conservation, recreation, and drainage areas. This represents an enhancement of existing uses. No major land use changes are implied, which continues to reinforce the county's desire to contain growth in existing populated areas and, thus, preserve the county's agricultural character.

The Kendall County Rural Policy Plan (1984) is the key future land use planning tool for this county. Here also, efforts are focused on containing growth in existing populated areas thereby preserving the county's overwhelmingly agricultural character.

G. Community Values/Attitudes

The northeastern Illinois region, as a whole, has undergone significant economic changes since the 1970s, as the national economy has been transformed into a post-industrial model with attendant periods of economic recession, stagnation, or inflation. The Northeastern Illinois Planning Commission, in formulating its Regional Land Use Policy Plan (1984), has developed a regional conservation approach and orderly development strategy in response to these conditions. The following issues have been identified as focal points around which to organize:

1. Northeastern Illinois needs to maintain its share of the nation's economic activity but, in doing so, a fair allocation of scarce public resources will be necessary to promote equality of economic, social, and cultural opportunity;

2 Stabilization of mature areas and revitalization of distressed areas need to continue. New growth and development should be allowed to take place in such locations and in such a manner as to support regional goals and objectives, thereby achieving a proper balance between providing a high quality of life and conserving environmental resources.

To be implemented successfully, this strategy needs more than the support of a planning process. It needs an effective effort in economic development, including education and manpower training. Its ultimate success depends on the cooperation of leadership in both newer and older areas in order to achieve an overall improvement in living conditions across the whole region.

5.3.10.2 Local Setting

A. Project Level

The propsoed SSC project site is located in western DuPage County, eastern Kane County, and northeastern Kendall County on both county-unincorporated and municipal lands (see Figure 5.3.10-1). The SSC project study area contains no federally designated parklands, such as national parks, monuments, preserves, rivers, scenic and historica trails, historic sites, recreation areas, and parkways. A major portion of the Illinois Prairies Path was designated in 1971 as a recreation trail in the National Trail System. (The Illinois Prairie Path). There are no federal or state designated wilderness area; no are there any federal or state designated wild and scenic rivers.

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 1,389 letters received by the DOE as of mid-May, 1988, 1,110 ltters were opposed to the project; 253 letters were in favor of the project; and 26 letters offered no opinion about the project. The types of issues raised in these letters included: residential relocation, the taking of agricultural land, impact to the educational system, tax base changes, property value changes, health and safety concerns, loss of critical habitats, impacts to endangered species groundwater withdrawal and contamination, and changes in scenic and visual character.

B. Facility Level

Table 5.2.10-1 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 5.3.10-1

THE PROPOSED ILLINOIS SSC SITE REGION

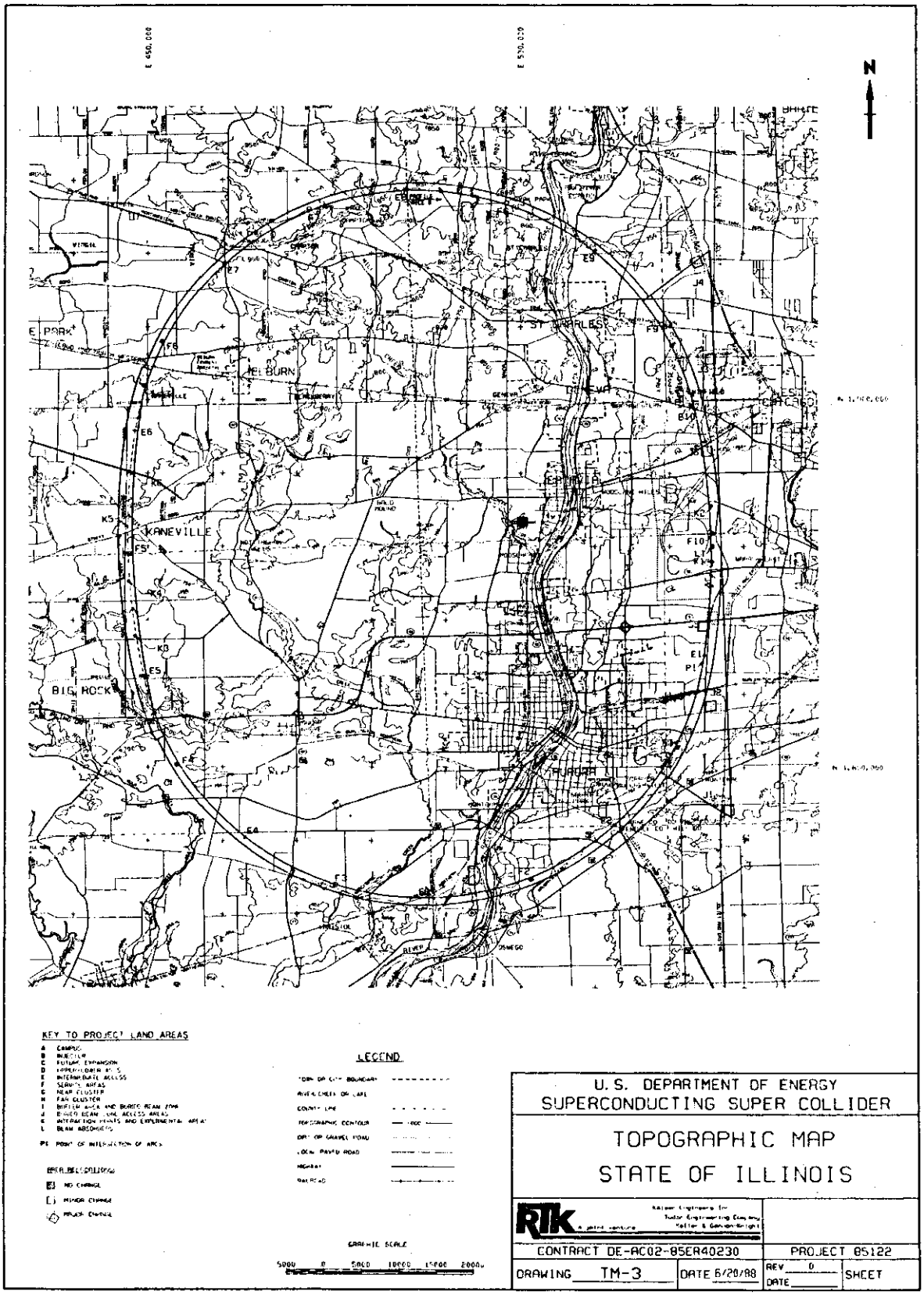


Table 5.3.10-1

LAND USE DATA
ILLINOIS SSC SITE

SSC Project Facility	City/ County Location	Ownership Patterns	Existing Zoning	Existing Land Use	Future Planned Land Use
Near Cluster Quadrant					
Campus area A	DuPage/Kane	Public	R-3/FD	Inst/rsch	Same
Injector area B	DuPage/Kane[a]	Public/private	Mixed	Inst/agr	Inst/rsch
Future expansion C	DuPage/Kane[b]	Public/private	Mixed res/FD	Inst/mixed	Mixed urban
BABBZ area I	DuPage/Kane[c]	Public/private	Mixed urban	Agr/mixed	Mixed urban
J1	Aurora[d]	Private	PDD	Agr	Res/mfg
J2	DuPage/Aurora	Private	PDD/I-2	Agr	Mfg
J3	West Chicago[d]	Private	I-2	Agr	Office/rsch
J4	DuPage	Private	R-4	Agr	Office/rsch
Near Cluster Ring	DuPage/Kane[c]	Public/private	Mixed urban	Agr/mixed	Mixed urban
E1	DuPage/Aurora	Private	R-4/PDD	Agr	Res
E10	DuPage/West/Chicago	Private	B-2/B-2	Agr	Comm
F1	DuPage/St. Charles	Private	PDD	Agr	Res
F9	DuPage	Private	M-1/No zoning (Airport)	Agr	Office/rsch
F10	DuPage	Public	R-3	Inst/rsch	Same
J5	Aurora[d]	Private	PDD	Agr	Office/rsch
J6	DuPage	Public	R-3	Inst/agr	Office/rsch
K1	DuPage	Public	R-3		
K2	DuPage	Public	R-3		
Far Cluster Quadrant					
Far Cluster Ring H	Kane	Private	FD/Mixed res	Agr/rural	Same
E5	Kane	Private	FD	Agr	Same
E6	Kane	Private	FD	Agr	Same
F5	Kane	Private	FD	Agr	Same
K3	Kane	Private	FD	Agr	Same
K4	Kane	Private	FD	Agr	Same
K5	Kane	Private	FD	Agr	Same
K6	Kane	Private	FD	Agr	Same
Lower Arc Quadrant					
Lower Ara Ring D	Kane/Kendall[e]	Private	Mixed	Agr/rural	Agr/mixed
E2	Kane/Kendall	Private	M-2/FD	Forested	MFG
E3	Kendall	Private	M-1	Agr	MFG
E4	Kendall	Private	A-1	Agr	Same
F2	Oswego[f]	Private	R-6	Agr	Residential
F3	Kendall	Private	A-1	Agr	Same
F4	Kane	Private	FD	Agr	Agr/open space
Upper Arc Quadrant					
Upper Arc Ring D	Kane	Private	Mixed res/FD	Agr/res	Res
E7	Kane	Private	FD	Agr	Res
E8	Kane	Private	PUD/FD	Agr/res	Res
E9	Wayne[g]	Private	W1	Res	Same
F6	Kane	Private	FD/E-2A	Agr/res	Res
F7	Kane	Private	FD/PUD	Agr	Agr/res
F8	Kane	Private	E-3	Agr	Res
Roads and rail	DuPage/Kane/Kendall	Private	Mixed	Agr/mixed	Same
Utilities	DuPage/Kane/Kendall	Private	Mixed	Agr/mixed	Same

a. Also includes part of the city of Batavia.
b. Also includes part of the city of Aurora.
c. Also includes portions of the cities of Aurora, St. Charles, and West Chicago.
d. Located in DuPage County.
e. Also includes portions of the village of Oswego.
f. Located in Kendall County.
g. Located in Kane County.

1. SSC Project Near Cluster Quadrant

The near cluster quadrant area represents mixed land use that encompasses portion of the municipal jurisdictions of Aurora, Batavia, St. Charles, Wayne, and West Chicago as well as unincorporated areas of DuPage and Kane Counties. The most prominent land use features are Fermilab and the DuPage County Airport. Areas of agricultural use and prime farmland are extensive within the site, however, patches of residential, commercial, industrial, and other urban uses are scattered throughout. The region is undergoind a transition from agricultural to mixed-use urban is an east to west direction in the face of urban expansion from the Chicago metropolitan area.

The varied uses present on the site are characteristic of this transitional phase of development, with land use plans that utilize mixed-use zoning and project total urbanization at some point in the future. Approximately 70% of the near cluster quadrant area is privately owned; the remainder is either the federally owned Fermilab or the DuPage County Airport. Descritpions of the following sites include a 1,000-ft buffer zone around the subject areas.

a. Campus Area A

The campus area includes major portions of Fermilab and is under institutional-office-research use consistent with current land use plans. The campus area is situated in unincorporated DuPage and Kane counties, only the western 15% being in Kane County. Although it is part of the Fermi National Research Laboratory site the area is zoned:

For single family residential and agricultural use. Zoning designations are R-3 and Farming District (FD) for DuPage and Kane coutnies respectively. As part of the Fermilab site the campus area is entirely federally owned.

b. Injector Area B

The injector area is located in unincorporated DuPage and Kane counties with its northwest corner intersecting the city of Batavia. A majority of the area is part of Fermilab, although within this area there are parcels devoted to farming, which are vacant, while others in conversion to a higher use of development. The northern area outside Fermilab is prime agricultural farmland, and the western area hosts institutional services and public buildings. There is a cemetery near the center of Area B on Fermilab property, and the east-west running Batavia Road crosses the northern portion. Gas and power lines servicing Fermilab cross the site diagonally. Future land use plans show a further intensification of the institutional research use and elimination of the agricultural uses. Small areas of residential and institutional development in the northern portion are also called for in future plans. The majority of the site is in DuPage county and is zoned R-3, with some R-2 in the

northern portion. The general industrial zone (I2) in the city of Batavia is found on the northwest corner and the western portion in Kane County is zoned FD. The injector area is primarily federally owned property.

c. Future Expansion Area C

The future expansion area land use consists largely of either the Fermilab facility or prime farmland agriculture. North of Highway 56 is the Fermilab main accelerator ring, which includes vacant and agricultural land that is part of Fermilab's property. South of the highway is prime agricultural farmland and small patches of single-family residential development. Future land use plans anticipate continued development of the residential areas and institutional-office-research facilities eliminating the agricultural uses. The area lies in unincorporated DuPage and Kane counties as well as the city of Aurora. The Fermilab site is federally owned property; the remainder is privately owned. Zoning for the unincorporated portion of DuPage and Kane counties is R-3 and FD respectively, with an area of DuPage county zoned R-2 on the southern edge. The city of Aurora intersects the southern third of the site, and that area is basically all zoned PDD (Planned Development District) with a small R-1 residential zone and B-3 commercially zoned area.

d. Buffer Area and Buried Beam Zone I

1) North Buffer Area and Buried Beam Zone I
Including Buried Beam Zone Access Areas J3 and J4

The north buffer area and buried beam zone I is located on unincorporated areas of DuPage and Kane counties as well as the cities of St. Charles and West Chicago. Land use consists mainly of prime farmland agricultural, transportation (DuPage County Airport), and industrial/manufacturing uses. Planned future land use is mainly office and industrial (manufacturing) with small sections of residential use in the north and south. This planned urbanization will eliminate agricultural uses from this area but will maintain and support the DuPage County Airport at a higher level of development than is currently experienced. Aside from the publicly owned airport, Area I is privately owned. Zoning throughout the site is mixed consisting mostly of residential and industrial.

Existing land use for proposed sites J3 and J4 is agricultural on prime farmland, although J3 borders manufacturing uses. Both areas are privately owned and located in DuPage County. J3 is in the city of West Chicago and J4 is on unincorporated land. Future land use plans for both sites call for office-research-development uses. Current zoning for J3 and J4 is I-2 (General Manufacturing District and R-4 (Single Family Residential) respectively.

2) South Buffer Area and Buried Beam Zone I, Including Buried Beam Zone Access Areas J1 and J2

The south buffer area and buried beam zone I is located in unincorporated parts of DuPage County as well as the city of Aurora. The majority land

use type is prime farmland agricultural with a concentration of residential uses in the southern sector. Smaller residential and mixed-use parcels are scattered throughout the area. Transportation and utility corridor uses account for the remainder. Future land use plans look for residential development of varying densities in the southern half and manufacturing-research uses to the north. Agricultural uses are expected to be phased out. Excluding the transportation corridors, this area is privately owned. Current zoning for the entire area is mixed through largely residential and PDD (planned development district).

The proposed locations of J1 and J2 place them on prime farmland sites under agricultural use, although J2 adjoins some residential use and J1 is partially outside of zone I. Planned future land uses for these sites are manufacturing for J2 and low-density residential and manufacturing for J1. Both sites are within DuPage County and privately owned; J2 is also within the city of Aurora, as is the northern quarter of J1. Current zoning for the city of Aurora in both sites is PDD, while the unincorporated portion of J2 is zoned I-2 (General Industrial).

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 portion of the ring lies in both DuPage and Kane counties in unincorporated areas as well as in the cities of Aurora, St. Charles, and West Chicago. Land use on the arc is predominantly agricultural, given its prime farmland status, even though industrial, institutional-research, transportation, and residential uses are scattered throughout. This includes the DuPage County Airport in the north, Fermilab in the center, and small residential areas dotting the southern section. Excluding the DuPage County Airport and Fermilab property, the arc area is privately owned. Future land use plans call for industrial/institutional/research uses in the center and northern sections with some residential use located just north of Fermilab. The southern portion is planned for a much more mixed use with areas of industrial, office, manufacturing, commercial, and varying density residential. These plans do not preserve any of the existing prime farmland for agricultural use. Current zoning under the jurisdictions mentioned is mixed urban throughout the arc, varying from single family residental to industrial.

Site F9 is located on the boundary of the city of St. Charles (Kane County) and unincorporated DuPage County, southwest of the DuPage County Airport. A Chicago and North Western railroad line runs east-west along the northern edge of the site, land use is currently undeveloped farmland closely associated with the airport property. Within 1000 ft are the DuPage County Airport, industrial use areas, and a few small gas mains. Future land use plans call for office/research uses. The unincorporated DuPage county portion of the site is currently not zoned indicating a use-dependent relationship with the DuPage County Airport, the adjacent area to the north that is also not zoned. The western edge

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of the site is the city of St. Chargles, Kane County, is zoned M-1 (Limited Manufacturing). The area is privately owned; however, just to the north beyond the railroad line is public airport property.

Site E10 is located partially in the city of West Chicago and partially in unincorporated DuPage County, just south of Route 38 on private property. Current land use is prime farmland, although within 1,000 ft are one residence and farm complex, three commercial businesses and an institutional structure found on the north side of Route 38 and toward the east. Future land use plans see the site as part of a local commercial area surrounded by office-research-development uses. Current zoning is designated as B-2 for both West Chicago and DuPage County, translating to Community Shopping District and General Business respectively.

Site J6 is on the existing Fermilab site in unincorporated DuPage County. Current land use is prime farmland agricultural with neighboring Burlington Northern Railroad and Fermilab utility lines. Future land use plans call for expansion of office-research-development uses in this and surrounding areas. The area is public property and currently zoned R-3 (Single Family Residential).

Site K2 is located within the existing Fermilab site in unincorporated DuPage County. It is public property, zoned R-3, and planned to remain under research 1 office use. The site is currently undeveloped.

Site F10 is located on the east side of the existing Fermilab main accelerator ring. The existing and future planned land uses are office-research-development. The site is federally owned property in unincorporated DuPage County and zoned R-3.

The description for site K1 is the same as that for the preceding K2 site.

Site J5 is located on the southeast corner of the intersection of the East-West Tollway and Eola Road in the city of Aurora in DuPage County. Existing land use is prime agricultural farmland, although to the east are two commercial businesses, one industrial structure, and a residence as well as vacant land for potential development. Future land use plans call for office-research-development uses on the site and surrounding it. City of Aurora zoning is PDD (Planned Development District).

Site E1 is also located in the city of Aurora as well as unincorporated DuPage County. The site is privately owned and current use is prime farmland agricultural; however, within 1,000 ft are two residences, a farm complex, and the Eola School which is owned by the Naperville Board of Education. Future land use plans call for low density residential development on and around the site area, excluding the school grounds. The southern 70% of the site is unincorporated DuPage County is zoned R-4 (Single Family Residential), while the northern 30% in the city of Aurora is zoned PDD.

Site F1 is located on the western edge of DuPage County in the city of Aurora. Existing land use on the site is prime farmland agriculture. To the east are scattered parcels of low density residential development, and to the west is the Oak Hurst Forest Preserve owned by the Kane County Forest Preserve District. Future land use plans call for maintenance of the northern section of the forest preserve, and low density residential development in the area of and around F1. Excluding the forest preserve, the site and surrounding areas are privately owned. Zoning in this portion of Aurora is PDD.

2. SSC Project Far Cluster Quadrant

Far Cluster Ring Including H, Intermediate Access Areas E5 and E6, Service Area F5 and Interaction Points and Experimental Areas K3, K4, K5 and K6

The far cluster quadrant is located entirely within Kane County and is privately owned. The arc area is unincorporated land with very little development, consisting mostly of farm related residences and structures. A number of rural residences of the western portion of Kaneville lie in the central portion of the area. Existing land use is nearly all prime farmland agriculture, and future land use plans propose no changes in use. There are approximately 60 residences in the area, more than half of which are found near Kaneville. Several transmission lines and roadways also cross the site. Zoning is almost entirely FD (Farming District) except for small areas zoned residential near the unincorporated town of Kaneville.

Site E5 is located on unincorporated private land north of Wheeler Road. Land use is prime farmland agricultural. One residence and farm complex are within 1,000 ft of the site. Future land use plans call for the area continuing under agricultural use. Kane County zoning is FD. Sites K3 and K4, lie in unincorporated Kane County in areas under agricultural use. Site K3 is located approximately 1,000 ft north of Scott Road with two farm complexes, and three farm residences just beyond 1,000 ft to the southwest. Site K4 is bounded on the east by a 138 kV transmission line, and bounded on the west by Dauberman Road. One farm complex and residence is located approximately 1,000 ft to the southwest. Both areas are privately owned, zoned FD, and planned to remain under their existing agricultural use.

Site F5 is also located on private property in unincorporated Kane County. Land use is prime farmland agricultural, with four residences and farm complexes within 1,000 ft. Kaneville is approximately 0.25 mi to the northwest; however, future land use plans call for a southerly expansion of the rural residential area of Kaneville into the site area. Proposed future plans for the rest of the area calls for a retention of agricultural use. Zoning for this site and surrounding area is FD.

Sites K5 and K6 are both under agricultural use and located in unincorporated areas of Kane County. Site K5 is intersected by Dauberman Road, and lies about 500 ft south of the intersection of Dauberman and Harter Roads. One farm complex and two residences are located within 1,000 ft, beyond which lies a number of residences and kaneville jsut to the southeast. Site K6 is located approximately 300 ft northeast of the intersection of the East-West Tollway and Dauberman Road. One farm complex and residence lies just beyond 1,000 ft to the northeast. Both of the sites, K5 and K6, are privately owned, zoned FD, and planned to remain under their existing agricultural use.

Site E6 is also in unincorporated Kane County, and is private property used as prime farmland agriculture. There are five residences, and one farm complex approximately 1,000 ft from the site. Future land use plans call for the preservation of agricultural use. Zoning on and around the site is FD.

3. SSC Lower Arc Quadrant

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

The lower arc quadrant contains unincorporated areas of Kane and Kendall counties, as well as a portion of the village of Oswego and city of Aurora. Land use consists mainly of prime farmland agriculture, with rural residences along roadways and concentrated near the Fox River/Oswego area. An industrial area is located just north of the Kane County line in the east, and the arc is crossed by the Fox River and the Virgil Gilman Nature Trail. The trail is owned and operated by the Fox Valley Park District and crosses the site just north of E2. Power lines, gas lines, and several roads also traverse the site. Aside from the nature trail and utility corridors, the area is privately owned. Kendall County has established future land use policy plans that call for agricultural preservation, limiting development to the Fox River area around which are areas planned for mixed use expansion. Zoning for the arc is mixed with industrial and residential zones in the central and eastern portions, mostly agricultural zoning in the western areas and scattered throughout.

Site E2 is located in Kendall County, partially in a small wooded area and near public recreational open space and the associated Virgil Gilman Nature Trail. A small residential area is within 1,000 ft to the east beyond the wooded lot. These, however, are the exception in principally prime farmland agricultural. The site is privately owned, and future land use plans call for some residential and open space to the north in Kane County, while future land use plans in Kendall County both for a transition to industrial uses. The northern third of the area in Kane County is zoned FD, while the southern two-thirds in Kendall county are zoned M-2 (Heavy Manufacturing District).

Site F2 is located in the village of Oswego in Kendall County on private property. Land use on and around the site is prime farmland agriculture, with some residential use located approximately 500 ft to the west. Future land use plans propose no changes affecting the site area, except a filling-in of residential area. The are is zoned R-6 (Single Family Residential) on Kendall County zoning maps.

Site E3 is in unincorporated Kendall County on private property under prime farmland agricultural use. Future land use plans propose no changes affecting the site area.

Site F3 is located just north of Galena Road in unincorporated Kendall County. Land use is prime farmland agricultural and future plans propose no changes affecting the area. The area is all under private ownership.

Site E4 is located just south of the Kane County line in unincorporated Kendall County. The site's land use context is the same as that for F3, except for a cemetery located within 1,000 ft to the northwest of the site.

Site F4 is in unincorporated Kane County on private property. Existing land use consists of prime farmland agriculture. Future land use plans show the southeast portion intersecting a proposed open space conservation recreation drainage area. The remaining portion, to the northwest, is planned to remain under existing agricultural use.

4. SSC Project Upper Arc Quadrant

Upper Arc Quadrant D Including Intermediate Access Areas E7, E8 and E9, and Service Areas F6, F7, and F8

The upper arc quadrant is located entirely within Kane County, intersecting the city of St. Charles and the village of Wayne in the eastern areas, the remainder being unincorporated. The arc is in transition from agricultural to residential/mixed-use as a result of urban expansion from the east. Approximately 50% of the arc area is currently prime agricultural farmland; the other half is largely low-density residential and vacant parcels in transition. Residential development is concentrated east of the Fox River around St. Charles and Wayne, while scattered developments are found along Ferson Creek to the west.

Significant features crossing the site include the Fox River and the Great Western Nature Trail as well as transportation and utility corridors. The Great Western Nature Trail is public recreational open space, owned and operated by the Kane County Forest Preserve District. The remainder of the area is privately owned. Future land use plans call for further intensification of low-density residential uses, leaving about 20% for either agricultural use or as public open space along Ferson Creek and the Great Western Trail. One small area of planned commercial-office-research use is found at the far eastern end near the DuPage County Airport. Zoning for the arc is largely residential in the

central and eastern areas, with agricultural zones (FD) in the western area and scattered throughout the central portion. PUD (Planned Unit Development) and SU (Special Use) residential zones are located in St. Charles and residential zones (WI) are found in the village of Wayne.

Site F6 is located in unincorporated Kane County and consists of prime farmland agricultural use with a small area of single-family residences to the southeast. The site and surrounding area is privately owned, and future land use plans call for continued agricultural use. The northern 75% of the site is zoned FD (Farming District), while the remaining northern portion intersects a small area zoned E-2A (Estate Residential).

Site E7 is also located in unincorporated Kane County on private property. It covers an area of prime farmland agriculture and vacant property in transition to residential use. More vacant land and a small lake are found to the northwest, and a small area of single-family residences is within 1,000 ft to the south. Future land use plans call for rural residential development throughout the area. Current zoning for the area is FD.

Site F7 is bordered on the south and east by rural residential development, while prime farmland agriculture lies to the north and west as well as on the site itself. Future land use plans divide the site and surroundings in a similar fashion between agricultural and single-family residential uses. The site is in unincorporated Kane County on private property. Current zoing is FD, except the edge of the site, south of Empire Road which in part of a residential PUD.

Site E8 is also divided between single-family residences to the east, and prime and important farmland agriculture to the west. There is also a small lake within 1,000 ft in the residential area. Future land use plans call for rural residential development throughout the surrounding area, and open space along Ferson Creek about 2,000 feet to the south. The land is on private property in unincorporated Kane County. The site is crossed by Denker Road which runs north to south through the western portion. The are west of the road (approximately 25% of the site) is zoned as part of a residential PUD, while the remaining portion to the east is zoned FD.

Site F8 is located just east of the intersection of Randall and Bolcum Roads in unincorporated Kane County. The area is privately owned, and land use consists of prime farmland agriculture. Future land use plans call for rural residential development on and around the site, with agriculture continuing to the northwest across Randall Road. Current zoning designations for the site is E-3 (Estate Residential).

Site E9 is located in the village of Wayne just north of the boundary with St. Charles in Kane County. It is private property in a low density single-family residential area just north of Country Club Road and east of the St. Charles Country Club. Residences are found to the north and

east, while vacant property, probably in transition to residential, is to the south and west. Future land use plans call for low density residential use on and around the site. Current zoing designated by the Village of Wayne is W1 (Single Family Residential).

5. Planned SSC Project Roads and Railroad Networks

Location descriptions of planned SSC project road and railroad improvements are provided in Section 1.2.1.2. Adjacent land use patterns for the road and railroad 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 upgrading.

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 for what has been generally described for the area. There are no future plans that constrain these areas from further improvements.

5.3.10.3. Soil and Prime Farmland Resources

A. Factors of Soil Formation and the Resulting Soil Cover

The soil cover in the northeast region of Illinois at the proposed SSC site is relatively young. Most soils in this area developed after the retreat of the last glaciers in the past 12,500 years. This glacial drift, the till with or without the overlying outwash, represents the dominant parent material upon which recent soils developed. The tills that are part of the Wedron Formation, encountered throughout the SSC site are the Yorkville and the Malden till members. The Yorkville till, the younger of the two, is a gray/light yellowish brown silty clay loam that is underlain by the Malden till, a yellowish brown loam with a high concentration of illitic clay. The outwash has stratified layers of sand and silt deposited in melt water. Some soils have also formed loess and recent alluvial deposits.

The dominance at the site of relatively fine-textured tills and of outwash of moderate coarseness resulted in soils with a mechanical composition that generate conditions favorable to plant growth. Most areas are covered by soils classified as "fine-silty". These are soils in which, (a) more than 85% of the soil is made up of particles smaller than 0.1 mm (16 times smaller than 1/16 of an inch) and (b) the clay fraction represents 18 to 34% of the fine earth, the soil fraction made up of particles smaller than 2 mm (Keys to Soil Taxonomy 1987).

The climate of the region is humid, temperate-continental. The average yearly air temperature is around 9.5 °C with a winter average of -4 °C and a summer value of 21.5 °C. The continental character of the climate (large summer to winter temperature differences) is also reflected in

the soil temperatures: the summer to winter soil temperature fluctuation reaches values below 5 °C only at depths in excess of 7 ft (Soil Taxonomy 1975, Agriculture Handbook No. 436, USDA-SCS). The average precipitation in the general area of the site is around 36.5 inches with roughly two-thirds of the rains falling during the growing season. The climate characteristics at the Illinois site are favorable to weathering and soil profile development. As a result, soils at the site are mature, with parent-rock carbonates fully leached and with clay migration from the upper profile and subsequent accumulation in the subsoil.

The generalized soil map of the United States identifies Udolls as the dominant soils in the upper two-thirds of the State of Illinois (Soil taxonomy 1975). The SSC proposed site, located in the northeast part of the region is also close to another perimeter, comprising Udalfs. Both Udolls and Udalfs in association with Aquolls and Aqualfs are found in the SSC area. The presence of these four soil categories is a reflection of the humid climate in which they are located and thus the prevailing soil moisture content is relatively high throughout the year. Soils having an aquic moisture regime (Aquolls and Aqualfs) are representative of conditions in which the soil water does not effectively circulate and thus becomes depleted of oxygen. Such soils, although with a high potential for crops, require special drainage management operations. An example of such a soil is the Drummer soil series that covers close to one-third of the fee-simple acreage at the site. During the wet season, when not drained, the Drummer soil has a water table within 1 ft of the surface, a condition that damages crops during most years (Soil Survey of Kane County, Illinois 1979). When drained, this soil has an excellent potential for crops and is categorized as prime farmland.

A total of 66 soil mapping units, representing 46 soil series, were identified at the Illinois SSC site, amounting to a fee simple acreage of 6,838.4.

Among the 46 soils present at the site, the major contributors to the soil cover are the already mentioned Drummer and the Mundelein soil series that account for 50% of the surveyed area. In addition, Markham, Wauconda, Grays, Barrington, and Catlin account for a little over one-fifth of the area. Table 5.3.10-2 presents the soils at the subgroup taxonomic level, the soil series, and corresponding acreages.

Drummer soil is predominantly developed on flat and shallow depressions of uplands. It has a black (mollic) silty clay loam surface horizon with superior farming attributes (good tilth and high moisture storage capacity subsequent to artificial drainage). Below the foot surface horizon, the subsoil of approximately 3.5 ft is a mottled silty clay loam in the upper part. At the base is a yellowish brown, gray, and light olive brown silt loam, loam or fine sandy loam. If the excess water is removed by surface and subsurface drainage, the Drummer soil acquires a condition that makes it a very good agricultural soil.

Table 5.3.10-2

SOIL SUBGROUPS AND SERIES WITH CORRESPONDING ACREAGES

Subgroup	Series	Acreage
Typic Argiudolls (737.2 acres)	Barrington	231.7
	Catlin	208.6
	La Rose	5.4
	Lorenzo	0.4
	Plano	13.3
	Proctor	7.8
	Saybrook	178.6
	Symerton	54.2
	Varna	37.2
Aquic Argiudolls (1,530.2 acres)	Andres	3.9
	Brenton	15.3
	Elburn	51.4
	Elliott	65.6
	Flanagan	54.6
	Lisbon	62.4
	Mundelein	1,277.0
Typic Hapludoll	Rodman	3.5
Typic Haplaquolls (2,293.6 acres)	Ashkum	61.4
	Drummer	2,156.5
	Milford	75.6
Cumulic Haplaquolls (122.7 acres)	Millington	26.6
	Otter	2.3
	Peotone	80.8
	Sawmill	13.0
Argiaquic Argialboll	Thorp	50.5
Typic Hapludalfs (241.1 acres)	Camden	9.6
	Dodge	82.5
	Fox	0.4
	Miami (incl. Miami-Casco complex 10-15% slope)	27.2
	Morley	33.9
	Rush	3.6
	St.Charles	0.5
	Zurich	83.6

Table 5.3.10-2 (Cont)

SOIL SUBGROUPS AND SERIES WITH CORRESPONDING ACREAGES

Subgroup	Series	Acreage
Mollic Hapludalfs (1151.6 acres)	Batavia	113.1
	Dresden	77.7
	Grays	262.7
	Harvard	177.2
	Markham	458.8
	Octagon	62.2
Udollic Ochraqualfs (599.6 acres)	Beecher	79.2
	Herbert	16.8
	Millbrook	42.2
	Virgil	94.8
	Wauconda	366.5
Limnic Medisaprist	Muskego	52.3
Total per Great Groups:	Argiudolls	2,267.4
	Hapludolls	3.5
	Haplaquolls	2,416.2
	Calciaquolls	46.6
	Argialbolls	50.5
	Hapludalfs	1,392.7
	Ochraqualfs	599.6
	Medisaprists	52.3
Total per Subgroups:	Udolls	2,270.8
	Aquolls	2,462.9
	Albolls	50.5
	Udalfs	1,392.7
	Aqualfs	599.6
	Saprists	52.3
Total per Orders:	Mollisols	4,784.2
	Alfisols	1,992.2
	Histosols	52.3

Mundelein soil is characteristically located in shallow depressions of outwash plains. It has a 1.5 ft surface horizon of very dark gray silt loam in the upper part and silty clay loam in the lower part, with a high concentration of organic matter (mollic). The subsoil is loamy at its base, 3 ft below soil surface, and silt loamy to fine sandy at 5 ft. The Mundelein soil has an exceptionally high farming potential in its natural state.

B. Farming Potential of Soils

The general suitability of soils for agricultural and recreational uses is assessed according to the Soil Capability Classification (for an example, see Soil Survey of DuPage and Cook counties, Illinois 1979). The system separates eight classes, I through VIII, with I representing the best soils that have few limitations in their use and that preserve a high and steady level of productivity under normal management practices. Classes II and III represent soils with moderate and severe limitations for crop growing. Soils included in class V are not usable as croplands, and soils included in class VIII are conditionally usable as wilderness and recreational areas.

The capability system identifies four possible soil use limitations. A letter "e" associated with the capability class number shows that the soil has an erosion hazard. A letter "w" stands for water, meaning that the soil is characteristically waterlogged, and letter "s" means that the top soil is shallow, droughty, or stony.

Table 5.3.10-3 presents acreages corresponding to each of the capability subclasses and sums up acreages for each of the main limitations encountered at the Illinois SSC site. Primary data for compiling the table were obtained from the soil surveys of the three host counties (Soil Survey of DuPage and Cook Counties, 1979; Soil Survey of Kane County, 1979; Soil Survey of Kendall County, 1978; Illinois, USDA-SCS). The acreage-weighed mean capability class equal to 1.75; this indicates that for all acreages considered (6,838.3 minus 9.6 acres of urban land-Orthents, complex, clayey), the "average" soil has better than moderate limitations for crops. In average, for every 3 acres of soils with moderate limitations (that can be mitigated), there is 1 acre of very good agricultural soil. This indicates a soil inventory of high agricultural potential at the Illinois SSC site.

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

Prime and unique farmlands are defined 7 CFR, Part 657. Two of the criteria are easily met by a high percentage of all soils in the northeast part of Illinois to qualify favorably as prime agricultural land. These two criteria are: 1) the temperature requirements and 2) the requirement that the soil be free of alkalis and excessive concentrations of salts. The identification of farmlands of statewide importance is done based on criteria established by the Cooperative Extension Service, the University of Illinois' Department of Agronomy, the State Association of Soil and

Table 5.3.10-3

ACREAGES PER CAPABILITY SUBCLASSES AND MAIN LIMITATIONS AT THE ILLINOIS SSC SITE

Capability Subclass	Acreage*
I	2,143.0
IIe	1,738.1
IIw	2,652.9
IIIe	212.5
IIIw	14.3
Vw	41.9
VIe	21.1
VIIs	3.5
VIIIw	1.4

Main Limitation	Acreage	Percent
e, erosion hazard	1,971.7	28.9
s, generally poor quality soil	3.5	0.1
w, excessive wetness hazard	2,710.5	39.7

* Mean Acreage-Weighed Capability for Site Equal to 1.75

Sources: Keys to Soil Taxonomy, 1987, SMSS Technical Monograph #6, Third Printing, Cornell University; Soil Taxonomy, 1975, Agricultural Handbook No.436, SCS, USDA; Soil Survey of DuPage and Part of Cook Counties, Illinois,1979, SCS, USDA; Soil Survey of Kane County, Illinois, 1979, SCS, USDA; Soil Survey of Kendall County, Illinois, 1978, SCS, USDA.

Water Conservation Districts, the Illinois Department of Agriculture, and the Soil Conservation Service. These criteria are understandably less stringent than those qualifying prime farmlands (Important Farmlands, March 1985,- Correlated Soil Mapping Units in Illinois that Qualify as Prime Farmland and Additional Farmland of Statewide Importance, USDA-SCS, Champaign, Illinois).

Information provided by the Illinois State Natural History Survey (Agricultural Evaluation Worksheet #1, Soil Map Unit Legend; DuPage County, Illinois) indicates that, as a general rule, soil units included in capability classes I and II pass the criteria test for prime farmland, while soil units included in capability classes III and IV fail as prime farmlands but qualify as farmlands of statewide importance. By using this general rule and referring to Table 5.3.10-3 the acreage of prime farmland at the Illinois site is shown to be equal to at most 6,534.1 acres (or over 95% of the fee simple acreage). This figure represents the sum of capabilities I and II. If one considers that only half of the capability subclass IIw qualifies as prime farmland (assuming that the other half corresponds to soils that are not drained but ought to be in order to qualify), then the prime farmland acreage is equal to 5,207.6, or 76% of the fee simple acreage. Based on information so far available one can say that the prime farmland acreage is between 5,200 and 6,500 out of a total of 6,830 acres. Accounting for the fact that less than 70 acres are in capability class V or greater, one can approximate that the difference between the total acreage and the prime farmland acreage represents farmland of statewide importance.

5.3.11 Socioeconomics and Infrastructure

5.3.11.1 Socioeconomics

All communities likely to experience measurable socioeconomic impacts because SSC development and operation in Illinois lie within a nine-county region in the northeastern portion of the state referred to as the region of influence (ROI) (Figure 5.3.11-1). This region may provide a sizable portion of the SSC labor force and for relocating job seekers, the most attractive and accessible residential opportunities within reasonable commuting distance of the SSC facilities exist in the confines of these nine counties.

Labor, goods, and services required locally for construction and operation of the SSC would come from throughout the ROI. However, socioeconomic effects probably would be greatest in DuPage, Kane, and Kendall counties because all of the SSC facilities would be located in these three counties, and project-related demands for housing and other services would be concentrated there. Consequently DuPage, Kane, and Kendall counties are considered the primary impact counties within the ROI for housing, services, and public finance issues.

A. Economic Activity, Labor Force, and Income

1. Regional Setting

The economy of the nine-county Illinois ROI has fluctuated in performance during the past two decades (Table 5.3.11-1). The employment base during this period experienced a markedly slow growth rate. Total employment growth averaged 0.6% annually between 1969 and 1984, as compared to the U.S. annual average of 1.9% (U.S. Department of Commerce, Bureau of Economic Analysis 1986).

From 1969 to 1984 annual employment growth in the Illinois ROI lagged behind the national average growth rate in all but one industrial sector. The agricultural services, forestry, and fisheries sector in the Illinois ROI experienced the largest regional percentage growth in employment during this period, increasing at an average annual rate of 5.8%, identical to the national average growth rate in that sector. Following agricultural services, other leading sectors in the ROI employment growth were the services sector which grew 3.2% annually, and the finance, insurance, and real estate sector which posted 2.6% average annual growth.

Five industrial sectors in the region experienced overall declines in employment during the 16-yr period. Led by the manufacturing sector with a 2.2% average annual loss in employment, farming, transportation and public utilities, construction, and mining all experienced losses in employment. Of these sectors, only farming and construction experienced similar employment losses at the national level; but losses within the ROI were of greater magnitude than the average national losses. Figure 5.3.11-2 shows the distribution of employment in the 11 major industrial

Figure 5.3.11-1

COUNTIES FOR SOCIOECONOMIC ANALYSIS IN THE ILLINOIS ROI

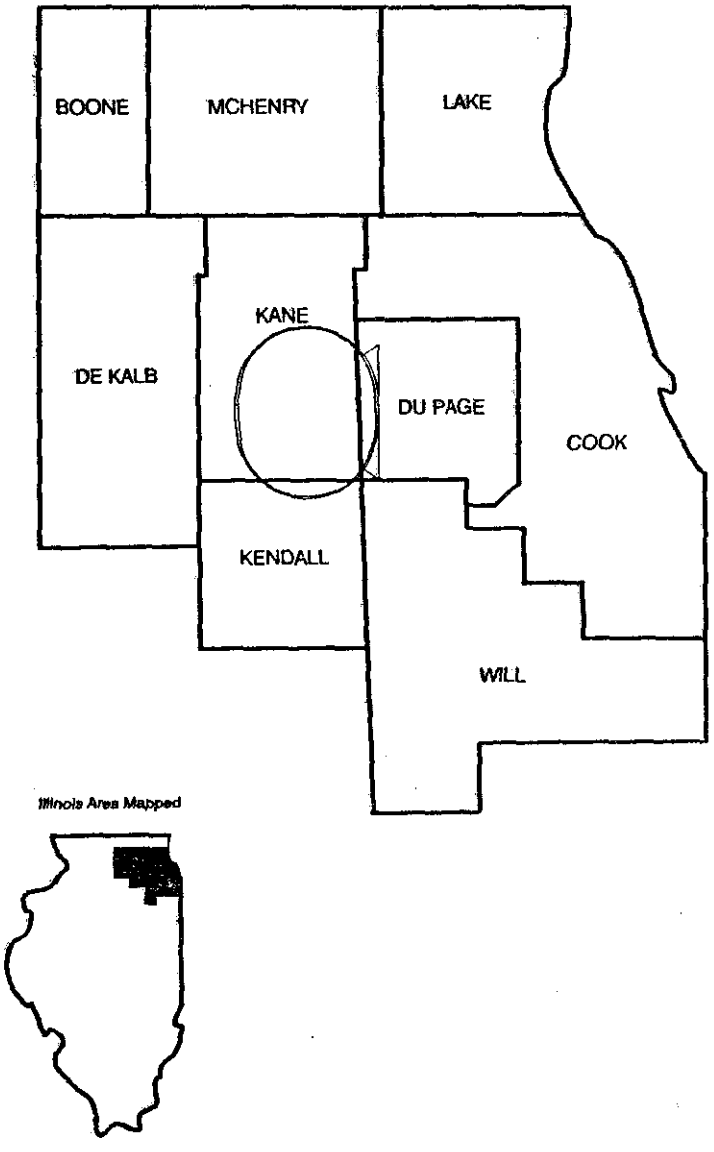


Table 5.3.11-1

HISTORIC ECONOMIC INDICATORS FOR THE ILLINOIS ROI, AND DUPAGE, KANE, AND KENDALL COUNTIES

	1969	1974	1979	1984	1987	Avg Annual Growth Rate
ILLINOIS ROI						
Total Employment[1]	3,459,515	3,531,316	3,762,196	3,770,030	NA[2]	0.6%
Earnings Per Worker[3]	$22,312	$23,648	$23,006	$22,720	NA	0.1%
Labor Force	NA	3,248,987	3,454,845	3,650,128	NA	1.2%[4]
Per Capita Personal Income[3]	$15,424	$16,421	$17,185	$16,932	NA	2.2%
Unemployment Rate	NA	4.1%	5.2%	8.2%	NA	NA
DUPAGE COUNTY						
Total Employment	145,221	206,218	273,229	355,066	NA	6.1%
Earnings Per Worker	$23,991	$24,077	$24,491	$23,047	NA	-0.3%
Labor Force	NA	219,616	283,316	337,488	NA	5.1%[4]
Per Capita Personal Income	$17,186	$18,228	$21,067	$20,814	NA	1.3%
Unemployment Rate	NA	2.5%	3.6%	6.1%	NA	NA
KANE COUNTY						
Total Employment	110,826	123,746	138,787	139,537	NA	1.5%
Earnings Per Worker	$22,919	$22,878	$22,142	$20,982	NA	-0.6%
Labor Force	NA	116,543	132,484	146,575	NA	2.2%[4]
Per Capita Personal Income	$13,716	$15,337	$16,805	$16,564	NA	1.3%
Unemployment Rate	NA	3.3%	4.7%	7.9%	NA	NA
KENDALL COUNTY						
Total Employment	12,441	16,178	16,487	14,650	NA	1.1%
Earnings Per Worker	$26,304	$28,691	$29,652	$26,464	NA	0.0%
Labor Force	NA	18,803	18,524	18,110	NA	6.6%[4]
Per Capita Personal Income	$15,240	$16,266	$16,638	$15,241	NA	0.0%
Unemployment Rate	NA	2.1%	3.6%	6.9 %	NA	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 1974-1986.*

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

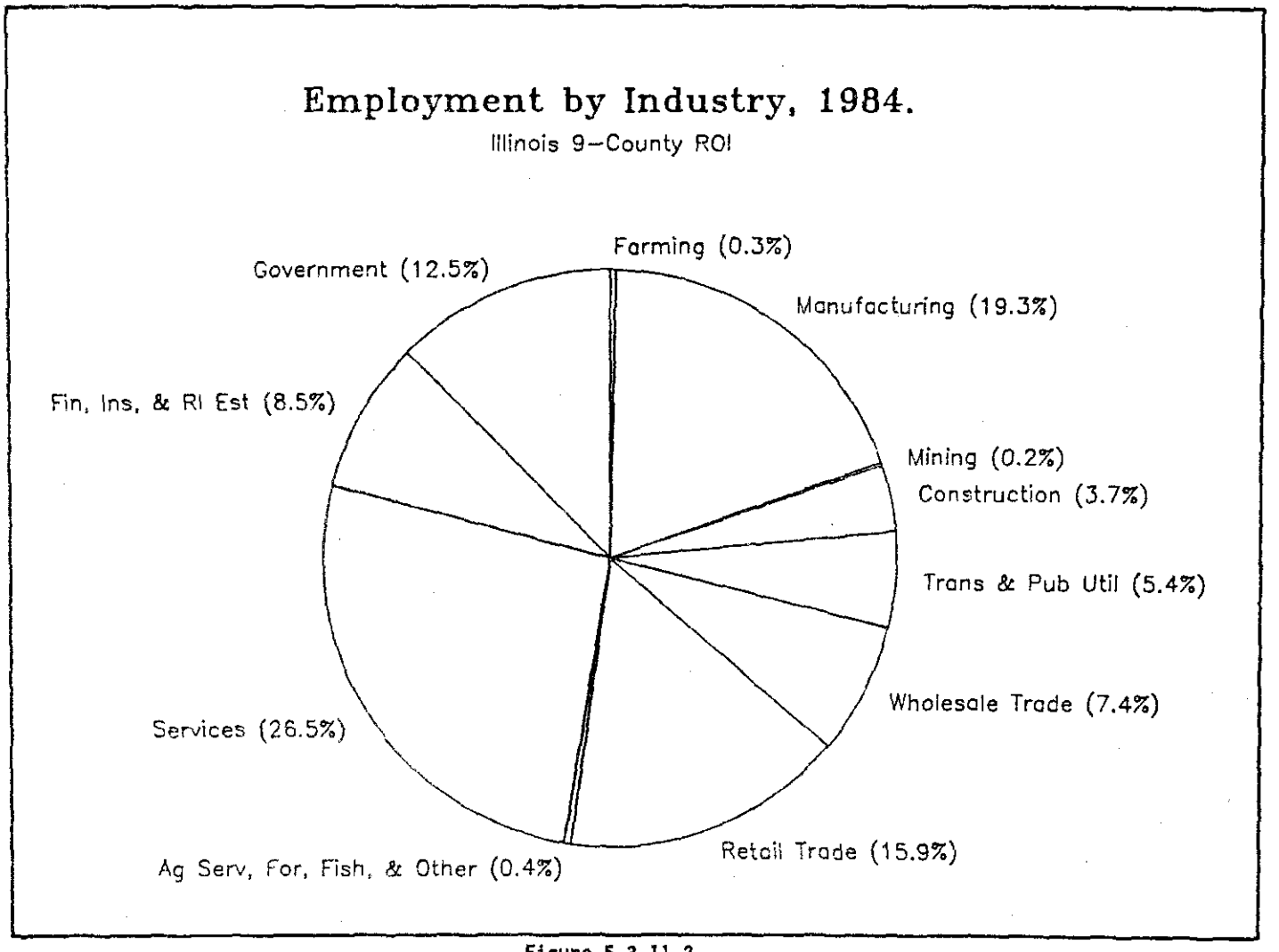


Figure 5.3.11-2

DISTRIBUTION OF EMPLOYMENT IN THE MAJOR INDUSTRIAL SECTORS IN THE ILLINOIS ROI

sectors in the Illinois ROI in 1984. The dominant sectors of the ROI economy, in terms of employment, were services (with 26.5% of ROI jobs), manufacturing (19.3%), retail trade (15.9%), and government (12.5%).

Average earnings per worker exceeded the national average in 1984. These were greatest in the transportation and public utilities ($37,818) and the wholesale trade ($31,911) sectors (all values represent 1988 dollars).

From 1974 to 1979, unemployment rates in the Illinois ROI consistently were lower than the national average rates. But since 1980, the ROI unemployment rate has exceeded the national average (Illinois Department of Employment Security 1988; U.S. Council of Economic Advisors 1988). In 1986, however, the gap between the ROI unemployment rate (7.2%) and national rate (6.9%) was the narrowest since 1979. The labor force in the ROI stood at more than 3,650,000 persons in 1984; but over the period from 1974 through 1986, it only showed an average annual growth rate of 1.2%.

Employment levels in the Illinois ROI are expected to continue increasing at a slow but steady average annual rate. Between 1988 and 2000, employment by place of work is expected to grow at an average annual rate of 0.6%, from an estimated 3.9 million jobs to 4.3 million; however this anticipated employment growth is less than the 1.3% annual growth projection for employment at the national level between 1988 and 2000 (U.S. Department of Labor, Bureau of Labor Statistics 1987).

Per capita personal income in the Illinois ROI in 1984 was $16,932 and has exceeded the national average every year since 1969.

2. Primary Impact Counties

a. DuPage County

DuPage County is the largest of the three primary impact counties, but it contributes only a small portion to the ROI employment and income totals. In 1984, DuPage County provided 69.7% of total employment in the three impact counties but only 9.4% of the employment in the Illinois ROI. The county also received 72.9% of total personal income in the primary impact counties, but only 11.7% of total personal income in the Illinois ROI. Total employment growth in the county averaged 6.1% annually between 1969 and 1984.

Employment in DuPage County grew at rates exceeding the average ROI and national rates in ten of the eleven industrial sectors. Employment in the services sector grew fastest from 1969 to 1984 at a rate of 9.1% yearly, followed closely by finance, insurance, and real estate (8.6%). agricultural services, forestry, and fishing (8.2%); and transportation and public utilities (7.7%). Only the farming sector posted an overall

loss in employment, diminishing annually by 3.8%, far more extreme than the ROI (1.9%) and national (1.0%) average rates of loss in farming employment. The distribution of employment in the 11 major industrial sectors in DuPage County in 1984 was similar to that of the Illinois ROI. The dominant sectors in the county's economy, in terms of employment, were the same as those for the ROI, but ranked differently: services represented 31.1% of total county jobs, retail trade 18.9%, and manufacturing 14.3%.

Earnings per worker in DuPage County in 1984 averaged $23,047, greater than the average for the nation, but lower than the ROI average. In 1984, the highest average earnings per worker were paid in the wholesale trade and transportation and public utilities sectors, each at over $33,000. Close behind were workers in manufacturing who averaged over $31,000.

For the last 12 years, unemployment rates in DuPage County remained consistently below those for both the Illinois ROI and the nation. Recent trends, from 1982 to 1986, show unemployment rates steadily dropping in the county from 8.2 to 4.6% (Illinois Department of Employment Security 1988). DuPage County's labor force grew at an annual average rate of 5.1% from 1974 to 1986, not quite as fast as total employment in the county during that period, but much more rapidly than the labor force of the ROI as a whole. In 1984, the labor force in the county included nearly 340,000 persons.

Between 1969 and 1984, per capita personal income in DuPage County remained well above the ROI and national averages. In 1984 it was $20,814 as compared to $16,932 for the ROI and $14,746 for the nation as a whole.

b. Kane County

Kane County, in terms of employment and total income, is the second largest of the three primary impact counties, but it contributes only a small portion to the ROI totals. In 1984, Kane County provided 27.4% of total employment in the three primary impact counties but just 3.7% of employment in the Illinois ROI. County residents accounted for 24.3% of total personal income in the primary impact counties but only 3.9% of total personal income in the Illinois ROI. Between 1969 and 1984 total employment growth in the county averaged 1.5% annually.

Average annual employment in Kane County grew at rates exceeding the ROI average and national rates in five of the eleven industrial sectors. Employment in the wholesale trade sector grew fastest from 1969 to 1984 at a rate of 9.1%, followed by agricultural services, forestry, and fishing (5.6%); mining (4.9%); and finance, insurance, and real estate (4.9%). During that period employment in the farming, manufacturing, and transportation and public utilities sectors posted losses consistent with trends at the ROI level; however, at the national level losses occurred only in the farming and manufacturing sectors during that same period. The 1984 distribution of employment in the 11 major industrial sectors in

Kane County were similar to those of DuPage County and the Illinois ROI. The dominant sectors in the county's economy, in terms of employment, were services (with 23.7% of the total county work force), manufacturing (23.1%), and retail trade (19.2%).

Average earnings per worker in Kane County in 1984 were $20,982, below both the ROI and national averages. In 1984, the highest average earnings per worker per sector were paid in wholesale trade at over $34,000.

Unemployment rates in Kane County have maintained a similar pattern to those of the ROI. From 1974 to 1979, unemployment rates in the county were below the national unemployment rates. Since 1980, however, unemployment rates in Kane County, which peaked in 1982 at 12.3%, have exceeded the national rates. Recent trends from 1982 to 1986 show county unemployment rates steadily dropping to approach the national average (Illinois Department of Economic Security 1988). Kane County's labor force, nearly 150,000 in 1984, has grown more rapidly than has total employment in the county in recent years, averaging 2.2% annually between 1974 and 1986.

In 1984, per capita personal income in Kane County was $16,564, less than the ROI average ($16,932), yet more than the national average ($14,746). Between 1969 and 1984, per capita personal income in the county remained in those same relative positions, growing from about $13,000 in 1969.

c. Kendall County

Kendall County is the smallest of the three primary impact counties and contributes only a minor portion of the employment and income ROI totals. In 1984, Kendall County provided only 2.9% of total employment in the three impact counties and merely 0.4% of the employment in the Illinois ROI. County residents received just 0.4% of total personal income in the Illinois ROI and 2.8% of total personal income in the primary impact counties. Between 1969 and 1984 total employment growth in the county averaged 1.1% annually.

From 1969 to 1984, average annual employment growth rates in Kendall County exceeded national rates in seven of the eleven industrial sectors and exceeded average ROI rates in eight of the sectors. The actual number of jobs created was considerably smaller, however. Employment in the agricultural services, forestry, and fishing sector grew fastest at a rate of 13.3%, followed by wholesale trade (7.5%) and construction (6.9%). Only employment in the farming and manufacturing sectors posted losses over this period, reflecting Illinois ROI and national employment trends. The dominant sectors of the county's economy in 1984, in terms of employment, were manufacturing (with 50.3% of total county jobs), services (13.5%), and government (9.9%).

Average earnings per worker in 1984 were $26,464, highest of the primary impact counties and higher than both the national and ROI averages. In 1984, the highest average earnings per worker in the county were paid in the manufacturing sector at over $37,000. The next closest were workers in transportation and public utilities who averaged just over $28,000.

From 1975 to 1981, unemployment rates in Kendall County remained consistently below those for both the Illinois ROI and the nation. In 1982, however, the unemployment rate in the county rose above both those averages to a high of 11.4%. Since then, the county rate has been steadily dropping, and in fact fell below the Illinois ROI and U.S. averages in 1984 and 1986 (Illinois Department of Employment Security 1988). In relative terms, the labor force of Kendall County has been growing far more rapidly than that in the rest of the ROI, at 6.6% annually between 1974 and 1986. In terms of absolute size, total labor force in the county amounted to nearly 20,000 persons in 1984.

In 1984, per capita personal income in Kendall County was the lowest of the primary impact counties at $15,241, above the national average ($14,746) but below the ROI average ($16,932). Between 1969 and 1984, per capita personal income in the county remained at or above the national average. Per capita income approximated the Illinois ROI average until 1978, but dropped behind the ROI average after that date.

B. Demographics and Housing

1. Regional Setting

Illinois ROI population has increased at varying rates during the past 50 years. Different counties within the ROI have grown more rapidly than others during this period, largely as a result of their respective roles in the evolution of metropolitan Chicago. Cook County has witnessed the greatest absolute growth in the region, increasing from 4.0 million to 5.3 million people since 1930. DuPage County, on the other hand, has grown most rapidly in relative terms, increasing nearly five-fold over the same time span. Recently, the population of the ROI has increased very slowly. Between 1970 and 1980, the population of the region grew at an average annual rate of 0.2%, increasing from 7.1 to 7.2 million during that decade (U.S. Bureau of the Census 1982b); Table 5.3.11-2 lists key demographic indicators for the area. By 1985, more than 7.4 million persons resided in the Illinois ROI (U.S. Bureau of the Census 1987a), the result of an average annual increase of 0.5% over the preceding 5 years.

Population projections for the region suggest continued slow growth in the area through the year 2030. By 1990, slightly more than 7.5 million people are expected to live in the Illinois ROI, the result of 0.4% average annual growth during the 1980s. Regional population is projected to exceed 7.6 million persons by the turn of the century, with annual change

Table 5.3.11-2

KEY DEMOGRAPHIC INDICATORS FOR THE ILLINOIS ROI

	1970	1980	1990	2000	2010	2020	2030
Population (millions)	7.10	7.24	7.51	7.63	7.71	7.78	7.84
Avg. Ann. Chg. over Preceding Decade	1.2%	0.2%	0.4%	0.2%	0.1%	0.09%	0.08%
			Age Distribution				
≤ 4 years	8.5%	7.4%	8.4%	7.3%	6.7%	6.4%	6.2%
5 - 19 years	28.6%	24.9%	21.0%	21.6%	19.6%	18.5%	17.7%
≥ 65 years	8.6%	10.0%	11.4%	11.6%	12.3%	14.4%	17.6%

Source: Historic Data by U.S. Bureau of Census 1982b.

slowing to less than 0.2% between 1990 and 2000. Average annual demographic growth is expected to slow to 0.1% between 2020 and 2030, as the population of the ROI reaches some 7.8 million by the latter date.

Changes in the age composition of the Illinois ROI population are anticipated to accompany its growth, particularly in terms of decreasing numbers of young persons and concomitant increasing numbers of older persons. In 1980, about 7.4% of the regional population were 4 years or younger, 25.9% were between 5 and 19 years, and 10.0% were 64 years or older (U.S. Bureau of the Census 1982b). In the year 2000, regional population projections suggest that the first two age categories will constitute 7.3 and 21.6% of the population, respectively, while the latter category will contain 11.6%. By 2030, persons aged 4 and younger are anticipated to represent only 6.2% of regional population, while those aged 5 to 19 will decrease to only 17.7% of the total; individuals in the oldest age group, on the other hand, will continue to increase, representing 17.6% of the population.

Housing in the Illinois ROI is dominated by Chicago (Cook County) and its suburbs, which account for more than half of the total year-round housing units in the state of Illinois. In 1980, the Bureau of the Census counted a total of nearly 2.7 million year-round housing units in the region (U.S. Bureau of the Census 1982a). Of that total, 55.3% (1.48 million) were owner occupied (or available for owner occupancy), 42.9% (0.54 million) were renter occupied (or available for renter occupancy),

and the remaining 1.8% were considered unavailable for occupancy, being either in transition (for example, under transfer of ownership) or deemed uninhabitable (for example, due to renovation or condemnation).

Of the total year-round housing units in the ROI, 94.4% were occupied in 1980. Considering only year-round units available for occupancy in the ROI, the 1980 vacancy rates were 2.0% for owner units and 6.4% for rental units.

Trends in ROI housing growth since 1980 can be inferred from the number of housing units authorized by building permits. The total number of building permits authorized in the region from 1981 to 1986 has exceeded 135,000, an average annual increase of nearly 23,000 per year. The actual yearly number of building permits issued has steadily increased from 9,517 in 1981 to 42,295 in 1986 (U.S. Bureau of the Census 1983, 1985, 1987b). Of over 2.61 million housing units in the Illinois ROI (excluding DeKalb County) sampled in a series of Federal Home Loan Bank vacancy surveys conducted in 1986-87, 53.3% were found to be single-family detached units, 45.9% multi-family units, and 0.8% mobile homes (Federal Home Loan Bank of Chicago 1986a, 1986b, 1986c, 1986d, 1987).

2. Primary Impact Counties

The portion of the Illinois ROI of primary interest with respect to demographics and housing consists of DuPage, Kane, and Kendall counties, in which the proposed SSC facilities would be located. Qualitative differences, in terms of residential opportunities and community character, distinguish these three counties.

DuPage County, home for a growing segment of the Chicago-related population currently expanding the "Western Suburbs," is largely urbanized. Research and other service oriented job opportunities enhance the role of DuPage County in the overall development of these western suburbs.

Kendall County, on the other hand, is distinctly more rural in nature. The Oswego area and Yorkville, the largest communities in the county, lie in the northernmost portions of the county near the SSC site.

Kane County has a mixed character, mostly rural in its western half, with development concentrated in a string of rapidly growing communities along the Fox River corridor on the eastern side of the county closest to the SSC, including Aurora and the "Tri-Cities" of Batavia, Geneva, and St. Charles.

In general, population in the ROI counties is greater in these areas closer to Chicago, which is also the trend in the three primary impact counties. DuPage County contains more people than the other two counties combined, and in recent years has been growing the fastest as well. Between 1970 and 1980, the population of DuPage County increased from

approximately 490,000 to nearly 660,000 million persons (U.S. Bureau of the Census 1982b), representing an average annual increase of 3.0%; by 1985, its population had grown to nearly 720,000 million representing a slower annual increase of 1.4% during those years (U.S. Bureau of the Census 1987a). Kane County's 1970 population of 251,000 grew to over 278,000 by 1980, increasing annually at a 1.0% rate; between 1980 and 1985 its population is estimated to have grown at a 1.4% annual rate to nearly 300,000. Finally, the population of Kendall County was recorded at approximately 26,000 in 1970, growing to slightly more than 37,000 by 1980 (at a 3.5% annual average rate) down to an estimated 37,000 in 1985 (a -0.1% annual change from 1980). Future growth in the populations of these counties is expected to reflect the evolution of Chicago suburbs, with DuPage and Kane counties continuing to grow more rapidly than the predominantly rural Kendall County.

Although nearly 75% of the year-round housing units in the Illinois ROI were found in Cook County in 1980, a large number were also located in the primary impact counties. According to the 1980 Census of Housing, DuPage County contained more than 234,000 year-round housing units, of which 72.3% were owner units, 26.5% were rental units, and 1.2% were unavailable for occupancy at the time; 94.6% of these units were occupied and vacancy rates for available units were 3.0% for owner units and 7.8% for rental units.

Kane County contained slightly fewer than 100,000 year-round housing units in 1980 with 65.2% owner-occupied, 33.2% renter-occupied, and 1.5% unavailable for occupancy. Of the total year-round units in the county, 95.2% were occupied in 1980. Considering only those units available for occupancy, 1980 vacancy rates were 1.7% for owner units and 6.5% for rental units.

Predominantly rural Kendall County contained just 12,000 year-round housing units in 1980, of which 73.1% were owner occupied, 25.7% were renter occupied, and 1.2% were unavailable for occupancy at the time. Of the total year-round units in the county, 96.5% were occupied in 1980. Considering just those units available for occupancy, 1980 vacancy rates were 1.3% for owner units and 5.3% for rental units.

The construction of new housing units, as indicated by building permits, has increased from 1981 through 1986 in the three primary impact counties, as it has throughout the ROI. During this 6-yr time span, a total of over 36,000 building permits were issued for construction of housing units in DuPage County, an average of more than 6,000/yr, increasing annually from 2,523 in 1981 to 10,510 in 1986 (U.S. Bureau of the Census 1983, 1985, 1987b).

The annual numbers of permits issued in Kane and Kendall counties have increased in a similar manner. More than 8,500 such permits were issued in Kane County from 1981 through 1986, an annual average of 1,430, with yearly numbers increasing from approximately 500 in 1981 to more than 3,350 by 1986. In Kendall County, 450 housing permits were issued over the same time period (an average of 75/yr), with the numbers increasing

from 33 in 1981 to 185 in 1986. Recent vacancy surveys by the Federal Home Loan Bank of Chicago (1986a, 1986b) have indicated declines in the total vacancy rates of the housing stock in all three primary impact counties.

As of 1985, 77 hotels and motels provided temporary lodging in the three primary impact counties (Illinois Department of Revenue 1988). Some 102 campground spaces with recreational vehicle hook-ups currently are located in Kane County, and another 434 are located in Kendall County (Illinois Department of Conservation 1988).

C. Public Services

Levels of public services provided by local governments within the ROI were analyzed using October 1982 employment data (U.S. Bureau of the Census 1984) and fall 1986 school statistics (Illinois State Board of Education 1987a, 1987b, and 1987c).

Key public services examined in this analysis include police and fire protection, provision of health care, and public educational instruction. Education levels of service are 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

Levels of public services for each ROI county, for the ROI as a whole, the State of Illinois, and the United States are presented in Table 5.3.11-3. Total local government employment for the ROI is 33.27 full-time equivalent (FTE) employees per 1,000 population, as compared with 32.15 for Illinois and 34.35 for the United States. Both police and fire protection levels of service for the ROI exceeded the Illinois and U.S. averages (largely because of the high urbanization within the ROI), while health care and education levels of service (general education/ employment and student/teacher ratio) were less than the state and national averages.

Of the nine counties in the Illinois ROI, DuPage, Kane, and Kendall counties are proposed to host the SSC ring and associated facilities, and these counties could be expected to experience the most direct impacts of SSC development. Health care services provided by these counties is supplemented by the large number of advanced medical facilities concentrated in Cook County that are accessible by air ambulance or within 30 minutes driving time of most primary impact county residents.

2. Primary Impact Counties

a. DuPage County

The Illinois SSC campus and injector facilities are proposed to be located in DuPage County and operated in conjunction with the existing Fermi National Accelerator Laboratory (Fermilab). Fermilab, adjacent to

Table 5.3.11-3

LEVELS OF PUBLIC SERVICE FOR THE ILLINOIS SSC SITE

Area	Police Protection	Fire Protection	Health and Welfare	Public Education General Education	Public Education Student/ Teacher Ratio	All Other	Total
Boone County	1.57	0.80	2.76	20.75	18.3	4.54	30.42
Cook County	4.29	1.47	2.19	14.74	20.6	12.28	34.97
DeKalb County	1.88	0.84	3.81	16.42	19.7	4.42	27.36
DuPage County	2.06	0.71	1.66	16.93	19.7	5.75	27.10
Kane County	2.34	0.91	0.03	23.48	21.3	6.88	33.64
Kendall County	1.56	0.08	0.32	16.91	19.1	3.33	22.20
Lake County	2.29	0.85	1.57	19.65	18.9	6.06	30.42
McHenry County	2.09	0.40	1.42	17.81	20.8	4.29	26.01
Will County	2.26	0.74	1.34	18.45	21.0	5.09	27.87
Region of Influence	3.71	1.27	1.97	15.86	20.4	10.46	33.27
Illinois	3.07	1.06	2.38	16.69	19.8	8.95	32.15
United States	2.34	1.02	3.84	18.44	18.0	8.71	34.35

Note: All table values represent full-time equivalent (FTE) employees per 1,000 population except student/teacher ratio.

* Low values indicate counties served primarily by volunteer fire departments.

Sources: U.S. Bureau of the Census 1984; Illinois State Board of Education 1987a, 1987b, and 1987c; U.S. Department of Education 1987.

the proposed site of the SSC campus, currently coordinates police and fire emergency protection with services provided by DuPage and neighboring counties. Such coordination would likely be expanded to serve the campus and associated SSC facilities. At present, however, levels of service for police and fire protection in DuPage County are below the ROI, state, and national averages.

In addition to health care provided by hospitals and medical centers in neighboring Cook County, seven general hospital care facilities in DuPage County provide the public with nearly 3,000 hospital beds.

DuPage County is divided into seven high school districts, 32 elementary school districts, and six unit school districts (grades K-12). Public education levels of service for the county of 16.93 full-time equivalent (FTE) employees per 1,000 population and a 19.7 student/teacher ratio approximate the state averages of 16.69 and 19.8 but fall short of the national averages of 18.44 FTE employees per 1,000 population and an 18.0 student/teacher ratio.

b. Kane County

Kane County is proposed to host nearly half the SSC ring, including the far experimental areas. The county presently supplies police and fire protection and public health care at levels of service lower than the ROI, state, and national averages.

Kane County is divided into nine unit school districts. Through 126 schools, these districts provide public school services and facilities to county residents. Although public education level of service for the county (23.48 FTE employees per 1,000 population) exceeds the ROI, Illinois, and U.S. averages (indicating a higher level of service), the fall 1986 student/teacher ratio (21.3) for the county does not meet the averages of the ROI, state, or nation.

The Kaneland Community Unit School District operates only two schools, the Kaneland Junior/Senior High School and Kaneland Elementary School with combined enrollment of 1,831 students. Both schools are located on the same campus, adjacent to the proposed location of the far experimental areas.

c. Kendall County

Only a small portion of the ring, with no key facilities, is proposed to pass through northern Kendall County. This mostly rural county maintains police and fire protection and health care levels of service below the ROI, state, and national averages. Kendall County, with a relatively small population and fewer specialized services than other more populated counties of the ROI, offers no general hospital care to residents. However, its health department does maintain minimal service for residents.

The county is divided into six school districts: three unit, two elementary, and one high school district, which together operate 19 schools. The student/ teacher ratio of 19.1 for the county indicates an educational instruction level of service better than the ROI and state, yet not as good as the national average level of service (represented by a 18.0 student/ teacher ratio).

D. Public Finance

1. Illinois State Government Finances

a. State Government Taxes

Illinois has a number of sales taxes and a state income tax. The largest revenue sources are the income tax and the state general sales taxes. Motor fuel taxes, motor vehicle fees, and a public utilities tax all provide substantial shares of state revenues. Major revenue sources are briefly discussed below. The tax revenue percentages exclude the State Lottery. All dollar values in the public finance discussion are current dollars for the fiscal years cited.

The income tax is the largest revenue source for the state, representing 35.76% of Illinois tax revenues in FY 1986. (Table 5.3.11-4). The base includes individuals, corporations, and fiduciaries.

In Illinois the sales tax refers to several taxes including state, county, municipal, and transit district retailer's occupation taxes, service occupation taxes, and use taxes. Local add-ons are permitted. The base is retail sales of tangible personal property. The state rate is 5%. In fiscal 1986, 34.35% of state tax revenues were derived from this source.

Motor fuels taxes are collected as user fees for public highways and waterways. The tax is 13 cents/gal for gasoline and special fuel. Diesel fuel is subject to an additional tax of 2.5 cents/gal. Agricultural, construction, and other nonhighway users are eligible for refunds of taxes collected. Commercial vehicles are subject to additional taxes. Motor fuel taxes provided 6.31% of Illinois tax revenues in 1986.

Passenger cars are subject to a flat $48 registration fee. Heavier vehicles pay $48 to $2,200 according to gross weight. Trucks, trailers, tractors, and buses have an alternate mileage-weight tax. This source also includes vehicle use tax levied on private motor vehicle sales, at the time of sale, which is graduated progressively by the price of the vehicle. There is also a small tax on passenger, pipeline, and rail carriers included here. This source accounted for 6.30% of Illinois tax revenues in 1986.

Electricity is taxed at 32 cents/kWh and gas at 2.4 cents/therm or 5% of gross intrastate receipts, whichever is lower. Telecommunications are taxed at 5%. These sources contributed 6.61% of tax collections in 1986.

TABLE 5.3.11-4

ILLINOIS STATE GENERAL REVENUE AND EXPENDITURE - 1986

Revenue/Expenditure	Amount in thousands	Per Capita
REVENUE		
Total Intergovernmental	$ 4,077,635	$ 353
Federal	3,986,653	345
Total Taxes	$ 9,800,757	$ 848
Sales and Gross Receipts	5,288,629	458
General Sales	3,366,226	291
Selective Sales, Gross Receipts	1,922,403	166
Alcohol	69,385	6
Insurance	145,722	13
Motor Fuels	618,868	54
Public Utilities	647,935	56
Tobacco	194,787	17
Individual Income	2,645,364	229
Corporation Net Income	859,707	74
Licenses	734,305	64
Corporate License Tax	60,666	5
Motor Vehicle	567,529	49
Occupation and Business Licenses	57,598	5
Documentary and Stock Transfer Fees	9,336	1
Property Tax	209,695	18
Charges and Misc. General Revenue	2,415,248	209
Current Charges	940,049	81
Total General Revenue	$ 16,293,640	$ 1,410
EXPENDITURE		
Total General Expenditure	$ 16,108,070	$ 1,394
Direct Capital Outlay	1,543,024	134
Population, 1986: 11,553,000)		

Source: U.S. Bureau of the Census. "State Government Finances in 1986", GF-86-No. 3, Oct. 1987.

Other taxes include the state replacement (or business personal property) tax, the cigarette tax, and the insurance companies tax. The largest of these, the replacement tax, yielded 2.14% of state tax revenues in 1986.

b. State Revenue and Expenditure

Table 5.3.11-4 presents state government general revenues and expenditures for fiscal 1986. Taxes lead intergovernmental revenues and charges as main revenue source categories. Sales and income taxes are the major taxes as discussed above. General revenues exceeded general expenditures by about 1%. Direct capital outlays were about 10% of general expenditures.

c. Local Government Organization and State Payments to Local Governments

There were 102 county, 1,280 city, 1,434 township, and 1,049 school district governments in Illinois at the time of the 1982 Census of Governments. Township governments exist in 85 counties and have the tax assessment, local road maintenance, and indigent support functions. In some instances, they also operate libraries, cemeteries, or hospitals. Illinois has no dependent school districts.

There were also 2,602 special district governments. Important ones include fire protection districts, street lighting districts, solid waste disposal districts, and water and sanitation districts. There is also a subordinate state agency called The Capital Development Board, which provides assistance to school districts for capital funding. Many special districts can levy property taxes and assessments, impose charges, and issue bonds under certain conditions.

The largest expenditure by the State of Illinois is for elementary and secondary schooling. The largest share of funding is for operations, which include state equalization. Categorical grants are also provided. Capital funding is locally provided.

Certain state taxes are earmarked for specific functions or distributed, often in part, to local governments. For example, one-twelfth of Illinois state income tax revenues are distributed to counties and municipalities by population. Also, one-sixteenth of state sales tax revenues collected within certain transit districts boundaries are given to them.

Motor fuel taxes are distributed, in part, to local governments, including cities, Cook County, other counties, and road districts. Some funds are allocated between the state and these groups by formula; other monies are grants based on specific needs.

In the late 1970s the business personal property taxes were repealed and replaced by a "replacement tax," mentioned above, which is distributed to property taxing districts according to business personal property tax relative shares at that time.

Other local taxes are collected by the state, including the local option sales taxes.

2. Local Governments

The following will consider local government revenues and expenditures in the of DuPage, Kane, and Kendall counties considered the primary impact area. The City of Aurora and the Township of Kaneville, both of which are in Kane County, are also included in this analysis.

a. DuPage County

Revenue and expenditure data for fiscal year 1986 are provided in Table 5.3.11-5 for DuPage County government. The largest local revenue sources are charges for services, property taxes, and local option sales taxes. State-shared tax revenues and intergovernmental grants are also major revenue items. For 1986, revenues exceeded total expenditures by about 10%, while project construction, a capital account, was about 10% of total expenditures.

DuPage County presented property taxpayers with 1985 tax bills for all jurisdictions in the following amounts:

Jurisdiction	Tax Levy
County government	$49,448,659
Municipal	56,362,521
Township, road district	15,188,746
K-12 school district	327,124,053
Special district	98,145,687
Total DuPage County	$546,269,666

Total 1985 assessed value in DuPage County was $8,138,932,760.

b. Kane County

Kane County revenues and expenditures for fiscal year 1986 are presented in Table 5.3.11-6. Property taxes lead charges and local sales taxes as the largest local sources. State intergovernmental revenues are also significant. In 1986, revenues exceeded total expenditures by 7%.

Table 5.3.11-5

DUPAGE COUNTY, ILLINOIS
COUNTY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
County tax revenues		
Property	$ 49,287,613	$ 68
Sales	8,573,270	12
State-shared		
Income	2,243,961	3
Motor Fuel	6,308,640	9
Replacement	1,411,328	2
Intergovernmental revenue		
Federal revenue sharing	1,358,092	2
Grants or refunds	13,742,542	19
Illinois reimbursements	1,170,925	2
Licences	2,756,653	4
Charges for services	31,098,124	43
Interest and rents	5,393,536	7
Other revenue	5,159,329	7
Total Operating Revenue	$ 128,504,013	$ 177
EXPENDITURE		
Operations	$ 97,854,386	$ 134
Bond redemption	5,051,652	7
Debt interest	1,593,162	2
Project/construction	12,014,416	17
Total Expenditure	$ 116,513,616	$ 160

Notes: Population, 1986: 727,700
Assessed Value: $ 8,116,032,000

Sources: For financial data: Illinois Office of the Comptroller, Statewide Summary of County Finance in Illinois 1988; for population figure: U.S. Bureau of the Census 1988.

218-829 O - 88 - 6 (BOOK 4)

Table 5.3.11-6

KANE COUNTY, ILLINOIS
COUNTY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
County tax revenues		
Property	$ 11,629,940	$ 39
Sales	2,591,242	9
State-shared		
Income	1,205,159	4
Motor fuel	2,627,056	9
Replacement	569,867	2
Intergovernmental revenue		
Federal revenue sharing	699,317	2
Grants or refunds	1,251,979	4
Illinois reimbursements	952,156	3
Licences	689,657	2
Charges for services	4,948,527	16
Interest and rents	904,301	3
Other revenue	1,849,827	6
Total Operating Revenue	$ 29,919,028	$ 99
EXPENDITURE		
Operations	$ 27,995,189	$ 93
Bond redemption	0	0
Debt interest	29	0
Project/construction	0	0
Total Expenditure	$ 27,995,218	$ 93

Notes: Population, 1986: 300,800
Assessed Value: $ 2,026,213,512

Source: For financial data: Illinois Office of the Comptroller, Statewide Summary of County Finance in Illinois 1988; for population figure: Bureau of the Census 1988.

Kane County property tax bills in 1985 for all jurisdictions amounted to the following:

Jurisdiction	Tax Levy
County government	$11,733,803
Municipal	24,031,204
Township, road district	7,095,348
K-12 school district	80,913,603
Special district	22,978,170
Total Kane County	$146,752,128

Total 1985 assessed value was $2,292,138,685.

1) City of Aurora

In Aurora, property and sales taxes are the largest revenue sources, as shown in Table 5.3.11-7 for fiscal 1986. State-shared taxes and other intergovernmental revenues are substantial, as are licenses, charges for services, and investment income. In 1986, revenues exceeded total expenditure by 15%. Capital expenditure was only 1% of total expenditure.

2) Kaneville Township

Kaneville Township, derived the bulk of its revenues for 1986 from property taxes and from a general fund and a road and bridge fund. A few dollars came in from other assorted sources, as indicated in Table 5.3.11-8. A shortfall of about 28% was registered in 1986; capital expenditure was 5% of total expenditure.

c. Kendall County

The major sources of funds for Kendall County are local property and sales taxes and state-shared sources, as shown for 1986 in Table 5.3.11-9. A surplus of 6% of total expenditures was recorded, of which 1% was capital expenditure (project construction).

Kendall County property taxes in 1985 amounted to the following:

Jurisdiction	Tax Levy
County Government	$2,011,902
Municipal	815,321
Township, Road District	1,538,378
K-12 School District	1,883,840
Special District	14,410,220
Total Kendall County	$18,775,821

Total assessed value in Kendall County for 1985 was $350,517,180.

Table 5.3.11-7

AURORA (KANE COUNTY), ILLINOIS
CITY REVENUES BY SOURCE AND TOTAL EXPENDITURE - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
City tax revenues		
Property	$ 13,212,989	$ 168
Sales	7,431,075	95
Foreign ins. co. tax	46,522	1
Utility receipt tax	0	0
State-shared		
Income	1,974,960	25
Motor fuel	1,357,778	17
Replacement	1,856,034	24
Other taxes	2,459,402	31
Intergovernmental revenue		
Federal revenue sharing	850,021	11
Federal grants	678,599	9
State grants	140,646	2
Other grants or refunds	0	0
Licences		
Vehicle	282,274	4
Liquor	221,952	3
Franchise fees	237,713	3
Inspection fees	486,760	6
Other licenses	486,655	6
Total licenses	1,715,354	22
Charges for services		
Recreation facilities	610,599	8
Other services	235,794	3
Total charges for services	846,393	11
Fines	469,079	6
Investment income	4,529,072	58
Other revenue	2,328,881	30
Total Operating Revenue	$ 39,896,805	$ 509
EXPENDITURE		
Capital expenditures	$ 423,129	$ 5
Operations	34,322,229	438
Total expenditures	34,745,358	443

Notes: Population, 1986: 78,420
Assessed Value: $ 456,775,398

Sources: For financial data: Illinois Office of the Comptroller. Statewide Summary of Municipal Finance in Illinois 1988; for population figure: Bureau of the Census 1988.

Table 5.3.11-8

**KANEVILLE TOWNSHIP (KANE COUNTY), ILLINOIS
TOWNSHIP REVENUES BY SOURCE AND TOTAL EXPENDITURES - 1986**

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Township tax revenues		
Property	$ 100,380	$ 75
State-shared		
Replacement	4,670	3
Other taxes	0	0
Intergovernmental revenue		
Federal revenue sharing	6,000	4
Other grants or refunds	122	0
Charges for services	7,390	6
Investment income	854	1
Other revenue	3,832	3
Total operating revenue	$ 123,248	$ 92
EXPENDITURE		
Capital expenditure	$ 9,226	$ 7
Operations	161,397	120
Total expenditure	$ 170,623	$ 127

Notes: Population, 1986: 1,340
Assessed Value: $ 16,512,417

Sources: For financial data: Illinois Office of the Comptroller, Statewide Summary of Township Finance in Illinois 1988; for population figure: Bureau of the Census 1988.

Table 5.3.11-9

KENDALL COUNTY, ILLINOIS
COUNTY REVENUES BY SOURCE AND TOTAL EXPENDITURE - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
County tax revenues		
Property	$ 2,015,159	$ 54
Sales	703,752	19
State-shared		
Income	587,174	16
Motor fuel	353,985	10
Replacement	242,206	7
Intergovernmental revenue		
Federal revenue sharing	102,150	3
Grants or refunds	961,790	26
Illinois reimbursments	101,411	3
Licences	139,512	4
Charges for services	494,792	13
Interest and rents	146,671	4
Other revenue	488,678	13
Total Operating Revenue	$ 6,337,280	$ 171
EXPENDITURE		
Operations	$ 5,908,212	$ 159
Bond redemption	0	0
Debt interest	0	0
Project/construction	57,997	2
Total Expenditure	$ 5,966,209	$ 161

Notes: Population, 1986: 37,100
Assessed Value: $ 320,786,444

Sources: For financial data: Illinois Office of the Comptroller, Statewide Summary of County Finance in Illinois 1988; for population figure: Bureau of the Census 1988.

5.3.11.2 Infrastructure

A. Transportation

1. Roads

Major highways and roads serving the proposed SSC site are shown in Figure 5.3.11-3. Data on these highways and roads are presented in Table 5.3.11-10.

Metropolitan Chicago 32 mi to the east of the proposed site is served by a freeway system that includes Interstate 94 (I-94) extending to the north and east, I-90 extending to the northwest and east, I-80 extending to the east and west, I-55 extending to the southwest, and I-57 extending to the south. *In addition, I-65 extends to the southeast from nearby* Gary, Indiana. I-88 (formerly State Route 5) is also a major tollway extending to the west. An extensive system of arterial and bypass freeways and highways join these interstates.

The proposed site is served by a network of interstate, U.S., state, and county roads. These include I-90 on the north and U.S. Route 34 on the south. I-88 is a major east-west tollway extending across the SSC site. State Routes 38, 56, 64, and 5 also cross the site in the east-west *direction. State Route 59 extends from I-90 to U.S. Route 34 to the* east of the proposed campus site. State Route 47 extends from I-90 to U.S. Route 34 across the site to the east of the far cluster.

State Routes 38, 56, and 59 and Kirk Road provide access to the campus area. Kirk and Batavia roads provide access to the existing Fermilab campus. State Routes 38 and 56, Dauberman Road, and I-88 provide access to the far cluster. Additional county and township paved roads provide access to most of the proposed locations for surface facilities.

2. Rail

The proposed SSC site area is served by a network of rail lines including two Chicago and North Western Transportation Company lines, two Burlington Northern Railroad lines, and one Elgin Joliet and Eastern Railway Company main lines that cross the proposed site. These rail lines are shown in Figure 5.3.11-3. Additional main lines of the Chicago and North Western Transportation Company, the Elgin Joliet and Eastern Railway Company and *Illinois Central Gulf Railroad pass nearby to the east and north of the* proposed site. An existing rail spur provides service to Fermilab. These railroads connect the proposed site area with Chicago and major cities to the west along the main lines and with most other U.S. cities through connections to other railroads.

Figure 5.3.11-3

ROADS AND AIRPORTS SERVING THE ILLINOIS SSC SITE

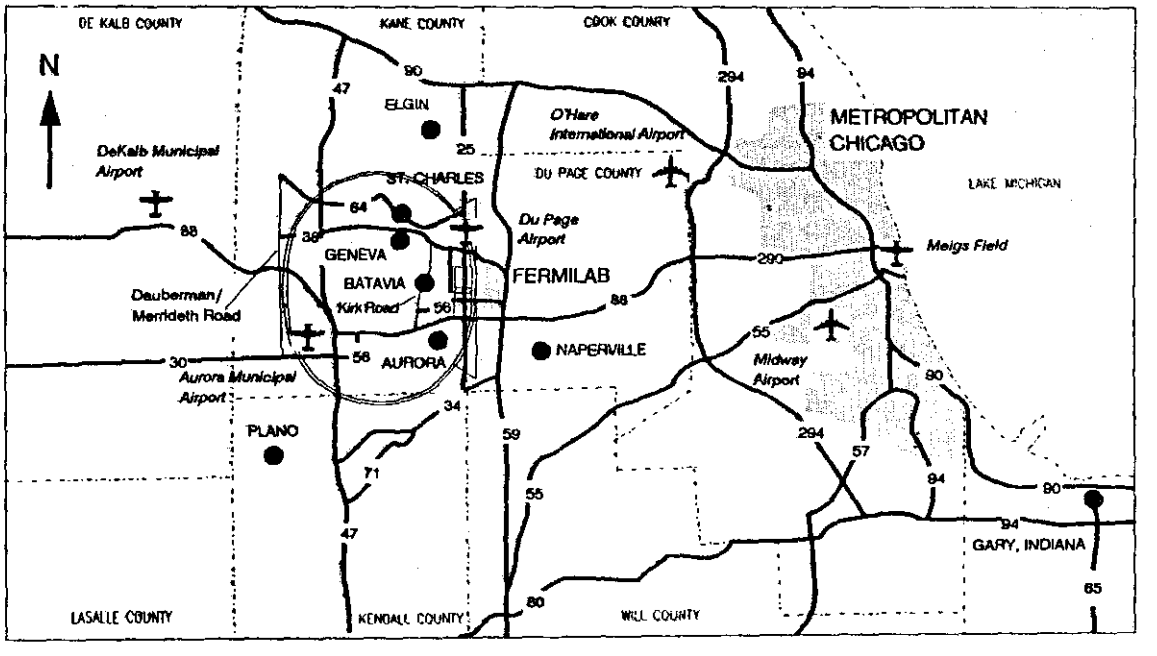


Table 5.3.11-10

PRESENT HIGHWAYS AND ROADS SERVING THE PROPOSED ILLINOIS SSC SITE

Road Segment	Length mi	Lanes	Capacity pcph[1]	Peak Hour Volume pcph[1]	LOS[2]
FREEWAYS/TOLLWAYS					
I-90: I-290 to State Route 59	9	4	8,000	6,650	D[3]
I-90: State Route 59 to State Route 47	13	4	8,000	3,000	B
I-88: I-294 to Naperville Road	13	6	12,000	6,800	C
I-88: Naperville Road to State Route 59	5	4	8,000	4,200	B
I-88: State Route 59 to Dauberman Road	19	4	8,000	1,500	A
State Route 56: I-88 to State Route 47	4	4	8,000	500	A
RURAL ROADS					
State Route 56: State Route 47 to Dauberman Road	4	2	2,800	550	C
State Route 38: Randall Road to Meredith Road	9	2	2,800	500	C
State Route 64: Randall Road to State Route 47	7	2	2,800	650	C[4]
State Route 47: I-90 to State Route 56	29	2	2,800	450	C[5]
State Route 47: State Route 56 to U.S. Route 34	7	2	2,800	900	C[5]
U.S. Route 34: State Route 31 to State Route 47	5	2	2,800	750	C
Dauberman/Meredith Road: State Route 56 to State Route 38	10	2	2,800	100	A[6]

Table 5.3.11-10 (Cont)

PRESENT HIGHWAYS AND ROADS SERVING THE PROPOSED ILLINOIS SSC SITE

Road Segment	Length mi	Lanes	Capacity pcph[1]	Peak Hour Volume pcph[1]	LOS[2]
URBAN/SUBURBAN ROADS (Reference: IDOT 1988)					
State Route 38: State Route 59 to Kirk Road	5	4	2,450	1,350	A[7]
State Route 38: Kirk Road to Randall Road	3	4	2,450	1,800	C[8]
State Route 56: State Route 59 to Kirk Road	4	2	1,300	1,050	C[9]
State Route 64: State Route 59 to Kirk Road	3	4	2,350	1,750	C[10]
State Route 64: Kirk Road to Randall Road	3	4	2,350	2,050	D[11]
U.S. Route 34: State Route 59 to State Route 31	9	2	1,300	1,150	D[12]
Kirk Road: State Route 64 to I-88	8	4	2,950	1,300	A[13]
State Route 59: U.S. Route 34 to I-88	4	4	2,750	1,850	B
State Route 59: I-88 to State Route 56	1	4	2,750	2,300	D
State Route 59: State Route 56 to I-90	18	4	2,750	1,800	B[14]
Batavia Road: State Route 59 to Fermilab Campus	3	2	1,300	550	A

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 become 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 generally poor level of driver comfort and convenience.

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

F: Forced or breakdown flow with traffic demand exceeding the capacity, unstable stop-and-go traffic.

Table 5.3.11-10 (Cont)

PRESENT HIGHWAYS AND ROADS SERVING THE PROPOSED ILLINOIS SSC SITE

NOTES (Cont):

3. Portions of I-90 close to I-290 experience LOS E.
4. Portions of State Route 64 close to Randall Road experience LOS D.
5. Portions of State Route 47 close to State Route 56 experience LOS D.
6. Portions of Dauberman and Meredith Roads close to Keslinger Road experience LOS B.
7. Portions of State Route 38 close to State Route 59 experience LOS B.
8. Portions of State Route 38 across the Fox River experience LOS D.
9. Portions of State Route 56 close to Kirk Road eperience LOS D.
10. Portions of State Route 64 close to State Route 59 experience LOS D.
11. Portions of State Route 64 across the Fox River experience LOS F.
12. Portions of U.S. Route 34 close to State Route 59 experience LOS F.
13. Portions of Kirk Road close to State Route 56 experience LOS B.
14. Portions of State Route 59 close to State Route 64 experience LOS C.

Sources: Illinois Department of Transportation 1984-1; 1984-2; 1985; 1988.

The Chicago and North Western and Burlington Northern rail lines in the site area carried more than 25 million tons of freight in 1986 (Illinois Department of Transportation 1987-1). The Elgin Joliet and Eastern rail lines in the site area carried 5 to 10 million tons of freight in 1986.

Amtrak provides passenger rail service to the proposed SSC site area using Burlington Northern Railroad tracks. Daily service is provided to the cities of Naperville and Plano (Illinois Department of Transportation 1987-2).

3. Air

The locations of airports serving the proposed site are shown in Figure 5.3.11-3.

The principal airport that would provide passenger and freight service to the proposed SSC site is the O'Hare International Airport. This airport, owned and operated by the City of Chicago, is located approximately 15 mi west-northwest of downtown Chicago and approximately 22 mi northeast of the proposed campus location. The airport is a major hub in the U.S. transportation system.

Airport operations are currently congested with 122,000 hours of delays experienced by scheduled airline operations in 1986. Delays are forecasted to increase to 166,000 hours in 1996. There are no future plans for construction of new runways (Yatzeck 1988).

Other airports in the area providing commercial airline service are the Midway Airport, Meigs Field, and the Greater Rockford Airport. Midway Airport and Meigs Field are owned and operated by the City of Chicago. Regional airline service is provided at Midway Airport and commuter airline service is provided at Meigs Field (Chicago Area Transportation Study 1984). The Greater Rockford Airport is owned and operated by the Greater Rockford Airport Authority. Regional airline service is provided at this airport.

Three general aviation airports capable of handling corporate jets also serve the proposed SSC site. The DuPage Airport, owned and operated by the Fox Valley Airport Authority, is located in West Chicago approximately 5.5 mi north of the proposed campus location (Fox Valley Airport Authority 1982). It is located in a proposed stratified-fee area between the locations of J3 and J4. The Aurora Municipal Airport, owned and operated by the City of Aurora, is located near the community of Sugar Grove approximately 8 mi west of downtown Aurora (Aurora Municipal Airport Plan Report 1985). It is located approximately 3 mi east of the southern end of the far cluster. The DeKalb Municipal Airport, owned and operated by the City of DeKalb, is located approximately 12 mi west north west of the far cluster (DeKalb 1980).

4. Waterways

The City of Chicago is located on Lake Michigan which gives it access to the Great Lakes/St. Lawrence Seaway System. Travel distance for ocean-going ships from the Atlantic Ocean to Chicago is 2,250 mi. The Port of Chicago has the capability to handle both bulk and containerized cargos. In 1984, the Port of Chicago handled 23.8 million tons of cargo (Illinois Department of Transportation 1987). The port is located approximately 35 mi east of the proposed site. The Illinois River and the Sanitary and Ship Canals provide waterway access from Lake Michigan to the Mississippi River system and the Gulf Coast. These waterways provide a major transportation route for bulk cargo to the Chicago area. The location of the sanitary and ship canals is shown in Figure 5.3.11-4.

5. Public Transit

a. Bus and Transit Service

Bus and transit service in the Chicago metropolitan area is provided by the Chicago Regional Transit Authority (RTA). This authority has three operating divisions, the Chicago Transit Authority (CTA), the Commuter Rail Division (Metra), and the Suburban Bus Division (Pace).

The CTA provides bus and rapid transit service to the City of Chicago and adjoining suburbs. This service operates 24 h/d, 7 d/wk, over 135 bus routes and six rapid transit lines. The combined bus and rapid transit system provided more than 640 million passenger trips in 1985 (Chicago Regional Transportation Authority 1987).

Metra provides Illinois-based commuter rail services in the Chicago area on 13 commuter lines that serve all six counties in the RTA service area. This includes lines to Aurora and Geneva in the proposed SSC site area. Metra provided more than 64 million passenger trips in 1985 (Chicago Regional Transportation Authority 1987).

Pace provides bus services to suburban Cook, DuPage, Kane, Lake, McHenry, and Will counties. Pace owns and operates four suburban bus systems and subsidizes the operations of ten municipal systems, providing funding support for 234 regular bus routes. Additionally, Pace contracts with 14 private bus companies for fixed route services. A number of Pace routes are located in the SSC site area. Pace provided more than 36 million passenger trips in 1985 (Chicago Regional Transportation Authority 1987).

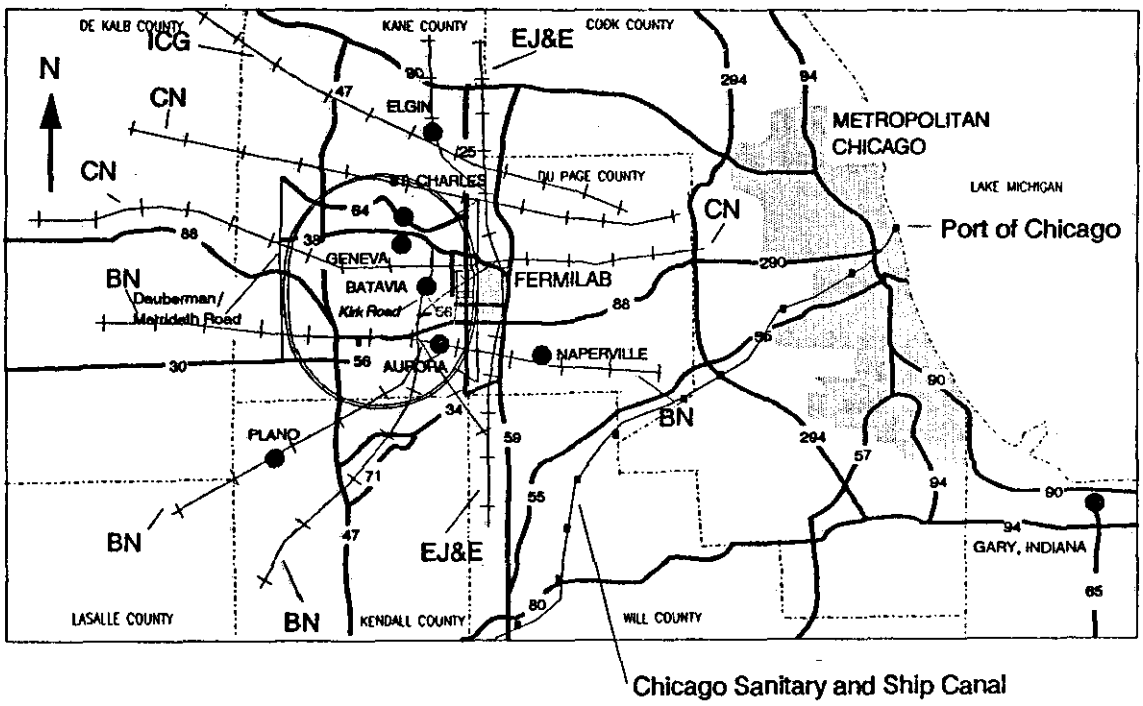
Greyhound bus service is available in Elgin and Aurora connecting these cities to Chicago and cities to the west.

b. Taxi Service

Privately operated taxi, shuttle, and limousine service is provided throughout the Chicago metropolitan area, including the Fox River Valley.

Figure 5.3.11-4

RAILROADS AND WATERWAYS SERVING THE ILLINOIS SSC SITE



BN - Burlington Northern
EJ&E - Elgin Juliet & Eastern
ICG - Illinois Central Gulf
CN - Chicago and Northwestern

c. Rental Car Service

Privately operated rental car services are located at O'Hare International Airport and many other locations in the Chicago metropolitan area. Additional rental car services are located at the Greater Rockford Airport and general aviation fields in DuPage and Aurora (Flight Guide 1986).

d. Para-Transit Services

Pace manages and funds an extensive para-transit network covering 75% of the RTA service area. This network consists of 58 subsidized para-transit services that provide door-to-door transportation for the elderly and handicapped, and in some cases, the general public. These services provided more than one-million passenger trips in 1985 (Chicago Regional Transportation Authority 1987).

B. Utilities

1. Electricity

a. Ownership

Electric service for the area in the vicinity of the Illinois site is provided by the Commonwealth Edison Company and its wholly owned electric utility subsidiary, the Commonwealth Edison Company of Indiana, Inc. Commonwealth Edison is a publicly held corporation.

b. Delineation of Service Territory

Commonwealth Edison supplies electricity to 3 million customers (approximately 8 million people) in Chicago and northern Illinois. The 11,252-mi service area extends into 25 counties and contains nearly 400 municipalities, including 702 of the state's population (Zessin 1988). Figure 5.3.11-5 delineates the boundaries of the Commonwealth Edison service territory.

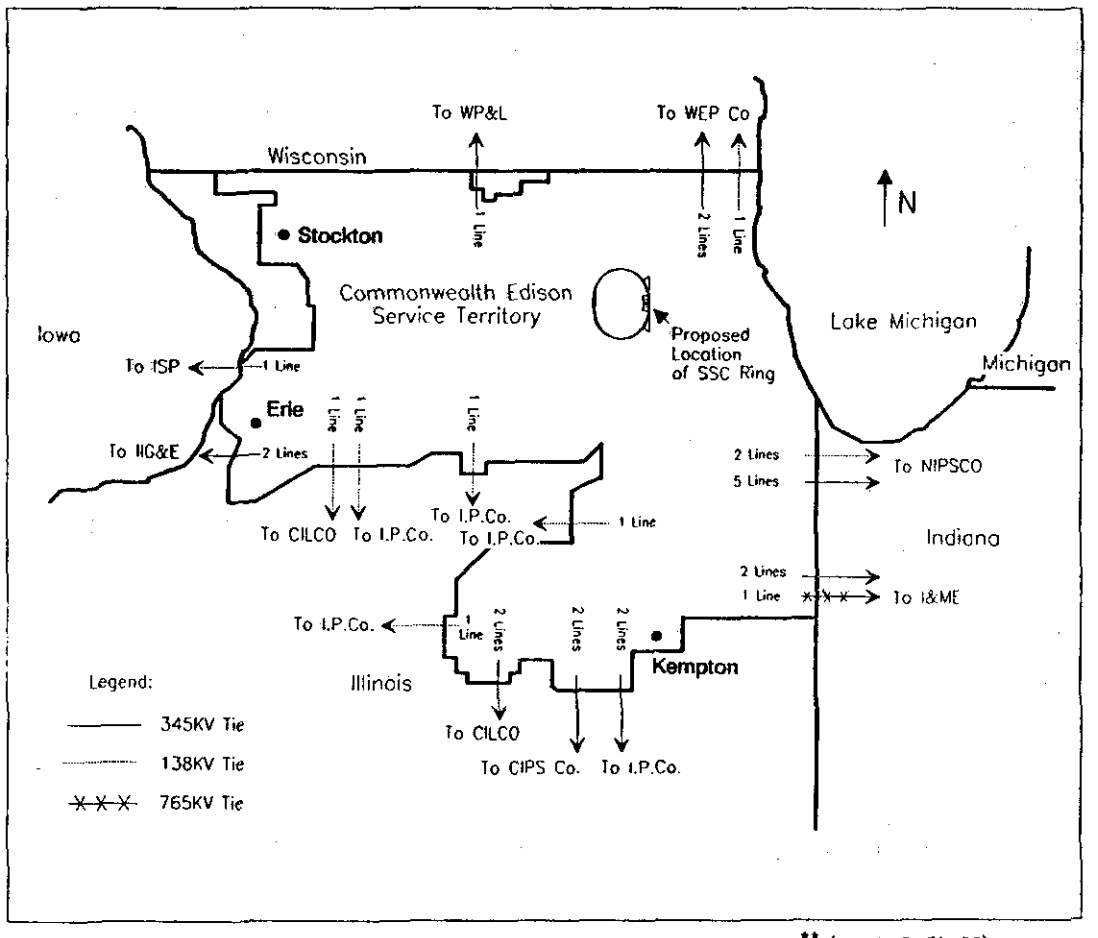
c. Interrelationship with Other Existing Utilities

Commonwealth Edison is a participating member of the Mid-America Interconnected Network (MAIN), one of nine regional councils that make up the North American Electric Reliability Council (NERC). MAIN consists of 13 regular member systems and one associate member in a region containing Illinois, the eastern third of Missouri, the eastern two-thirds of Wisconsin, and most of the Upper Peninsula of Michigan (North American Reliability Council 1987).

MAIN participates in two interregional reliability coordination agreements with other regions of NERC. One includes MAIN, the East Central Area Reliability (ECAR) Coordination Agreement, and the Tennessee Valley

Figure 5.3.11-5

COMMONWEALTH EDISON COMPANY SYSTEM INTERCONNECTIONS



** (As of 12-31-86)

Summary of Commonwealth Edison Interconnections

	765KV	345KV	138KV
Indiana & Michigan Electric Co.(I&ME)	1	2	
Wisconsin Electric Power Co.(WEP Co.)		2	1
Illinois Power Co.(I.P.Co.)		2	4
Central Illinois Public Service Co.(CIPS Co.)		2	
Interstate Power Co.(ISP)			1
Iowa-Illinois Gas andElectric(IIG&E)		2	
Wisconsin Power & Light Co.(WP&L)		1	
Northern Indiana Public Service Co.(NIPSCO)		5	2
Central Illinois Light Co.(CILCO)		2	1
	1	18	9

Authority (TVA) subregion of the Southeastern Electric Reliability Council (SERC); the other includes MAIN, the Mid-Continent Area Power Pool (MAPP), and the Southwest Power Pool (SPP). These agreements provide for review of the adequacy and security of the interregional systems (North American Reliability Council 1987).

Commonwealth Edison has a total of 28 high-voltage MAIN interconnections at 138, 345, and 765 kV. These ties provide access to other power systems in the Midwest (Commonwealth Edison Maps 1986). Figure 5.3.11-5 shows the Commonwealth Edison interconnections to other electric utilities.

d. Existing Network

Table 5.3.11-11 presents the capacities and firing mixtures of Commonwealth Edison's generating plants and primary energy sources in service as of the end of 1987.

e. Planned Future Upgrades/Additions

Commonwealth Edison recently announced a construction budget of $3.65 billion for the period 1988-1992. The new budget continues an overall downward trend that has prevailed since the spending plan peaked at $5.85 billion for the period 1981-1985. No new generating stations are planned prior to the late 1990s, as it is believed there is an abundant capacity to handle growth. Planned expenditures will be applied to operating generating stations as well as the reinforcement of transmission and distribution systems (Commonwealth Edison 1987).

2. Natural Gas

a. Ownership

The Northern Illinois Gas Company (NI Gas) supplies natural gas service to the vicinity of the Illinois site. NI Gas is a public utility principally engaged in the purchase, storage, transportation, distribution, and sale of natural gas.

NI Gas is a subsidiary and the principal business of NICOR, Inc., a publicly owned Illinois Corporation (NICOR 1987).

b. Delineation of Service Territory

NI Gas is the largest distributor of utility energy in Illinois, serving nearly 1.6 million customers in the northern third of the state. This service territory is approximately bounded by Decatur to the south and Moline to the east. NI Gas also serves a strip of territory in the eastern part of the state running from Burlington to Alton (NICOR 1987).

NI Gas presently provides service to Fermilab and the surrounding area.

Table 5.3.11-11

COMMONWEALTH EDISON GENERATION PLANTS AND PRIMARY ENERGY SOURCES IN SERVICE.

Station	Net Owned Generating Capacity (MW)
Nuclear:	
Dresden	1,588
LaSalle County	2,156
Quad Cities	1,183
Zion	2,080
Byron	2,240
Braidwood	1,120
Subtotal:	10,367
Fossil:	
Kincaid (coal)	1,108
Powertown (coal)	1,400
State line (coal)	490
Joliet (coal)	1,327
Fisk (coal)	321
Crawford (coal)	542
Collins (oil)	2,698
Waukegan (coal)	725
Will County (coal)	1,092
Various locations (diesel & other fuels)	1,331
Subtotal:	11,034
Total*:	21,401

* Actual system peak load in 1987 was 15,683 MW.

c. Interrelationship with Other Natural Gas Utilities

NI Gas purchases natural gas from four interstate pipeline suppliers: Natural Gas Pipeline Company of America; Midwestern Gas Transmission Company; Northern Natural Gas Company; and Panhandle Eastern Pipe Line Company.

d. Existing Network

The NICOR 1987 annual report shows routings for the existing network of NI Gas' major gas mains with their interconnections to pipeline suppliers (NICOR 1987). In 1987, NI Gas Sold 302 billion ft^3 of natural gas, and transported an additional 101 billion ft^3 of customer-owned gas. In addition, NI Gas maintains a vast underground aquifer gas storage system that is interconnected with the distribution system. Gas injected into these storage fields can be withdrawn for winter's peak demand periods (White 1988).

e. Planned Future Upgrades/Additions

NI Gas continually upgrades its gas system to meet expected growth within its service territory. NI Gas plans gross additions to its utility plant, amounting to approximately $500 million over the next 5 years to provide firm, uninterrupted service to nearly 1.6 million customers. It also expects to connect its system to a fifth major pipeline supplier, American Natural Resources, by January 1, 1989 (White 1988).

3. Telecommunications

a. Ownership

Telecommunications service in the vicinity of the proposed site to the area is provided by the Illinois Bell Telephone Company, a wholly owned subsidiary of American Information Technologies Corporation (Ameritech) (Illinois Bell 1987). Ameritech is the parent of five midwestern Bell companies and seven information industry subsidiaries (Ameritech 1987).

b. Delineation of Service Territory

Illinois Bell provides exchange and exchange access telecommunications services to 3.7 million customers in 456 Illinois municipalities (Illinois Bell 1987).

The Ameritech Bell Group provides communications services and long-distance connections to over 11 million business and residential customers in Illinois, Indiana, Michigan, Ohio, and Wisconsin (Ameritech 1987).

c. Interrelationship with Other Telecommunications Systems

Illinois Bell interconnects with nearly 100 interexchange carriers, providing long-distance telecommunications service outside the Illinois Bell service area (Illinois Bell 1987).

d. Existing Network

Illinois Bell has recently put into service 24 digital switching machines and 22 remote switching units. This equipment serves 358,000 lines, bringing the percentage of Illinois Bell lines served by digital switching to 26%. By the end of 1987, 80% of the switching centers in northeastern Illinois were interconnected with fiber cable (Illinois Bell 1987).

Illinois Bell serves Fermilab in Batavia from a switching office in Geneva that is equipped with a digital switch (AT&T Technologies' No. 5ESS). The switch serves the Fermilab area via remote modules located at the lab, linked by fiber optic cable to the Geneva office.

e. Planned Future Upgrades/Additions

Construction has begun on a new switching center in Schaumburg, which is expected to go into service in late 1988 (Illinois Bell 1987). By 1989, all switching offices for areas adjacent to the proposed site, including Aurora, Naperville, West Chicago, and Geneva, are expected to be provided with digital system service.

5.3.12 Cultural and Paleontological Resources

5.3.12.1 Cultural Resources

A. Cultural History and Scientific Basis

The cultural history of northern Illinois begins with the Paleo-Indian Period prior to 8000 B.C. (McGimsey et al. 1986). The few sites recorded for this period consist of small lithic scatters which contain lanceolate projectile points, chipped stone tools, and biface tools that may represent short-term settlements. Most of these sites occur in upland locations adjacent to bogs and kettle depressions, although sites have also been recorded near streams and on floodplain terraces (Harrison et al. 1977).

The Archaic Period that follows is generally divided into Early Archaic (8000 B.C. to 6000 B.C.), Middle Archaic (6000 B.C. to 3000 B.C.) and Late Archaic (3000 B.C. to 500 B.C.). Adaptations and changes during the northern Illinois, Archaic period are poorly understood since few sites have been excavated and information is limited. Early Archaic sites occur near bogs, kettle depressions, headwaters of tributary streams, and uplands adjacent to major drainages (Springer et al. 1978). Middle Archaic sites demonstrate a greater tendency toward occupation of larger river valleys (Conrad 1981). Each period is identified by diagnostic projectile points. Site size remains relatively small with Middle Archaic sites containing a greater density of debris than the earlier sites. The Late Archaic exhibits a more intensive use of small upland sites with larger sites present in the major river valleys (Fortier 1983). Evidence of horticulture is apparent suggesting an increased demand for predictable food resources. Population seems to have increased by this period. Interregional exchange is established toward the latter part of the Late Archaic along with two distinctive mortuary traditions known as the Red Ochre and Glacial Kame (Ritzenthaler and Quimby 1962).

The Early Woodland (500 B.C. to 100 B.C.) is poorly known although the available data indicate a shift in site locations toward larger river systems and away from upland areas to floodplains and valley margins. Sites are slightly larger and contain a greater density of artifacts (Springer 1985). Ceramics, burial mounds, horticulture, and interregional exchanges are present. Evidence of a shift to greater reliance on aquatic and floodplain resources may be seen.

The Middle Woodland (100 B.C. to A.D. 400) exhibits an elaboration of mortuary practices, changes in social organization, larger and potentially long-term occupation sites, and more reliance on horticulture. Site locations show a pattern of settlement near the major river systems. Sites in northern Illinois were much smaller and less populated than in other parts of the Midwest, the typical and Havana-ware ceramics and lameller blades are absent. Except near the Illinois River, mortuary complexes are lacking (Springer 1982, 1985). The Kishwaukee and Rock River basins in the northwest corner of the SSC study area show these

differences. It has been suggested that this area was used seasonally by groups using the larger drainage systems. Mound groups are present along the Fox, Des Plaines, and DuPage rivers (Early 1972), but the lack of well documented sites makes comparisons of adaptations difficult.

During the Late Woodland/Mississippian Period (A.D. 400 to 1600), a number of changes occur in subsistence practices, settlement patterns, and demographics. Permanent village settlements reflect the increasing cultivation of maize. Mississippian Period sites are distinguished by the development of regional commercial/political centers supported by smaller villages. Specific adaptations are designated as Effigy Mound, Middle Mississippian, and Oneota, but their temporal and spatial limits are not well documented. Effigy Mound sites have been recorded on floodplain terraces and bluffs along the Fox and Rock rivers (Boris 1984). Mississippian traits including shell tempered ceramics, diagnostic projectile points, and intensive maize cultivation appear around 1150 B.C. During this period village sites occur along major drainages and the uplands are used primarily as hunting territories. A Middle Mississippian site of the Langford Tradition has been investigated within the study area (Wiant and Hassen 1984). The Oneota tradition coexisted with the Effigy Mound tradition, appearing around 750 A.D. and continued until historic times. It represents an intensification of local resources exploitation and maize agriculture.

The historic period begins in the 1670s with exploration of the Mississippi and Illinois rivers by Marquette and Joliet, and Nicholas Perrot's visit to the Chicago area. The Pottawatomie, Sauk, and Fox tribes lived in villages along the Fox River, and had seasonal campsites in the hills and on the prairies to the west. By the 1700s, the Kickapoo, Miami, and Mascoutan tribes were being pushed into Illinois by members of the Iroquois Confederacy and by the expansion of Euro-American settlers.

The northern portion of Illinois was only sparsely settled by Euro-American populations before 1830, except in the large river valleys. Following the opening of the Erie Canal in 1825 and steam navigation on the lakes by 1830, immigration into Illinois increased. The settlement pattern was influenced by new transportation routes. After 1850, the frontier settlement pattern changed and most immigrants settled in the urban centers (Ingalls 1987).

In Kane County, the first settlers established themselves near the Fox River, constructing mills to take advantage of the free water power and the nearby timbered areas (Pooley 1968). By 1839-1840, eleven mills were located on the Fox River and seven were on smaller streams within the SSC study area. Nine villages existed in the study area during the same period. Farming was concentrated in the upland area with more than two hundred plowed fields recorded in 1839-40. Farming was extended into the prairie with the invention of McCormack's Virginia Reaper and John Deere's Moldboard Plow. Immigrants and migrants coming into Kane County were from many ethnic backgrounds which are reflected in the settlement patterns and architecture of the various communities that they established (LeBaron 1878).

The population increased significantly after the Civil War with people looking for jobs in the mills and factories being built along the Fox River. The westward expansion of the railroad from 1850 to 1875 meant that farmers and manufacturers could reach distant markets more easily. Dairy farming became prominent in the 1860s.

Early in the 1900s, drainage districts were organized; by excavating ditches and installing drain tiles, the remaining prairie became suitable for cultivation. Dairy farming eventually declined in the 1930s to 1940s and was replaced by wheat and corn crops.

B. Known National Register Sites/Sacred Sites

No currently recognized National Register sites are located within the boundaries of facilities of the proposed SSC project area; however, evaluation of some previously recorded sites and sites remaining to be identified could result in the identification of significant sites. A number of National Register historic districts and properties are located in nearby communities. The towns of Aurora, Batavia, Elgin, Geneva, Montgomery, St. Charles, Sugar Grove, and Wasco all have properties listed on the National Register of Historic Places and State Historic Landmarks. The town of Kaneville, which is located close to the far cluster H has one property listed as a State Historic Landmark and may have other structures potentially eligible to the National Registry of Historic Places. No Native American sacred sites have been identified.

C. Previously Recorded Sites and Research in the Project Area

Prior to the SSC siting studies performed by the Illinois State Museum (McGimsey et al. 1986) only 88 prehistoric sites had been recorded in the immediate 16-township area. These sites were documented by local residents or by professional archaeologists conducting small-scale systematic cultural resource surveys. A systematic survey was conducted prior to construction of Fermilab (early 1970); the remainder of the Fermilab property has since been surveyed (Jeske 1986).

The Illinois State Museum studies for the SSC project have included fieldwork, archival research, and consultation. These studies have involved identification of resources in what is referred to as the P-ring or, primary proposed corridor ring alignment; the Corridor-5, a $\pm 5^{o}$ rotation of the P-ring using a point on the east side of Fermi Lab as a tangent; and the "candy stripe" features the Corridor-5, the hypothetical path of an access point generated by ring rotation.

Artifacts collected by local amateur archaeologists were inspected and an effort was made to contact all rural inhabitants within the Corridor-5 area to record their knowledge about local archaeological sites. More than 245 persons were interviewed and 105 archaeological sites were identified. In addition, artifact collections curated by the Geneva Historical Museum, Batavia Depot Museum, and White School Museum in Oswego were examined.

Table 5.3.12-1 summarizes the most recent available findings of the ongoing survey and evaluations of the proposed Illinois SSC area. The affected areas of intermediate access, service, interaction point, and beam absorber port locations were examined if possible. Parcels were not inspected if landowner permission was denied or if the ground surface was obscured by vegetation.

Seventy-eight prehistoric archaeological sites have been identified in the project area to date. (Wiant 1988, personal communication); fifty-five of these are located within the proposed SSC project area (P-ring). Twenty-four sites are located on Fermilab property; 13 of these sites have been tested to determine if they are eligible for nomination to the National Register; final determinations are pending. One site was identified in intermediate access area E2. Twenty five sites have been identified within the far cluster, too within the near cluster, and three within acquisition lands near the Fermilab complex.

Sixteen sites could also be affected if alterations are made to the location of the collider ring. This could involve three sites located near intermediate access area E2, two each near service areas F3 and F4, five sites in the far cluster, and four sites in the near cluster.

Seven additional publistoric archeological sites have been identified within the extended project area referred to as the Corridor 5.

In addition, 11 historic archeological sites have been identified and verified to date within the project area (Wiant, pers. comm. May 1988). Four of these area located within the for cluster (P-ring) and four within the near cluster "early stripe"; two others are located within the Corridor-5 boundaries.

Ten historic cemeteries have been identified in the Corridor-5 area. One of these is located on the Fermilab property, and one is within the easement corridor (lower arc) of the P-ring alignment, and eight are elsewhere within the Corridor-5 area.

Several government-sponsored architectural surveys have been completed in portions of the 16 Township area. The Illinois Department of Conservation (IDOC) sponsored the Illinois Historic Sites Survey focusing on urban settings, during which sections of the proposed SSC project area were surveyed (IDOC 1972a, 1972b). IDOC also conducted the Illinois Historic Landmarks Survey to produce a record of historically significant state landmarks (IDOC 1974a, 1974b, 1974c). The Kane County Development Department initiated a systematic rural structure surveys in rural and urban areas of Kane County (Zellie 1977; Korling 1977; Eizis 1979; Hervert and Allen 1980; Surra 1981). In 1985, a reconnaissance program was begun to document all standing structures in the unincorporated sections of Kane County and in small sections of DuPage, Kendall and Will Counties that were included within the SSC-related 16 Township area (Ingalls 1987).

Table 5.3.12-1

RECORDED ARCHAEOLOGICAL SITES IN THE PROPOSED ILLINOIS SSC SITE

Project Location	Corridor-5	Candy Stripe	P-Ring	Comments
Campus/Injector	22*	0	24	Occupied by Fermilab
Intermediate Access:				
E1		0	0	No access
E2		4	1	Surveyed
E3		0	0	Surveyed
E4		0	0	Surveyed
E5		0	0	Surveyed
E6		0	0	Surveyed
E7		0	0	No access
E8		0	0	Woods
E9		0	0	Grass/woods
E10		0	0	Surveyed
Service Area:				
F1		0	0	Surveyed
F2		0	0	No access
F3		2	0	Surveyed
F4		2	0	Surveyed
F5		0	0	Pasture
F6		0	0	Surveyed
F7		0	0	Surveyed
F8		0	0	Surveyed
F9		0	0	Surveyed
F10		0	0	Surveyed
Near Cluster		4	2	2% surveyed
Far Cluster		5	25	70% surveyed
Abort Beam Access				
J1		0	0	Subdivision
J2		0	0	50% surveyed
J3		0	0	Surveyed
J4		0	0	No access
J5		0	0	Not surveyed
J6		0	0	Fermilab
Interaction Points				
K1		0	0	Fermilab
K2		0	0	Fermilab
K3		0	0	Not surveyed
K4		0	0	Surveyed
K5		0	0	Not surveyed
K6		0	0	Not surveyed
P-Ring Easement			3	
Subtotal	7	16	55	
Total = 78				

All unincorporated rural sections of the 16-township area have been systematically surveyed during the rural structure surveys. Of the 587 standing structures documented within the Corridor-5 area, 323 lie within the corridor but outside the P-ring. Ninety-three structures are included within the "candy stripe" areas, 62 are situated in the P-ring areas outside the facilities locations, and 30 structures are located in the beam absorber easement areas. Seventy-four structures are found in the near and far clusters. Only five structures are located within areas designated for intermediate access, service area, buried beam zone access areas, or interaction points (State of Illinois 1988). Table 5.3.12-2 summarizes these findings.

Three Native American villages are documented within the 16-township area in historical records of Kane, Kendall, Will, and DuPage counties. Based on maps and written descriptions of site location, all of these sites are in developed sections of Aurora, Dundee, and Oswego. None are located within the P-ring affected area (State of Illinois 1988).

Six mound groups are recorded in the project vicinity; three have been destroyed and the other three will not be affected by the proposed project (State of Illinois 1988). There are several references to the discovery of Native American burials within the 16-township area including a newspaper story, an unpublished manuscript, and a 1911 memorandum found at the Aurora Historical Society Museum. It is not apparent if these were inhumations of prehistoric or historic Native Americans. None of these is located in the P-ring affected areas (Wiant 1988, personal commumication).

The Illinois State Museum is in the process of contacting official tribal representatives for each tribal group historically reported for the area.

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

The unsurveyed areas of the ring alignment and locations at which surface facilities would be constructed are physiographically comparable to those already inventoried (McGimsey et al. 1986). This fact, paired with the results from models used to predict the probable location of cultural resources, indicates that the distribution, density, and character of historical and archaeological sites in uninventoried areas will be similar to the inventoried areas.

E. Unknown but Potential Resources

To evaluate the potential resources within the proposed SSC project area, a preliminary model projecting possible locations of archaeological sites was developed (McGimsey et al. 1986). The model is based on the relationship between known archaeological sites and certain environmental variables. Four variables were used to characterize the location of known sites: occurrence of soil types, distance to water, surficial geology, and pre-Euro-American settlement vegetation. In addition, the model is

Table 5.3.12-2

PRE-WORLD WAR II STANDING STRUCTURES IN THE PROPOSED ILLINOIS SSC SITE

Project Location	Corridor-5	Candy Stripe	P-Ring	Comments
Intermediate Access:				
E1		0	0	Surveyed
E2		2	0	Surveyed
E3		2	0	Surveyed
E4		9	0	Surveyed
E5		0	0	Surveyed
E6		0	0	Surveyed
E7		13	1	Surveyed
E8		6	0	Surveyed
E9		1	0	Surveyed
E10		0	0	Surveyed
Service Area:				
F1		0	0	Surveyed
F2		2	0	Surveyed
F3		4	0	Surveyed
F4		14	1	Surveyed
F5		0	0	Surveyed
F6		6	0	Surveyed
F7		8	1	Surveyed
F8		5	0	Surveyed
F9		0	1	Surveyed
F10		0	0	Surveyed
Near Cluster		0	37	Surveyed
Far Cluster			37	Surveyed
Beam Absorber Easement Areas			30	Surveyed
J1		2	0	Surveyed
J2		8	0	Surveyed
J3		3	0	Surveyed
J4		6	1	Surveyed
J5		2	0	Surveyed
J6		0	0	Surveyed
Interaction Points				
K1		0	0	Surveyed
K2		0	0	Surveyed
K3		0	0	Surveyed
K4		0	0	Surveyed
K5		0	0	Surveyed
K6		0	0	Surveyed
P-Ring Easement			62	
Subtotal	323*	93	171	
Total = 587				

* Located outside the SSC ring footprint.

based on three assumptions: 1) regularities in site locations reflect the way human populations used the landscape, 2) the modern range of environmental diversity is similar across the study area, and 3) the selected environmental variables adequately account for the location of sites. The results are presented in three categories: 1) "high site probability" represents those areas expected to have a higher density of sites than surrounding areas, 2) "sites expected but probability unknown" identifies those areas for which a probability estimate cannot be generated, but in which sites are known to occur, 3) the "insufficient data" category includes those areas for which not enough information was available to make a projection. Portions of the proposed SSC study area fall into each of these categories with the highest probability sites being located along the Fox River.

To estimate the density of historic archaeological sites in nonurban regions of the study area, a probability model was developed (McGimsey et al. 1986). Various combinations of four variables - surficial geology, soil types, hydrology, and pre-Euro-American settlement vegetation were grouped to define environmental settings. Site density values for unmapped areas were assigned on the basis of the scores for mapped areas with similar environmental settings. Density values were experessed as low, medium, or high. The proposed SSC site is principally an area of medium probability; however, the soil associations and Quaternary deposits along the Fox River carry the highest density probabilities throughout the valley.

5.3.12.2 Paleontological Resources

A. Scientific Basis

For a description and discussion of the stratigraphy of the proposed project area reference should be made to Section 5.3.1.2.

Paleontological investigations have focused primarily on Quaternary deposits and associated fossils. Quaternary drift constitutes more than 98% of the surficial deposits in the study area, and fossils in this stratum will have the greatest potential for being affected by the SSC project development and construction. However, because the SSC study area has not been systematically surveyed, a paleontological site predictive model was developed to estimate the distribution of Pleistocene fossil sites (McGimsey et al. 1986). The model incorporated published and unpublished information about the landscape, fossils, and geologic deposits associated with known Pleistocene fossil sites throughout the Midwest.

Among the geologic deposits found in the project area, the Grayslake peat could contain pollen, plant macrofossils, and vertebrates. Most of the recorded fossil localities listed on Table 5.3.12-3 are probably from this deposit, including many of the mastodon sites. Recent studies (King 1981) demonstrate that Grayslake peat provides important paleobotanical sequences. Swamps are other areas that may also contain similar

resources. The Cahokia alluvium has produced vertebrate fossils and molluscan shells (Hajic 1981; Graham et al. 1981). The Equality formation has produced vertebrate (Graham et al. 1981), invertebrate, and plant fossils (Heinrich 1982) in Illinois and elsewhere (Delcourt et al. 1980). The Mackinaw Member of the Henry formation has produced vertebrate fossils (Parmalee 1967), and the Batavia Member produced a mastodon at the site listed in Table 5.3.12-3. Plant macrofossils and molluscan remains from outwash deposits have been recorded near the project area (Kempton 1966). The Wedron formation occasionally produced fossil vertebrates, mollusks, and pollen in outwash deposits.

Based on the above knowledge, geologic formations were ranked on the basis of their potential for yielding fossil remains (McGimsey et al. 1986). For example, the Grayslake peat was ranked high because of the many fossil sites that have been discovered in this unit and the diversity of paleontological resources contained. Swamp areas have also been ranked high because they frequently contain bogs composed partly of Grayslake peat. The Cahokia alluvium, Equality formation, and Henry formation were ranked moderate because these units do not yield fossils as consistently as the Grayslake peat. The Wedron and Glasford formations were ranked low because fossils occur sporadically within their till deposits and are generally restricted to the interbedded fluvial and lacustrine deposits that compose a small part of these formations.

B. Known Paleontological Localities

Illinois State Museum paleontologists have been conducting surveys for paleontological localities in the Corridor-5 area (McGimsey et al. 1986). Only paleontological localities from the Pleistocene and Holocene epochs of the Quaternary Period have been included in this survey. Pre-Quaternary localities were not mapped because they lie within bedrock and are generally buried under Quaternary deposits.

The Vertebrate Paleontology Files at the Illinois State Museum, as well as a search through the existing scientific literature, yielded information on 13 known localities in the Corridor-5 area. These primarily contained vertebrate fossils as well as paleobotanical remains and molluscs. However, only four of these localities had detailed information regarding their stratigraphic location. These localities are listed in Table 5.3.12-3.

The literature search was followed by a field survey to locate exposures of Quaternary deposits within the proposed SSC site. Forty-seven localities were visited and 14 of these were sampled for paleontological resources. None of the quarries or exposures yielded resources.

The Illinois State Museum also conducted a field survey of all high probability areas in the 16-township area, including bogs and natural depressions located using aerial photographs, topographic maps, and General Land Office plats and notes. During this survey 30 localities were identified, but only 22 were visited and cores extracted along

Table 5.3.12-3

RECORDED FOSSIL LOCALITIES IN THE VICINITY OF THE PROPOSED ILLINOIS SSC SITE

Locality Name	Type	Formation	Age (years BP)
Forest Preserve	Vertebrate	Henry/Batavia	13,100 to 15,240
Aurora Mastodon	Vertebrate	Grayslake peat	Late Pleistocene
	Vertebrate	Grayslake peat?	Late Pleistocene
Naperville Mastodon	Vertebrate	Grayslake peat?	Late Pleistocene
Batavia Mastodon	Vertebrate	?	Late Pleistocene or Holocene
	Vertebrate	?	Late Pleistocene
Yorkville Mastodon	Vertebrate	?	Late Pleistocene
Maple Park Mastodon	Vertebrate	?	Late Pleistocene
Oswego Mastodon I	Vertebrate	?	Late Pleistocene
Oswego Mastodon II	Vertebrate	?	Late Pleistocene
Bristol Station Mastodon	Vertebrate	?	Late Pleistocene
Larson Gravel Pit	Paleobotanical	Henry Mbr/Mackinaw mbr Winnebago formation	12,000 to >32,000
Batavia Soil Builders Bog	Molluscan	Grayslake peat	2,000 to 10,000

Source: McGimsey et al. 1986.

transects. Thirteen of the 22 sampled localities are considered to have high probabilities of containing paleontological material, because abundant paleobotanical plant remains were recovered. Sediment samples analyzed at the Illinois State Museum confirmed the presence of Pleistocene and Holocene pollen grains and indicate that such localities are of value to studies of past climates and vegetation. Nine localities are considered to have low potential

C. Characterization of Geological Strata and Paleontological Potential

To assess the potential impact of proposed SSC surface construction on paleontological valuable resources, another field reconnaissance was conducted within the corridor. Twenty six possible localities were visited and three localities that appeared to have higher potential were sampled. Of the 26 sites within the corridor, 14 were located within the study area, including the three sampled ones. Five of the localities within the study area were not sampledd because the team could not gain access to the property.

Although the construction localities selected for investigation intersect high probability areas (Grayslake peat and Cahokia aluuminum in the eastern and southern parts of the ring, none were found to contain any paleontological resources, not even the three sampled one. However, one locality had a good accumulation of peat and would warrant further sampling if a project component were to be placed there.

In conclusion, all preliminary data would indicate at this time that the proposed SSC site is located in an area of medium paleontological site probability (McGimley et al. 1986).

Fourteen of the 26 localities, including the three sampled areas, are located within the study area. Eight of these 14 have little or no potential for containing paleontological resources. Five were not sampled because the team could not gain access to the property. One locality has a good accumulation of peat and would require further sampling if a project component were to be placed there.

All preliminary data at this time would indicate that the proposed SSC site is located in an area of medium paleontological site probability (McGimley et al. 1986).

5.3.13 Scenic and Visual Resources

5.3.13.1 Visual Character of the Region

The proposed SSC site is within the Till Plain section of the Central Lowland physiographic province (Hunt 1967; Fenneman 1938). This province is extremely flat to gently undulating, presenting little local topographic relief. Elevations throughout the eastern part, which includes the site, are generally less than 1,000 ft (Pirkle 1982). With few exceptions, the landscape is broadly uniform. The few local exceptions, such as the natural bridges, rock arches, remnants of rock masses and buttelike landforms in the Driftless Area of the province, are located more than 75 mi northwest of the SSC site (Pirkle 1982).

Little of the native prairies and woodlands remain. Vegetation in the Central Lowlands is dominated by croplands and pastures; trees are present in many parts of the region in forests, woodlots, and along stream courses (White 1979).

The Central Lowlands has an abundance of small bodies of water and several large rivers and thousands of small marshes and ponds dot the landscape. The Illinois River is the principal drainage within the Till Plain and a major tributary to the Mississippi River, which defines the section's western boundary.

In sum, there are few striking natural features in the region. Beyond the outskirts of major cities and their suburbs, the dominant characteristics of the landscape are evidences of agricultural development, such as conspicuous farmsteads, pastures, and croplands. Villages and small towns occur at regular intervals over the land, with large and small cities more irregularly spaced.

5.3.13.2 Visual Character of the Site

A. Topography

The study area topography is characteristic of the Till Plain, with flat to rolling plains and few moraines. Elevations within the area enclosed by the collider ring vary from 600 ft along the Fox River in the southeast quadrant to over 1,000 ft near the headwaters of Blackberry Creek below the northwest quadrant. Local relief is minimal. The western half of the ring generally passes through nearly flat farmland. For the rest of the site area, elevational differences generally range between 30 to 60 ft.

No striking landforms occur within the site. There are several distinct rises, such as Johnson's Mound Preserve, and one morainal ridge that crosses the northwestern edge of the collider ring rising 200 to 220 ft (Section 5.3.1.1). However, these mounds and ridges are rolling and forested, presenting no outcrops or escarpments. Even the Fox River and its major tributaries show little relief. The Fox River is incised 50 ft while Mill and Blackberry creeks have cut only 5 to 10 ft into the rolling surface.

B. Vegetation

West of the Fox River, the landscape is dominated by cultivated farmland. Great expanses of fields are broken by small areas of forested lands and by occasional fencerows, woodlots, windbreaks, forest preserves, and riparian zones next to the several creeks and streams within the ring. Along part of the northwestern quadrant, the terrain on the steeper morainal ridge is somewhat more forested because it is less suited to farming. Trees are prevalent in the residential areas of the several communities along the Fox River.

C. Water Features

Northeastern Illinois has many lakes, streams, rivers, reservoirs, and surface impoundments. There are several small lakes and ponds within the area enclosed by the ring (e.g., Nelson Lake, Mooseheart Lake, Lily Lake, Ferson Lake). These bodies of water are noticeable only from points along their shorelines. The major surface water systems in the study area are the Fox River and the West Branch of the DuPage River, both tributary to the Illinois River. The Fox River crosses the collider ring north to south. The valley around this river has many public areas used for boating, hunting, and swimming, and constitutes a scenic resource of significance to Aurora and its neighboring communities. The principal tributaries to the Fox River are Mill Creek and Blackberry Creek, both central to the ring area. These small streams are generally concealed by riparian vegetation, and therefore are inconspicuous.

D. Cultural Modifications

Nearly all the landscape in or near the site has been modified by man. Much of the eastern half of the area enclosed by the collider ring is settled, primarily along the Fox River, and includes the communities of Aurora, St. Charles, Geneva, and Batavia. Along the southeastern quadrant and the northern arc, the landscape is transitional between urban/suburban and rural/agricultural. In these areas there is a mix of land use and farmland is rapidly being supplanted by residential development and other land uses. For instance, between Butterfield Road and E1, Eola Road passes by or intersects a cemetery, a residential development, a transmitter, a veterinary clinic, a school, Interstate 88, residual farmlands, and the Illinois Prairie Path (a recreational facility). Such areas with many unrelated land use occurring in proximity to each other do not have a cohesive visual character and much visual change can occur without being noticed.

Near F2 and E2, commercial and light industry areas occur south of State Highway 34, but residential development is moving toward this area from the north. Along the upper arc, residential development is leapfrogging into farmland. Where dissimilar land uses occur in discrete but proximate areas, there may still be a dominant visual identity that could be adversely affected; however, some kinds of changes can usually occur without being noticed.

218-829 0 - 88 - 7 (BOOK 4)

To the west of the river, population diminishes abruptly and farmlands predominate. Here land use patterns are simple, stable, and ordered. Visual character is clearly defined. The farms consist of expansive, rectilinear fields and regularly spaced groupings of farm structures (silos, barns, sheds, homes).

In some areas, transmission lines are visually disruptive. South of E4 and parallel to U.S. Highway 30, between K3 and K4 running east-west, and just north of E1, there are 345-kV transmission line structures that dominate some views and are not in character with rural or residential land uses.

E. Viewshed Definition

Because of the flat to rolling terrain, viewsheds are not usually well defined, varying from open, panoramic views extending several miles in all directions, to views abbreviated to the immediate foreground by structures, woodlots, fencerows, and urban and residential development. In the northernmost section of the ring, there is some enclosure caused by terrain, but topographic screening in the area is rare.

5.3.13.3 Sensitivity

A. Travel Routes

State Highway 25, where it parallels the Fox River between Oswego and St. Charles, is indicated on an Illinois State Road Map (Gousha Company) as a scenic route. So are State Highway 64, from St. Charles west across the state; State Highway 56/U.S. Highway 30, from Aurora west through Sugar Grove and beyond past the ring; and State Highway 38 (Batavia Road), from Batavia east to the outskirts of Chicago. Of these routes, only State Highways 64 and 38 would pass close to surface facilities serving the SSC. However, such informal designation as "scenic" indicates that views from these travel routes are potentially of moderate sensitivity.

Three recreational trails pass near the to SSC facilities. The Virgil Gilman Trail passes by E2; the Prairie Path is less than 1 mi north of E1; and the Great Western Nature Trail is 2,000 ft north of E7. Views from these trails are highly sensitive.

B. Public Use Areas

Most of the western half of the collider ring passes through agricultural land, which is low in sensitivity to visual impacts. Along the eastern half, the upper arc, and the lower southeastern quadrant, residential development occurs in or near the proposed site of some SSC facilities.

Surface facilities would be close to several residential areas and areas currently undergoing residential development. For instance, E1, F2, and F8 are sited in the midst, or close to, land currently undergoing subdivision improvements, or flagged for such construction. No homes have been built yet, and it is assumed that they will not be built before the site selection process has been completed. It is therefore assumed that people buying homes in those areas will be doing so after the proposed SSC facilities have been built, or with the knowledge that such facilities will be built nearby. In either case, people living in the new subdivisions are assumed not to be sensitive to the visual character change of the nearby SSC structures.

Some homes in subdivisions or rural residential areas exist next to the E3, F4, F7, E8, and E9 proposed SSC facilities. In addition, F2 would be near existing residences, as well as being in the middle of a proposed development, as noted above. Views from the existing residential subdivisions are considered to be highly sensitive, and those from rural residential areas moderately so.

One facility (E4) is near a cemetery. Religious facilities and cemeteries are considered to be moderately sensitive.

C. Laws, Plans, Policies, and Regulations

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

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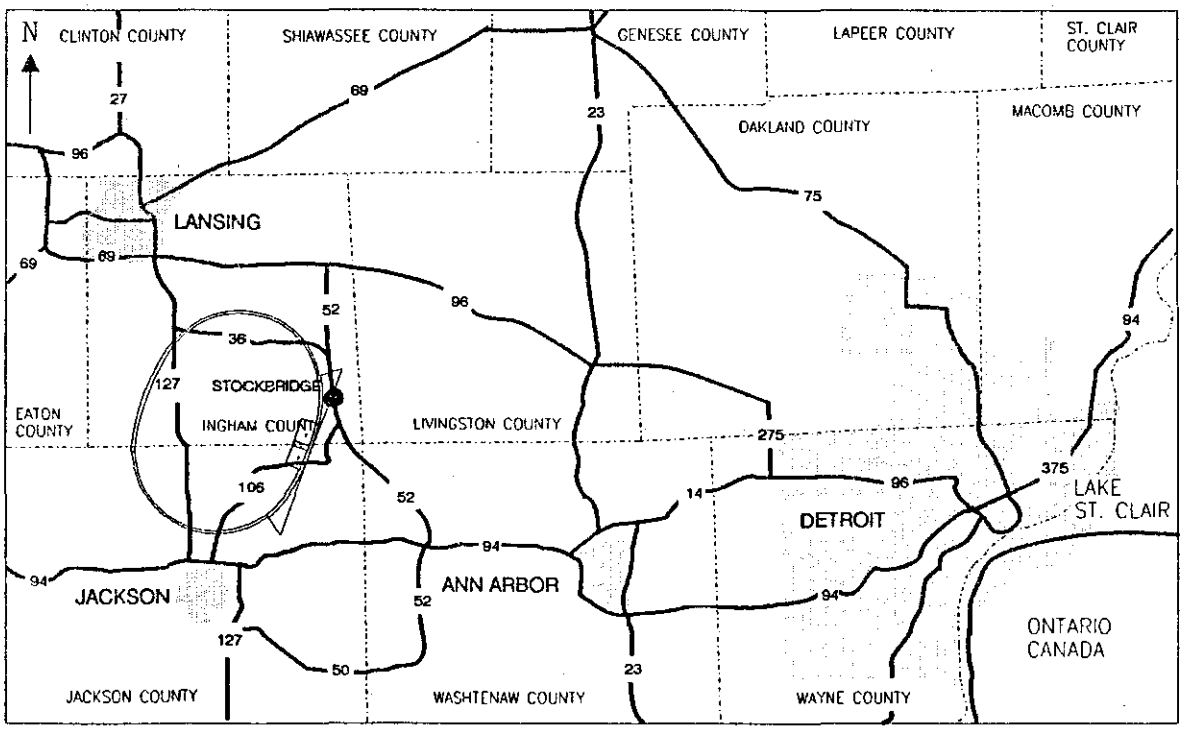
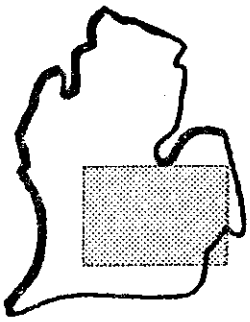
24 CFR Part 51. Noise Abatement and Control. Department of Housing and Urban Development.

40 CFR 50, Environmental Protection Agency, Primary and Secondary Ambient Air Quality Standards (Air Pollution Sources Reference).

Affected Environments at Site Alternatives

M I C H I G A N





Michigan - **The proposed site is located approximately 35 miles northwest of Ann Arbor in the southern portion of Michigan. It includes portions of Ingham and Jackson Counties. The entire tunnel would be constructed by tunneling techniques thru shales, limestone, dolomites, and sandstone below the water table.**

CONTENTS

		Page
5.4	MICHIGAN	1
5.4.1	Earth Resources	1
5.4.1.1	Physiography and Topography	1
5.4.1.2	Stratigraphy	1
5.4.1.3	Geologic Structure	7
5.4.1.4	Geoengineering Conditions	11
5.4.1.5	Geologic Hazards	14
5.4.1.6	Economic Geologic Resources	16
5.4.2	Water Resources	21
5.4.2.1	Surface Water Hydrology, Quality, and Use	21
5.4.2.2	Groundwater Hydrology, Quality, and Use	31
5.4.3	Climate and Meteorology	39
5.4.3.1	General Description	39
5.4.3.2	Temperature	39
5.4.3.3	Precipitation	39
5.4.3.4	Wind	42
5.4.3.5	Humidity	42
5.4.3.6	Severe Weather	42
5.4.4	Air Quality	46
5.4.4.1	Conditions Affecting Air Quality	46
5.4.4.2	Air Quality	47
5.4.4.3	Regional Air Pollution Sources	50
5.4.5	Noise and Vibration	53
5.4.5.1	Ambient Noise Levels	53
5.4.5.2	Other Noise Sources	53
5.4.5.3	Ambient Vibration Levels	53
5.4.5.4	Other Vibration Sources	55
5.4.6	Environmental Radiation	58
5.4.6.1	Natural Radioactivity	58
5.4.6.2	Man-Made Radiation	60
5.4.6.3	Background Radiation	61

CONTENTS (Cont)

		Page
5.4.7	**Nonradioactive Environmental Hazards**	62
5.4.7.1	Hazardous/Toxic Materials	62
5.4.7.2	Biological Hazards	62
5.4.8	**Existing Waste Management Facilities**	64
5.4.8.1	Sewage Facilities	64
5.4.8.2	Solid Waste Facilities	66
5.4.8.3	Hazardous Waste Disposal Facilities	68
5.4.8.4	Radioactive/Mixed Waste Disposal Facilities	68
5.4.9	**Ecological Resources**	69
5.4.9.1	Regional Ecological Characteristics	69
5.4.9.2	Terrestrial Ecosystem Characteristics	69
5.4.9.3	Aquatic Ecosystems	79
5.4.9.4	Economically, Recreationally, and Culturally Important Species	80
5.4.9.5	Threatened and Endangered Species	82
5.4.9.6	Unique Ecosystems and Communities Potentially Affected	84
5.4.10	**Land Resources**	85
5.4.10.1	Regional Setting	85
5.4.10.2	Local Setting	89
5.4.10.3	Soil and Prime Farmland Resources	103
5.4.11	**Socioeconomics and Infrastructure**	108
5.4.11.1	Socioeconomics	108
5.4.11.2	Infrastructure	129
5.4.12	Cultural and Paleontological Resources	141
5.4.12.1	Cultural Resources	141
5.4.12.2	Paleontological Resources	147
5.4.13	Scenic and Visual Resources	151
5.4.13.1	Visual Character of the Region	151
5.4.13.2	Visual Character of the Site	151
5.4.13.3	Sensitivity	152
REFERENCES		154

TABLES

		Page
5.4.1-1	Lithologic Descriptions	4
5.4.1-2	Summary of Fault Characteristics	11
5.4.1-3	Geotechnical Characteristics of Soils	12
5.4.1.4	Geotechnical Characteristics of Rocks	13
5.4.2-1	Gauge Data in Project Vicinity	24
5.4.2-2	Channel and Floodplain Characteristics at the Collider Ring	25
5.4.2-3	Surface Water Quality Data in Project Vicinity	27
5.4.2-4	Surface Water Use in Project Vicinity	30
5.4.2.5	Summary Description of Hydrogeologic Units in the Vicinity of the SSC Site - Michigan	32
5.4.2.6	Range of Groundwater Quality in the Vicinity of the SSC Site - Michigan	36
5.4.2.7	Recent Municipal Groundwater Use in the Vicinity of the SSC Site - Michigan	37
5.4.3-1	Normal and Extreme Temperature Data	40
5.4.3-2	Mean Precipitation and Snowfall Data for Southeast Lower Michigan Region	41
5.4.3-3	Maximum 1-Hour and 6-Hour Rainfall by Return Period	42
5.4.3-4	Monthly Average Wind Speed and Direction	43
5.4.3-5	Dewpoint and Relative Humidity Data	44
5.4.3-6	Extreme Wind Speed and Return Period Data	45
5.4.4-1	Frequency of Occurrence of Atmospheric Stability Classses at Michigan SSC Site	46
5.4.4-2	Annual Frequency of Wind Speed and Direction - Michigan SSC Site	48

TABLES (Cont)

		Page
5.4.4-3	Ambient Air Pollutant Allowable Concentrations and Background Levels	49
5.4.4-4	Regional Air Pollution Sources - Michigan SSC Site	51
5.4.5-1	Regional Vibrations - Michigan SSC Site	57
5.4.6-1	Radon Levels	59
5.4.8-1	Existing Sewage Treatment Plant Capacities	64
5.4.8-2	Existing Sanitary Landfills	66
5.4.9-1	Forest Vegetation Types Within the Michigan Site Vicinity	71
5.4.9-2	Commercial Forest Land - 1980	71
5.4.9-3	Timber Production From Commercial Forest Land - 1980	73
5.4.9-4	Crop Statistics for Jackson and Ingham Counties	73
5.4.9-5	Wetlands Within Proposed Surface Facility Locations	76
5.4.9-6	Species List: Mammals and Some Bird Species of Michigan Site Vicinity	78
5.4.9-7	Livestock Statistics for Jackson and Ingham Counties	79
5.4.9-8	Fish of the Grand River in the Vicinity of the Michigan Site	81
5.4.9-9	Michigan Special Status Plant Species from the SSC Vicinity	83
5.4.10-1	Michigan SSC Site Facility Description: Land Use Data	92
5.4.10-2	Soil Subgroups, Series, and Major Components in Complex Units with Corresponding Acreages	105

TABLES (Cont)

		Page
5.4.10-3	Capability Subclasses and Corresponding Acreages at the Michigan SSC Site; Acreages for Each of the Three Limitations	107a
5.4.10-4	Acreages Corresponding to Each of the Five Limitations as Main and Secondary Hazards	107b
5.4.10-5	Estimated Prime Farmlands, Drained Prime Farmlands, and Other Agricultural Lands at the Michigan SSC Site	107c
5.4.11-1	Historic Economic Indicators for the Michigan ROI, and Ingham and Jackson Counties	110
5.4.11-2	Key Demographic Indicators for the Michigan ROI	115
5.4.11-3	Levels of Public Service for Michigan SSC Site	119
5.4.11-4	Michigan State General Revenue and Expenditure - FY 1986	123
5.4.11-5	Ingham County, Michigan - County Revenue by Source and Total Expenditure - 1986	125
5.4.11-6	Lansing (Ingham County), Michigan - City Revenue by Source and Total Expenditure - 1987	126
5.4.11-7	Stockbridge (Ingham County), Michigan - Village Revenue by Source and Total Expenditure - 1987	127
5.4.11-8	Jackson County, Michigan - County Revenue by Source and Total Expenditure - 1986	128
5.4.11-9	Jackson (Jackson County) Michigan - City Revenue by Source and Total Expenditure - 1987	130
5.4.11-10	Present Highways and Roads Serving the Proposed Michigan SSC Site	132
5.4.11-11	Consumers Power Company Natural Gas Statistics	138

TABLES (Cont)

		Page
5.4.12-1	Known Prehistoric Archaeological Sites Within the Direct Impact Area of Proposed Michigan Site	143
5.4.12-2	Locations of Potentially Impacted Historic Archaeological Sites	145
5.4.12-3	Late Pleistocene Vertebrate Fossils Previously Located in Ingham, Jackson, Livingston, and Washtenaw Counties	149

FIGURES

		Page
5.4.1-1	Topographic Setting - Michigan SSC Site	2
5.4.1-2	Stratigraphic Column - Michigan SSC Site	3
5.4.1-3	Subcrop Map of Areal Distribution of Paleozoic Sediments	8
5.4.1-4	Surface Distribution of Glacial Soils	9
5.4.1-5	Geologic Profile Along Collider Ring	10
5.4.1-6	Michigan Natural Resources	18
5.4.2-1	Major Watersheds in Michigan	22
5.4.2-2	Hydrologic Features - Michigan SSC Site	23
5.4.4-1	Ambient Air Quality Monitoring Stations and Regional Air Pollution Sources - Michigan SSC Site	52
5.4.5-1	Sensitive Noise Receptors - Michigan SSC Site	54
5.4.5-2	Regional Vibration Sources - Michigan SSC Site	56
5.4.7-1	Locations of Known and Suspected Contaminated Sites	63
5.4.8-1	Approximate Location of Existing Sewage Treatment Plants in Michigan SSC Region	65
5.4.8-2	Approximate Location of Existing Sanitary Landfill in Michigan SSC Region	67
5.4.9-1	Significant Forested Tracts at the Proposed Michigan SSC Site	70
5.4.9-2	General Distribution of Wetlands in the Michigan Site Vicinity	75
5.4.10-1	Proposed Michigan SSC Site Region	90

218-829 0 - 88 - 8 (BOOK 4)

FIGURES (Cont)

		Page
5.4.11-1	Counties for Socioeconomic Analysis in the Michigan SSC Region	109
5.4.11-2	Employment by Industry, 1984 - Michigan ROI	112
5.4.11-3	Major Transportation Systems Serving the Michigan Site	131

5.4 MICHIGAN

5.4.1 Earth Resources

5.4.1.1 Physiography and Topography

The proposed Michigan SSC site, situated in the Eastern Lake section of the Central Lowland physiographic province, is an area characterized by glaciated lowlands with moraines, lakes, and lacustrine plains (Fenneman 1938). Topography in the site and vicinity is dominated by glacier-caused landforms (Figure 5.4.1-1); low, hummocky hills of end moraines; north to south trending esker hills; rolling till plains (ground moraine); and glacial outwash channels (Farrand 1982).

Elevations in the site vicinity range from 880 ft at streams exiting to the north and west (U.S.G.S. 1919, 1970a, and b), to 1,000 ft atop morainal ridges (U.S.G.S. 1919, 1970b, c, and d, 1976). To the southeast, one major moraine rises to 1,140 ft (U.S.G.S. 1973a). Relief in the area is low: on the order of 30 to 50 ft in the rolling till plains (U.S.G.S. 1970a and d), and 70 to 190 ft in the hummocky moraines (U.S.G.S. 1970c, 1973a).

The drainage pattern in the site area (Figure 5.4.1-1) is controlled by the glacially produced land forms, with streams flowing around and between moraines, and along glacial outwash channels in a glacially-deformed dendritic pattern. Natural drainage at the site is sluggish with numerous ponds and swamps. The southwestern portion of the site drains to the Grand River and the northeastern and northwestern portions drain to the Cedar River (U.S.G.S. 1919, 1970b and c, 1976), and its tributary, Sycamore Creek, respectively (U.S.G.S. 1970d, 1973c). The southeastern portion drains to the Portage River (U.S.G.S. 1970d, 1973c). Tributary creeks are generally incised less than 10 ft into the rolling till plain, whereas major rivers, following outwash channels, commonly lie 50 to 70 ft below the plains.

5.4.1.2 Stratigraphy

A stratigraphic column of the bedrock and overlying glacial sediments within and surrounding the Michigan site is depicted in Figure 5.4.1-2. Lithologic descriptions of these units are given in Table 5.4.1-1. Information provided in this section was obtained from various sources including Farrand (1982), Kelly (1936), Michigan Department of Natural Resources (1964), Vugrinovich (1984), Forstat and Sorensen (1982), Lasemi (1975), Monnett (1948), and Hale (1941). The time scale used to approximate the ages of the rock units is the "Decade of North American Geology 1983 Geologic Time Scale" (Palmer 1983).

The Carboniferous rocks of the Saginaw formation and Grand Rapids group, together with the overlying glacial drift are the principal units to be involved in shaft and tunnel construction. Sandstone, shale, limestone, and dolomite are the predominant rock types in the Carboniferous units.

Figure 5.4.1-1

TOPOGRAPHIC SETTING - MICHIGAN SSC SITE

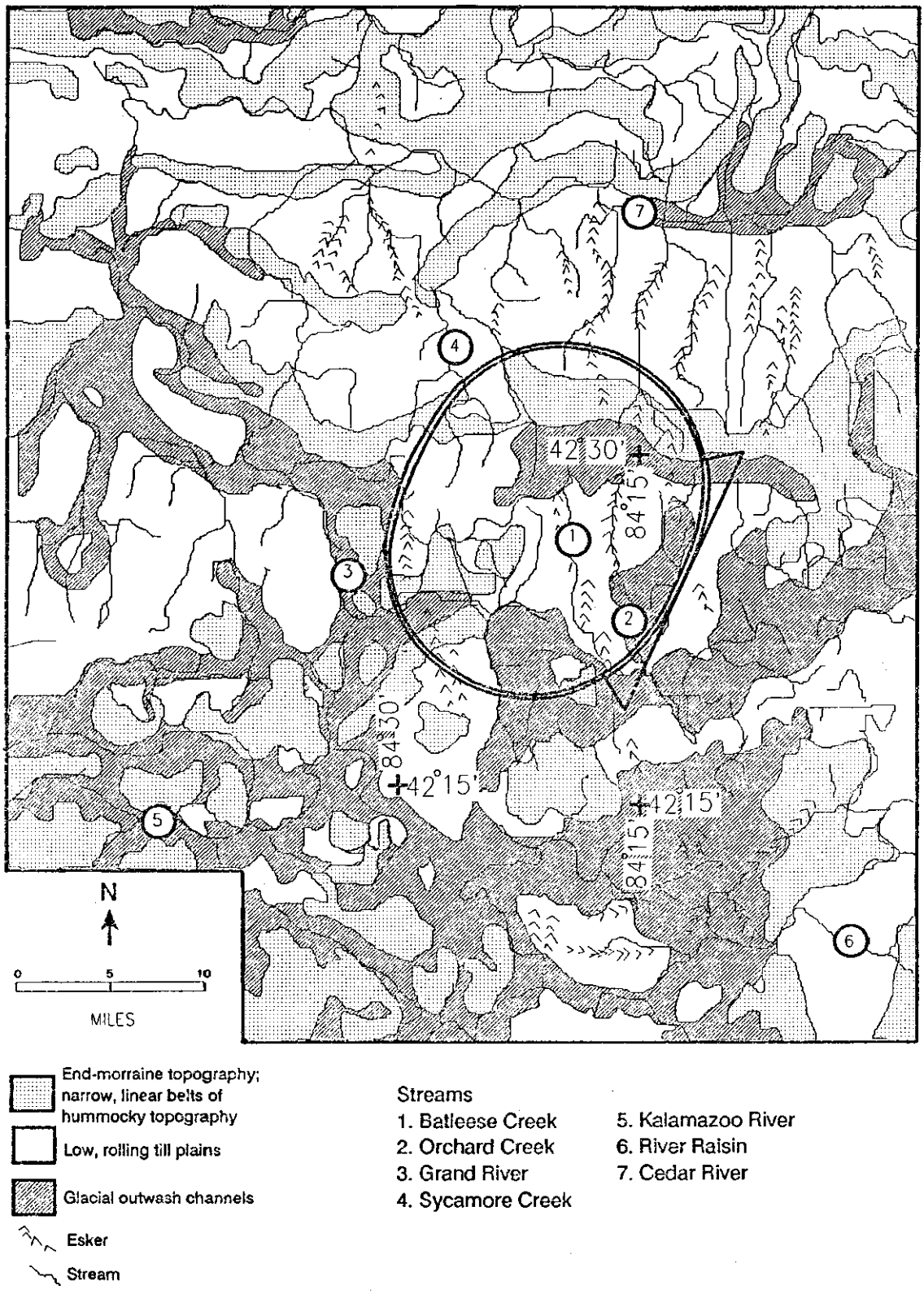
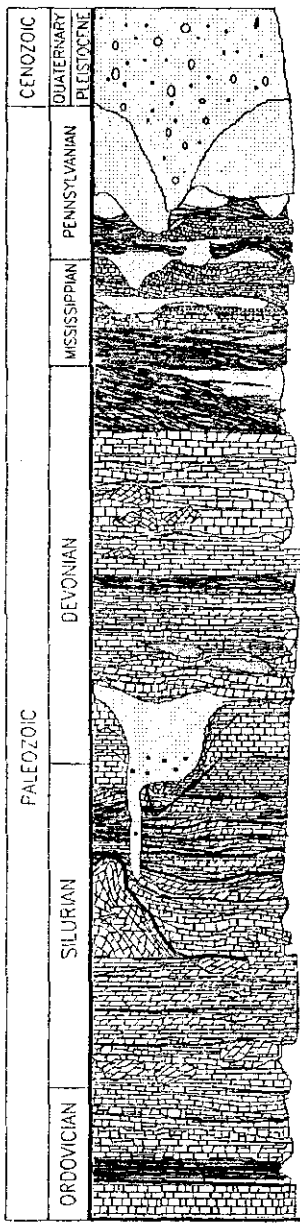


Figure 5.4.1-2

STRATIGRAPHIC COLUMN - MICHIGAN SSC SITE



AGE		NAMES	APPROXIMATE MAXIMUN THICKNESS (FEET)	DOMINANT LITHOLOGY
CENOZOIC	QUATERNARY PLEISTOCENE	Undifferentiated Glacial Drift (Predominantly Wisconsinan)	133	Clay, silt, sand, gravel cobbles, and boulders
PALEOZOIC	PENNSYLVANIAN	Grand River Formation		Sandstone and conglomerate
		Saginaw Formation		Shale, sandstone, and siltstone
	MISSISSIPPIAN	Grand Rapids Group: Bayport Limestone	50	Limestone, dolomite, and sandstone
		Grand Rapids Group: Michigan Formation		Shale, sandstone, and limestone
		Marshall Sandstone	298	Sandstone
		Coldwater Shale	1300	Shale and dolomite
	DEVONIAN	Ellsworth Shale	1320	Shale, limestone, and dolomite
		Traverse Group	830	Limestone with minor shale
		Rogers City/Dundee Limestone	475	Limestone
		Detroit River Group	1450	Dolomite, limestone, and halite
		Bois Blanc Formation	800	Dolomite
	SILURIAN	Garden Islands Group	100	Dolomite
		Boss Islands Group	700	Dolomite
		Salina Group	3150	Shale, dolomite, and halite
		Niagra Group	980	Dolomite
	ORDOVICIAN	Cataract Group	200(?)	Shale and dolomite
		Richmond Group	950	Limestone and shale
		Trenton Group	1100	Limestone with minor shale

Units intersected by proposed tunnel and shafts

Sources: Michigan Department of Natural Resources, 1964

Table 5.4.1-1

LITHOLOGIC DESCRIPTIONS

Formation	Lithology	Other Characteristics
Undifferentiated Glacial Drift	Clay, silt, sand, gravel, cobbles, and boulders deposited as ground and end moraines and outwash. The morainal material consists of medium- to coarse-textured till. The outwash consists of fine to coarse, well-sorted gravel, sand, and silt.	
Grand River Formation	Predominantly coarse sandstone with a siliceous or ferruginous cement and basal beds of conglomerate. Most abundant in central portion of Michigan Basin.	Not present at site but does occur in the stratigraphic sequence elsewhere in the region.
Saginaw Formation	Cyclical sequence of light and dark (sandy and sand-free), locally calcareous, fossiliferous shale in lenticular beds, white to light gray micaceous sandstone, silt-stone, and thin beds of shaly, fossiliferous limestone and coal. Occasional pyritic replacement of fossils and disseminated pyrite. Uppermost unit intersected by proposed tunnel. Lateral heterogeneities result from numerous unconformities upsetting cyclic lithologies.	Principal coal-bearing formation in Michigan.
Grand Rapids Group Bayport Limestone	Subdivided into the following two formations: Upper portion consists of gray to dark gray micritic limestone interbedded with brown to light brown dolomite, and lenses of gray to gray brown, fine- to medium-grained friable sandstone. Middle portion consists of gray brown, sandy, finely crystalline limestone inter-bedded with thin beds of gray shale and dolomite. Lower portion is predominantly brown to light brown microcrystalline, locally cherty, dolomite-interbedded limestone with grayish white, fine- to medium-grained quartzose sandstone.	Upper portion commonly eroded along unconformity.
Michigan Formation	Green, greenish gray, dark gray to black, and red, locally bituminous or sandy shale, interbedded with dark (locally red) micaceous sandstone, beds of gypsum and anhydrite, and occasional breccias. Impure, brown to buff dolomitic limestone occurs at the base.	Lowermost unit expected along the proposed tunnel alignment.

Table 5.4.1-1

LITHOLOGIC DESCRIPTIONS (Cont)

Formation	Lithology	Other Characteristics
Marshall Sandstone	White, gray, and pink to red, coarse- to very fine-grained, locally shaly, calcareous (dolomitic) sandstone. Finer grained and reddest in lowermost portion.	
Coldwater Shale	Gray shale interbedded with gray to brown, locally fossiliferous dolomite. Calcareous component increases with depth.	
Ellsworth Shale	Gray to gray green shale with abundant red shale, limestone, and dolomite lenses.	Includes Berea sandstone and Bedford shale members.
Traverse Group	Thin- to coarse-bedded limestone with local bioherms. Locally shaly and cherty. Bottom of unit marked by shale unit (Bell Shale).	
Rogers City/Dundee Limestones	Clean, uniformly bedded limestone.	
Detroit River Group	Thin- to coarse-bedded dolomite and limestone with lenses of halite.	
Bois Blanc Formation	Locally sandy and cherty dolomite.	
Garden Island Formation	Sandy dolomite; locally shaly near base.	
Bass Islands Group	Clean, uniformly bedded dolomite.	
Salina Group	Thick sequence of interbedded dolomitic shale, dolomite, and abundant halite.	
Niagara Group	Locally cherty dolomite with several bioherms.	Regional source of hydrocarbons.
Cataract Group	Locally sandy shale with lenses of dolomite and cherty dolomite.	

Table 5.4.1-1

LITHOLOGIC DESCRIPTIONS (Cont)

Formation	Lithology	Other Characteristics
Richmond Group	Locally shaly and cherty limestone with intercallated shale overlying massive shale with scattered, thin limestone beds.	
Trenton Group	Relatively clean, massive, locally dolomitic limestone, sandy at base, with interbedded shale.	Regional source of hydrocarbons.

Sources: Forstat and Sorensen 1982; Farrand 1982; Michigan Department of Natural Resources 1975; Vugrinovich 1984; Kelly 1936; Monnett 1948; Hale 1941

The remainder of the Paleozoic column underlying these rocks is composed chiefly of dolomite and limestone. Several of the older units contain oil and gas reservoirs (Section 5.4.1.6).

5.4.1.3 Geologic Structure

The Michigan SSC site is covered with a continuous layer of glacial material that overlies the sequence of Paleozoic sedimentary rocks described in Section 5.4.1.2. A subcrop map of the Paleozoic sediments areal distribution beneath the glacial cover is shown in Figure 5.4.1-3. The surface distribution of glacial materials in the vicinity of the site is shown in Figure 5.4.1-4. In general, the bedrock units dip approximately 35 ft/mi to the northwest; dips may increase locally along buried regional structures (Ells 1969). A cross section along the proposed ring is presented in Figure 5.4.1-5.

Surface features, principally the result of Wisconsinan (10,000 to 75,000 years ago) glaciation, are described in Section 5.4.1.1. The glacial materials lie on a highly eroded surface of bedrock and their thickness is greater where they infill buried valleys. Bedrock structure is generally associated with the structure of the Michigan Basin. The site lies on the southeastern portion of the basin and bedrock units dip northwest toward its center. On a regional scale, subcrop patterns of progressively younger sediments are semicircular and concentric toward the center of the basin.

Superimposed on the basinal structure are a series of anticlines, synclines, and monoclines with a predominant northwest strike and plunge. These features are Paleozoic and, in the vicinity of the site, are collectively termed the Washtenaw Anticlinorium (Ells 1969). Specific structures include the Howell Anticline east of the site, the Albion-Scipio trend to the southeast, and the Freedom Anticline and Lucas Monocline to the east and southeast. In addition, the Henrietta Field in the middle of the ring produces oil from a monoclinal trap in the lower Paleozoic units (see Section 5.4.1.6). These intrabasinal structures have been postulated to be associated with faults and shear zones (Ells 1969; Prouty 1983) and, in the case of synclinal features such as the Albion-Scipio trend, with the dolomitization (and accompanying volume loss) of underlying limestone (Prouty 1976). However, there is no conclusive evidence regarding the presence of Paleozoic faults associated with these features (Ells 1969); the only mapped fault in the region is the Bowling Green Fault described in Table 5.4.1-2.

Available joint data for the Carboniferous formations at the site (Heinzman 1988b) indicate the Bayport formation to be the most densely fractured unit of the sequence. Measurements taken in a quarry indicate that joints in the Bayport occur along two principal orientations: a primary one oriented N70W with an average spacing between joints of 2 ft, and a secondary one oriented N17E with an average spacing of 5 ft. Measurements in the Marshall formation from another quarry indicate a major joint set oriented N40-60E and a secondary set oriented N70-80W; joint spacings on the two sets average 13.6 and 6 ft respectively.

FIGURE 5.4.1-3

SUBCROP MAP OF AREAL DISTRIBUTION OF PALEOZOIC SEDIMENTS

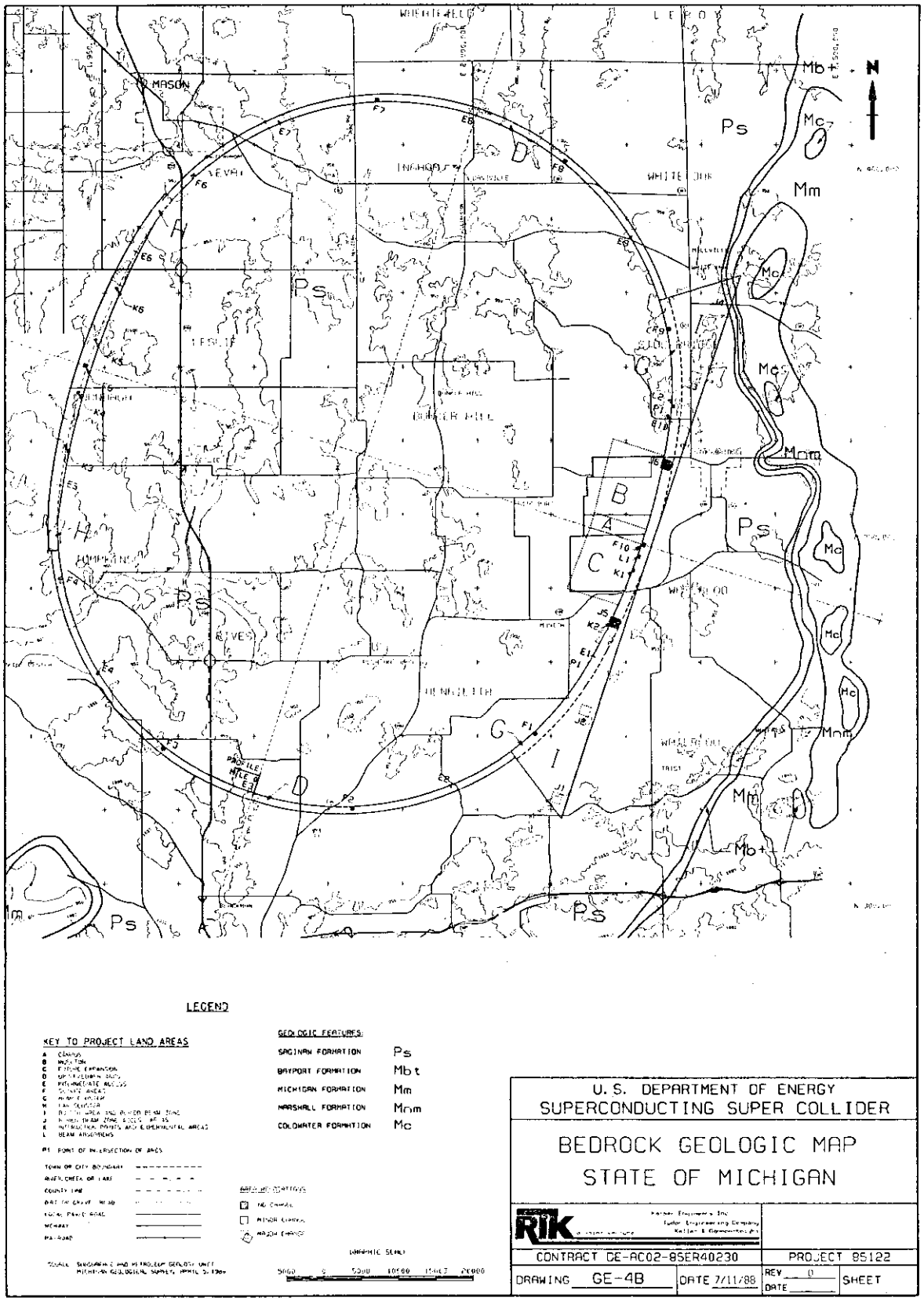
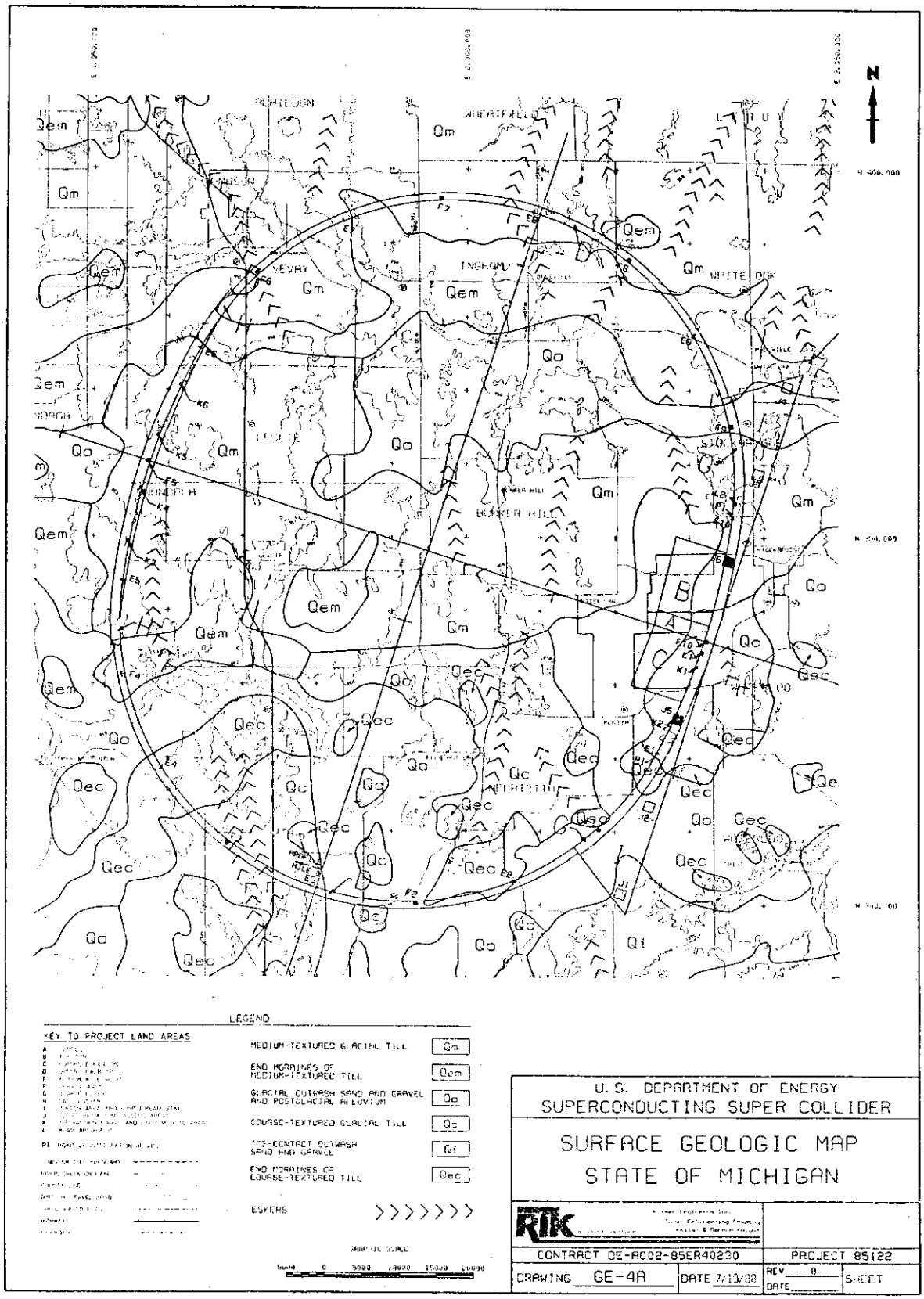


FIGURE 5.4.1-4

SURFACE DISTRIBUTION OF GLACIAL SOILS



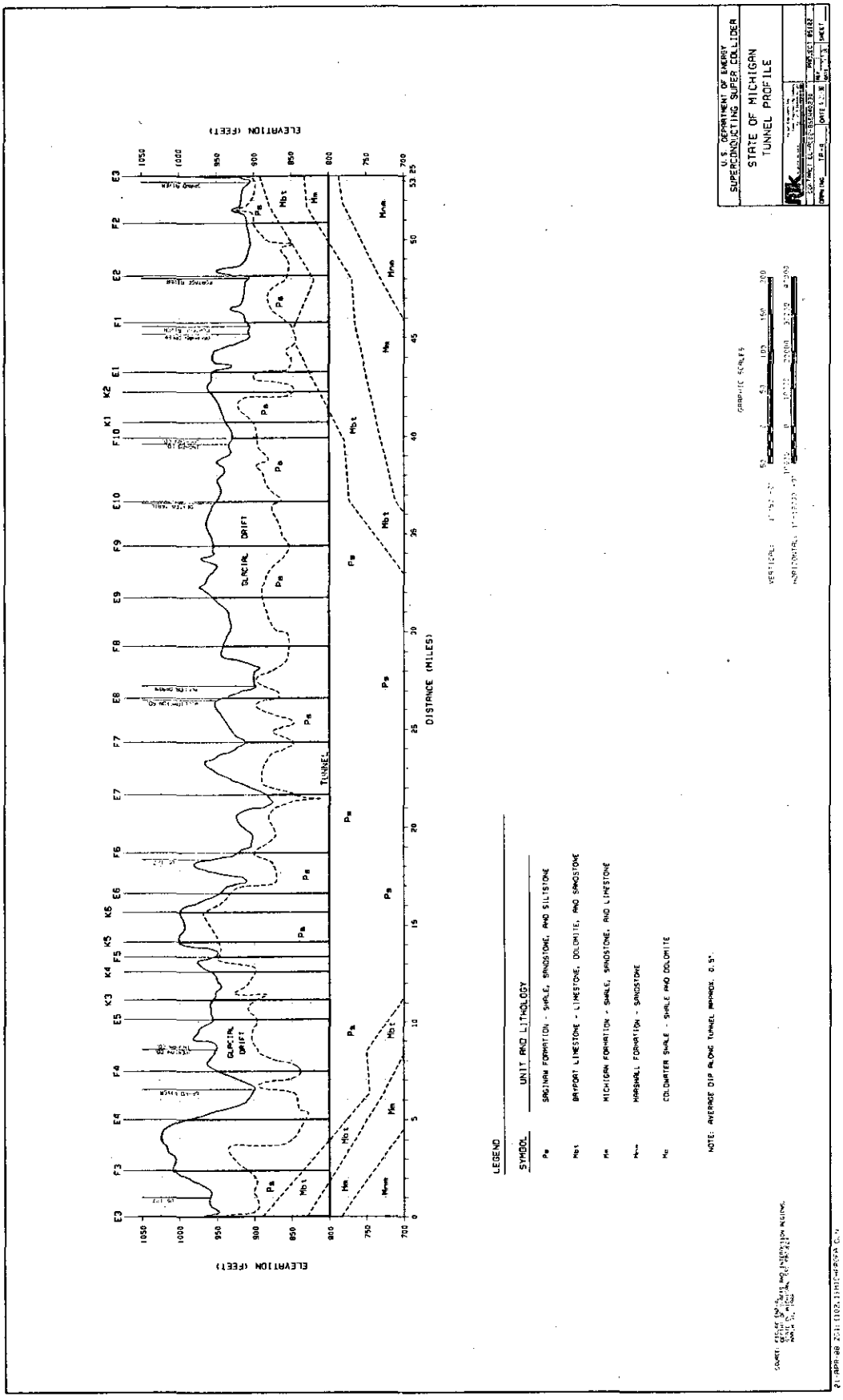


FIGURE 5.4.1-5

GEOLOGIC PROFILE ALONG COLLIDER RING

Table 5.4.1-2

SUMMARY OF FAULT CHARACTERISTICS

Fault	Location	Strike	Dip	Thickness	Displacement/Age
Bowling Green Fault	60 mi south	N-NE	---	---	200 ft Silurian

Data compiled for the Saginaw formation from two surface outcrops indicate two different orientations for each site. Joints with a strike of N40-75W are spaced an average of 14.2 ft apart (with spacings between very continuous joints reaching 60 ft), while another set striking N50E has an average spacing of 13.8 ft (Heinzman 1988b).

5.4.1.4 Geoengineering Conditions

The geoengineering materials at the Michigan SSC site include:

- o Glacial deposits (soils)
  - Clay
  - Silt
  - Sand
  - Gravel or cobbles.
- o Rocks
  - Shale
  - Siltstone
  - Sandstone
  - Mudstone
  - Limestone
  - Dolomite.

The overburden soils covering the bedrock contain glacial deposits as listed above. Table 5.4.1-3 presents the geotechnical properties of soils. The soils are classified as SM, SP, or SM-SP based on the Unified Soil Classification System (U.S.C.S.). The upper 20 ft of the granular soils are loose to dense sand with the standard penetration test values varying from 2 to 50 blows per ft. The glacial soils are classified as CL, CL-CM, and CL-ML also based on U.S.C.S. designation. The uniformity coefficient, Cu, which is the ratio of the grain size at 60% finer by weight (D60), and the grain size at 10% finer by weight (D10) varies from 1 to over 60 (Chung 1988). Soil characteristics are termed uniform with Cu less than 4 or 5, and termed well-graded with Cu greater than 10. Soil zones with high permeability may exist at access shaft locations.

Table 5.4.1-3

GEOTECHNICAL CHARACTERISTICS OF SOILS

Deposit	Soil Material	Soil Description	Dry Density lb/ft^3	Moisture Content %	Liquid Limit/ Plasticity Index LL/PI	Unconfined Strength lb/in^2
Glacial	Fine-Grained	CL, CL-ML	108 (101-114)	18 (14-23)	25/9 (15-35/6-15)	ND
	Granular	SM, SP, SM-SP	112 (97-127)	16 (2-27)	17/7	ND

Notes: Data represent average and range (in parentheses) from seven boreholes.

ND - No data available.
ML - Low plasticity inorganic silts.
CL - Inorganic clays of low to medium plasticity.
SM - Silty sand.
SP - Sand, poorly graded, minor fines.

Source: Chung 1988b.

in the site area (Christiansen et al. 1986). The New Madrid seismic zone is about 500 mi south of the SSC site; earthquakes in this zone in 1811 and 1812 had epicentral intensities of about XII. Estimates of intensities at the SSC site from these events are about III to IV, similar to those caused by local events (for example, the 1967 Lansing earthquake).

Algermissen et al. (1982) estimate that ground accelerations with a 90% probability of not being exceeded within 50 years will be about 0.04g. There are no potentially active faults known in the proximity of the SSC site (Howard et al. 1978).

Surficial deposits in the site area are granular sediments which, in a loose, unconsolidated, saturated state, could be susceptible to liquefaction. However, the infrequency and small magnitude of earthquakes in this region render any liquefaction hazard very small.

Gassy ground conditions have been encountered in southern Michigan and seem to be related to three phenomena: natural occurrences of gas in bedrock; "drift gas" occurrences in which gas has migrated naturally from a bedrock source into the till; and uncontrolled releases of gas from a high pressure bedrock reservoir during hydrocarbon drilling. Of the three phenomena, drift gas occurrences are the most frequently encountered, being evident in a small portion of the water wells drilled in the region (Heinzman 1988a). The gas is methane with some nitrogen and carbon dioxide that has migrated into the drift from the underlying bedrock. The flow of gas from the affected water wells generally declines after a few days to a few weeks. Two conditions appear to be important to drift gas occurrences: a permeable source rock in contact with the base of the drift, and clay layers within the drift to trap the gas. Mississippian-aged and older strata that subcrop around the periphery of the Michigan basin are the source rocks (only one occurrence of drift gas is related to younger bedrock--Pennsylvanian-aged Saginaw formation in northern Saginaw County). Trapping clay strata are most common in the lacustrine sediments that flank the Great Lakes. The regional distribution of source rocks and lacustrine clay drift is such that drift gas occurrences are generally restricted to a band, about two counties wide, bordering the Great Lakes. The closest occurrences to the site are about 17 mi east in central Livingston County. There have been no explosions or accidents in the region caused by drift gas.

Gassy bedrock has occasioned one major explosion; in 1971, an explosion and deaths in the Port Huron Water Intake Tunnel, Detroit, was attributed to methane seepage from the Devonian Antrim shale through which the tunnel was driven (Johnston 1975). The Antrim shale, where it subcrops beneath drift in southeastern Michigan, appears to be the principal source rock for gas trapped in the drift; the Mississippian Coldwater and Berea-Bedford formations are lesser sources of gas leakage. None of these formations will be excavated at the site.

Deep, highly pressured gas reservoirs can result in escape of methane into the upper bedrock and the till during hydrocarbon drilling. An example of this occurred in 1968 at Cal-Lee oil field about 15 mi west

of the site (Woodruff 1969). A well being drilled into the Ordovician-aged Trenton formation experienced an uncontrolled gas flow up the well bore. The flow was quickly controlled at the wellhead; but, gas apparently continued to leak into the porous upper bedrock strata, and from there into the overlying drift. Within days, the gas appeared to have migrated through the drift (apparently within a channel deposit) as far as the town of Marshall 10 mi away. At Marshall, the gas erupted from the ground, and also entered domestic wells, resulting in one explosion. As a result of the Marshall incident, the State of Michigan issued stringent regulations concerning drilling, casing, and cementing practices (Woodraff 1969). Some of the well fields at the site have produced from deep high-pressure reservoirs, so it is possible, though improbable, to inadvertently encounter either an unrecorded well or a poorly plugged abandoned well during tunnel excavation.

Ground subsidence related to oil and gas production has not been observed in the Michigan basin. Although a large number of oil and gas wells have been drilled in the site area (Section 5.4.1.6), subsidence associated with oil and gas extraction at the site is not expected to be a problem. Problems with large-scale subsidence in the world are related to large pressure declines in shallow, thick, highly compressible reservoirs. In contrast, the reservoirs beneath the Michigan site are thin (localized reefs), deep (2,000 to 5,000 ft), and not highly compressible (carbonate rocks) (Table 5.4.1-1).

No other geologic hazards are expected at the site. There is no volcanic activity in the region. The site topography is sufficiently subdued that landslides are not expected.

5.4.1.6 Economic Geologic Resources

The Paleozoic sedimentary rocks in the region of the site provide abundant sources of stone for industrial uses. The overlying glacial drift also has suitable sources of industrial resources, principally aggregates. Carboniferous strata throughout the Michigan basin have been exploited for their hydrocarbon and coal reserves. Present production is generally limited to oil and gas from several sedimentary units beneath the proposed tunnel horizon.

A. Earthen Construction Materials

Aggregate and cement resources in Michigan are produced from the abundant supply of glacial overburden and calcareous rock. Past and present producers of sand, gravel, and stone in the vicinity of the site are shown in Figure 5.4.1-6. These data were extracted from the Bureau of Mines' Minerals Industry Location System (MILS) database. MILS files indicate three producers of sand and gravel are located within the ring, two are on or near the proposed ring, and another nine are within 5 mi of the ring (Bureau of Mines 1988). The current annual production of four suppliers of aggregate within 5 mi of the proposed site is 1.45 million ton/yr. Their total reserves are estimated at 22 million yd^3 (about 38.5 million short tons) (Ott 1988).

Table 5.4.1-4

GEOTECHNICAL CHARACTERISTICS OF ROCKS

Unit	Seismic Velocity Ratio Vs/Vp	Unconfined Compressive Strength lb/inch^2	Tensile Strength lb/inch^2	Young's Modulus lb/inch^2 x 10^6	Poisson's Ratio	Bulk[a] Density lb/f^3
Sandstone	ND	3,280 (1,080-5,76[b])	580 (151-2,021)	2.30[c]	0.16	143 (127-165)
Mudstone/ siltstone/ shale	ND	2,710 (2,260-3,500)	490 (382-635)	1.40[c]	ND	154 (137-175)
Limestone	ND	5,553 (3,744-6,120)	1,041 (642-1,198)	6.3 (1.60-9.35)	0.28	157 (143-163)

Notes: Data values are averages with ranges shown in parentheses.

ND = No data available.
* Based on two best.

a. Typical values
b. Based on two tests
c. Based on one test

Source: Chung 1988a; Heinzman 1988c.

The rock at the site consists of sandstone, siltstone, and limestone of the Saginaw formation; limestone and dolomite of the Bayport formation; shale, sandstone, and limestone of the Michigan formation; and sandstone of the Marshall Sandstone formation. Engineering properties of these rocks are presented in Table 5.4.1-4. At the proposed tunnel horizon, the rocks along the collider ring are predominantly sandstone, limestone, shale, and interbedded sandstone and shale.

Drill hole data, cores, and exposures in quarries and highway cuts at various locations along the corridor ring reveal the following:

- High permeability zones in glacial soils, likelihood of water inflows at shaft locations.
- Rock quality designation (RQD) values range from fair to good. The RQD values associated with sandstone are generally higher than those associated with shale, limestone, and mudstone.
- Results of swell and slake durability tests show the maximum swell pressure under full saturation ranging from zero to 5.6 lb/inch^2.
- The mean unconfined compressive strength for sandstone is reported to be 3,280 lb/inch^2; those for shale and limestone are 2,710 lb/inch^2 and 5,550^2 lb/inch, respectively. Values reported for the Young's modulus of the rocks range between 1.4 x 10^6 lb/inch^2 to 6.3 x 10^6 lb/inch^2 (Chung 1988a; Heinzman 1988c).
- Higher values for permeability are reported along lithologic contacts than within single lithologies.
- Substantial joints in the rocks are spaced 2 to 14 ft apart (Section 5.4.1.3)
- Potentially deleterious materials such as coal, pyrite, and gypsum are present in small quantities in the rocks at tunnel depth.

5.4.1.5 Geologic Hazards

The proposed Michigan site is located in the Central Stable Region of the North American continent. The site lies in Zone 1 of the UBC seismic risk map (International Conference of Building Officials 1988). Zone 1 is characterized as a zone where minor damage can occur from earthquakes generating modified Mercalli intensities of V to VI. There have been 15 earthquakes within about 100 mi of the site in historical times (Bricker 1977). The largest, with epicenter intensities of IV, were in 1883 and 1947, about 58 and 54 mi away. The nearest earthquake was in 1967 with an intensity of IV. It was less than 10 mi north of the site near Lansing.

Distant earthquakes that occurred in seismic zones near Anna, Ohio, and New Madrid, Missouri, have also been felt in the site area. The largest event in the Anna seismic zone, about 120 mi southeast of the site, was a 1937 event that generated modified Mercalli intensities of III to IV

Cement is available from Charlevoix and Alpena counties in the northern part of the Lower Peninsula, and from Monroe County approximately 50 mi from the site. Combined production from these three sources is 4.3 million ton/yr, and available reserves at each plant should last between 50 and 100 years. The closest plant to the site in Monroe County is the smallest of these producers with an annual production of 1 million ton/yr. All three plants maintain terminal facilities on the Detroit River (Ott 1988).

B. Energy Resources

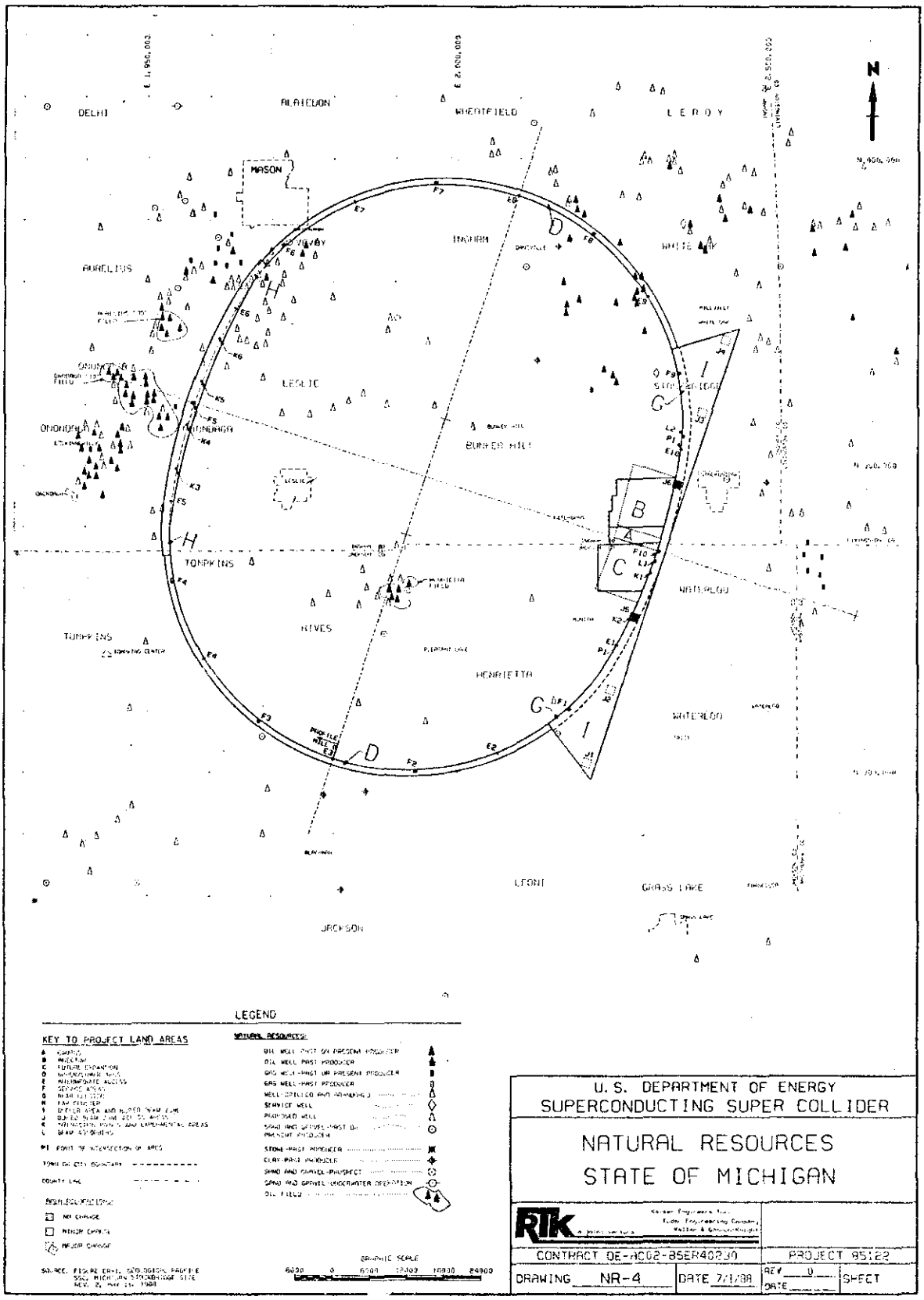
Several of the sedimentary units, described in Section 5.4.1.2, beneath the proposed ring are known to contain abundant hydrocarbon resources. The Devonian Traverse group (365- to 380-million years old), the Silurian Salina-Niagara groups (415- to 430-million years old), and the Ordovician Trenton-Black River groups (450- to 470-million years old) are all major sources of oil and gas in Michigan. These formations occur at approximately 2,000, 3,600, and 5,000 ft below the surface at the proposed site location.

Over 17 million barrels of oil were produced as of 1977 in the Walker Field in the Southern Peninsula from the Traverse group. Traverse fields are abundant in the southwestern portion of the state where traps usually consist of small bioherms or porosity pinchouts in the carbonate rocks (Lilienthal 1978). The porous carbonates of the Silurian, Salina, and Niagara groups have also been important sources of hydrocarbons. Folding and collapse of evaporites in the Salina has also produced structural traps in the overlying Traverse group (Lilienthal 1978). The Albion-Scipio trend (see Section 5.4.1.3) southwest of the site contains one of the largest oil and gas fields in Michigan; over 100 million barrels of oil and 175 million ft^3 of gas have been produced. Production in this 35-mi long field is from the Trenton and Black River groups, and is thought to be associated with dolomitized rock along deep-seated faults and fractures (Lilienthal 1978). Large volumes of natural gas are also characteristic of the Trenton as evidenced by the well-publicized near blow-out of a well outside Marshall in Calhoun County, and the evidently associated, spontaneous, explosive eruptions of gas from a swamp 10 mi away (Woodruff 1969) (see Section 5.4.1.5).

Oil and gas well locations in the vicinity of the proposed ring are plotted on Figure 5.4.1-6. Data shown are primarily from the Michigan Department of Natural Resources (1987), though these are supplemented in the eastern portion of the figure by data supplied by the Petroleum Information Corp. (1988). There are 33 past or present producers of oil within the ring, 5 on the ring, and 56 additional wells within 5 mi of the ring. Drilled and abandoned wells are more abundant: 80 within the ring, 9 on the ring, and 104 within 5 mi. Gas wells total one within the ring and 16 within 5 mi.

Figure 5.4.1-6

MICHIGAN NATURAL RESOURCES



The Henrietta Field near the center of Figure 5.4.1-6 contains five wells that produce from the crest of a monocline in the Trenton-Black River group. Over 25,000 barrels of oil have been produced from these wells (Michigan Geological Survey 1987; Heinzman 1988b). The 18-well Onondaga "10" field west of the ring produces from a 1,200-acre reef in the Niagara group. Production from this field has exceeded 7.5 million barrels of oil and 9,500 million ft^3 of natural gas since 1971 (Michigan Geological Survey 1987; Heinzman 1988b).

Just north of the Onondaga "10" field, the Aurelius "35" field has produced about 2 million barrels of oil and 1,100 million ft^3 of natural gas from the same rock (Michigan Geological Survey 1987; Heinzman 1988b).

Additional strata considered as potential future sources of hydrocarbons in the region include the Ordovician Prairie du Chien formation and the Devonian Antrim shale (Heinzman 1988b). Abundant organic matter in the shales of the Antrim may be a potentially significant source of hydrocarbons; the potential in the Prairie du Chien in the eastern portion of the basin is considered low because the formation is largely eroded (Lilienthal 1978). All of the known and potentially productive horizons at the site are significantly below the proposed tunnel depth.

Coal production in Michigan has been largely confined to the Pennsylvanian (280-million to 320-million-year-old) Saginaw formation of the Michigan basin. Coal occurrences in the state are typically sporadic and may vary greatly in thickness over short distances; many coal beds are too limited in extent or thickness for extraction (Kalliokoski and Welch 1976). Profitable mining of coal beds commonly requires beds to be at least 3 ft thick (Cohee et al. 1950). Of the numerous fields once mined in nine counties on the eastern and southeastern portions of the basin (including Ingham and Jackson counties), only one remains in production. Coal mining in the vicinity of producing oil wells has been greatly limited because of safety considerations (Kalliokoski and Welch 1976).

Occurrences of natural gas (drift gas), composed primarily of methane, have been noted in a number of localities throughout the state. The gas was probably derived from hydrocarbon-bearing strata in the sediments beneath the drift (notably from the Berea sandstone member of the Ellsworth shale and Antrim shale in the southern peninsula) where it migrated into overlying stratigraphic traps. Only one deposit, discovered in 1929 in Mason County, has been commercially exploited; most deposits consist of very small volumes of gas that at best are suitable only for home use (Heinzman 1988a). As a whole, these deposits are not considered a significant regional resource.

C. Metallic Resources

No record of metallic mineral exploitation or exploration in the vicinity of the proposed site is contained in the MILS database (Bureau of Mines 1988). Sulfide mineralization occurs sporadically throughout the stratigraphic column (see Section 5.4.1.2), but no deposits of significant size have been identified.

D. Other Resources

From 1957 through at least 1976, Michigan led the nation in the production of peat. In that time, Michigan had used only 0.7% of its reserves, estimated at about 539 million short tons. Eighty percent of these reserves are in the northern part of the state. A 1974 survey showed only one peat producer near the proposed site in eastern Ingham County (Walden 1976). Two past producers of clay inside the proposed ring and four within 5 mi are shown in Figure 5.4.1-6. These localities were extracted from the MILS database and their present status is uncertain (Bureau of Mines 1988).

5.4.2 Water Resources

5.4.2.1 Surface Water Hydrology, Quality, and Use

A. Surface Water Runoff and Flooding

The proposed Michigan SSC site is located almost entirely within the Grand River basin, with a very small amount draining to the upper reaches of the Huron River basin to the east (Figure 5.4.2-1). While the site location includes the divide between these two major basins, not all of the site falls within headwater tributaries. The Grand River itself crosses the ring location twice in the southeast quadrant, flowing north across the ring near E3, and then west across the ring between E4 and F4 (see Figure 5.4.2-2). The other major tributaries crossing the ring location are Sycamore and Mud creeks, which flow north to join the Grand River near Lansing; Deer and Doan creeks, which flow north to join Red Cedar River, another tributary to the Grand River; and Batteese and Orchard creeks, and Portage River, which join together in the southeast quadrant before emptying into the Grand River just south of the ring.

The area surrounding the site is characterized by low relief and poor drainage. Many of the major tributaries have been straightened, channelized and/or dredged to promote drainage because of their poor gradients. As a result of the topography, many natural lakes and ponds are found in the region. The larger lakes include Portage, Pleasant, Mud, White, Batteese, and Huntoon (Figure 5.4.2-2).

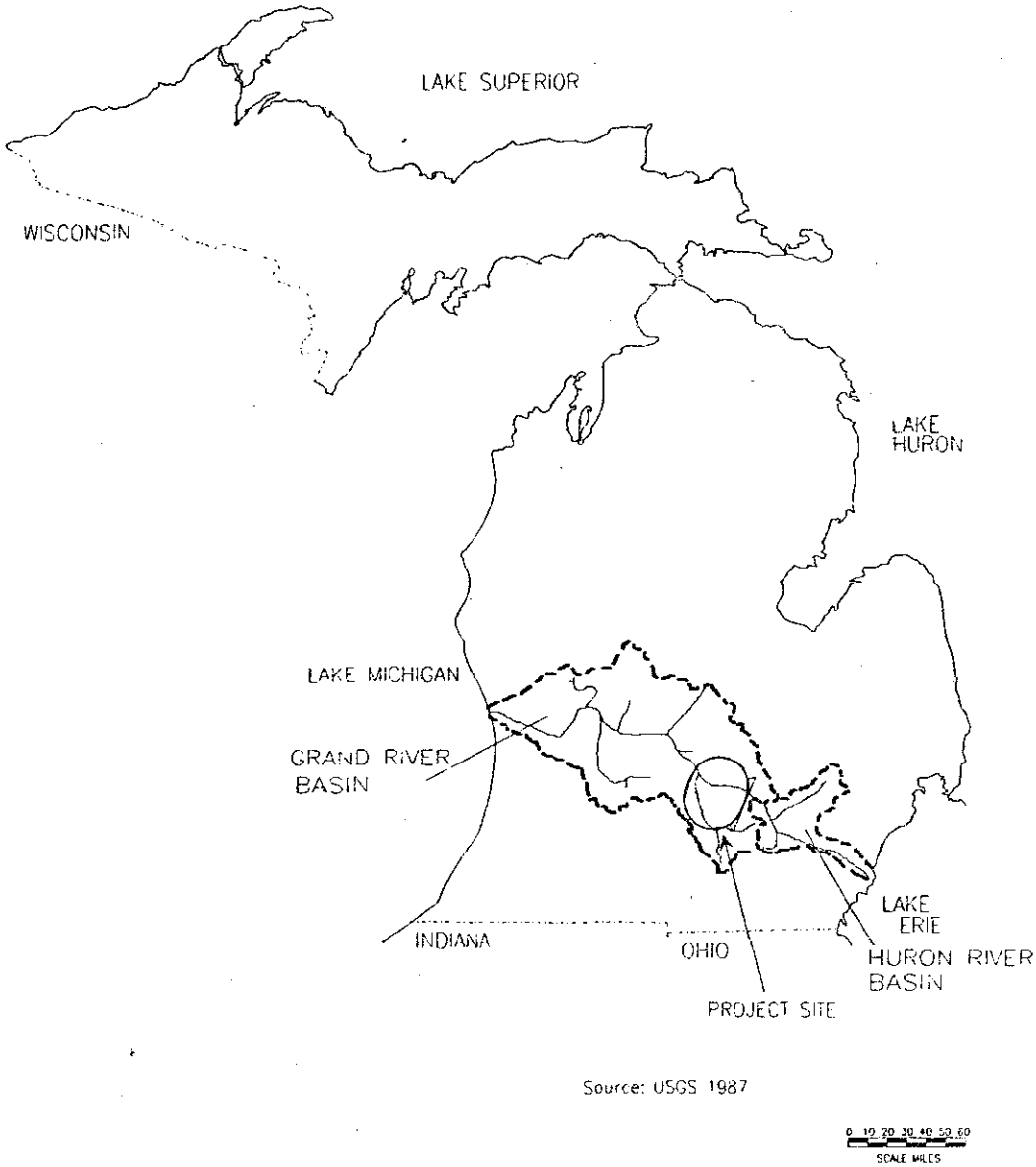
Six active U.S.G.S. stream gauging stations are located in the site vicinity with records ranging in length from 11 to 55 years. These stations are listed in Table 5.4.2-1, and general discharge characteristics are given. Channel and floodplain characteristics for the major streams and tributaries are given in Table 5.4.2-2. Except for the Grand River, these streams are generally small with limited drainage areas. However, they are commonly located in broad valleys with significant flood potential.

Historical floods of major proportions on the upper Grand River have been infrequent over the past 50 years. In Jackson County, the two largest floods occurred in June of 1937 and June of 1968. Damages from the latter were exacerbated because of backwater caused by flow blockage downstream from the city of Jackson. The discharge for the 1968 flood was estimated to be only a 25-year recurrence interval event (Department of Agriculture 1976).

Downstream on the Grand River, as well as on some other tributaries such as Sycamore Creek and Portage and Red Cedar rivers, major floods occur more frequently, on the order of once in ten years. The communities of Lansing-East Lansing, Eaton Rapids, and Mason all had their worst flooding in 1947. The Portage River floods easily from backwater when the Grand River is at high stage because of its shallow gradient (Michigan Water Resources Commission 1961).

Figure 5.4.2-1

MAJOR WATERSHEDS IN MICHIGAN



Source: USGS 1987

Figure 5.4.2-2

HYDROLOGIC FEATURES - MICHIGAN SSC SITE

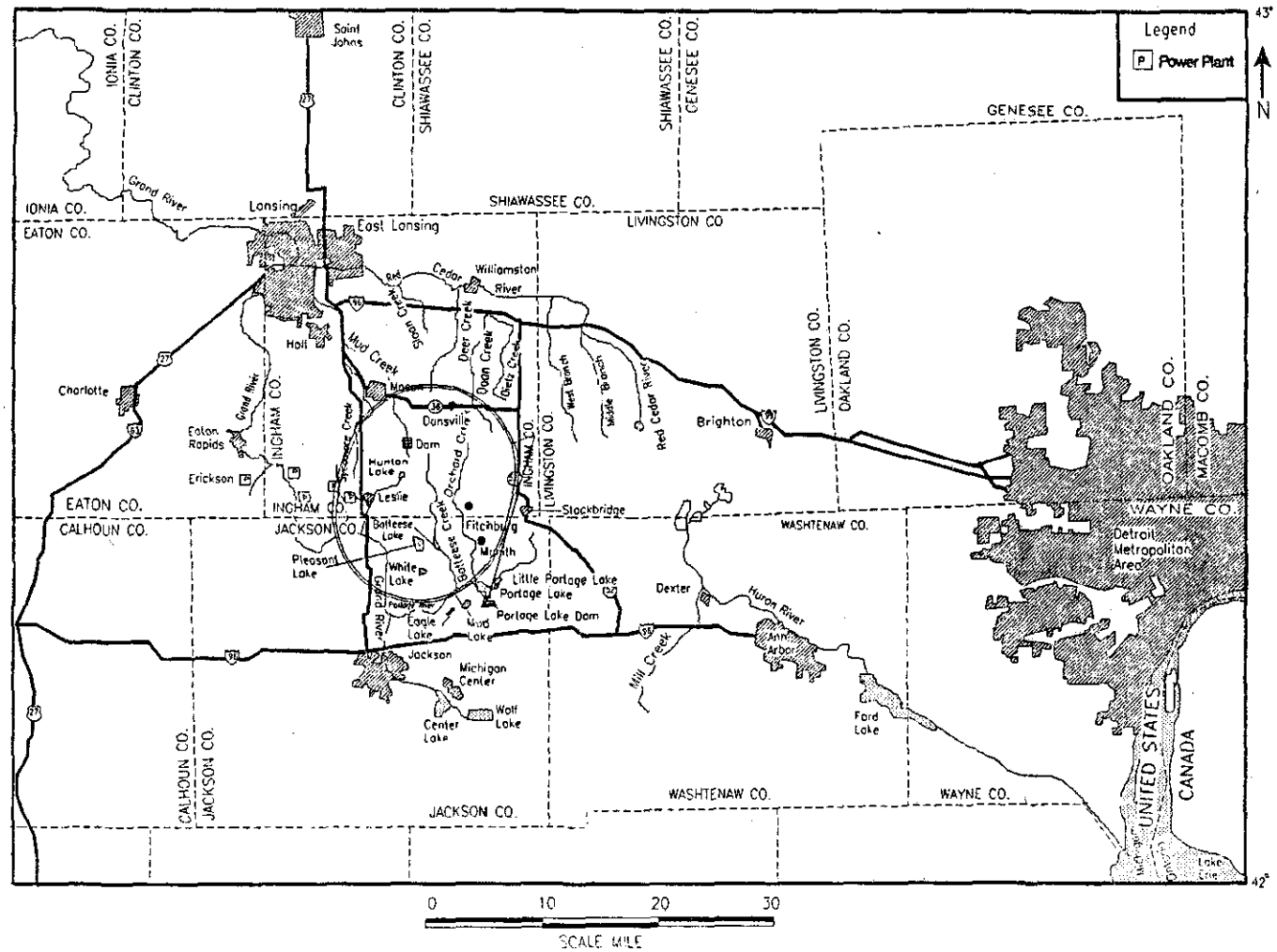


Table 5.4.2-1

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%
Grand River near Lansing (No. 04113000)	1230	24,500	3-26-04	2.8	844	2583	923	467	2461	123
Grand River at Jackson (No. 04109000)	174	1,070	6-25-37	9.2	123	320	148	84	49	30
Red Cedar River at E. Lansing (No. 04112500)	355	5,940	4-20-75	3.0	208	---	---		---	---
Red Cedar River near Williamston (No. 04111379)	163	1,790	2-26-85	2.6	106	---	---		---	---
Sloan Creek near Williamston (No. 04112000)	9.34	1,290	4-18-75	0.01	6	23	3	1	0.4	0.2
Deer Creek Near Dansville (No. 04111500)	16.3	962	4-19-75	0.04	6	33	8	4	2	0.8

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

Source: Miller et al. 1987.

Table 5.4.2-2

CHANNEL AND FLOODPLAIN CHARACTERISTICS
AT THE COLLIDER RING

Drainage Channel	Drainage Area mi^2	Bankfull Channel Width ft	Bankfull Channel Depth ft	Floodplain Width ft
Grand River Basin				
Sycamore Creek near F6	18	20	4	75
Mud Creek near E7	15	12	10	1,000
Deer Creek near F7	6	15	8	500
Doan Creek near F8	19	15	6	500
Grand River near E3	363	50	?	1400
Grand River near E4:F4	447	75	?	300
Batteese Creek near F1:E2	24	15	4	200
Orchard Creek near F1	58	40	?	1,000
Portage River near E2	85	60	?	1,000

Note: Drainage areas were measured from U.S.G.S. topographic map, channel widths and depths and floodplain widths were estimated during site visits in 1988, except for the Grand River near E3, which was obtained from the Federal Emergency Management Agency (1984).

Flood-prone areas delineated by the U.S.G.S. (1975) indicate significant flooding potential in the southeastern and southwestern quadrants of the ring. This flooding potential is primarily associated with the Grand and Portage rivers, Batteese Creek, and several lakes in the Portage drainage, including Portage, Little Portage, Mud, and Eagle lakes. The other major tributaries in the area have limited flood-prone areas. Specific access and service areas with possible impacts from flooding include E2, F2, and F6. The campus, injector, and expansion areas have Orchard Creek and tributaries traversing them with a 500-ft wide, or less, flood-prone area. The actual extent of river and stream flooding is not large, and should be a lesser problem than the poor drainage conditions for surface facilities.

No existing or planned flood control measures, including dams, are found on the rivers and streams in the project area. Two dams are found in the area: the Portage Lake Dam in Jackson County and the Dansville Game Area Dam on Mud Creek in Ingham County. These dams are for purposes of recreation and wildlife habitat, respectively (Morgan 1988).

B. Surface Water Quality

Part 4 of Michigan Public Act 245, the Water Resources Commission Act, provides specific water quality standards for designated uses of surface waters. Streams and rivers in the project area generally have more than one designated use, including agriculture, partial or total body contact recreation, navigation, warm water fisheries, and industrial and public water supply. Based on a limited amount of data, these streams appear to be generally within the standards.

Table 5.4.2-3 gives water quality standards for several streams in the project area, and data on these water quality constituents where available. Notable constituents commonly in excess of standards are mercury and fecal coliform, occasional exceedances are also found with dissolved oxygen and chloride.

Goudy (1986) reports that the Grand River water quality is degraded downstream of the large metropolitan areas, like Lansing and Jackson. The stretch of Grand River downstream from Jackson, including both ring crossings, has experienced an oily bottom sludge accumulation which is heavily impacting the macroinvertebrate community. Degradation of the Grand River water below Jackson, outside of sludge accumulation, is thought to be a result of sewer overflow and previous improper wastewater treatment (Goudy 1986).

Table 5.4.2-3

SURFACE WATER QUALITY DATA IN PROJECT VICINITY

Parameter	Unit	Standard	Maximum	Minimum	Average
Stream: Grand River at Maple Grove Road STORET Station No. 380031 Period of record: 1971-1987					
Fecal Coliform	#/100ml	≤200	92,000	2	1463
pH		6.5-9.0	8.6	7.3	7.8
Temperature	°C		26.0	0	11.9
Dissolved Oxygen	mg/l	≥7.0	12.2	4.2	8.0
Dissolved Solids	mg/l	≤750	708	267	451
Turbidity	FTU	---	22.0	1.2	6.1
Chloride	mg/l	≤125	154.0	20	55
Sulfate	mg/l	---	101.0	42	64
Nitrate	mg/l	---	---	---	---
Lead	µg/l	≤655	47	2	16
Mercury	µg/l	≤0.2	1.0	0.1	0.37
Stream: Portage River near Mouth STORET Station No. 380229 Period of record: 1971-1987					
Fecal Coliform	#/100ml	≤200	610	200	378
pH		6.5-9.0	8.2	7.9	8.0
Temperature	°C		24.0	20.5	22.1
Dissolved Oxygen	mg/l	≥7.0	6.8	5.3	5.9
Dissolved Solids	mg/l	≤750	429	393	414
Turbidity	FTU	---	16.0	5.3	10.1
Chloride	mg/l	≤125	26.0	23	24
Sulfate	mg/l	---	110	48	104
Nitrate	mg/l	---	---	---	---
Lead	µg/l	≤655	22	20	21
Mercury	µg/l	≤0.2	0.2	0.1	0.2
Stream: Orchard Creek near Fitchburg STORET Station No. 04109700 Period of record: 1968					
Fecal Coliform	#/100ml	≤200	---	---	---
pH		6.5-9.0	6.9	---	---
Temperature	°C		---	---	---
Dissolved Oxygen	mg/l	≥7.0	---	---	---
Dissolved Solids	mg/l	≤750	298	---	---

Table 5.4.2-3 (Cont)

SURFACE WATER QUALITY DATA IN PROJECT VICINITY

Parameter	Unit	Standard	Maximum	Minimum	Average
Turbidity	FTU	---	---	---	---
Chloride	mg/l	≤125	3	---	---
Sulfate	mg/l	---	78	---	---
Nitrate	mg/l	---	17	---	---
Lead	µg/l	≤655	---	---	---
Mercury	µg/l	≤0.002	---	---	---
Stream: Sycamore Creek in Mason; STORET Station No. 330239; Period of record: 1981-1982					
Fecal Coliform	#/100ml	≤200	---	---	---
pH		6.5-9.0	8	8.2	7.9
Temperature	°C		18.7	22.0	11.5
Dissolved Oxygen	mg/l	≥7.0	9.1	11.0	8.0
Dissolved Solids	mg/l	≤750	562	676	484
Turbidity	FTU	---	2.6	3.3	1.6
Chloride	mg/l	≤125	---	---	---
Sulfate	mg/l	---	---	---	---
Nitrate	mg/l	---	---	---	---
Lead	µη/l	≤655	1	---	---
Mercury	µg/l	≤0.002	<0.5	---	---
Stream: Deer Creek near Dansville; STORET Station No. 04111500; Period of record: 1963-1968					
Fecal Coliform	#/100ml	≤200	---	---	---
pH		6.5-9.0	---	8.2	7.2
Temperature	°C	---	13	---	---
Dissolved Oxygen	mg/l	≥7.0	---	---	---
Dissolved Solids	mg/l	≤750	---	340	312
Turbidity	FTU	---	---	---	---
Chloride	mg/l	≤125	---	14	8
Sulfate	mg/l	---	---	46	44
Nitrate (N)	mg/l	---	12	12	12
Lead	µg/l	≤655	---	---	---
Mercury	µg/l	≤0.002	---	---	---

Sources: STORET data; Michigan Water Resources Commission 1986.

Suspended sediment loads estimated for the entire Grand River basin are on the order of 21 to 27 tons/mi²/year. The range of values for the 15 largest watersheds in Michigan goes from almost 3 to over 500 tons/mi²/year, and the Grand River value is close to the median amount (Cummings 1984).

Five wastewater treatment plants on streams draining the SSC project area have current NPDES permits in effect. These are Eaton Rapids, Jackson, Leslie, Mason, and Stockbridge. The Stockbridge plant is still under construction, so no discharges have been made to date (Michigan Water Resources Commission 1988). Limitations placed on discharges from these treatment plants are for fecal coliform, pH, dissolved oxygen, and chlorine.

C. Surface Water Use

Five primary uses have been identified for surface water in Michigan by Bartholic, et al. (1982). The largest surface water use is thermoelectric power production, with 79.2% of the water use statewide. Industrial uses require 10.3%, municipal water supply 7.9%, and irrigation and rural water uses 1.4% and 1.2%, respectively. Projected increases in total water use by the year 2000 in Ingham and Jackson counties are 13.8% and 8.6%, respectively.

Little specific surface water use data is available for the two counties in which the SSC site is located. Table 5.4.2-4 is a compilation of the best available data on surface water use for the SSC project location. Three power plants use Grand River water for cooling. The Lansing plant downstream from the proposed site is the greatest user by far (Van Til and Scott 1986). No municipal surface water users are identified in either Ingham or Jackson counties (Bedell 1982). Seasonal irrigation demand for Ingham and Jackson counties has been estimated at about 1,590 acre-ft and 5,780 acre-ft, respectively. It is expected to continue growing by about 8% annually, and the greatest demand for expansion will be in groundwater sources (Bartholic et al. 1982).

Table 5.4.2-4

SURFACE WATER USE IN PROJECT VICINITY

Source	Use	Quantity Current acre-ft/yr	Quantity Projected acre-ft/yr
Ingham County			
Grand River	Cooling	138,435	----
Unspecified sources	Irrigation	1,176	----
Unspecified sources	Industrial	200	----
Jackson County			
Unspecified sources	Irrigation	2,352	----
Unspecified sources	Industrial	112	----

Sources: Van Til and Scott 1986; Bedel 1928; Bargholic et al. 1982.

5.4.2.2 Groundwater Hydrology, Quality, and Use

A. Groundwater Hydrology

The proposed Michigan site is characterized by glacially deposited material overlying late Paleozoic bedrock. The shallow bedrock units consist primarily of sandstones, limestones, and shales with dolomite, siltstone, and minor evaporites. The glacial deposits and certain shallow bedrock units yield significant quantities of groundwater and are developed. Four major hydrogeologic units are differentiable: 1) the glacial drift, 2) the Saginaw formation, 3) the Mississippian Aquitard, and 4) the Marshall formation (Corps of Engineers 1970; Vanlier et al. 1973). Table 5.4.2-5 summarizes characteristics of these hydrogeologic units. These units and the general hydrogeologic conditions in the vicinity of the Michigan site are described in the following sections:

1. Glacial Drift

Glacial deposits are the surficial geologic unit throughout the Michigan SSC site. Three principal types of glacial deposits are present: 1) outwash deposits consisting of sorted silt, sand, and gravel; 2) lake deposits consisting of interlayered clay, silt and sand; and 3) till deposits consisting of an unsorted mixture of clay, silt, sand, gravel and boulders. The glacial drift varies in thickness from approximately 10 to 200 ft. A regional thinning of the glacial drift begins south of Jackson County, outside of the general area of influence of the proposed Michigan site (Michigan Water Resources Commission 1961; Vanlier et al. 1973; Western Michigan University 1981).

The water supply potential of the glacial drift varies areally because of variations in drift thickness and lithology. The sand and gravel aquifers are locally unconfined, again resulting from the lithologic complexity of the unit. The water table is typically shallow with depth-to-water ranging from about 5 to 50 ft. With the shallow water table, groundwater movement in the glacial drift is strongly controlled by surface topography. Groundwater movement generally follows surface drainage and moves from topographic highs to streams or lakes and other topographic lows (Western Michigan University 1981; Gilbert/Commonwealth of Michigan 1988a).

Infiltration to the glacial deposits is the primary source of recharge to underlying bedrock aquifers. For south-central Michigan, it is estimated that about 4 inches of water infiltrates into the ground annually. Of this amount, about 2 in/yr is estimated to infiltrate to the shallow groundwater reservoir while the other 2 inches is lost to evapotranspiration (Vanlier et al. 1973). Two inches per year of infiltration to shallow groundwater suggests recharge on the order of 100 acre-ft/yr/mi^2.

218-829 0 - 88 - 9 (BOOK 4)

Table 5.4.2-5

SUMMARY DESCRIPTION OF HYDROGEOLOGIC UNITS IN THE VICINITY OF THE SSC SITE - MICHIGAN

Hydrogeologic Unit	Approximate Thickness ft	Physical Description	Hydraulic Properties	Water-Bearing Characteristics
Glacial Drift	10-200	Till, outwash, and lake deposits consisting of clay, silt, sand, and gravel	K (till) = $6x10^{-7}$ cm/s K(sand & gravel) = 10^{-2} to $6x10^{-6}$ cm/s T = 400 to 4,000 ft^2/d	Local discontinuous aquifers; variable yield due to variation in thickness and lithology; unconfined to locally confined; well yields <10 to 1,750 gal/min
Saginaw Formation	0-250	Cyclic sequence of sandstone, shale, and limestone with twin coal beds	K = 10^{-2} to $<10^{-6}$ cm/s T = 350 to 10,700 ft^2/d S = 10^{-4} to $8x10^{-5}$	A major aquifer in region; yield dependent on thickness of sandstone penetrated; unconfined to leaky confined; well yields 10 to 1,000 gal/min
Mississippian Aquitard	90-300	Includes Bayport limestone and Michigan formation; Bayport limestone and dolomite interbedded with siltstone and sandstone; Michigan shales and sandstone with beds of gypsum and anhydrite	No aquifer test data	Units considered an aquitard and confine the underlying Marshall formation aquifer; small well yields can be developed locally from porous dolomites and sandstones
Marshall Formation	170-230	Fine-grained to very coarse-grained sandstone, with dolomite cement; shale and siltstone near base	T = up to 33,500 ft^2/d	A major aquifer in region; leaky confined to unconfined; well yields from <20 to 2,000 gal/min

Notes: T = Transmissivity
K = Hydraulic Conductivity
S = Storativity

Sources: Corps of Engineers 1970; Radfar 1979; Western Michigan University 1981; Michigan Geological Survey 1987; Michigan Department of Public Health 1988; Gilbert/Commonwealth of Michigan, Inc. 1988b and 1988c.

As indicated, the water supply potential of the glacial drift is variable. Well yields depend on the nature and thickness of sand and gravel penetrated. Reported well yields range from less than 1 gal/min to 1,750 gal/min. Reported specific capacities range from very small to in excess of 80 gal/min/ft (Western Michigan University 1981; Michigan Department of Public Health 1988). Because of the uncertainty and variation of well yield, the glacial drift is not extensively developed for municipal supply but is quite commonly developed for rural domestic use.

Hydraulic properties of the glacial drift are also highly variable. Reported hydraulic conductivities range from 10^{-2} to 6×10^{-7} cm/s. The lowest estimated value, 6×10^{-7} cm/s, is for till. The higher portion of the range, field test values ranging from 10^{-2} to 3×10^{-4} cm/s and an estimated value of 6×10^{-6} cm/s, are for sand and gravel or outwash deposits. Transmissivity estimates based on aquifer test results range from 400 to 4,000 ft^2/d. Reported specific capacities range from less than 2 to in excess of 80 gal/min/ft of drawdown (Kehres 1984; Michigan Department of Public Health 1988; Western Michigan University 1981; Gilbert/Commonwealth of Michigan 1988b).

2. Saginaw Formation

The Saginaw formation directly underlies the glacial drift in all except the extreme southern (south of the City of Jackson) and eastern portions of the Michigan site, and is a major developed aquifer. The Saginaw is a cyclic sequence of sandstone and shale and thin beds of limestone and coal. Sandstone and shale dominate the formation, but the percentage of each varies considerably over the area. Thickness of the unit varies from 0 to about 250 ft. The unit is thickest in the north-central portion of the site and generally thins to the east and south where the underlying formations subcrop beneath the glacial drift (Vanlier et al. 1973).

The regional component of groundwater movement in the Saginaw formation (and all underlying bedrock units) is northward towards the central portions of the Michigan basin. This is basically accentuated by a notable cone of depression in the Saginaw resulting from extensive pumping of the unit in the vicinity of Lansing (Vanlier et al. 1973).

Sandstone beds within the Saginaw are unconfined to leaky confined depending on the occurrence of shale layers and the permeability of overlying glacial deposits. Well yield in the Saginaw is controlled by the thickness of sandstone penetrated and the availability of recharge from overlying glacial deposits. Reported well yields range from 10 to 1,000 gal/min. The majority of the 125+ wells developed in the Saginaw by Lansing have yields of from 100 to 700 gal/min. Specific capacity ranges from 0.1 to 12 gal/min/ft of drawdown (Corps of Engineers 1970; Radfar 1979; Vanlier et al. 1973; Michigan Department of Public Health 1988; Gilbert/Commonwealth of Michigan 1988b).

Considerable data are available to define the hydraulic properties of the Saginaw formation. Reported hydraulic conductivity ranges from 10^{-2} to less than 10^{-6} cm/s, the lower values generally, but not exclusively, being associated with shale units. Transmissivity ranges from about 350 to almost 10,700 ft^2/d. Storativity from limited test data is reported from 10^{-4} to 8×10^{-5} (Radfar 1979; Western Michigan University 1981; Michigan Department of Public Health 1988; Gilbert/Commonwealth of Michigan 1988c).

3. Mississippian Aquitard

The Bayport limestone and the Michigan formation directly underlie the Saginaw Formation over most of the Michigan site. To the south, west, and east of the site, these formations may directly underlay the glacial drift or are exposed. The Bayport limestone consists of limestone and dolomite interbedded with siltstone and sandstone. The Michigan formation directly underlies the Bayport, and is composed primarily of shale with minor beds of sandstone, limestone, dolomite, and evaporites in the form of gypsum and anhydrite. The combined units range from approximately 90 to 300 ft thick (Michigan Geological Survey 1987; Western Michigan University 1981).

Both of these units yield small amounts of water locally for domestic use, but are generally viewed as aquitard confining the underlying Marshall formation. Successful wells in both formations are most likely where they directly underlay glacial drift. Where they occur beneath the Saginaw formation, they are generally not successfully developed for water supply because of low permeability and well yield and, for the Michigan formation, potentially poor water quality (Vanier et al. 1973; Western Michigan University 1981). No data on hydraulic properties are available because of the limited development of the formations.

4. Marshall Formation

The Marshall formation underlies the entire area of the proposed Michigan SSC site. It consists of fine-grained to coarse-grained sandstone with dolomitic cementation. Minor shale and siltstone beds occur, mostly near the base of the unit. The unit ranges in thickness from about 170 to 230 ft (Western Michigan University 1981).

The unit is a major regional aquifer for the southern peninsula of Michigan. In Ingham County, however, the Marshall is typified by small yields and poor-quality water primarily because of the increased depth of the unit which results in lower recharge and permeabilities. From central Jackson County southward, the Marshall formation occurs at shallower depths and is a very productive unconfined to leaky confined aquifer, although water quality does typically decrease with depth. The unit is especially productive where it subcrops beneath glacial drift (Corps of Engineers 1970; Western Michigan University 1981).

Reported well yields and specific capacities range from 20 to 2,000 gal/min and 2 to 100 gal/min/ft of drawdown, respectively. Yields of several hundred gallons per minute are common in southern Jackson County. Depth of wells ranges from 100 to 400 ft. Limited data in hydraulic properties was encountered in information and publications reviewed. A transmissivity of 33,500 ft^2/d is reported for the Marshall near Battle Creek in western Michigan (Western Michigan University 1981).

B. Groundwater Quality

Groundwater quality of the three local aquifer units (glacial drift, Saginaw formation, and Marshall formation) is relatively similar. Most groundwater is of calcium-magnesium bicarbonate type, although significant concentrations of chloride, sulfate, and sodium do occur. The waters are typically very hard and have elevated concentrations of dissolved iron (Vanlier et al. 1973). The chemical quality of the various hydrogeologic units is summarized in Table 5.4.2-6.

Groundwater in the glacial drift shows a relatively wide variation in total dissolved solids, ranging from 200 to 1,000 mg/l. This results from the varied lithology and source rock material, and variations in recharge and groundwater movement. The water typically has a high iron content. Locally elevated chloride values are probably the result of surface sources such as road salt (Vanlier et al. 1973).

The Saginaw formation is typified by hard to very hard water with locally high iron. Areas of high chloride content occur within the Saginaw, generally at depth. It is assumed the source is upward leakage from underlying units, probably both natural leakage and leakage through improperly constructed or abandoned deep wells (Corps of Engineers 1970; Vanlier et al. 1973). Water quality does not seem to vary significantly over the area of the proposed Michigan site.

Water in the Mississippian aquitard (Bayport limestone and Michigan formation) varies from fresh to saline. Fresh waters only occur where the units are shallow and directly overlain by glacial deposits. Elevated sulfate is typical of Michigan formation water because of the gypsum occurrence in the unit. The Marshall formation generally yields good quality water in the southern portion of the Michigan site. In the northern portion of the Marshall area, groundwater is saline. Table 5.4.2-7 reflects the good quality water derived from the Marshall (Corps of Engineers 1970; Vanlier et al. 1973).

C. Groundwater Use

Groundwater is extensively used in the Michigan site vicinity, both for municipal supply and rural domestic use. Lansing and Jackson and a great majority of smaller communities with municipal supply systems use groundwater exclusively. Table 5.4.2-7 lists 1984 groundwater use by

Table 5.4.2-6

RANGE OF GROUNDWATER QUALITY IN THE VICINITY OF THE SSC SITE - MICHIGAN

Source	Range of Chemical Constituents mg/l				
	Total Dissolved Solids	Chloride	Sulfate	Iron	Hardness[a] ($CaCO_3$)
National drinking water standards	500	250	250	0.3	none
Glacial drift	200-1,000	<10-325	40-100	<0.1-6	250-450
Saginaw formation	70-500	<1-400	<10-125	<0.1-9	100-550
Mississippian aquitard	314[b]	<1-20	<10-80	<0.1-6	150-400
Marshall formation	300-950	<10-370	20-70	<0.1-9	150-400

Notes: [a] Typical classifications of the hardness of water are as follows: 0 to 60 mg/l = soft to slightly hard; 60 to 120 mg/l = moderately hard; 120 to 180 mg/l = hard; >180 mg/l = very hard.
[b] Only a single measurement available.

Sources: Corps of Engineers 1970; Radfar 1979; Ingham County Health Department 1987; Gilbert/Commonwealth Inc. of Michigan 1988d; U.S. Environmental Protection Agency 1977; Vanlier et al. 1973; Driscoll, 1986.

Table 5.4.2-7

RECENT MUNICIPAL GROUNDWATER USE IN THE VICINITY OF THE SSC SITE - MICHIGAN

	1984 Groundwater Pumpage acre-ft
Ingham County	
E. Lansing-Meridian TWP	6,830
Lansing	25,310
Other Lansing TWP	1,230
Leslie	340
Mason	740
Michigan State University	5,040
Stockbridge	170
Webberville	210
Jackson County	
Concord	200
Grass Lake	770
Jackson	9,300
Springport	145
State Prison-Jackson	1,790
Washtenaw County	
Ann Arbor	3,700*
Chelsea	605
Dexter	225

* Primary source is surface water, pumped 14,110 acre-ft from the Huron River.
Source: Huffman 1985.

municipal water supply systems in the Michigan SSC site vicinity. Ann Arbor obtains approximately one fourth of its annual supply from groundwater; the remainder is surface water pumped from the Huron River (Huffman 1985; Twenter 1975).

Communities in the northern portion of the area, including Lansing, Mason, Leslie, and Stockbridge pump almost exclusively from the Saginaw formation. Of the 128 wells in the Lansing municipal supply system as of 1984, 125 were completed in the Saginaw and three were completed in the overlying glacial deposits. In the southern part of the Michigan SSC site vicinity, the Saginaw is generally absent and the Marshall formation and the glacial drift are developed. Jackson pumps exclusively from the Marshall formation, while the State Prison near Jackson pumps from both the Marshall and the glacial drift (Vanlier et al. 1973; Corps of Engineers 1970).

Groundwater is also used extensively for rural domestic supply. All aquifer units are developed, although usually the shallowest productive formation in an area is used. Consequently, the glacial drift is more frequently used for rural domestic supply than it is for municipal supply.

The only areas of concentrated groundwater withdrawals are around Lansing and Jackson. Here, the aquifers are locally overstressed and water level declines have occurred. Water level declines in the Lansing area have exceeded 100 ft; however, from 1980 through 1984, pumpage decreased slightly and water levels showed some recovery. Increased reliance on glacial deposits is planned to reduce overpumpage in the Saginaw (Vanlier et al. 1973; Huffman 1985). Elsewhere within the Michigan site vicinity, groundwater withdrawals are small and well-distributed, and no areas of significant overdraft or declining water levels are apparent.

No detailed projections of groundwater use were available for review. Estimates of infiltration to glacial deposits suggests groundwater recharge on the order of 100 acre-ft/yr/mi^2. Although the portion of this recharge that reaches deeper aquifer units cannot be quantified, it may be assumed, based on the pumpage shown in Table 5.4.2-7, that groundwater is available for use on a regional level. Given the relative abundance of the resource, it is assumed that groundwater will continue to be used and that its use will increase generally in proportion to population growth. Planning and careful management of the groundwater resource will be required in the Lansing and Jackson areas.

5.4.3 Climate and Meteorology

5.4.3.1 General Description

The climate of the Michigan SSC site alternates between North American mid-continental and semimarine, because of the influence of the Great Lakes. Because of the lake waters' slow response to temperature changes and the dominating winds, the onset of both winter and spring are set back. This effect is more pronounced for areas closer to the lake shore than the SSC site.

5.4.3.2 Temperature

Winter temperatures can be extreme, with measurements below zero several times during the year course of the season. Summer conditions can include periods of uncomfortable hot and humid weather that are often broken after a few days by the arrival of Canadian air.

Temperatures in the region vary from an average low of 20°F in January and February to an average high of 86°F in July. The extreme high temperature recorded was 105°F, which occurred in July; the extreme low temperature recorded was -24°F, which occurred in December. The temperature drops below freezing on an average 125 days per year. Frost penetration reaches an average of 25 inches and an extreme of 50 inches in depth (U.S. Weather Bureau 1941). Normal and extreme temperature and heating degree-day data are shown in Table 5.4.3-1.

5.4.3.3 Precipitation

The annual precipitation distribution in Michigan is even, with approximately 55-60% occurring during the normal growing season. Summer precipitation generally falls as showers or thunderstorms; winter precipitation (as snow) is steady and of lighter intensity. Severe drought conditions are infrequent, but mild meteorological drought is not uncommon (National Oceanic and Atmospheric Administration 1974).

The Southeast Lower Michigan climatic region receives an average of 30.68 inch/yr of precipitation. The peak month for precipitation is May, with a mean of 3.41 inches. The month with the least precipitation is January, with a mean of 1.91 inches. The region receives a mean of 36 inch/yr of snow. Mean precipitation and snowfall data are shown in Table 5.4.3-2. Also, 1-, 2-, 5-, 10-, 25-, 50-, and 100-year return period extreme rainfall data are shown in Table 5.4.3-3.

Table 5.4.3-1

NORMAL AND EXTREME TEMPERATURE DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average maximum temperature, °F	33	35	44	58	70	81	86	84	76	65	48	36
Average minimum temperature, °F	20	20	27	38	47	58	62	61	56	43	32	23
Highest maximum temperature, °F	67	68	82	88	95	104	105	104	100	89	81	64
Lowest minimum temperature, °F	-16	-20	-7	8	28	38	48	43	30	22	0	-24
Heating, in degree-days	1180	1060	940	520	220	40	0	0	90	360	740	1090

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

Table 5.4.3-2

MEAN PRECIPITATION AND SNOWFALL DATA
FOR SOUTHEAST LOWER MICHIGAN REGION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean monthly precipitation, inches	1.91	1.94	2.43	2.84	3.41	3.27	2.65	2.75	2.66	2.64	2.21	1.97
Mean monthly snowfall, inches	8.0	7.0	5.0	1.0	0	0	0	0	0	0.2	3.0	6.5

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

Table 5.4.3-3

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

Return Period Years	Rainfall (inches) 1-Hour	6-Hour
1	1.1	1.6
2	1.3	1.8
5	1.6	2.3
10	1.8	2.7
25	2.1	3.1
50	2.3	3.5
100	2.6	3.7

Source: U.S. Weather Bureau 1961.

5.4.3.4 Wind

Winds in Michigan are highly dependent on seasons. During the summer months, winds are predominantly toward the northeast when the semi-permanent Bermuda High Pressure Center is located off the southeastern U.S. During the winter, wind directions change as migrating cyclones and anti-cyclones move through the area (National Oceanic and Atmospheric Administration 1974).

The prevailing wind direction at the Michigan SSC site is toward the northeast at an average annual speed of 10 mi/hr. The monthly average speeds vary from 7 mi/hr to 13 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 5.4.3-4.

5.4.3.5 Humidity

The yearly mean relative humidity in the region of the proposed Michigan SSC site is 73%. The monthly average relative humidity peaks in January at 80%, and reaches its lowest values in April, May, June, July, and August at 70%. Mean and maximum dewpoint and mean relative humidity data are shown in Table 5.4.3-5.

5.4.3.6 Severe Weather

Severe weather in the region of the proposed Michigan SSC site is best characterized through the discussion of tornadoes, extreme winds, thunderstorms, ice storms, blizzards, and hail.

Tornadoes in the region of the site are relatively rare. The yearly probability of a point being struck by a tornado is approximately 7.35×10^{-4}, which corresponds to a return period of 1,400 years (Thom 1963).

Table 5.4.3-4

MONTHLY AVERAGE WIND SPEED AND DIRECTION

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average wind speed, mi/h	12	11	12	13	11	9	7	9	8	10	12	11
Wind blowing toward	NE	NE	E	E	NE	NE	NE	NE	N	N	NE	NE

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

Table 5.4.3-5

DEWPOINT AND RELATIVE HUMIDITY DATA

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean dewpoint temperature, °F	19	19	25	35	45	56	60	59	53	43	32	23
Maximum 12 hour 1000 mB dewpoint, °F	53	51	60	65	70	74	76	76	75	68	63	55
Mean relative humidity, %	80	78	70	70	70	70	70	70	75	75	75	78

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

For the period of record 1950-1986, 393 tornadoes were observed within a 50-nautical mile radius of Stockbridge. These events caused 150 deaths and 1,575 injuries (National Severe Storms Forecast Center 1988).

Extreme expected winds in the region are shown in Table 5.4.3-6 by maximum wind speed and return period.

Table 5.4.3-6

EXTREME WIND SPEED AND RETURN PERIOD DATA

Return Period yr	Wind Speed mi/h
10	60
25	70
50	80
100	87

Source: Thom 1968.

Thunderstorms occur in the region on an average of 46 times per year, with peak activity in June, July, and August (National Climatic Center, 1981). Hail greater than 0.75 inches in diameter is observed, on the average, 1.8 times per year (U.S. Weather Bureau 1969).

Blizzards in Michigan are less frequent than tornadoes but, on occasion, do occur (National Oceanic and Atmospheric Administration 1974).

5.4.4 Air Quality

5.4.4.1 Conditions Affecting Air Quality

A. Topographical

The Michigan SSC site is characterized by generally flat to gently rolling terrain in most of the ring, with slightly more relief in the southeastern portion adjacent to the Waterloo State Recreation area. Neither of these terrains will adversely affect air dispersion. Tree-covered sections or portions are interspersed between clear-cut farm fields throughout most of the area, with the southeastern portion again having a higher percentage of tree cover.

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 Section 5.1.4 of Appendix 5 (Arizona). The site's relative frequency of occurrence of the six stability classes is shown in Table 5.4.4-1. Class A has the highest degree of dispersion.

Table 5.4.4-1

FREQUENCY OF OCCURRENCE OF ATMOSPHERIC STABILITY CLASSES AT MICHIGAN SSC SITE

Class	Definition	% Occurrence
A	Extremely unstable	<1
B	Unstable	4
C	Slightly unstable	9
D	Neutral	62
E	Slightly stable	10
F	Stable and extremely stable	15

Source: NCDC 1988.

The Michigan SSC site is located near the center of the state. It is outside the area where land/water interfaces influence meteorology. Numerous small to average size lakes occur in the vicinity, although none large enough to affect meteorology. G. C. Holzworth's number of "forecast days" of high pollution potential is between 0 and 10 indicating good dispersion conditions (Holzworth 1972). Holzworth's methodology was also described in detail in Section 5.1.4 of Appendix 5. The influence of winds on dispersion conditions on an annual basis is demonstrated in Table 5.4.4-2. The table is an annual summary of the frequency of wind speed and direction for the Lansing first-order National Weather Service Station National Climatic Data Center ((NCDC) 1988).

5.4.4.2 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 Michigan. The primary standards are shown in Table 5.4.4-3.

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 one year, the highest representative regional value is shown. These values are delineated, along with the applicable standard for each pollutant, in Table 5.4.4-3. Selected ambient air quality monitoring stations are plotted in Figure 5.4.4-1.

Table 5.4.4-2

ANNUAL FREQUENCY OF WIND SPEED AND DIRECTION
MICHIGAN SSC SITE

Direction	Speed-Knots 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	Greater than 21	Total
N	.007893	.018108	.017034	.009294	.001210	.000137	.053676
NNE	.005625	.011166	.011508	.005754	.000982	.000274	.035310
NE	.006456	.013929	.015961	.008289	.001073	.000114	.045822
ENE	.009452	.019637	.016669	.008768	.000868	.000091	.055486
E	.007183	.015870	.016189	.007786	.000776	.000160	.047965
ESE	.005461	.012285	.009659	.004384	.000228	.000000	.032017
SE	.005012	.011554	.015504	.008974	.000936	.000023	.042004
SSE	.004398	.011326	.017628	.011075	.001370	.000137	.045934
S	.009282	.023177	.045851	.027104	.002809	.000343	.108565
SSW	.006318	.016874	.030164	.026853	.004704	.000617	.085530
SW	.005570	.014226	.028931	.029502	.006508	.001850	.086585
WSW	.006352	.015185	.021738	.018473	.005868	.003083	.060698
W	.011699	.028931	.033429	.031717	.011075	.004293	.121143
WNW	.008005	.018838	.023359	.017126	.002991	.001119	.071438
NW	.006680	.015025	.019295	.011805	.001690	.000206	.054700
NNW	.006067	.013335	.014112	.008266	.001256	.000091	.943127
Total	.111454	.259465	.337032	.235169	.044344	.012536	

Source: National Climatic Data Center, Weather Station No. 14836 (Lansing, Michigan), Period of Record 1/82-12/86.

Table 5.4.4-3

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	107*	Holy Cross School, Lansing, 1986
TSP-annual geo. mean	75	45	Holy Cross School, Lansing, 1986
SO_2-3-hr	1,300	144*	Eastern High School, Lansing, 1986
SO_2-24-hr	365	99*	Eastern High School, Lansing, 1986
SO_2-annual	80	15	Eastern High School, Lansing, 1986
NO_2-annual	100	34	Osborn High School, Detroit, 1986
CO-1-hr	40,000	23,700*	Stopel Park, Detroit, 1986
CO-8-hr	10,000	10,400*	West Union, Detroit, 1986
O_3-1-hr	235	253*	Lansing, 1986
Pb-calendar quarter	1.5	0.06*	Lansing, 1986

* Highest representative regional value given.

Source: Air Quality Report 1986, Air Quality Division, Michigan Department of Natural Resources.

C. Compliance Status

Of the counties in the region of the Michigan SSC site, the nonattainment or noncompliance status is as follows. All of Calhoun, Clinton, Eaton, Hillsdale, Ingham, Jackson, Lenawee, Livingston, Monroe, Oakland, Shiawassee, Washtenaw, and Wayne counties are in nonattainment status for ozone (O_3). Parts of Calhoun and Monroe counties are in noncompliance with the secondary total suspended particulate (TSP) standard.

Parts of Monroe and Wayne counties are in nonattainment with the primary TSP standard. Parts of Oakland and Wayne counties are in nonattainment with the carbon monoxide (CO) standard (EPA 1985).

D. Proximity to Sensitive Areas

The Michigan SSC site is proposed for a Prevention of Significant Air Quality Deterioration (PSD) Class II area, which allows for moderate growth in air pollutant emissions. The closest PSD Class I area, that permits minimal air quality deterioration is Seney Wilderness. It is 300 mi north of the site.

5.4.4.3 Regional Air Pollution Sources

Air pollution sources in the project vicinity are listed in Table 5.4.4-4, and plotted in Figure 5.4.4-1. The permit for the Michigan State University source is pending.

Table 5.4.4-4

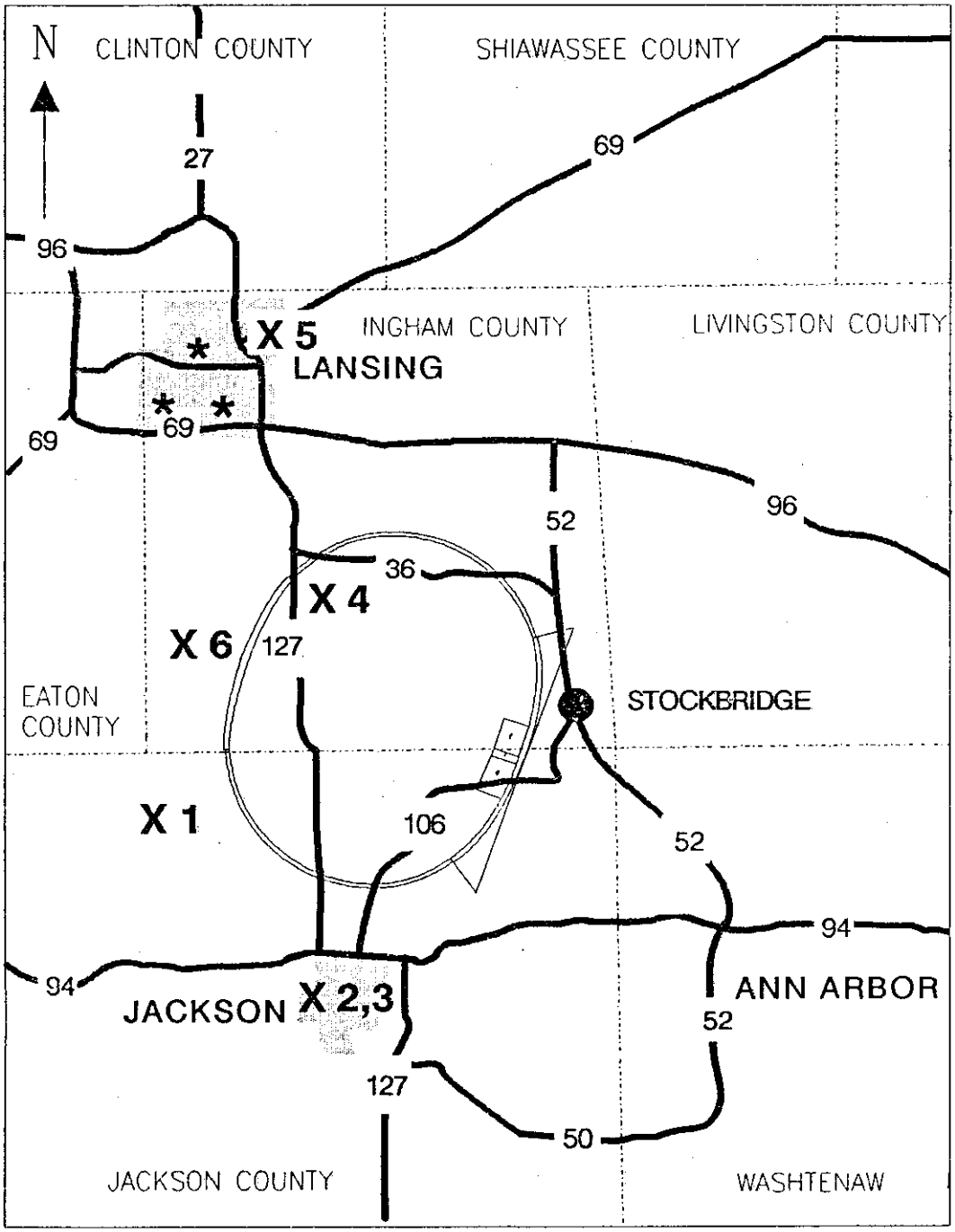
REGIONAL AIR POLLUTION SOURCES
MICHIGAN SSC SITE

Source Name	Location	Permitted or Actual Emissions (ton/yr) TSP	SO_2	NO_x	CO
Speciality Castings Inc.	Springport	98.6	-	-	-
Thompson McCully Co.	Jackson	55.2	698.1	223.0	-
Jackson Board of Public Works	Jackson	11.7	76.7	198.2	245.0
Wyeth Labs	Mason	5.8	197.1	31.8	7.2
Michigan State University	East Lansing	60.4	1,208.9	806.0	403.0
Conoco Aurelius	Aurelius	0.35	12.3	9.9	0.2

Source: Michigan Department of National Resources, Air Quality Division, 1989.

Figure 5.4.4-1

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



X = Air Pollution Source

* = Ambient Air Quality Monitoring Station

5.4.5 Noise and Vibration

This section describes applicable noise and vibration background noise and vibration background conditions at the proposed Michigan SSC site.

5.4.5.1 Ambient Noise Levels

A. Applicable Standards

Applicable noise abatement criteria in the region of the proposed Michigan SSC site have been promulgated by the Federal Highway Administration (FHWA) and the Department of Housing and Urban Development (HUD). FHWA and HUD noise abatement criteria are discussed in Section 5.1.5 of this Appendix. No regulations, other than nuisance ordinances, exist in the state of Michigan.

B. Background Levels

SSC site background noise levels are typical of areas under agricultural use, and measured L_{eq}'s range from 40 to 65 dBA. The day-night sound level (L_{dn}) is expected to average 50 dBA (EPA 1982).

C. Proximity to Sensitive Areas

Sensitive areas in the project locale include hospitals, schools, recreational facilities, churches, cemeteries, and residences. One hospital, six schools, eight recreational facilities, 11 churches, seven cemeteries, and 2,701 residences are located within 2 mi of the service areas. Sensitive noise receptors in the project vicinity are shown in Figure 5.4.5-1.

5.4.5.2 Other Noise Sources

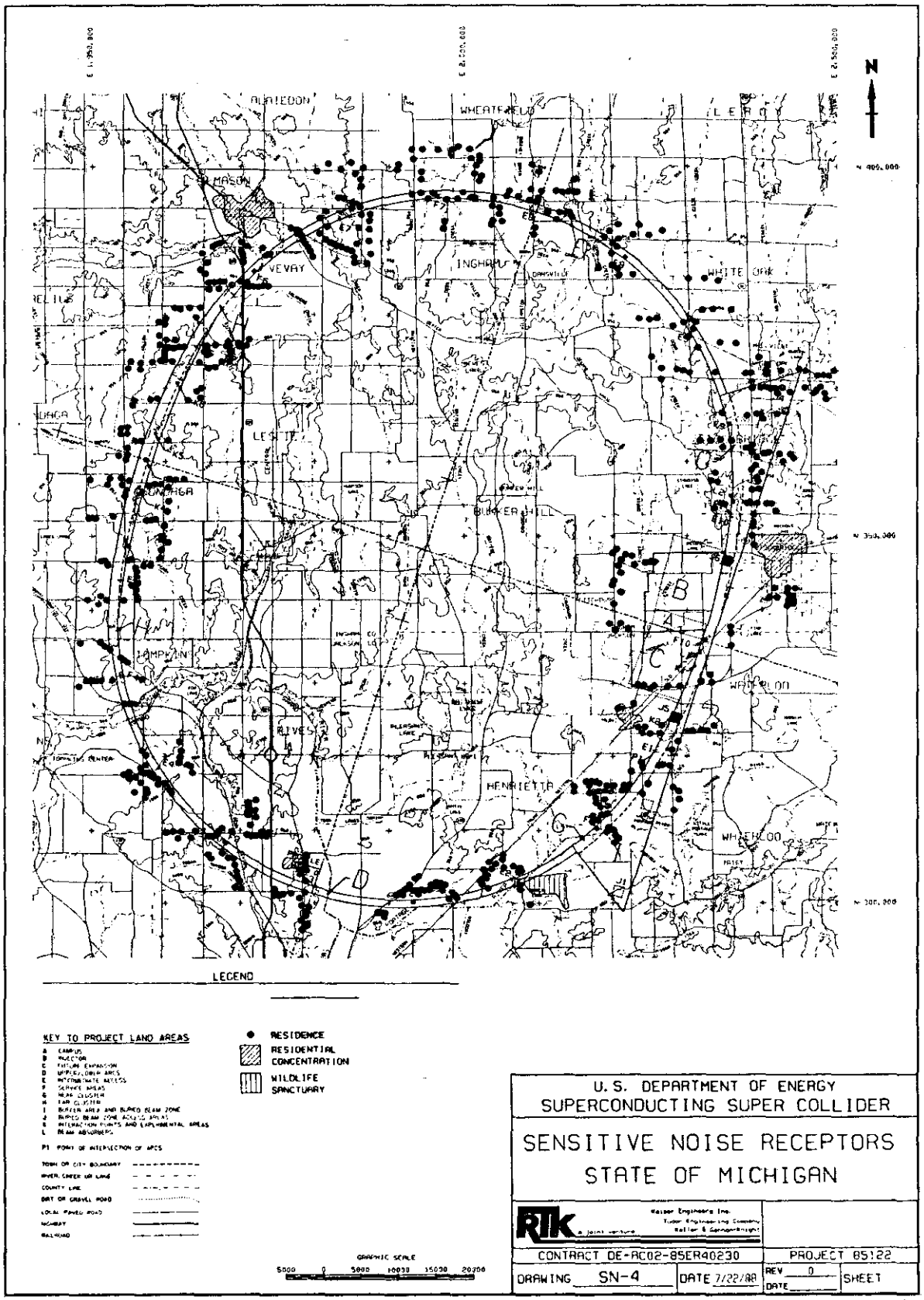
Sources of man-made noise in the region include road traffic, small aircraft, farm machinery. Noise produced by U.S. Highway 127 was measured at a L_{eq} of 57 dBA at a distance of 600 ft. Interstate Highway 94, which is more than 3 mi away from the collider ring at its closest approach, is expected to produce more noise than U.S. 127. Michigan routes 36 and 50 produce noise at approximately the same level as U.S. 127 (University of Michigan 1988). Wildlife is another noise source.

5.4.5.3 Ambient Vibration Levels

Ambient vibration levels in the project vicinity are highly dependent on the proximity to man-made vibration sources. Naturally occurring vibrations, which result from weather phenomena exciting vibrations that travel long distances in the earth, are low frequency. Vibrations from large, distant earthquakes will also produce vibrations at the site.

Figure 5.4.5-1

**SENSITIVE NOISE RECEPTORS
MICHIGAN SSC SITE**



5.4.5.4 Other Vibration Sources

Vibration sources in the region include railroads and highways, and are plotted in Figure 5.4.5-2. The Conrail Railroad crosses the ring at three points and passes within 2.5 mi of interaction point K6. Vibrations produced by the railroad are shown in Table 5.4.5-1 (Woods 1987).

U.S. 127 also crosses the ring at two points, and passes within 8,500 ft of interaction point K6. Vibrations produced by traffic on U.S. 127 were measured in two places, and these values are also shown in Table 5.4.5-1 (Woods 1987).

Figure 5.4.5-2

**REGIONAL VIBRATION SOURCES
MICHIGAN SSC SITE**

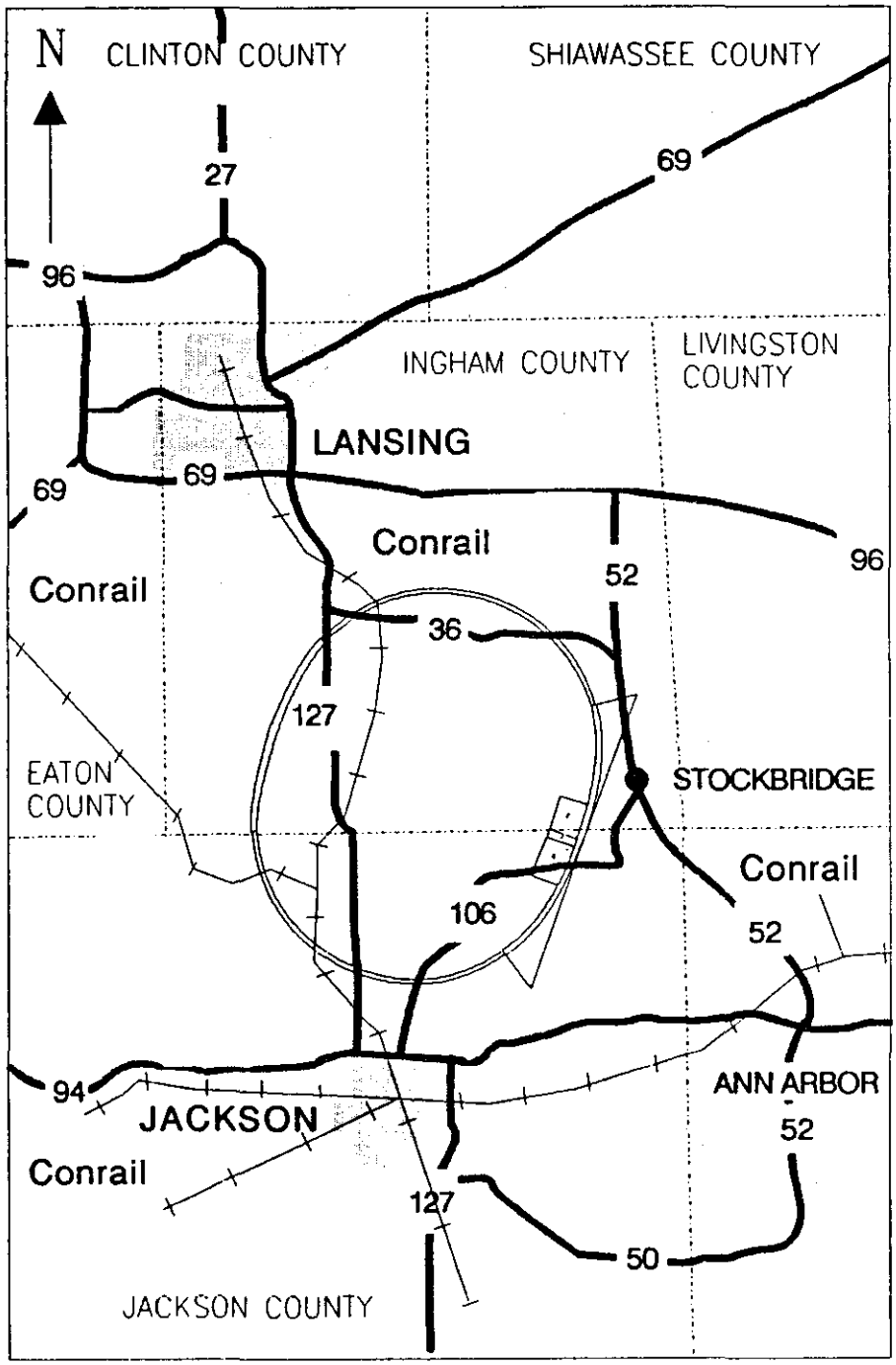


Table 5.4.5-1

REGIONAL VIBRATIONS
MICHIGAN SSC SITE

	Location of Measurement Point Relative to Source		Measured Vibrations			
			Horizontal		Vertical	
	Horizontal	Vertical	Displacement	Frequency	Displacement	Frequency
Source	ft	ft*	inches	Hz	inches	Hz
U.S. 127 (South)	10	0	8.4×10^{-5}	9.4	2.4×10^{-5}	9.5
U.S. 127 (North)	20	0	1.4×10^{-4}	59	2.3×10^{-5}	52
Conrail	25	0	9.7×10^{-4}	29	1.8×10^{-3}	30

* Feet below ground level.

Source: (Woods 1987)

5.4.6 Environmental Radiation

5.4.6.1 Natural Radioactivity

A. Radon

Indoor radon levels reported by the University of Pittsburgh Radon Project and the 1987 EPA National Survey (EPA 1987) are presented in Table 5.4.6-1. The average reported indoor radon levels in Ingham and Jackson residences was 1.80 pCi/l (Cohen 1988).

The Ra-226 concentration at the proposed tunnel depth ranged from 0.17 to 0.62 pCi/g with an average of 0.4 pCi/g (Teledyne 1988).

Uranium possesses an affinity for crude oil and is frequently associated with oil and gas fields. Since the proposed site contains oil and gas wells, the radon contained in natural gas is of significance in calculations of radiation exposure estimates (NCRP 1975).

There are no identified uranium ore deposits in the proposed site.

Four samples of water from the rock strata at the proposed tunnel depth showed Ra-226 concentrations ranging from 1.2 to 2.6 pCi/l with an average of 1.7 pCi/l. Three samples had uranium concentrations ranging from 0.20 to 0.53 pCi/l. A fourth sample yielded a uranium concentration of 14.2 pCi/l for an average of 3.8 pCi/l. Th-232 concentrations varied from less than 0.2 pCi/l to 0.90 pCi/l with an average of 0.5 pCi/l.

No anomalies in radionuclide concentrations were reported.

B. Soil/Rock

A field investigation of radioactivity in the location of the proposed SSC site was conducted in February of 1988. Seven soil samples from various positions along the ring were collected and analyzed (Teledyne, 1988). The samples were analyzed for the following 13 radioisotopes: Ra-226, Th-234, Bi-214, Ac-228, Pb-212, Tl-208, K-40, U-234, Th-230, U-235, U-238, Th-232 and Th-228. Ra-226 concentrations ranged from 0.27 to 1.2 pCi/g with an average of 0.5 pCi/g. U-238 concentrations ranged from 0.075 to 15 pCi/g with an average of 2 pCi/g and Th-232 concentrations ranged from 0.069 to 0.31 pCi/g with an average of 0.11 pCi/g. No anomalies in radionuclide concentrations were reported.

Eleven core samples from various locations around the ring at the proposed tunnel depth were analyzed for the 13 isotopes listed above (Teledyne 1988). The depths of core samples were from 95 ft to 200 ft. The Ra-226 concentration varied from 0.17 to 0.62 pCi/g with an average

Table 5.4.6-1

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	49659	1.76	4.01	80	18	2
Basement	23984	3.37	7.87	59	34	7
Michigan						
Living space	1865	1.33	2.27	89	11	0
Basement	2202	1.93	3.21	83	16	1
Basement/living	498	---	2.71	87	13	0
Ingham County						
Living space	36	1.32	1.82	92	8	0
Basement	22	2.19	2.88	82	18	0
Jackson County						
Living space	13	1.51	1.75	100	0	0
Basement	19	4.00	4.71	47	53	0

Source: Cohen 1988; EPA 1987.

of 0.4 pCi/g. The U-238 concentration ranged from 0.024 to 0.45 pCi/g averaging 0.15 pCi/g. The concentration of Th-232 ranged from 0.26 to 0.52 pCi/g averaging 0.1 pCi/g. None of the soil or rock samples exhibited anomalies in radionuclide concentrations.

C. Water

Four samples each of surface water, groundwater, and rock water (from the proposed tunnel depth) were analyzed for the thirteen isotopes reported above (Teledyne 1988). The surface water Ra-226 concentrations varied from less than 0.7 to 1.8 pCi/l with an average of 1.1 pCi/l. The uranium concentration (U-238 and U-234) ranged from 1.6 to 3.6 pCi/l with an average of 2.6 pCi/l, and Th-232 concentrations varied from less than 0.1 to 0.36 pCi/l with an average of 0.28 pCi/l.

Ra-226 concentrations in three of the four groundwater samples were less than 1 pCi/l. The other sample was reported at 1.2 pCi/l. The concentration of uranium ranged from less than 0.2 to 5.6 pCi/l with an average of 1.9 pCi/l. The Th-232 concentration varied from less than 0.4 to 0.93 pCi/l with an average of 0.47 pCi/l.

D. Measurement 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 this site.

5.4.6.2 Man-Made Radiation

The State of Michigan is not currently an agreement state with the Nuclear Regulatory Commission (NRC) in regulating the uses of radioactive reactor byproduct materials. But all of the facilities in the state that use or process reactor byproducts are regulated by the NRC. There are about 700 locations in the state authorized by the NRC to use or process radioactive byproduct materials. There are about 1,150 locations using/possessing naturally occurring or accelerator-produced radioactive materials (RAM) that are registerable or licensable in accordance with the state legislature, MCL 333.13515 (CRCPD 1987).

In the vicinity of the proposed SSC site, there are 43 facilities that currently possess the NRC licenses to use RAM (NRC 88). Most of the facilities are located in the Jackson and Lansing areas. The primary uses of radioactive sources are medical facilities, industrial facilities, and academic/research 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 that would contribute to national background levels.

A computer search was conducted through the Remedial Action Program Information Center at the Oak Ridge National Laboratory (ORNL), to identify any DOE facility under decommission orders in this area. The only facility nearby is the former Bridgeport Brass Company Special Metal Extrusion Plant located in Adrian, which is about 40 mi southeast of the proposed SSC tunnel. Results of a survey conducted by the ORNL revealed concentrations of U-238 up to 21,000 pCi/g in residue, scale, and other miscellaneous materials collected from the bottom of service pits, service manholes, and holding tanks (Haywood 1982).

5.4.6.3 Background Radiation

Measurements were made in February 1988, with 12 thermoluminescent dosimeters placed at locations around the proposed collider ring and at 1 meter above the surface for a measurement period of 22 days (Teledyne Isotopes 1988). The range of equivalent dose rate measured was from 32 to 94 mrem/yr. This value compares favorably to the value of 89 mrem/yr (Oakley 1972) previously obtained for the average dose equivalent rate caused by terrestrial and cosmic radiation in the State of Michigan.

5.4.7 Nonradioactive Environmental Hazards

5.4.7.1 Hazardous/Toxic Materials

No toxic chemical processing plants, RCRA generators, or CERCLA-listed sites are located within the proposed SSC area.

No sites of known contamination were identified within the SSC corridor, although several known or potentially contaminated sites located more than 1 mi from the corridor have been identified by the State of Michigan and by Ingham County (see Figure 5.4.7-1).

A landfill (Allied-Herguth-Richards) just outside the SSC corridor in Onondaga Township is known to have contaminated the drift aquifer, but local groundwater flow is away from the ring (in a north-northwesterly direction) and contamination should not be present in the proposed corridor (Godbold 1988).

A gas desulfurization plant operated by Petrotech (now UKP Energy in Denver, Colorado) was formerly located on the outside edge of the SSC corridor in Vevay Township. Although the project has been decommissioned and the equipment has been removed, residual soil contamination from spills could be present.

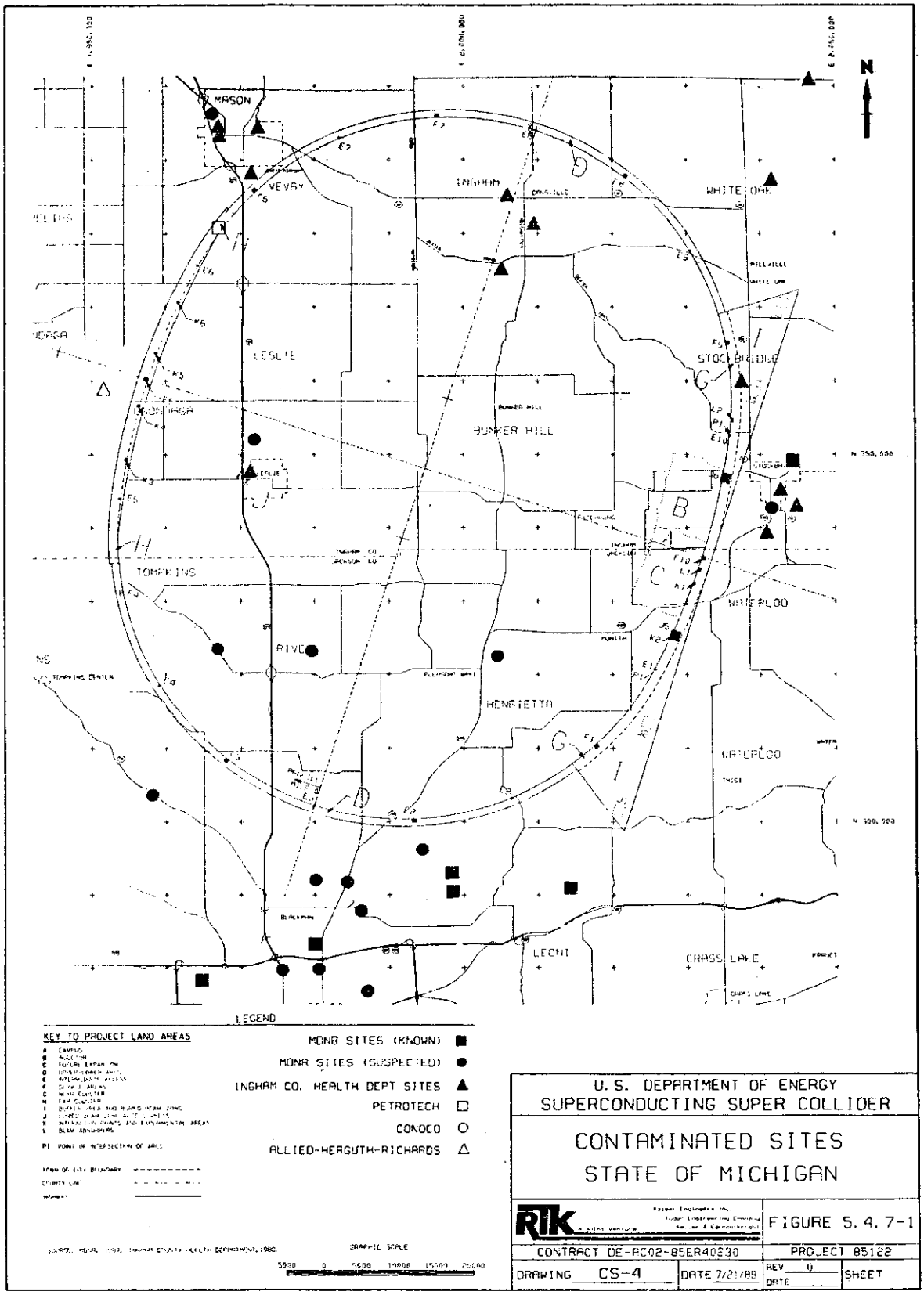
In Aurelius Township, a gas processing plant operated by CONOCO is located less than 2,000 ft from the corridor. This is the only industrial operation within a mile of the SSC ring that involves potentially hazardous materials.

5.4.7.2 Biological Hazards

No biological hazards are known to exist within or adjacent to the proposed site.

Figure 5.4.7-1

LOCATIONS OF KNOWN AND SUSPECTED CONTAMINATED SITES



5.4.8 Existing Waste Management Facilities

5.4.8.1 Sewage Facilities

Figure 5.4.8-1 shows the approximate location of the existing sewage treatment facilities in Michigan. Table 5.4.8-1 provides the plant capacities, shows in which county they are located, what municipality they are in, how far they are from the SSC site, and gives annual current flow rates and excess capacities. Five of the seven wastewater treatment plants in Ingham County (closest to the ring) have excess remaining capacities.

Table 5.4.8-1

EXISTING SEWAGE TREATMENT PLANT CAPACITIES

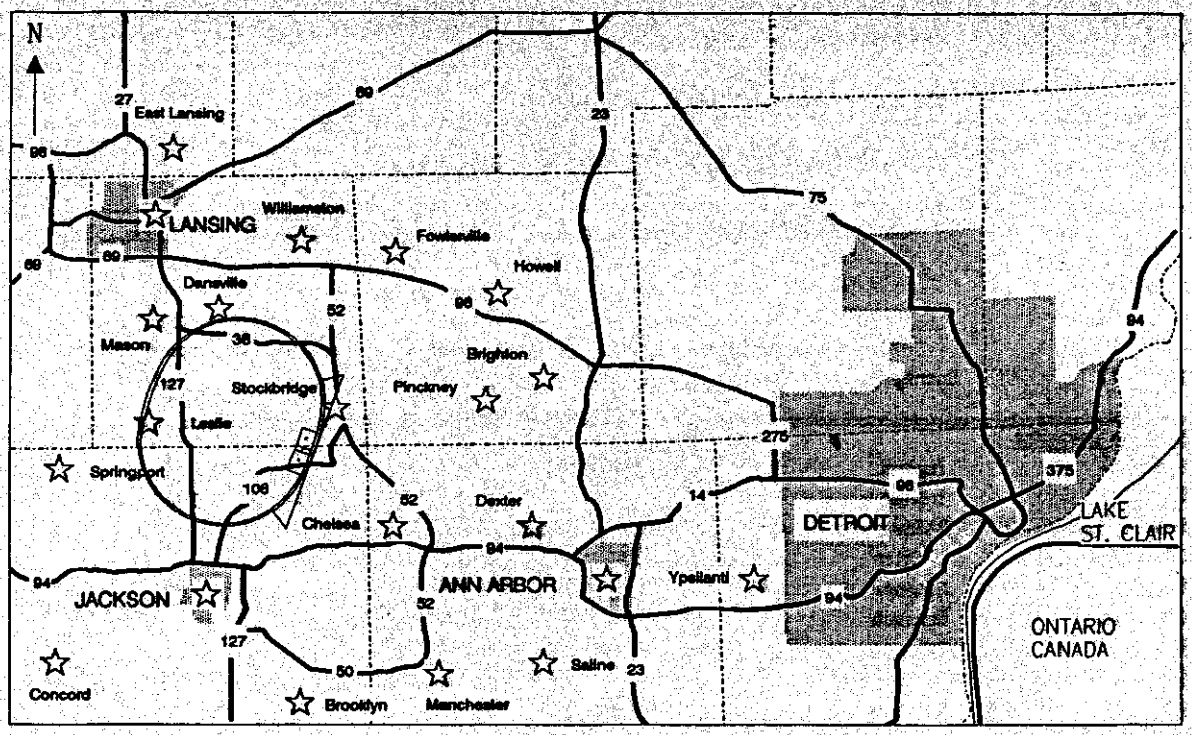
County	Municipality	Approximate Distance from SSC Site mi	Treatment Capacity million gal/d	Actual Average million gal/d	Excess Capacity million gal/d
Ingham	Dansvile	10	0.062	0.027	0.025
	East Lansing	20	18.7	10.6	8.1
	Lansing	30	50.1 (Includes wet-weather flow)	21.7	20.0
	Leslie	10	0.35	0.27	0.08
	Mason	17	1.2	0.9	0.3
	Stockbridge	1	0.15	0.11	0.04
	Williamston[1]	20	0.65	0.36	0.09
Jackson	Brooklyn	25	0.16	0.20	0
	Concord	30	0.12	0.15	0
	Jackson	15	18.8	12.7	6.1
	Springport		0.17	0.054	0.116
Livingston	Brighton	20	1.2	0.8	0.4
	Fowlerville	20	0.8	0.5	0.3
	Howell	17	1.8	0.97	0.83
	Pinkney	10	0.1	0.19	0
Washtenaw	Ann Arbor	20	29.5	18.3	11.2
	Chelsea[2]	10	0.6	0.62	0
	Dexter	13	0.58	0.24	0.34
	Manchester[3]	20	0.37	0.28	0.09
	Saline		2.31	1.25	1.06
	Ypsilanti	30	28.9	13.0	15.9

Notes: 1. Expansion to 0.65 mgd completion date: July 1989
2. Expansion to 0.91 mgd completion date: Jan 1989
3. Expansion to 0.43 mgd completion date: Sept 1989

Source: Michigan Department of Natural Resources, Surface Water Quality Division, 1988

Figure 5.4.8-1

APPROXIMATE LOCATION OF EXISTING SEWAGE TREATMENT PLANTS
IN MICHIGAN SSC REGION



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

Stockbridge, located approximately 1 mi from the campus area, has a primary treatment facility followed by spray irrigation with underdrains discharge to a local stream. Design flow is 150,000 gal/ day, and presently, peak flow is approximately 115,000 gal/day.

5.4.8.2 Solid Waste Facilities

Figure 5.4.8-2 shows the approximate location of the existing sanitary landfills. Table 5.4.8-2 presents the facilities by name, approximate distance from the SSC site, available capacity, and use rate in Ingham, Jackson, Livingston, and Washtenaw counties.

Table 5.4.8-2

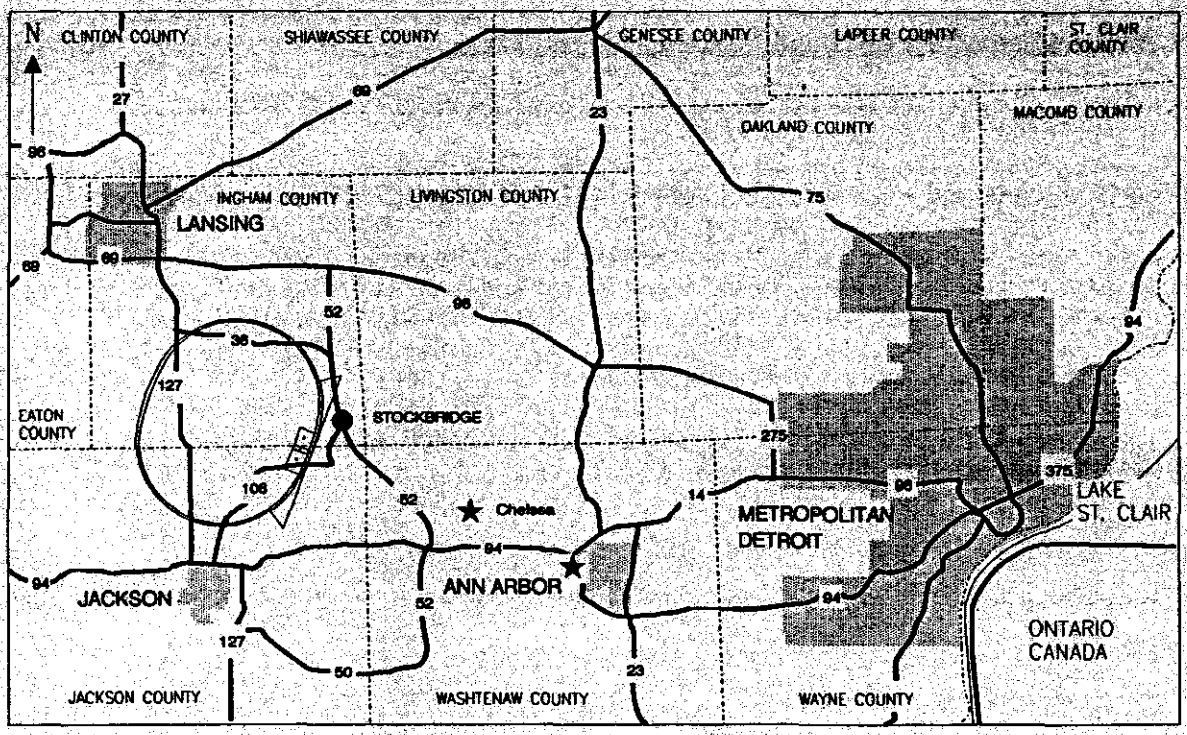
EXISTING SANITARY LANDFILLS

		Type II Landfill			Type III Landfill	
Landfill	County	Approx. Distance from SSC Site mi	Remain. Years	Remain. Capacity Yd^3	Remain. Years	Remain. Capacity Yd^3
Lansing District						
Granger[1]	Ingham	39	17	14,000,000		
Daggett	Ingham	40			4	140,000
Venice Park	Shiawassee	46	14-15	12,000,000		
Granger[2]	Clinton	48	18	18,000,000		
Grand Blanc	Genesee	59	0.5	300,000		
Citizens[2]	Genesee	59	3	2,000,000		
Pollard	Genesee	62	0.5	180,000		
Seymour Road	Genesee	62	4	1,300,000		
Richfield	Genesee	75	3	3-4,000,000		
Jackson District						
Chelsea	Washtenaw	11	5	365,000		
Jackson County	Jackson	25	5	ND		
McGill Road	Jackson	25			ND	400,000
Liberty Road	Jackson	35			ND	500,000
Ann Arbor	Washtenaw	35	1	600,000		
Ann Arbor[2]	Washtenaw	35	10-15	17,000,000		
Arbor Hills	Washtenaw	40	10	28,000,000		
C&C Landfill	Calhoun	50	10-12	ND		
Laidlaw	Lenawee	50	ND	ND		
Detroit District						
Wayne Disp.[3]	Wayne	40	3.5	2,000,000		
Lyon Developm.	Oakland	43	5	1,700,000		
Oakland Disp.	Oakland	47	11.5	2,200,000		
Woodland	Wayne	48	3.5	2,000,000		
City Sand/LF	Wayne	54	4.5	1,700,000		

Notes: ND - No data.
1. As of June 1988.
2. Proposed Expansion.
3. Also licensed for hazardous waste disposal.

Figure 5.4.8-2

APPROXIMATE LOCATION OF EXISTING SANITARY LANDFILL IN MICHIGAN SSC REGION



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

5.4.8.3 Hazardous Waste Disposal Facilities

No treatment, storage, or disposal facilities are located in the proposed SSC area. Currently, only one hazardous waste landfill (Type 1) is licensed to operate in Michigan: Wayne Disposal in Belleville (Wayne County). It is estimated to have only 5 to 7 years of life remaining. However, additions are planned to the facility that would add 10 to 15 years to its life.

5.4.8.4 Radioactive/Mixed Waste Disposal Facilities

Currently there are no commercial low-level radioactive/mixed waste disposal facilities operating in Michigan.

The RAM users in Michigan generated 1,026 m^3 (2,140 curies) of low-level RAM in 1986 as reported by disposal site operators. The commercial nuclear power reactors generated 96.2% by volume of the total low-level radioactive waste (LLRW). The industrial and academic facilities generated 2.6% and 1.2% of the total waste respectively. Utility wastes consisted of spent resins, filter sludges/evaporator bottom (40.25%), dry compressible waste/contaminated equipment (59.67%), irradiated components (0.04%), and other waste (0.03%). Most of the LLRW was Class A (97.8%). Class B and Class C LLRW accounted for 0.6% and 1.6% of the total volume respectively (EG&G 1987).

5.4.9 Ecological Resources

5.4.9.1 Regional Ecological Characteristics

A. Definition of Drainage Basin and Boundaries

The Michigan SSC site is located almost entirely within the Grand River basin, with a small amount of drainage to the upper reaches of the Huron River basin to the east (Figure 5.4.9-1).

B. Relationship of Ecological Resources with Other Resources

Much of the diversity of ecological resources at the Michigan SSC site results from extensive waterways, lakes, and wetlands. Additionally, the presence of a wildlife preserve and state recreation area provides a stable natural environment to support both native flora and fauna.

C. Classification of Ecosystem Types and Distribution

The site is located within a number of ecotypes: forest, agricultural, and several types of wetlands. Both terrestrial and aquatic ecotypes are diverse throughout the vicinity.

The terrestrial ecotypes include:

- Upland and lowland forests and woodlots.
- Agricultural systems, including timber, row crops, orchards, pasture, and rangeland.
- Forested and emergent wetlands.

5.4.9.2 Terrestrial Ecosystem Characteristics

A. Plant Community Composition

Approximately 15% of the project area is forested, half is upland forest; the remainder is lowland forest. About 20% of the site is wetlands.

1. Forests and Woodlands

Distribution and size of significant forested tracts in the area of the Michigan site are shown in Figure 5.4.9-1. There are no climax forests in the site area; only disturbed remnants of the forest remain. Second and third growth woodlots exist on uplands in parcels from a few to about 2,000 acres in size. The remaining lowland forest exists as irregular forest bands along stream channels. Table 5.4.9-1 illustrates forest vegetation types that exist in these two environments in the project vicinity. Table 5.4.9-2 gives a list of commercial tree types and forest acreage by county and dominant tree species.

Figure 5.4.9-1

**SIGNIFICANT FORESTED TRACTS
AT THE PROPOSED MICHIGAN SSC SITE**

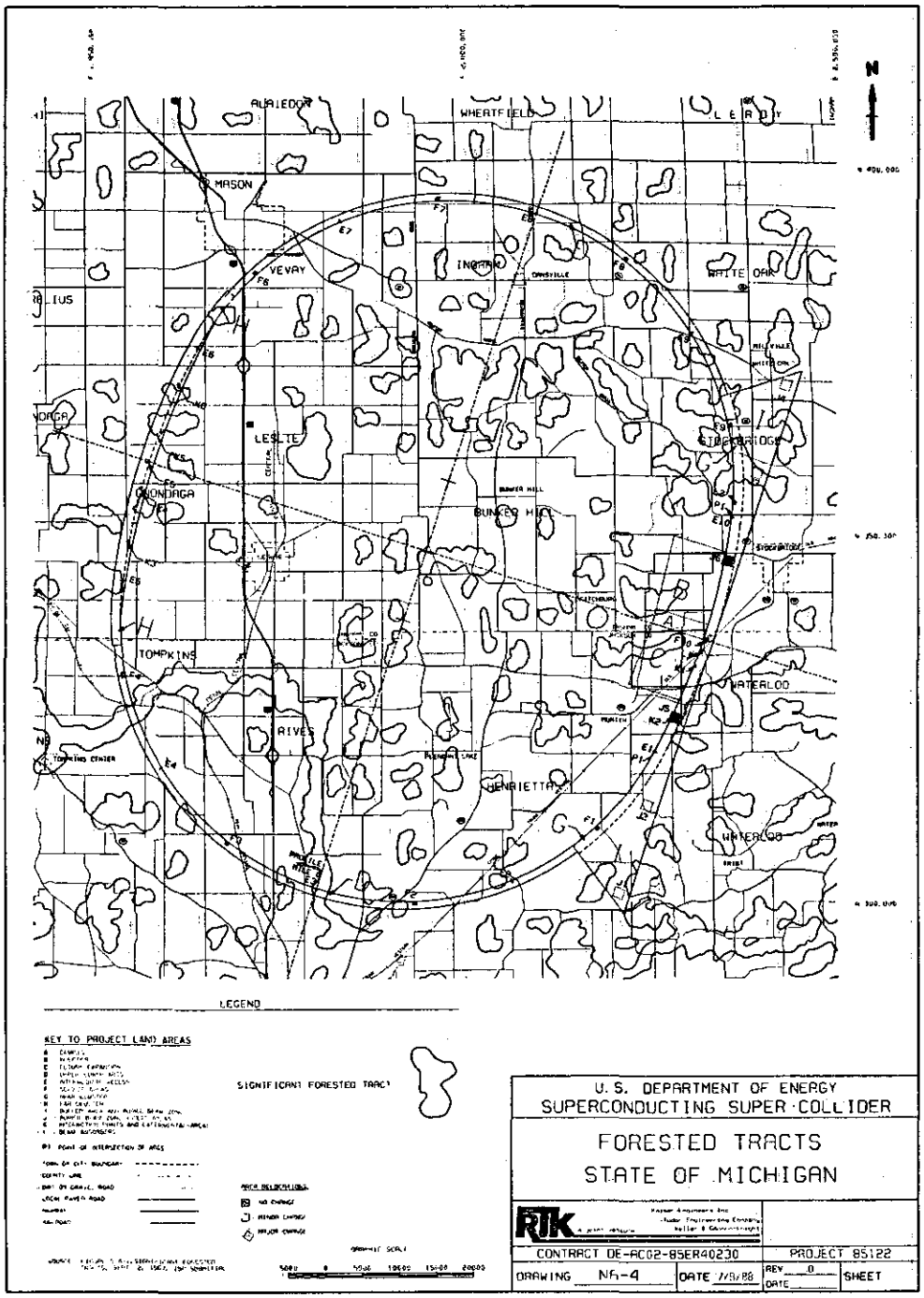


Table 5.4.9-1

FOREST VEGETATION TYPES WITHIN THE MICHIGAN SITE VICINITY

Vegetation Type	Approx. %
Lowland hardwood	51
Upland hardwood	42
Aspen/white birch	3
Pine	2
Other upland conifer	1
Lowland conifer	1

Source: Michigan Department of Natural Resources 1987.

Table 5.4.9-2

COMMERCIAL FOREST LAND - 1980

Tree Types	Jackson County Acres	Ingham County Acres
Maple-birch	33,200	28,200
Oak-hickory	35,800	3,400
Elm-ash-soft maple	11,800	5,400
Aspen	0	5,100
Exotic	2,600	9
TOTAL	83,400	42,109

Source: U.S. Forest Service 1982 and 1983.

a. Upland Forests

The dominant species in the upland forests are white oak, black oak, red oak, pignut hickory, shagbark hickory, and white ash. The shaded understory is populated with hophornbeam and flowering dogwood with openings of witch hazel and downy serviceberry. Open disturbed areas, such as old fields and roadsides, provide a habitat for black cherry and red cedar.

Elevated areas with drier, coarse sandy soils are favored by the oak-hickory forest type. Sugar maple, beech, black walnut, tulip tree,and butternut hickory grow in association with the oak-hickory species on more mesic sites, at lower elevations and in loamy soils.

b. Lowland Forests

Lowland forests are found in long bands along floodplains, stream terraces, and swales on wet or moist soils. Dominant species are eastern cottonwood, black willow and peach willow on wet and silty stream banks; silver maple, black maple, red maple, pin oak, American elm, and slippery (red) elm and ash on periodically flooded stream terraces; black walnut, tulip tree, butternut, and sycamore on moist fertile deep soils that are infrequently flooded; and boxelder, sumac, and ash on all types of wet, mesic sites. Lowland forest lots can be found up to 1,000 acres in size.

2. Agricultural Systems

Timber production is summarized in Table 5.4.9-3. In Jackson and Ingham, the two counties encompassing the Michigan site, timber is used almost entirely for sawlogs, which are subsequently cut into hardwood lumber. Small amounts of softwood timber and veneer peeler logs are produced. Pulpwood is not harvested in this area. Within Jackson and Ingham counties, a total of 125,500 acres were devoted to commercial forest land in 1980 (U.S. Forest Service 1982 and 1983).

Corn for grain is the predominant crop grown in the area. Other major crops include winter wheat, soybeans, and corn for silage. Table 5.4.9-4 lists the average annual acres harvested over the 10-year period from 1977-1986. Soybean and barley show an increasing trend in acreage harvested over the study period. Winter wheat and fall potatoes (studied from 1979-1986) show a slight increase in acreage harvested. There was a slight decrease in acreage devoted to corn for grain, corn for silage, oats, and dry beans (MI Agricultural Statistics Service 1978-1987).

Hay and other silage crops are primarily grown for local use by livestock producers. Approximately 30,000 acres is devoted to these forage crops annually.

Table 5.4.9-3

TIMBER PRODUCTION FROM COMMERCIAL FOREST LAND - 1980 (Millions of Board Feet)

Category	Jackson County	Ingham County
White oak	2,236	847
Red oak	1,990	1,387
Hickory	308	210
Yellow birch	3	0
Hard maple	481	768
Soft maple	1,205	908
Beech	156	160
Ash	551	332
Cottonwood	4	100
Aspen	10	16
Basswood	122	264
Black walnut	151	19
Elm	26	77
Paper birch	47	0
Other hardwoods	422	151
TOTAL	7,712	5,239

Source: U.S. Postal Service 1982.

Table 5.4.9-4

CROP STATISTICS FOR JACKSON AND INGHAM COUNTIES

Crop	Average Annual Acres Harvested 1977-1986
Grain corn	153,510
Winter wheat	33,070
Soybeans	24,512
Silage corn	19,571
Oats	11,800
Dry beans	2,566
Barley	225
Fall potatoes	197
TOTAL	245,451

Source: MI Agricultural Statistics Service 1978-1987.

Vegetable crops are grown on scattered small acreage locations throughout Jackson and Ingham counties. Drained muck soils provide a suitable medium for growing onions, carrots, peppers, cabbage, pickling cucumbers, muskmelon, squash, processing and table tomatoes, and sweet corn. Acreages farmed remain fairly constant; however, changes do occur in the crop selected for production, based on market forecasts.

Fruit crops are grown primarily in the upland mineral soils on small acreages. The principal fruit crop is apples; although small amounts of peaches, cherries, blueberries, plums, prunes, and pears are also produced. Mint and sod are grown exclusively in muck soils in the site vicinity as specialty crops.

3. Wetlands

The general distribution of major wetlands is shown in Figure 5.4.9-2. Almost all of the wetlands present in the site vicinity show some evidence of disturbance.

Wetlands located within proposed surface facility locations are detailed in Table 5.4.9-5. Wetlands present in the proposed campus/injector/future expansion areas are indicated in Figure 5.4.9-2.

a. Forested Wetlands

Forested wetlands are dominated by two types of flora: deciduous tree species and shrub species. Dominant deciduous species include red maple, black ash, yellow birch, American elm, silver maple, and American hornbeam. Shrub species, such as buttonbush, sandbar willow, dogwood, and immature tree species, predominate in shrub wetlands.

b. Emergent Wetlands

There are three types of emergent wetlands present in the Michigan site vicinity. Each has its own characteristic set of species that distinguishes it from other emergent wetlands. The marsh wetlands are vegetated by numerous herbaceous species such as cattails, burreed, sedges, rushes, bulrushes, spikerushes, nutgrass, horsetails, arrowhead, and smartweed. The wetland meadow is vegetated by species similar to the marsh wetland. In addition, wet meadows host grasses such as reed canary grass, red top, and cutgrass. Bog wetlands also have vegetation similar to that found in the marshes. In addition, tamarack, leatherleaf, pitcher plant, and sundew occur in these areas.

Figure 5.4.9-2

GENERAL DISTRIBUTION OF WETLANDS IN THE MICHIGAN SITE VICINITY

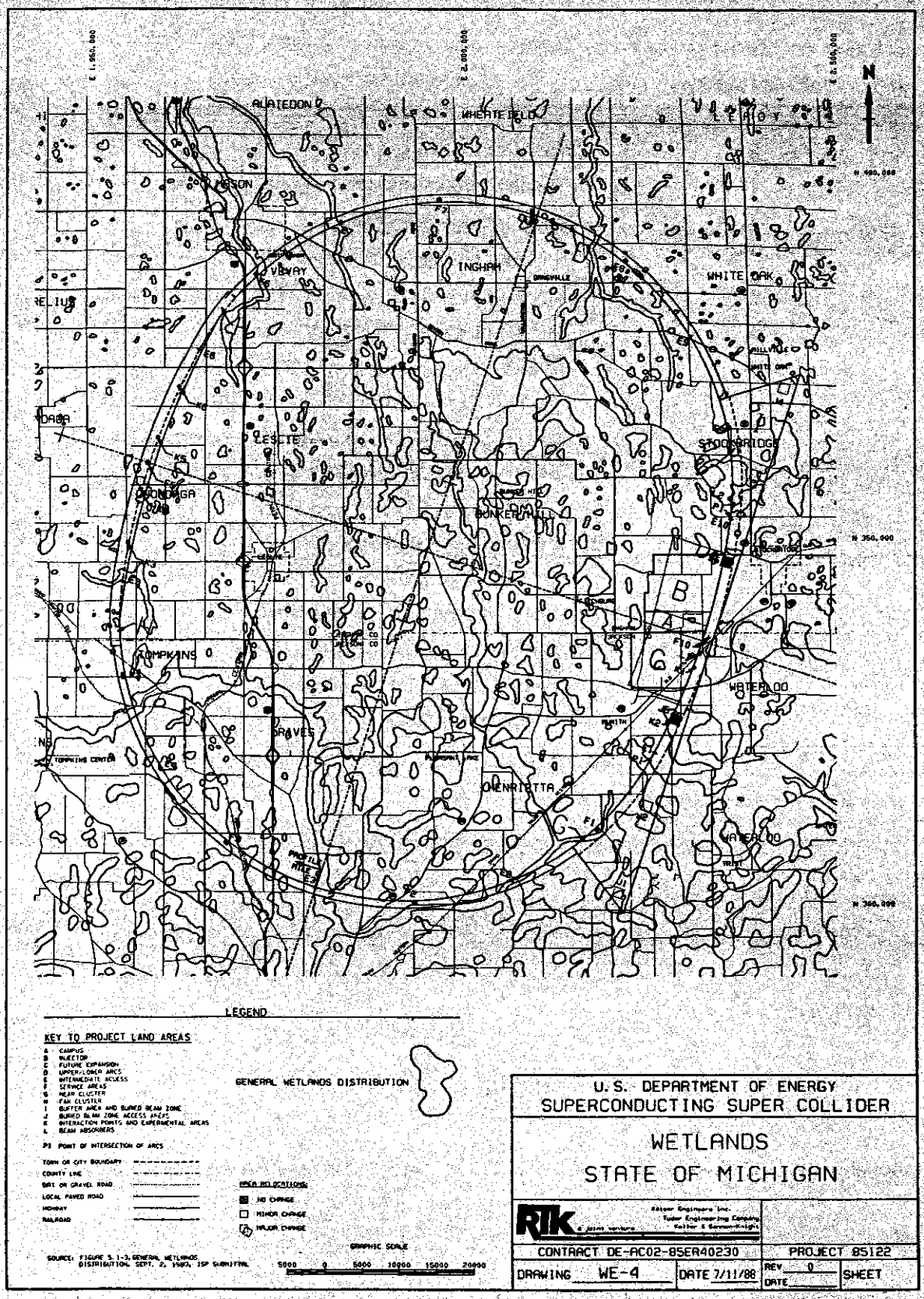


Table 5.4.9-5

WETLANDS WITHIN PROPOSED SURFACE FACILITY LOCATIONS

Area	Wetland Type	Extent
E1	B	Very small presence
	C	Through SW portion
E5	B	Very small presence
	C	Northwestern portion
E7	A	Through center of location
F1	A	Large presence throughout
J2	A	Small presence, SE corner
	C	Very small presence, SE corner
J3	A	Small presence, SW corner
	B	Several isolated pockets
	C	Small presence
J5	A	Extends throughout
	C	Center of location
J6	A	Small presence, NE corner
	C	Small presence, E portion
K2	A	Large presence
K4	A	Western portion

Note: A. Palustrian emergent or scrub-shrub emergent wetlands.
B. Palustrian open water wetlands.
C. Palustrian forested, scrub-shrub or forested scrub-shrub wetlands.

Source: Department of Interior 1988.

B. Animal Community Composition

Terrestrial consumer communities are diverse and widespread reflecting the diversity and discontinuity of cover types in the vicinity.

1. Wildlife

Abundant and diverse wildlife habitats exist in the vicinity of the Michigan site. Much of this diversity comes out of the areas set aside for wildlife development. The Dansville State Game Area and the Waterloo Recreation Area both support large wildlife populations. As can be seen from Figure 5.4.9-1 and 5.49-2, these are primarily wetland areas within the Grand River Basin, with areas of lowland hardwood forest along stream channels. Species associated with these habitat types, along with their predators, compose the wildlife populations within the proposed site and vicinity.

Numerous waterfowl make the Michigan site their home. Some of the waterfowl species commonly observed in the area are the greater sandhill crane and great blue heron, classified as unique and special interest species by the U.S. Forest Service, along with several species of bittern, coots, ducks and rail. Many small songbirds are also evident, as are small mammals, including several species of moles, shrews, and boles. Four species of bats inhabit Jackson and Ingham counties. Coyotes, weasels, mink, woodchucks, muskrats, skunks, and raccoons are the primary predators, with small populations of bobcats and badger. Oppossum are widespread, and beaver are found in more secluded wooded stream channels. Table 5.4.9-6 for a complete species list of mammals found within proposed site and its vicinity. Many of the species associated with the wetland and lowland hardwood forest are game species, which are discussed in Section 5.4.9-4.

2. Livestock

Beef and milk cattle, lambs, hogs, pigs, laying hens, and fryers are raised in large numbers in Jackson and Ingham counties. Table 5.4.9-7 lists the average annual livestock production for the counties between 1978 and 1987. Annual milk production averaged 236 million lb between 1978 and 1987 (MI Agricultural Statistics Service 1978-1987).

During the study period 1978-1987, a slight decrease was noted in the number of head of milk cows, sheep, and lambs. Beef cow, hen, and pullet production remained virtually static. A slight increase was observed in milk production. The largest change was in hog and pig production, where a sharp increase was observed over the study period (MI Agricultural Statistics Service 1978-1987).

C. Ecosystem Level Processes

Disturbance of land/wetland surface flora and fauna are followed by rapid revegetation during the growing season in Michigan due to the availability of nutrients and rainfall. Typically, however the plants and animals

Table 5.4.9-6

SPECIES LIST: MAMMALS AND SOME BIRD SPECIES OF MICHIGAN SITE VICINITY

Mammals

Common Name	Scientific Name
Badger	Taxidea taxus taxus
Beaver	Castor canadensis
Cottontail rabbit	Sylvilagus floridanus
Coyote	Canis latrans
Grey Fox	Vulpes cinereoargenteus
Hoary bat	Lasuirus cinerus
Least shrew	Cryptotis parva
Least weasel	Mustela rixosa
Little brown bat	Myotis lucifugus
Long-tailed weasel	Mustela frenata
Masked shrew	Sorex cinerus
Meadow vole	Microtus pennsylvanicus
Mink	Mustela vison
Muskrat	Odatra zibethica
Oppossum	Dipelphis virginiana
Pine vole	Pitymys pinetorum
Prairie mole	Scalopus aquaticus
Raccoon	Procyon lotor
Red bat	Lasuirus borealis
Red Fox	Vulpes fulva
Short-tailed shrew	Blarina brevicauda
Silver-haired bat	Lasionycteris noctivagans
Star-nosed mole	Condylura cristata
Striped skunk	Mephitis mephitis
White-tailed deer	Odocoileus virginianus
Woodchuck	marmota monax

Birds

Common Name	Scientific Name
American bittern	
Black duck	Anas rubripes
Blue-winged teal	Anas platyrhynchos
Bobwhite quail	Colinus virginianus
Canvas-back duck	Aythya vahsineria
Common coot	Fulica americana
Least bittern	
Prairie chicken	Tympanuchus cupido
Redhead duck	Aythya americana
Ring-neck pheasant	Phasianus colchicus
Ruffed grouse	Bonasa unbellus
Sandhil Crane	Grus canadensis
Sharptailed grouse phasianellus	Pedioecetes
Wood duck	Aix sponsa

Sources: State of Michigan Department of Natural Resources 25th Biennial Report 1969-1970; Martin, A.C. et al. 1951. American Wildlife and Plants.

that recolonize represent succession to a different general habitat type than was there before because of disturbance-altered soil microclimate conditions and/or altered surface water characteristics. Successful reclamation of previous habitat associations requires attention to providing these necessary substrate conditions. This is particularly true in wetlands recovery.

Table 5.4.9-7

LIVESTOCK STATISTICS FOR JACKSON AND INGHAM COUNTIES

Livestock Class	Average Annual Livestock Production 1978-1987
All hens and pullets	75,840[a]
All hogs and pigs	43,700[a]
Milk cows	18,440
All sheep and lambs	11,630
Beef cows	8,620

a. 1979-1986 averages.

Source: MI Agricultural Statistics Service, 1978-1987.

5.4.9.3 Aquatic Ecosystems

A. Lotic Ecosystems

Warmwater fish communities are present in the rivers of the site vicinity. A listing of the various rough, forage, and sport fish species present in the Grand River is given in Table 5.4.9-8. The major stream fisheries in the project vicinity are located on the Grand River, primarily below the project site, on the Red Cedar River north of the project area, and on the Huron River to the east. These streams are all considered top quality warmwater mainstreams by the Michigan Department of Natural Resources in that they contain good self-sustaining populations of warmwater game fish and are readily fishable. Lower Sycamore Creek, in the project area, is another good warmwater sportfishing stream, that reportedly offers good northern pike fishing. (MI Department of Natural Resources 1988).

These are no steams in the site area that contain self-sustaining populations of trout or salmon. However, a few small streams in the area have enough groundwater influx to provide suitable temperatures for brown trout, which can be maintained by stocking. Streams of the site area where this is done include: Mackey brook, Sandstone, Columbia, and Trist creeks. Each of these streams is distant from planned SSC facilities. Several streams of the area support spring and fall runs of anadromous fish (salmonids). Installation of fish ladders at five dams below the SSC project area (early 1980's) has resulted in the establishment of salmon runs, primarily coho salmon, from Lake Michigan up the Grand River, which extend on the mainstream as far as Moores Park Dam in Lansing. Access to the lower Red Cedar River from below Moores Park Dam is unimpeded, and some migrants have been reported in Sycamore Creek, a Red Cedar creek tributary that drains a portion of the proposed ring area. Long range plans of the Michigan Department of Natural Resources include the possible extension of such runs upstream on the Grand River to Eaton Rapids and introduction of long running anadromous strains (Michigan Department of Natural Resources 1988).

Several aquatic species designated as rare by the state of Michigan are present in the area. These species are discussed in section 5.4.9.5.

B. Lentic Ecosystems

Most of the lentic, or standing water communities in the area are associated with wetlands and will be discussed with this section in 5.4.9.6.

5.4.9.4 Economically, Recreationally, and Culturally Important Species

The vicinity of the Michigan SSC site has numerous species that are recreationally important. Inland sport fisheries are located throughout the region. Species managed in these fisheries include largemouth bass, northern pike, bluegill, crappie, yellow perch, walleye, salmon, and rainbow trout. The major stream fisheries in the site vicinity are along the Grand River. Sport fishing species found in the Grand River are listed in Table 5.4.9-8. Lower Sycamore Creek also supports warm-water sport fishing.

Table 5.4.9-8

FISH OF THE GRAND RIVER IN THE VICINITY OF THE MICHIGAN SITE

Common Name	Scientific Name	Category
Mud pickerel	Esox americanus	Sport
Northern pick	Esox Cucius	Sport
Brown bullhead	Ictalurus nebulosus	Sport
Yellow bullhead	Ictalurus natalis	Sport
Bullhead spp.	Ictalurus spp.	Sport
Channel catfish	Ictalurus punctutus	Sport
Smallmouth bass	Micropterus dolomeui	Sport
Largemouth bass	Micropterus salmoides	Sport
Warmouth	Lepomis gulosus	Sport
Longear sunfish	Lepomis megalotis	Sport
Green sunfish	Lepomis cyanellus	Sport
Pumpkinseed	Lepomis gibbosus	Sport
Bluegill	Lepomis macrochirus	Sport
Rock bass	Ambloplites rupestris	Sport
Black crappie	Pomoxis nigromaculatus	Sport
Yellow perch	Perca flavescens	Sport
Golden redhorse	Moxostoma erythrurum	Rough
Black redhorse	Moxostoma duquesnei	Rough
Greater redhorse	Moxostoma valenciennesi	Rough
Redhorse spp.[a]	Moxostoma spp.	Rough
Hog sucker	Hypentelium nigricans	Rough
White sucker	Catostomus commersoni	Rough
Carp	Cyprinus carpio	Rough
Creek chub	Semotilus atromaculatus	Forage
Hornyhead chub	Nocomis biguttata	Forage
Common shiner	Notropis cornutus	Forage
Spotfin shiner	Notropis spilopterus	Forage
Striped shiner	Notropis Chrysocephalus	Forage
Sand shiner	Notropis stramineus	Forage
Bluntnose	Pimephales	Forage
Stoneroller	Campostoma anamalus	Forage
Blackside darter	Percina maculata	Forage
Johnny darter	Etheostoma nigrum	Forage
Rainbow darter	Etheostoma caeruleum	Forage
Central mud minnow	Umbra limi	Forage

a. May also include Silver redhorse (M. anisurum), Northern redhorse (M. macrolepidotum), all collected elsewhere on the Grand River.

Source: Nelson and Smith, 1981.

Game species that are common in the area include cottontails, white-tailed deer, waterfowl, and fox squirrels. Other species frequently hunted include ring-necked pheasant, bobwhite quail, wild turkey, woodcock, and ruffed grouse. Commonly hunted waterfowl include wood ducks, mallards, blue-wing teal, and Canada geese. Muskrat, mink, raccoon, red fox, coyotes, opossum, and woodchuck are frequently trapped or hunted in the area.

Bird and wildlife observation are on economic resource in the area. Waterfowl nesting habitats are common to the protected lands such as Dansville, Waterloo, and Haehnle. Observation of sandhill cranes and of the great blue heron rookeries are special resources.

Jackson and Ingham counties together account for 7% of Michigan's equine population. A wide variety of racing, show, and pleasure horses are raised in the area.

5.4.9.5 Threatened and Endangered Species

A. Federally Listed and Candidate Species

No federally listed plant or animal species is known to be present or to frequent the immediate area of the SSC site. No critical habitat as designated by the U.S. FWS is present in the area. One Category 2 plant species, kitten tails (*Besseya bullii*) is known to occur in two locations in Jackson County.

The Indiana bat (*Myotis sodalis*), an endangered species, may migrate to the southern Michigan area during spring and summer to form nursery colonies in riparian and floodplain forests along streams and rivers. There is no designated critical habitat within the proposed site vicinity. (Department of Interior 1988).

Several other special status animals, particularly highly mobile species, may occur occasionally in the project area. Federally protected species in this category include the bald eagle, Kirtland's warbler, piping plover, and loggerhead shrike. Known nesting sites for these species in Michigan are all remote from the SSC project area (MI Department of Natural Resources 1987).

B. State Listed Species

Twenty-five species of plants that exist in Jackson and Ingham counties are listed as special status by the state of Michigan (Table 5.4.9-9). All are listed as threatened except three. The prairie fringed orchid (*Platanthera leucophaea*) is listed as endangered. Two other species, fire pink (*Silene virginica*) and log sedge (*Carex decomposita*), are both listed as "threatened if not extirpated."

Table 5.4.9-9

MICHIGAN SPECIAL STATUS PLANT SPECIES FROM THE SSC VICINITY

Scientific Name	Common Name	Status
Diarrehna americana	Beak grass	Threatened
Poa paludigena	Bog bluegrass	Threatened
Carex typhina	Cattail sedge	Threatened
Helianthus mollis	Downy sunflower	Threatened
Valeriana ciliata	Edible valerian	Threatened
Aristida necopina	False arrow feather	Threatened
Silene virginica	Fire pink	Threatened, if not extirpated
Panax quinquefolius	Ginseng	Threatened
Hydrastis canadensis	Golden-seal	Threatened
Besseya bullii	Kitten-tails	Threatened
Panicum leibergii	Leiberg's panic-grass	Threatened
Carex decomposita	Log sedge	Threatened, if not extirpated
Muhlenbergia richardsonis	Mat muhly	Threatened
Sporobolus heterolepis	Prairie dropseed	Threatened
Platanthera leucophaea	Prairie fringed orchid	Endangered
Arabis perstellata	Prairie rock-cress	Threatened
Carex crus-corvi	Raven's-foot sedge	Threatened
Scutellaria parvula	Small skullcap	Threatened
Eleocharis caribaea	Spikerush	Threatened
Asclepias hirtella	Tall green milkweed	Threatened
Eupatorium sessilifolium	Upland boneset	Threatened
Baptista lactea	White or prairie false indigo	Threatened
Cypripedium candidum	White lady-slipper orchid	Threatened
Platanthera ciliaris	Yellow or orange-fringed orchid	Threatened
Scleria triglomerata	Tall nut-rush	Proposed special concern
Scirpus clintonii	Clinton's bulrush	Proposed special concern
Polygala cruciata	Cross-leaved milkwort	Special concern
Juncus biflorus	Two-flowered rush	Special concern
Gymnocladus dioicus	Kentucky coffee tree	Special concern
Eleocharis engelmannii	A spike rush	Special concern
Celtis tenuiflora	Dwarf hackberry	Special concern
Carya laciniosa	Big shellbark hickory	Special concern
Carex subimpressa	A sedge	Special concern
Angelica venenosa	Hairy angelica	Proposal special concern

Source: MI Department of Natural Resources 1987; Michigan National Features Inventory 1987.

Several animal species designated with special status by the State of Michigan may be located on the proposed site. Mitchell's satyr (Neonympha mitchellii) and the least shrew (Cryptotis parva) are both classified as threatened species. The king rail (Rallus elegans) is classified as threatened. Two fish species, black red horse (Moxostoma duquesii) and greater redhorse (Moxostoma valenciennesi) are listed as rare in Michigan.

5.4.9.6 Unique Ecosystems and Communities Potentially Affected

A. Statutorily Protected Areas

One 40-acre tract of black spruce receives special protection and study at the Waterloo Recreation Area. Other plants in the vicinity common to the sphagnum bogs of the area are also protected at the recreation area (Michigan DNR 1977).

B. Unique Communities

There are several unique communities in the vicinity of the Michigan site. Both the Waterloo Recreation Area and the Haehnle Wildlife Sanctuary contain numerous unique communities. A unique dry, mesic southern forest is located near the recreation area. An unusual wetlands bog is located in the recreation area. A good example of a marsh habitat is present at the Haehnle Wildlife Sanctuary.

A state champion pignut hickory tree (Carya glabra), largest and oldest known to occur in the State, is located on or near Area B of the proposed collider alignment.

C. Marginal Range Association and Transition Zones

Transitional zones exist throughout the Michigan site because of the diversity of ecotypes. Transition zones that can be expected in the vicinity include:

- Agricultural/woodlands
- Agricultural/wetlands
- Woodlands/wetlands
- Urban/agricultural
- Urban/woodlands
- Urban/wetlands.

D. Prime Farmlands, Wildlife Refuges, and Other Management Areas

The Dansville State Game Area is located within the proposed ring. Waterloo State Recreation Area and Haehnle Wildlife Refuge, operated by the Audubon Society, are both located on the southeast boundry of the proposed site. Several other, smaller areas of particular ecological interest are in the vicinity of the Michigan site.

Prime farmland is further discussed in Section 5.4.10.

5.4.10 Land Resources

5.4.10.1 Regional Setting

A. Jurisdictional Setting

The proposed Michigan site is located approximately 50 mi west of Detroit in an area bounded by Lansing on the north, Jackson on the south, and Ann Arbor on the east, in portions of southeastern Ingham and northeastern Jackson counties. Those portions of the two counties in which the SSC project is located encompass 13 townships and are largely unincorporated land. The county seats of each jurisdiction and the year of respective establishment are as follows: Mason, Ingham County (1829), and Jackson, Jackson County (1829) (Kane 1972). The area of each jurisdiction is listed below:

County	Area mi^2
Ingham	560
Jackson	705
Total	1,265

The SSC project is situated in areas that are represented by the following federal, state, and local elected officials (Michigan Legislative Council 1987):

- United States Senate
  Carl M. Levin
  Donald W. Riegle, Jr.

- United States House of Representatives
  Carl D. Pursell, 2nd District
  Bob Carr, 6th District

- State Senate
  Nick Smith, 19th District
  William A. Sederburg, 24th District

- State House of Representatives
  Philip E. Hoffman, 23rd District
  Debbie Stabenow, 58th District

- Ingham County Board of Commissioners

- Jackson County Board of Commissioners

B. Ownership Patterns

Land ownership in the SSC project two-county area is predominantly private, with notable exceptions being the 4,200-acre Dansville State

Game Area in Ingham County; and the 18,027-acre Waterloo State Recreation Area and Michigan State Department of Corrections land holdings in Jackson County. There are also some small scattered state and local government holdings in the area. Aside from these exceptions, a pattern of predominantly private ownership is consistent with land ownership patterns of southcentral Michigan.

C. Historic Land Uses

The growth of south central Michigan is linked intimately to its geologic/geographic setting. Ancient geologic forces and later glaciation processes gave the region the following attributes: 1) a thick bedrock that includes sandstone and limestone, useful as building materials and as the raw material in cement; 2) layers of impermeable clay that create a high water table; 3) a lowlands environment that supports agriculturally rich soils; 4) lakes interspersed among glaciated-caused landforms, such as moraines, esker hills, rolling till plains, and glacial outwash channels, that serve as important recreational resources, like the Waterloo State Recreation Area; and 5) drainages, such as the Grand River, the River Raisin, and the Kalamazoo River, all of which have their headwaters located in various portions of Jackson County. These features were recognized by prehistoric peoples as conducive to habitation (see Section 5.4.12).

European-type settlements first appeared in the region in the late 1820s and 1830s as part of the settling of the Northwest Territory. The area's two oldest population centers are Jackson and Lansing which developed along roughly parallel tracks. Jacksonbourgh was founded in 1828 by Horace Blackman, who purchased 160 acres along the banks of the Grand River and settled there. A post office was established in 1830; its first newspaper was started in 1837; and the first railroad tracks were laid in 1844. By 1850, the city shortened its name to the present one, and the Republican Party was formed in the city "under the oaks" on July 6, 1854 (Jackson County Commission n.d.).

The City of Lansing was founded in 1847 as a result of the State Legislature selection of Lansing Township, Ingham County as the newly designated State Capital. The selection was made for purely geographic reasons, given its central location to all parts of the state. The Lansing area grew quickly as evidenced by the following major milestone accomplishments: 1) the 1855 founding of the nation's first land grant college, Michigan Agricultural College, which became Michigan State University; 2) the 1863 laying of railroad track that connected Detroit, Lansing and Milwaukee together; and 3) the 1880 production of a one horsepower, stationary boiler engine by Pliney Olds, that later became the hub for a major automobile manufacturer (Lansing Regional Chamber of Commerce 1985)). As the automobile industry grew, the Detroit-Lansing-Jackson triangle became a major economic force not only in the state, but the nation as well. While the industry has declined in recent years, the Buick-Oldsmobile-Cadillac Group of General Motors is still the dominant employer in the Lansing area. (Tri-County Regional Planning Commission n.d.

Ingham and Jackson counties were also endowed with fertile soils and, as a result, developed a strong agricultural base, composed of primarily small- to middle-sized farms that have historically grown crops, such as corn, wheat, soybeans,and vegetables; or have been in dairying (Ingham County Department of Development n.d.). There has also been some low-level oil and gas extraction activities in western Ingham County where there have been commercially developable resource pockets (Yanochko 1988) (see Section 5.4.1).

D. Existing Land Use Plans, Policies and Controls

Land use planning in south central Michigan is conducted at the state, regional, and local levels of government; the local level includes not only county-level activities, but also townships and municipalities. Land use planning at the state level is conducted primarily by the Michigan Department of Natural Resources, with its various divisions, such as Forest Management, Geological Survey, Lands, Land Resource Programs, Parks, Recreation Services, Waterways, and Wildlife; the Department of Transportation; and the Department of Commerce, with its Local Development Services Bureau (Michigan Legislative Council 1987).

Land use planning at the regional level is conducted by the Tri-County Planning Commission for Ingham, Eaton, and Clinton counties; and Region 2 Planning Commission for Jackson, Lenawee, and Hillsdale counties (Tri-County Regional Commission 1987, Region 2 Planning Commission 1988). Both organizations are voluntary associations of local governments operating in their respective jurisdictions. Both commissions were formed under the Michigan Regional Planning Commission Act of 1945, which recognized that planning services can be most economically provided between local units of government on a cooperative, voluntary basis. Both organizations were formed in 1956. The Tri-County Regional Planning Commission includes 78 primary governmental units that are composed of the three member counties, 48 townships, 10 cities, and 17 villages. The Region 2 Planning Commission includes 50 primary governmental units that are composed of two out of three counties, 29 out of 59 townships, 7 out of 8 cities, and 13 out of 20 villages located in the three-county area. Both commissions are currently certified by the Michigan Department of Transportation (for the Federal Highway Administration and the Urban Mass Transit Administration) as the Metropolitan Planning Organization (MPO) for the urban areas in and around Lansing (Tri-County) and Jackson (Region 2). In addition, both commissions have been designated as the Federal Project Review Agency for their respective jurisdictions and are certified by the state to act in such capacities. Both agencies are designated repositories for census information. The Tri-County Regional Planning Commission is designated as a certified development corporation.

Key Tri-County Regional Planning Commission plans include: Transportation Services Integration Plan (1977), Regional Housing Opportunity Plan (1977), Section 208 Water Quality Management Plan (1977), Long Range Regional Street and Highway Plan (1979), Ingham County Solid Waste Management Plan (1983), and the Tri-County Region Overall Economic Development Program (1987).

Key Region 2 Planning Commission plans include: Land Use Atlas, Jackson County (1973), Overall Economic Development Plan for Jackson County, A Plan for Future Land Use (1977), Regional Housing Element (n.d., Recreation and Open Space Plan (1977), Regional Areawide Housing Opportunity Plan n.d., Regional Overall Economic Development Plan n.d., and Regional Natural Resources Plan n.d.

Under Michigan state law, establishment of comprehensive zoning regulations is delegated to either the township level of county government for all unincorporated lands or to incorporated municipalities, such as cities and villages. As a result, these local bodies become key planning agencies for enacting any major development changes. All 13 townships directly affected by the SSC project have zoning ordinances in effect as do the cities of Leslie and Mason and the Village of Stockbridge.

E. Existing Land Use

Existing land use in the south central Michigan region continues to build on the area's historically developed land use patterns. As a result, major employment centers like Lansing and Jackson have developed as nodes that are linked by regional road and rail corridors that crisscross the state in a grid pattern. The dominant land use between these development corridors is agricultural. Other major land uses in the area include the Waterloo State Recreation Area and the Dansville State Game Area.

F. Future Planned Land Use

Lansing and Jackson continue to be dominant centers of economic activity, with new growth occurring at their respective peripheries, especially along major transportation corridors. For Lansing, much of this development is happening in state-certified industrial parks and other types of research parks located along Interstate 96, heading east towards State Route 52. (Ingham County Department of Development n.d., Grobe 1988).

For Jackson, new development is occurring along U.S.127 as far north as Interstate 94, and from there, either to the west around the Jackson Airport or toward the east to Ann Arbor. (Mason 1988)

For the townships that contain incorporated communities, such as Stockbridge (Village of Stockbridge), Leslie (City of Leslie), and Vevay (City of Mason), growth is expected to occur at the fringes of these centers.

For those townships in the region that are decidedly rural in character, little in the way of major departures from the existing land use pattern is anticipated.

G. Community Values/Attitudes Toward Development

Ingham County communities, such as Williamston, Webberville, Dansville, and Stockbridge have recognized the value of their strategic location near Lansing and Michigan State University and its associated development potential. All four of these communities as well as others in the county have recently prepared development plans to guide them in their economic revitalization and growth (Ingham County Department of Development 1986, 1984, 1983, and 1982). The economic development strategy pursued calls for creating conditions for responsible growth, such as, 1) actively retaining existing industries by resolving any managerial discomforts currently experienced, 2) assisting new industries with locational, siting, and financing needs, and 3) providing training programs tailored to meet the individual needs of new employees (Ingham County Department of Development n.d.).

The County and City of Jackson has been a historically strong manufacturing center, given its proximity to 80% of the "Big Three" U.S. and Canadian automobile assembly plants located within a 300-mi radius. As such, the county has one of the nation's highest concentrations of tool and die shops, screw machine shops, platers, steel fabricators, component assemblers, and heat treatment facilities. The county's economic development board is The Jackson Alliance whose role is to actively promote business revitalization and growth in the area by providing location and building assistance, nurturing entrepreneurial business developments through education and technical assistance programs, and sponsoring labor training programs.

5.4.10.2 Local Setting

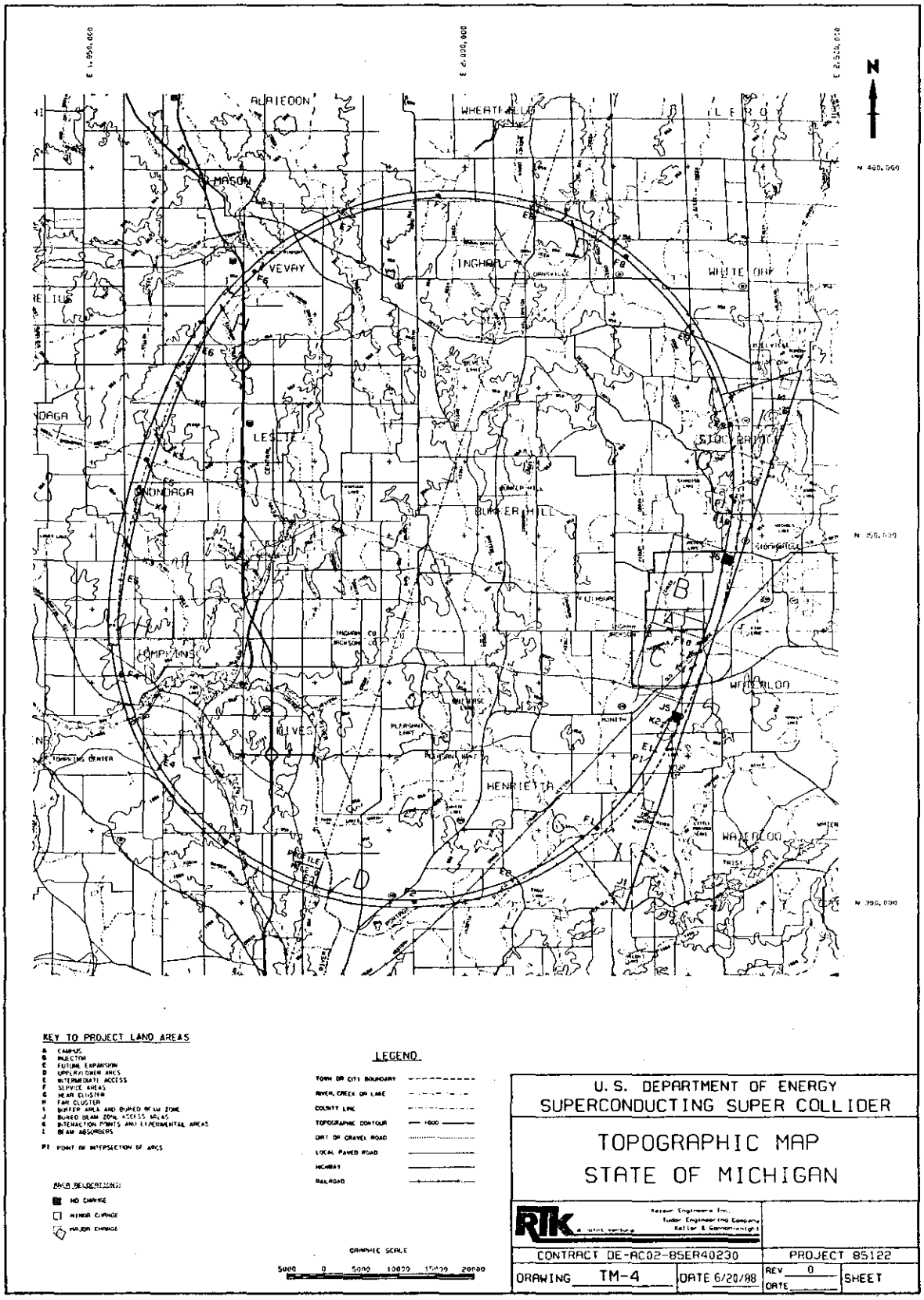
A. Project Level

The proposed SSC project site is located in portions of southeastern Ingham and northeastern Jackson counties, on lands that are largely unincorporated portions of 13 townships (see Figure 5.4.10-1). The SSC project study area contains no federally designated parklands, such as national parks, monuments, preserves, rivers, scenic or historic trails, historic sites, recreation areas, and 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 agricultural in nature, except for the following two significant land uses: the 4,200-acre Dansville State Game Area, located in the interior of the collider arc region; and the 18,027-acre Waterloo State Recreation Area and 690-acre Audubon Haehnle Wildlife Sanctuary, located on the southeast periphery of the lower near cluster quadrant. The Dansville State Game Area is managed by the Michigan Department of Natural Resources, Wildlife Division who, among other wildlife management activities, rear Sichuan pheasants and Sichuan x ringneck hybrid birds for release as hunting stock in the project study area (State of Michigan 1988). The Waterloo State Recreation Area provides recreational opportunities for a variety of pursuits, such as camping,

Figure 5.4.10-1

PROPOSED MICHIGAN SSC SITE REGION



hunting, fishing, nature, hiking, and horseback riding trails, and snowmobiling (Michigan Department of Natural Resources n.d.). The Haehnle Wildlife Sanctuary includes Mud and Eagle lakes and, as such, is a regionally important migratory bird stop-over habitat, as the area falls within a secondary duck migration corridor that stretches from U.S. and Canadian prairies to the east coast. The sighting of sandhill cranes in the fall is a noteworthy educational experience and a recreational opportunity (State of Michigan 1988).

Population centers are located in three areas: 1) adjacent to the near cluster quadrant (Village of Stockbridge), 2) along the upper arc quadrant (City of Mason and Village of Dansville), and 3) along U.S. Highway 127 that traverse the collider arc region on a north-south axis (City of Leslie).

Community values and attitudes toward the SSC project are generally positive, even though there has been a moderate amount of letters received from the public as part of the DOE public scoping process (see Volume III: Methodology for Site Selection). Of the 138 letters received by the DOE as of mid-May, 1988, 103 letters were in favor of the project; 24 letters were opposed to the project; and 11 letters offered no opinion about the project. The types of issues raised in these letters included: labor supply changes, impacts to the educational system, road and congestion problems, tax base changes, and increased demand for water and electricity.

B. Facility Level

Table 5.4.10-1 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 for each of the proejct facilities.

1. SSC Project Near Cluster Quadrant

The near cluster quadrant is located in White Oak and Stockbridge townships in Ingham County, and Waterloo, Henrietta, and Leoni townships in Jackson County. The municipality of Stockbridge is located just to the east of the area, and the Waterloo State Recreation Area and Audubon Haehnle Wildlife Sanctuary are intersected in the southern part of the quadrant. Land use consists basically of farming with much of the area designated as prime farmland, with parcels of range/open space, residential, forested, recreational, and wetland scattered throughout the site. Other uses include small gravel quarries, cemeteries, roadways, railroads, overhead transmission lines, and a golf course. The near cluster quadrant is largely privately owned, with the exception of the state-owned recreation area. Local township zoning codes reflect the respective county-based regional plans that call for maintenance of the area's agricultural/rural residential character.

Table 5.4.10-1

MICHIGAN SSC SITE FACILITY DESCRIPTION: LAND USE DATA

SSC Project Facility	Township/ County Location	Ownership Patterns	Existing Zoning	Existing Land Use	Future Planned Land Use
Near Cluster Quadrant					
Campus area A	Stockbridge[a]	Private	AR	Agr	Same
Injector area B	Stockbridge[a]	Private	AR	Agr/rural	Same
Future expansion C	Waterloo[b]	Private	AG-1/AG-2	Agr/rural	Same
BABBZ area I	Several[ab]	Private/public	AG/AG-1/AR	Mixed rural	Same
J1	Leoni[b]	Private	AG	Agr	Same
J2	Waterloo[b]	Private	AG-2	Agr	Same
J3	Stockbridge[a]	Private	AR	Forested	Same
J4	White Oak[a]	Private	AG/Res	Agr/rural	Same
Near Cluster Ring	Several[ab]	Private	AG/Ag-1/AR	Agr/rural	Same
E1	Waterloo[b]	Private	AG-1	Forested/agr	Same
E10	Stockbridge[a]	Private	AR	Agr	Same
F1	Henrietta[b]	Private	AG-1	Rural	Same
F9	Stockbridge[a]	Private	AR	Range/forested	Same
F10	Waterloo[b]	Private	AG-1	Agr	Same
J5	Waterloo[b]	Private	AG-1	Rural	Same
J6	Stockbridge[a]	Private	AR	Agr	Same
K1	Waterloo[b]	Private	AG-1	Agr	Same
K2	Waterloo[b]	Private	AG-1	Forested	Same
Far Cluster Quadrant					
Far Cluster Ring (H)	Several[ab]	Private	AR/A-1/R-1	Agr/rural	Same
E5	Onondaga[a]	Private	AR	Forested	Same
E6	Vevay[a]	Private	A-1	Agr	Same
F5	Onondaga[a]	Private	AR	Agr	Same
K3	Onondaga[a]	Private	R-1		Same
K4	Onondaga[a]	Private	R-1/AR	Range	Same
K5	Onondaga[a]	Private	AR	Agr	Same
K6	Vevay[a]	Private	A-1	Agr	Same
Lower Arc Quadrant					
Lower Arc Ring (D)	Several[b]	Private	AG/AG-1	Rural	Same
E2	Henrietta[b]	Private	MH-1	Forested	Same
E3	Blackman[b]	Private	AG-1	Agr	Same
E4	Tompkins[b]	Private	AG	Range/forested	Same
F2	Henrietta[b]	Private	AG-1	Agr	Same
F3	Rives[b]	Private	Agr	Agr/quarry	Same
F4	Tompkins[b]	Private	AG	Agr	Same
Upper Arc Quadrant					
Upper Arc Ring (D)	Several[a]	Private	Agr/rural	Agr/rural	Same
E7	Vevay[a]	Private	A-1	wetland	Same
E8	Ingham[a]	Private	AG	Agr	Same
E9	White Oak[a]	Private	Agr/Res	Agr	Same
F6	Vevay[a]	Private	M-1	Agr	Same
F7	Ingham[a]	Private	AG	Agr	Same
F8	White Oak[a]	Private	Agr-Res	Agr	Same

Table 5.4.10-1 (Cont)

MICHIGAN SSC SITE FACILITY DESCRIPTION: LAND USE DATA

SSC Project Facility	Township/ County Location	Ownership Patterns	Existing Zoning	Existing Land Use	Future Planned Land Use
Roads and rail	Several[ab]	Private	Agr	Agr	Same
Utilities	Several[ab]	Private	Agr	Agr	Same

a Located in Ingham County
b Located in Jackson County
Sources: Aurelius Township 1977; Aurelius Township 1984; Blackman Township 1987a; Blackman Township 1976b; Henrietta Township 1980; Henrietta Township 1987; Ingham County 1984; Ingham Township 1977a; Ingham Township 1977b; Leoni Township 1985; Leoni Township 1987; Leslie Township 1984; Onondaga Township Zoning District Map; Onondaga Township 1978; Region 2 Planning Commission 1977a; Rives Township Zoning Ordinance; Rives Township 1976; Stockbridge Township Zoning Map; Stockbridge Township 1981; State of Michigan 1988; Tompkins Township 1967; Tompkins Township 1980; Vevay Township 1977a; Vevay Township 1977b; Waterloo Township 1981; Waterloo Township 1985; White Oak Township Zoning Map; White Oak Township 1987.

a. Campus Area A

Campus area A is privately owned, lies just north of the Jackson County line in Ingham County in Stockbridge Township. Land use is almost entirely farming with three residential parcels and some small wooded, wetland, and range areas. Two minor roads cross the site. Zoning is Agriculture Residential (AR), and the Tri-County Regional Plan calls for a continuation of this use.

b. Injector Area B

Injector area B located in Stockbridge Township, Ingham County, has the same agricultural land use character as campus area A. Several more residences are located here, particularly along Heeney, Holland, and Moechel roads. Two gravel pits, Derby Cemetery, part of Jacobs Lake, and a golf course are also located in the area. Forested areas and rangeland are scattered throughout, with a large wooded area in the southwest portion. The site is privately owned and zoned Agricultural Residential (AR). The Tri-County Regional Plan proposes no change in use.

c. Future Expansion Area C

Future expansion area C is predominantly agricultural farmland, and is zoned Agricultural-1 and -2 with some scattered large forested areas, as well as smaller parcels of rural residential, rangeland, and wetland. A few minor roads and a rail line traverse the area, as does a transmission line in the north. Within 1,000 ft are significant forested areas and wetlands to the west, as well as forest, commercial, and residential lands, and the Manith Cemetery to the south. Both the Waterloo Township zoning ordinance and Region 2 Land Use Plan propose no change in use.

d. Buffer Area and Buried Beam Zone I

1) North Buffer Area and Buried Beam Zone I, Including Buried Beam Zone Access Areas J3 and J4

The north buffer area and buried beam zone I exhibit basically the same mixture of agricultural/rural residential, rangeland, wetland, and water features found in the rest of the near cluster quadrant. The land is privately owned and falls within the townships of White Oak and Stockbridge in Ingham County. Both local zoning ordinances and current regional plans propose no change to the agricultural and rural character of the area, with the possible exception of future residential development near Stockbridge. Zoning is Agricultural Residential (AR) in both townships, except for a small area zoned Rural Residential (RR) near Stockbridge. Village of Stockbridge jurisdiction begins approximately 1,000 ft to the east of the area and is composed of mixed urban land uses.

Other significant features within the 1,000-ft buffer area include the North Stockbridge Cemetery and a campground at Lowe Lake, with its associated forest and wetlands.

Area J3 is composed largely of forested land, with some cropland to the north and a narrow strip of residential land on the west. Land use within 1,000 ft is of the same composition, including a large wetland further west. The area is considered to be prime farmland and is zoned Agricultural Residential (AR) under Stockbridge jurisdiction. The Tri-County Regional Plan proposes no change to the present agricultural/rural uses.

Area J4, located within White Oak township, is zoned as Agricultural Residential (AR). The area is privately owned and designated as farmland of statewide importance. Current land use consists of cropland farming with one small residential parcel located in the northcentral area. Surrounding uses are similar with some wooded and wetland areas located to the north. The Tri-County Regional Planning Commission proposes no change in use.

2) South Buffer Area and Buried Beam Zone I, Including Buried Beam Zone Access Areas J1 and J2

The south buffer area and buried beam zone I, located in Jackson County, includes portions of the Waterloo, Henrietta, and Leoni townships. The southern half overlaps part of the Waterloo State Recreation Area and the Haehnle Wildlife Sanctuary. Large areas of wetlands and forest are the major features throughout the site. Slightly less abundant, but equally scattered, are cropland, single-family residences, and rangeland. Recreation/open-space is the primary use of the wetlands near Portage Lake, which are part of the Waterloo State Recreation Area. The Mud Lake wetlands to the southwest are part of the Haehnle Wildlife Sanctuary. Aside from these public uses, the land is privately owned and zoned as agricultural/rural residential. The Region 2 Land Use Plan proposes no change in use.

Area J1, located in the Township of Waterloo, Jackson County, on the southeast corner of the intersection of Coon Hill and Randolph Roads, approximately 1,000 ft west and north of the Waterloo State Recreation Area stepped boundary, is privately owned. Land use is largely cropland agriculture, with some forested areas. Forested areas and wetlands are found to the east of the site, and to the southwest at approximately 500 ft. Two adjoining residential parcels are located to the northwest, and the remaining area is cropland agriculture. The existing cropland on site is designated as farmland, while the wooded areas are classed as farmland of statewide importance. Township zoning is Agricultural District (AG), and regional land use plans propose no change in use.

Area J2, located in Leoni Township, Jackson County, and the Waterloo State Recreation Area, is privately owned, but is bounded on the east and west by state property. On-site land use is largely cropland agriculture with some forested land on the northeast corner and along

218-829 0 - 88 - 11 (BOOK 4)

the western edge. Land use on the state property to the east and west is basically open space/recreation in forest range, and wetland areas. Use of the private land to the south includes cropland agriculture and wetland fringed with forest. Single-family residential, cropland, forest, and rangeland are the mixed uses of the private lands to the north. Zoning for the site is Agricultural District (AG-1); however, neighboring areas to the east are recreational/open space. The Region 2 Land Use Plan proposes no change to the agricultural and recreational/ parkland uses. Approximately half of the site area is designated as prime farmland; the remainder is classed as farmland of statewide importance.

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 ring traverses Stockbridge and Waterloo townships in Ingham County, with smaller portions found in White Oak, Henrietta, and Leoni townships in Jackson County. The area is basically all privately owned. Land use is predominantly cropland agriculture; however, patches of forested land, wetland, rangeland, and residential uses are scattered throughout, accounting for approximately one-third of the area. Two gravel extraction sites are also included, one in each county. Surrounding land uses are a continuation of the agriculture-forested-wetland-range-residential mix. Zoning is generally agricultural/rural residential, with almost all of the arc designated as either prime farmland or farmland of statewide importance. Regional land use plans propose no change to the area's rural/agricultural use, as well as preserving unique forest and wetland while encouraging development around existing roads, none of which affect the site. An isolated small area of Leoni Twonship which is zoned as a Commercial District (C-1), is located in the arc region between sites E1 and F1.

Site F9 is located in Stockbridge Township, Ingham County, on the north side of Oakley Road. The area is privately owned range and forested land. Cropland agriculture and forested areas lie to the north, while to the south is rangeland and some residential use. The area is designated as farmland of statewide importance with some designated prime farmland to the southeast. Zoning is Agricultural Residential (AR); regional land use plans propose no change in use.

Area E10, located in Stockbridge Township, Ingham County, is just south of Dexter Trail. The area is designated as farmland of statewide importance and is private property under cropland agricultural use. Parcels of residential use are located to the north and east, while the remaining surrounding areas are cropland. Current zoning calls for agricultural uses within the designation of Agricultural Residential (AR) and future land use plans propose no change in use.

Area J6, located in Stockbridge Township, Ingham County, south of Morton Road approximately one-half mile west of Stockbridge, is almost entirely cropland agriculture with small areas of range and forest land. Land

use in the immediate vicinity is agricultural; however, within 1,000 ft are found residential, forested, range, wetland, and gravel excavation. Local zoning is Agricultural Residential (AR), with some Rural Residential zones located within 1,000 ft to the north. Future land use plans propose no change in use; however, there may be some future residential expansion into the area. The area is privately owned and contains both prime farmland and farmland of statewide importance.

Area F10, located in Waterloo Township, Jackson County, is bisected by Mount Hope Road. An overhead transmission line runs along the southern edge of the area and an old railroad grade lies a few hundred feet to the southeast. Land use on and around the location is cropland agriculture, and it is designated as prime farmland. The area is privately owned and zoned Agricultural-1. Regional land use plans propose no change in use.

Site K1 is located in the Waterloo Township of Jackson County in a privately owned area of cropland agriculture. The area is zoned Agricultural-1 (AG-1), and land use plans propose no change in use. Designated prime farmlands and farmlands of statewide importance surround the site, however the site itself does not carry this designation. Surrounding land use is agricultural with some farm residential, and the Grand Trunk Western Rail Line is located approximately 1,000 ft to the west.

Area J5, also located in Waterloo Township, Jackson County north of the intersection of Huttenlocker and Waterloo-Manith Roads, consists mainly of forested and wetland areas with some cropland, with a parcel of residential land on the east side. A similar mix is found beyond the area with more cropland and a gravel excavation site located within 1,000 ft. The small town of Manith is found approximately 1 mi to the west. The area is private property, zoned agricultural, and land use plans propose no change in use.

Site K2 is located in Waterloo Township, Jackson County, entirely within site J5 on forested land with areas of wetland and agricultural use found within 1,000 ft. In Jackson County, Waterloo Township, the area is zoned (Agricultural-1 (AG-1). The site is privately owned and designated as farmland of statewide importance; some areas of prime farmland are found within 1,000 ft. Land use plans propose no change in use.

Area E1, in Waterloo Township, Jackson County located 0.5 mi west of Huttenlocker Road and 300 ft northeast of Randolph Lake, is open forest and cropland. To the north and east are located cropland agricultural areas, while forested areas and Randolph Lake are located to the south and east. The area is privately owned and designated as farmland of statewide importance. Local zoning is Agricultural-1 (AG-1) and regional land use plans propose no change in use.

Area F1, in Henrietta Township, Jackson County located just north of the Portage River and west of Dunn Road, is privately owned and designated as farmland of statewide importance. Current land use consists of residential and forested land, as well as farmland and cropland agriculture. Woodlands and residential uses are found to the north and west, while to the south is rangeland, with the Portage River and cropland agriculture located beyond. Extensive cropland areas are located to the west. Local zoning is Agricultural District (AG-1); regional land use plans propose no change in use.

2. SSC Project Far Cluster Quadrant

a. 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

The far cluster quadrant area, situated in Ingham County, is primarily in the townships of Vevay and Onondaga with small sections at the corner of Aurelius and Leslie townships. The very southern tip of the arc crosses the county line into Tompkins Township of Jackson County, terminating about 500 ft from this boundary. Cropland agriculture is the predominant land use, with small patches of forested land, residence, and rangeland scattered throughout. Land use in an area of 1,000 ft surrounding the far cluster ring is basically of the same character as the interior, but also includes a few wetlands, gravel quarries, utility uses, and the Onondaga Dragstrip. The far cluster ring consists of private property and a majority of it is designated as prime farmland. Local zoning is generally agricultural with significant areas between sites E5 and K4 in Onondaga Township zoned Low-Density Residential (R-1). Regional plans propose no change in use.

Area E5 is in a forested area around which lies cropland agriculture to the north and east. Portions of the area to the southeast and northeast are designated as prime farmland. It is privately owned property located in the Township of Onondaga, Ingham County. Local zoning is Agricultural Residential (AR). Regional land use plans propose no change in use.

Site K3, located in Onondaga Township, Ingham County, is privately owned in an area of cropland agriculture, with Edgar Road running north/south along its eastern edge. Three residences are found within 1,000 ft: one to the west and two to the south along the roadway. Remaining surrounding area are agricultural with some forested land. Approximately one-half of the site area is designated as prime farmland, and the remainder is classed as farmland of statewide importance. Surrounding lands are similarly designated. Zoning is Low Density Residential (R-1) and land use plans propose no change in use.

Site K4, located in Onondaga Township, is privately owned and is located approximately 100 ft south of Covert Road in an area of open rangeland. Several residences are found along the roadway within 1,000 ft, and areas of agricultural use are located beyond a 500 ft range. The site and

surrounding area is designated as farmland of statewide importance with some undesignated farmland located to the northwest. The area is zoned Low Density Residential (R-1) in part and Agricultural Residential (AR) in remaining portions. Regional land use plans propose no change in use.

Area F5, located in Onondaga Township, Ingham County, is entirely cropland agriculture with some small patches of wooded land found at a distance of 500 to 1,000 ft away. The area itself and land to the north is designated as prime farmland, while to the south is classed as farmland of statewide importance. The area is privately owned and zoned as Agricultural Residential (AR). Regional land use plans propose no change in use.

Site K5, located in Onondaga Township, is privately owned and zoned Agricultural Residental (AR), and consists entirely of cropland agricultural use. Surrounding areas are all agricultural with only a small wooded area located to the north within 1,000 ft. The site and all surrounding area is designated as prime farmland, and the regional land use plans propose no change in use.

Site K6, located in Vevay Township, Ingham County, is privately owned and used for cropland farming. A small lake and wooded area to the west and southwest are the only exceptions from the agricultural use surrounding the site. The whole area is designated as prime farmland. Township zoning is Agricultural (A-1) and the regional land use plan propose no change in use.

Area E6 and the surrounding land use is also cropland agriculture, with some parcels of residential land and woodland located at a 500 to 1,000 ft distance. It is in Vevay Township, Ingham County, and is zoned Agricultural. Regional land use plans for this private property propose no change of this agricultural use.

3. SSC Project Lower Arc Quadrant

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

The lower arc quadrant is located entirely in Jackson County in the Townships of Henrietta, Leoni, Blackman, Rives, and Tompkins, approximately 4 mi north of the city of Jackson. Land use is largely cropland agriculture with patches of residential use, forested land, rangeland, and wetland. Other uses include a portion of the Southern Michigan State Prison Farm, a small corner of the Waterloo State Recreation Area, gravel pits near site F3, sewage disposal ponds, and the Draper Cemetery in Rives Township. Notable features crossing the site are U. S. Highway 127, Portage River, Grand River, two abandoned railways, and the existing Conrail line. The land is privately owned except for the state holdings. Zoning in the area is all Agricultural/Rural Residential. The only exception is a Mobile Home District near site E2 in Leoni Township.

Region 2 Land Use Plan proposes no change to the agricultural/rural residential use, as well as recognition of the Grand River area as public recreational open space. The plan also recommends the continued use of the state prison farm as an institutional use.

Area E2, located in Henrietta Township, Jackson County, just north of the Portage River and west of Wooster Road, is on privately owned, forested land that extends to the west, while cropland agriculture and a residence are on Wooster Road. To the north is more agricultural and forested land, another residence, and a small lake. Land use to the south also includes agricultural and forested land, as well as the Portage River. The site is zoned as a Mobile Home District (MH-1), and is designated as prime farmland. Regional land use plans propose no change in use.

Area F2, located in Henrietta Township, Jackson County, is privately owned prime farmland. Land use is cropland agriculture with some forested area located on the southeast corner. Surrounding lands are either agricultural or forested; however, a cluster of residential uses lies 800 ft to the north along the Hawkins Road/Route 106 intersection. The Portage River and state prison property boundary are found at the same distance to the south of site F2. Local zoning is Agricultural District (AG) and regional plans propose no change in use.

Area E3, located in Blackman Township, Jackson County, between the Grand River and Lansing Avenue, is cropland agriculture with some forested land to the north and west toward the river, as well as a few small residential parcels located along Lansing Avenue approximately 1,000 ft away. The area is privately owned, zoned Agricultural District (AG-1), and regional plans propose no changes in use. An isolated portion of state prison property is located on both sides of the Grand River approximately one-half mile east. The regional land use plans propose no change to the detention facility use. Creation of public recreational open space in areas surrounding the Grand River is also planned.

Area F3, located in Rives Township, Jackson County, between the Penn Central rail line and Murray Road, is used for cropland agriculture and gravel extraction. Gravel pits are located to the northeast and southeast, and to the east are woodlands, wetlands, and the Conrail railroad tracks. A few residential parcels and more cropland are the uses within 1,000 ft to the west. Local zoning is Agricultural District and regional land use plans propose no change for this use. A majority of the site area is designated as prime farmland.

Area E4 located in Tompkins Township, Jackson County, is privately owned rangeland and forested land. Areas of wetland, range, woodland, and cropland are all found within 1,000 ft of the site. Local zoning is Agricultural (AG) and regional plans propose no land use change in the future.

Area F4, located in Tompkins Township, Jackson County, is on the north side of Snyder Road and is privately owned. Land use is entirely cropland agriculture on and surrounding the site with only one residence found within 1,000 ft. The area is zoned Agricultural (AG). Regional land use plans propose no change in use.

4. SSC Project Upper Arc Quadrant

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

The upper arc quadrant is located in Ingham County in the townships of Vevay, Ingham, and White Oak. Land use is largely cropland agricultural with a scattering of small residential parcels, rangeland, and wetland. The western portion near Mason is of a more mixed use with large gravel quarries, Jewett Airport, Mason-Jewett golf course, and some commercial/light industrial areas. U. S. Highway 127/Conrail line crosses the site. There are a few small lakes within the arc and another gravel pit in the central portion near site E8. Several oil wells are located on or near the eastern section, as well as an oil pipeline running southwest to northeast. The land is privately owned and local zoning is generally agricultural or rural residential, except near Mason, where small industrial and commercial zones are also found. The Region 2 Land Use Plan proposes no change to the agricultural and rural residential uses, while promoting urbanized use near established centers, such as Mason. The Mason city boundary lies approximately 2,500 ft northwest of the arc near site F6.

Area F6, is located in Vevay Township, Ingham County approximately 0.50 mi south of the City of Mason on privately held land. It is currently used for cropland agriculture, which extends to the north and west. Immediately east of the area is a large gravel quarry and a lake bordering that within 1,000 ft. To the south is an adjacent commercial area beyond which lies more rangeland and agricultural cropland. The Conrail line divides the agricultural and gravel extraction uses along the east corner, and the area is designated as prime farmland. Zoning for the site is Limited Industrial (M-1), surrounded by small parcels devoted to industrial and commercial uses. Agriculturally used areas are zoned as such (A-1).

Area E7 is located in Vevay Township, Ingham County, on private property but lies within a large wetland area. A gravel quarry is located a few hundred ft to the northeast, and some wooded areas are found about 700 ft to the west. The wetland extends beyond 1,000 ft to the northwest and southeast. Local zoning is Agricultural (A-1). The Region 2 Land Use Plan calls for the continued preservation of the wetland habitats throughout the area.

Area F7, located in Ingham Township, Ingham County, approximately 400 ft south of Columbia Road, is privately owned and used entirely for cropland agriculture. Two small residential parcels are located on Columbia Road approximately 300 and 600 ft from the site, respectively.

The land is zoned as an Agricultural Enterprise District (AG). It is also designated as prime farmland, and The Region 2 Land Use Plan proposes no change in use.

Area E8, located in Ingham Township, Ingham County, about 1.2 mi north of Dansville, and east of Williamston Road, is used for cropland agriculture as is the area to the east. North are some residential parcels adjacent to the intersection of Columbia and Williamston roads. A small wetland lies approximately 200 ft to the southwest and to the west is more wetland, some forested area, and a gravel quarry located just beyond 1,000 ft from the site. Local zoning is Agricultural Enterprises District (AG), with a large area zoned Rural Residential (RR) located approximately 300 ft to the west. Regional land use plans propose no change in use.

Area F8, in White Oak Township, Ingham County, is located on privately owned land used for cropland agriculture. This use prevails at the site and in the immediate surrounding area. There is one residence and two small woodlots located within 1,000 ft, however. The site is designated as prime farmland. Local zoning is Agricultural-Residential (AR) and regional land use plans propose no change in use.

Area E9, in White Oak Township, Ingham County, is located on the east side of Dietz Road and just north of Carter Road and is privately owned. The land use is cropland agriculture, although it does intersect the northern edge of a residential lot. Five other rural residential parcels are within 1,000 ft located along both roads. The remainder of the surrounding area is under agricultural crop production and is designated as prime farmland. The area is zoned Agricultural-Residential, (AR) and regional land use plans propose no change in land use.

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 and rail 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 improvement.

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 for what has been generally described for the area. There are no future plans that constrain these areas from further improvement.

5.4.10.3 Soil and Prime Farmland Resources

A. Factors of Soil Formation and the Resulting Soil Cover.

The Michigan SSC proposed site is located in the Thumb Upland physiographic division of the Michigan lower peninsula. At the site the Paleozoic sedimentary rocks, represented mainly by limestones and sandstones, are overlain by rocks transported during the Wisconsin glaciation and deposited during and subsequent to the ice recession. The Kalamazoo morainic formation, an accumulation of heterogeneous glacial debris, represents a major soil parent material in the southern part (Jackson County) of the collider (Soil Survey of Jackson County, MI 1981). The glacial till, an important soil forming material, was carried by the advancing ice and thus has not been sorted. The outwash, on the other hand, is a melt water segregated material. The Marlette soil is developed on till while Boyer soil is developed in outwash. Texturally much finer soils, such as Lenawee soil, developed in lacustrine outwash, a material deposited in quasi-stagnant water over longer periods. Recent alluvial deposits are parent material for Cohoctah and similar soils.

The climate at the Michigan SSC site is cool and humid. It is believed to have been practically unchanged for the past 10,000 years (Soil Survey of Jackson County, MI 1981), a period during which the present soil cover developed. The mean annual air temperature is around 8.7°C, with mean summer and winter temperatures of 20.8°C and -4°C, respectively. Based on these data, mean annual soil temperature is estimated to be 9.5-10°C with a mean summer soil temperature of around 20°C, and a mean winter soil temperature of -3°C (Soil Taxonomy, Agricultural Handbook No.436 1975). These data reflect a mesic-bordering to frigid soil temperature regime, meaning that soil temperature conditions were and are suboptimal to weathering and soil formation. The annual precipitation at the site amounts to 30 inches with rains quite evenly distributed among the 12 months (Soil Survey of Jackson Co., MI, and Soil Survey of Ingham Co., MI 1981 and 1979, respectively). The considerable supply of water associated with a moderate potential evapotranspiration results in an udic soil moisture regime. On many surfaces, because of high groundwater, the soil water is depleted of oxygen and the gleying process (iron reduction) proceeds unhindered. This feature is predominantly displayed in the lacustrine Lenawee soil. The climate characteristics of the site are also conducive to a partial leaching of carbonates to different depths, depending on the initial carbonate concentration of the till, the texture of the earth matrix, the duration of the leaching process, and the microclimatic characteristics. Marlette soil is leached typically to 30 inches, Riddles soil has the carbonatic horizon below the solum at 5 ft, while Spinks soil, with a coarser texture throughout the profile, is leached to a depth greater than 5 ft. Leaching of carbonates and iron reduction are direct consequences of the udic/aquic soil moisture regimes. The soil formation at the Michigan SSC site is also expressed by the accumulation of organic matter in the surface (A) horizon (primarily umbric but also mollic diagnostic horizons), evidenced in soils of the Brookston, Gilford, Boyer, or

Marlette soil series. The translocation and accumulation of clay is manifested to different degrees in soils such as the Brookston, Kibbie, Riddles, and Sisson series.

The generalized soil map of the United States (Soil Taxonomy, Agricultural Handbook No.436 1975) shows that, at the location of the Michigan SSC site, the soil cover is represented characteristically by the suborder Udalfs with a good representation of Aqualfs and Aquolls. Indeed, out of the reduced-fee simple acreage of 7180.4, 3513.7 acres (48.9%) are represented by Udalfs, 696.9 acres (9.7%) are represented by Aqualfs, and 1031.4 acres (14.4%) are represented by Aquolls (the reduced-fee simple area is obtained by considering only the main soil components in a complex mapping unit). In addition, 465 acres (6.5%) of the reduced-fee simple area are covered by Aquepts. A very important component of the soil cover in Michigan, amounting to 1473.4 acres (20.5%), is represented by Histosols (Saprists and Hemists). These soils are predominantly organic and called mucks in the SSC region. The concept of a muck soil however, extends beyond the boundaries of Histosols; both Henrietta and Martisco mucks encountered at the SSC site are Inceptisols (Histic Humaquepts), and thus mineral soils.

A total of 72 soil mapping units were identified at the Michigan SSC site, representing 40 soil series; 7 of these 40 series cover half of the reduced-fee simple land. The 7 series (acreages) are: Spinks (849), Houghton (606), Riddles (562), Capac (547), Gilford (351), Hillsdale (348), and Palms (339). Table 5.4.10-2 presents the soils at the subgroup taxonomic level, the soil series, and corresponding acreages. The real-fee simple area is equal to 7750.45 acres with almost 2/3 in Ingham County (5043.1) and a little over 1/3 in Jackson County (2707.4). The acreage presented in Table 5.4.10-2, the reduced fee simple area (7180.42), excludes those small percentage components of complex soil units because no firm quantitative information is available on their acreages.

The Spinks, Riddles, and Capac soil series covering in excess of 2,000 acres (considering participation in complex units) are representative of Hapludalfs and Ochraqualfs at the SSC site. These are soils characterized by a nonmollic (nongranular, subangular blocky structure) surface horizon and by an argillic subsoil (a horizon of clay accumulation). Riddles and Spinks soils encountered mainly on till and moraines, respectively, are well drained, while Capac is a somewhat poorly drained soil (reflected by its surface grayish color). Both Riddles and Spinks soils have an A2 subsurface horizon of rather poor edaphic characteristics (those attributes needed to provide favorable soil/plant relationships).

The poor internal drainage of the Capac soil resulted in a limited leaching of carbonates to approximately 2 ft, while Riddles and particularly Spinks (because of its coarser textural makeup) have the carbonates leached at and in excess of 5 ft, respectively. The coarse texture of Spinks is, edaphically, a negative of this soil.

TABLE 5.4.10-2

SOIL SUBGROUPS, SERIES, AND MAJOR COMPONENTS IN COMPLEX UNITS WITH CORRESPONDING ACREAGES

Subgroup	Series	Acreage
Typic Hapludalfs (1320.7 acres)	Boyer	97.6
	Eleva Variant	4.6
	Hillsdale	347.6
	Leoni	3.2
	Oshtemo	254.7
	Owosso	18.7
	Riddles	562.1
	Saylesville	2.4
	Sisson	29.8
Aquollic Hapludalfs (481.9 acres)	Brady	206.9
	Dixboro	188.6
	Kibbie	86.4
Arenic Hapludalfs (133.1 acres)	Metea	10.2
	Okee	67.4
	Ormas	55.5
Glossaquic Hapludalf	Teasdale	215.5
Glossoboric Hapludalf	Marlette	289.7
Psammaquentic Hapludalf	Thetford	151.4
Psammentic Hapludalfs (921.2 acres)	Arkport	72.2
	Spinks	849.0
Aeric Ochraqualfs (690.9 acres)	Aubbeenaubbee	139.8
	Capac	547.0
	Del Rey	4.1
Udollic Ochraqualf	Matherton	6.0
Typic Haplaquolls (798.3 acres)	Colwood	312.3
	Gilford	351.5
	Granby	134.5
Fluvaquentic Haplaquoll	Cohoctah	35.5
Typic Argiaquolls (197.6 acres)	Barry	40.6
	Brookston	85.1
	Sebewa	71.9
Mollic Haplaquepts (285.3 acres)	Keowns	266.7
	Lenawee	18.6
Histic Humaquepts (179.7 acres)	Henrietta	179.3
	Martisco	0.4

TABLE 5.4.10-2 (Cont)

SOIL SUBGROUPS, SERIES, AND MAJOR COMPONENTS IN COMPLEX UNITS WITH CORRESPONDING ACREAGES

Subgroup	Series	Acreage
Typic Medisaprist	Houghton	606.5
Limnic Medisaprist	Edwards	197.5
Terric Medisaprists	Adrian	211.6
	Palms	338.6
Typic Medihemist	Napoleon	119.2
Total per Great Groups:	Hapludalfs	3,513.5
	Ochraqualfs	696.9
	Haplaquolls	833.8
	Argiaquolls	197.6
	Haplaquepts	285.3
	Humaquepts	179.7
	Medisaprists	1,354.2
	Medihemists	119.2
Total per Suborders:	Udalfs	3,513.5
	Aqualfs	696.9
	Aquolls	1,031.4
	Aquepts	465.0
	Saprists	1,354.2
	Hemists	119.2
Total per Orders:	Alfisols	4,210.4
	Mollisols	1,031.4
	Inceptisols	465.0
	Histosols	1,473.4

The Gilford series, a representative of Haplaquolls covering more than 800 acres, developed in moderately coarse outwash deposits. The soil has a fine-granular surface horizon of high farming potential. The subsoil, the B-horizon, is moderately compact with no accumulation of illuviated clay; it is mottled throughout the profile reflecting the persistence of water (aquic soil moisture regime).

The Houghton and Palms soil series, covering around 1,000 acres at the SSC site, are organic soils (Histosols) that are very poorly drained and almost always waterlogged. The presence of deoxygenated water prevents complete decomposition of the organic matter, although, in the Saprists, the most abundant histosols at the site, the decomposition is sufficiently advanced to result in a quasihomogeneous organic mass where few undecomposed fibers are identifiable.

B. Farming Potential of Soils.

A widely recognized classification system for purposes of ranking soils according to their overall suitability for crops, pasture or hayland, woodland, and recreation, is the Soil Capability System (Soil Survey of Ingham Co., MI, 1979, USDA-SCS, p.36). The capability class (with eight classes, I-VIII) ranks soils according to their limitations and versatility for producing crops common to the region, according to the risk of harming the soil through use, and depending on their reaction when conservation/management practices are being followed. Soils included in classes I, II, III, and IV have few, moderate, severe, and very severe limitations respectively when used for cultivated crops. Soils in class VI have limitations that cannot be economically removed and in general can only be used as rangelands or recreational lands. Class VIII is represented by practically bare land, which has a limited recreational use. The capability subclass is indicated by a small letter that identifies the major limitation of the soil. The letter "e" stands for erosion hazard, "s" stands for a shallow or a droughty/stony soil, "w" indicates a condition of prolonged wetness, and "c" reflects unfavorable climatic conditions.

Table 5.4.10-3 presents acreages corresponding to each of the capability subclasses and sums up acreages for each of the main limitations encountered at the Michigan SSC site. Primary data for compiling the table were obtained from the soil surveys of the two host counties (Soil Surveys of Jackson and Ingham Counties, MI, USDA-SCS, 1981 and 1979).

Table 5.4.10-3

CAPABILITY SUBCLASSES AND CORRESPONDING ACREAGES AT THE MICHIGAN SSC SITE; ACREAGES FOR EACH OF THE THREE LIMITATIONS

Capability Subclass	Acreage
IIe	1,267.8
IIw	2,553.7
IIIe	618.7
IIIs	1,050.9
IIIw	1,578.2
IVe	41.1
IVw	409.6
Vw	35.5
VIe	35.5
VIw	119.2
VIIIw	14.2

Main Limitation	Acreage	Percent
e, erosion hazard	1,963.1	25.4
s, generally poor quality soil	1,050.9	13.6
w, excessive wetness hazard	4,710.4	61.0

Note:

The acreage-weighed capability for the site is equal to 2.64, roughly half way between capability classes II and III. This is an indication that, considering all acreages (7750.5 less 26.1 acres which are pits, udorthents/udipsamments and unclassified Ingham County histosols and aquents), the "average" soil has moderate to severe limitations for farming and cultivating crops. Since 91.5% of acreages are included in classes II and III, one can say that at the Michigan site, soils are in general of fair to good quality, provided considerable conservation/management practices are consistently implemented. For almost 2/3 of the area (4,710.4 acres corresponding to 61% of the fee simple acreage) the main limitation for farming is excessive wetness (understandable since all soils have udic/aquic moisture regimes). Therefore, drainage operations are important farm management practices.

A more comprehensive picture of the soil suitability for farming at the site can be obtained by considering not only the main limitation, as was done in Table 5.4.10-3, but all hazards associated with a soil unit.

Table 5.4.10-4 presents such a picture, considering five hazards that often are interrelated. For example, with the Gilford-Colwood complex (in excess of 500 acres in Jackson County), the poorly drained soils on flatlands and depressions, excess water is a deficiency that can be altered by using combined surface and subsurface drainage systems. If drainage is not implemented and the land is used for pasture, soil compaction will take place with possibly economically irreparable damages. Thus, water removal from such lands will also remove the potential for soil compaction. Similarly, the Spinks loamy sand, covering 520 acres, is often subjected to drought and windblowing. When proper water conservation measures are used (cover crops, green manure crops, crop residue management, manure and no-till cropping systems), the tendency of the soil to become droughty is reduced and so is the likelihood of windblowing.

TABLE 5.4.10-4

ACREAGES CORRESPONDING TO EACH OF THE FIVE LIMITATIONS AS MAIN AND SECONDARY HAZARDS

Hazard	Acreage
Excess water	4,561.7
Surface compaction	4,047.3
Water erosion	1,949.2
Droughtness	2,189.1
Soil blowing	4,063.6
Total hazards x acres	16,810.9
Total acreage = 7,724.4	
Average hazard per acre = 16,810.9/7,724.4 = 2.2	

Table 5.4.10-4 shows that on average, each acre of land at the site has 2.2 hazards. Since hazards are often coupled, management practices intended to remove a particular hazard often result in a soil free of limitations for farming. Thus, the soil cover at the Michigan SSC site has a considerable proportion of good agricultural lands.

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

One of the criteria for assessing prime farmlands (7 CFR, Part 657, p.449 1986) is the soil moisture regime. When soils are wet throughout over long periods, with practically stagnant water, and the soil profile is mottled (symptomatic of reduced conditions) the aquic soil moisture regime by itself restricts the soil from being qualified as prime farmland,

irrespective of other soil attributes that might be very favorable for crop growing. If, however, the soil is drainable and, subsequent to drainage, acquires a nonaquic moisture regime, the soil will be considered prime farmland, assuming all other criteria are complied with. Table 5.4.10-5 indicates that most of the prime land inventory at the Michigan SSC site (2,136 acres out of 3,726, i.e. 57%) was initially wet land.

An estimate of the prime farmland at the Michigan SSC site is, as indicated in Table 5.4.10-5, equal to 3,726 acres. This includes 200 acres of unique farmlands.

TABLE 5.4.10-5

ESTIMATED PRIME FARMLANDS, DRAINED PRIME FARMLANDS, AND OTHER AGRICULTURAL LANDS AT THE MICHIGAN SSC SITE

Capability Subclass	Prime Farmlands (acres)	Drained Prime Farmlands (acres)	Other Agricultural Lands (acres)
IIw	312.0	1641.4	692.8
IIIw		494.3	1,092.5
IVw			409.6
Vw			35.5
VIw			119.9
VIII			14.2
IIe	1,278.0		
IIIe			608.6
IVe			41.1
VIe			35.5
IIIs			949.9
Total	1,590.0	2,135.7	3,999.6

5.4.11 Socioeconomics and Infrastructure

5.4.11.1 Socioeconomics

Measurable socioeconomic impacts caused by the SSC development and operation in Michigan probably would be confined to the 12-county region depicted in Figure 5.4.11-1. Included in the region are the metropolitan areas of Lansing, Ann Arbor, and Jackson, and much of metropolitan Detroit and Battle Creek. A sizable labor force already resides in this region; and for inmigrating job seekers, the most attractive and accessible residential opportunities within reasonable commuting distance of the Michigan SSC facilities are here.

Labor, goods, and services required locally for construction and operation of the SSC would come from throughout the 12-county region of influence (ROI). The greatest impacts, however, probably would occur in Ingham and Jackson counties. All of the SSC facilities would be located in these two counties, and project-related demands for housing and other services would be concentrated there. The ROI is the focus of study for economic and demographic issues, and Ingham and Jackson counties are considered the primary impact counties for public services and finance issues. Livingston and Washtenaw counties also are evaluated in terms of population and housing.

A. Economic Activity, Labor Force, and Income

1. Regional Setting

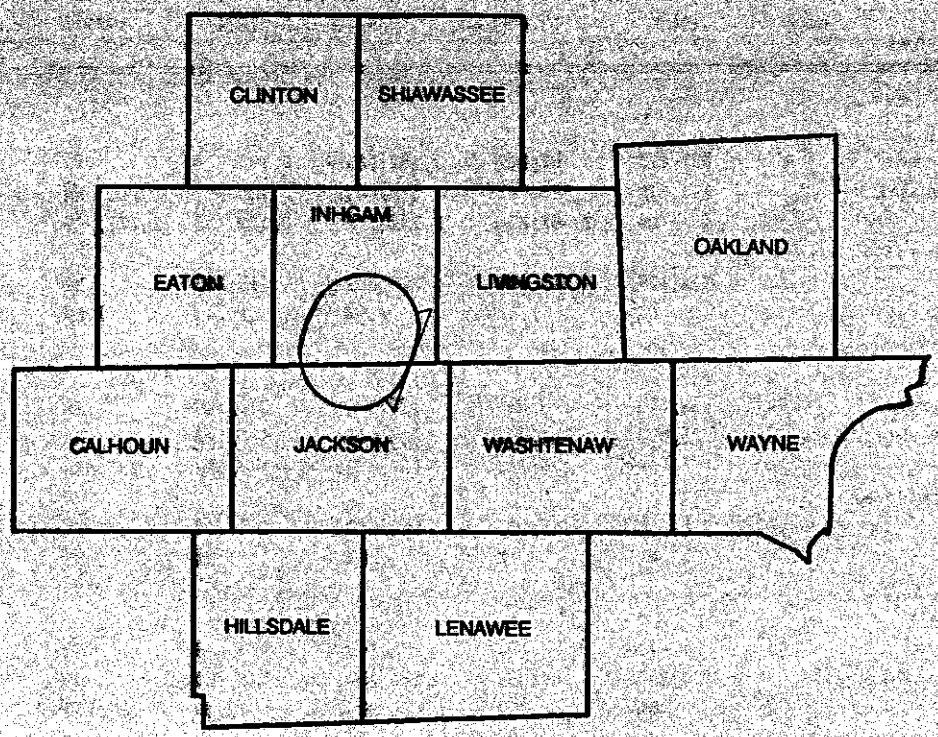
The economy of the 12-county ROI has been relatively stable during the past two decades (Table 5.4.11-1). The employment base in the Michigan ROI during this period stayed nearly level. Total employment growth in the ROI averaged 0.2% annually between 1969 and 1984 as compared to the U.S. annual average of 1.9% (U.S. Department of Commerce, Bureau of Economic Analysis, 1986).

Annual employment growth in the Michigan ROI from 1969 to 1984 lagged behind the national average growth rate in all but one industrial sector (mining). The agricultural services, forestry, and fisheries sector experienced the largest percentage growth in employment, increasing at an average annual rate of 5.3%, slightly below the national average growth rate of 5.8% in that sector. Other leading sectors in ROI employment growth were the mining sector, which grew at a 4.4% annual growth rate, and the services sector, which grew annually at a rate of 3.1%.

Four industrial sectors in the region experienced overall declines in employment during the 16-yr period. Led by the construction sector with a 2.6% average annual loss in employment, farming, transportation, and

Figure 5.4.11-1

COUNTIES FOR SOCIOECONOMIC ANALYSIS
IN THE MICHIGAN SSC REGION



Michigan Area Mapped

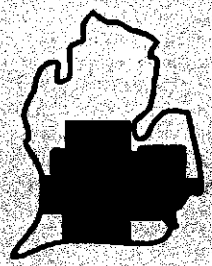


Table 5.4.11-1

HISTORIC ECONOMIC INDICATORS FOR THE MICHIGAN ROI AND INGHAM AND JACKSON COUNTIES

	1969	1974	1979	1984	1987	Average Annual Growth Rate
MICHIGAN ROI						
Total employment [1]	2,037,873	2,107,207	2,257,225	2,109,323	NA [2]	0.2%
Earnings per worker [3]	$28,510	$28,663	$29,009	$25,994	NA	-0.6%
Labor force	NA	2,087,250	2,197,775	2,169,425	2,277,925	0.9% [4]
Per capita personal income [3]	$14,127	$15,060	$16,659	$15,716	NA	0.7%
Unemployment rate	NA	7.0%	7.5%	10.4%	7.6%	NA
INGHAM COUNTY						
Total employment	138,045	149,665	174,572	173,369	NA	1.5%
Earnings per worker	$25,903	$24,830	$26,049	$25,119	NA	-0.2%
Labor force	NA	126,700	137,850	147,525	155,475	1.8% [4]
Per capita personal income	$12,250	$13,063	$14,649	$14,174	NA	1.0%
Unemployment rate	NA	8.1%	6.8%	10.2%	6.8%	NA
JACKSON COUNTY						
Total employment	60,439	62,192	65,142	58,068	NA	-0.3%
Earnings per worker	$24,839	24,882	$24,450	$21,264	NA	-1.0%
Labor force	NA	65,800	68,300	63,800	62,700	0.4% [4]
Per capita personal income	$12,649	$13,124	$13,124	$13,749	NA	0.1%
Unemployment rate	NA	5.8%	7.2%	12.5%	7.8%	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 growth rates are for 1970-1987.

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

public utilities, and manufacturing all experienced job losses. Of these sectors, only farming and construction also experienced employment losses at the national level; additionally, the ROI losses were of greater magnitude than the average national losses. Figure 5.4.11-2 shows the distribution of employment in the 11 major industrial sectors in the Michigan ROI in 1984. The dominant sectors of the ROI economy, in terms of employment, were services (with 25.8% of ROI jobs), manufacturing (22.7%), retail trade (16.5%), and government (15.0%).

In 1984, average earnings per worker in the Michigan ROI exceeded the national average. Average earnings per worker in 1984 were greatest in the manufacturing ($43,521) transportation, and public utilities ($37,278) sectors (all values represent 1988 dollars).

For the last two decades, unemployment rates in the Michigan ROI have exceeded the national average rates (Michigan Employment Security Commission 1988; U.S. Council of Economic Advisors 1988). The ROI labor force grew slowly between 1970 and 1987, averaging less than 1% annually but still included nearly 2,280,000 persons in 1987.

Per capita personal income in the Michigan ROI in 1984 averaged $15,716 and has exceeded the national average every year since 1969. ROI per capita personal income, which peaked in 1978 at $16,902, appears to be rising from a 1982 low.

Employment in the Michigan ROI is expected to continue increasing at a slow but steady average annual rate. Between 1988 and 2000, employment by place of work is expected to grow at an average annual rate of 0.4%, from an estimated 2.2 million jobs to just under 2.4 million. This level of employment growth falls below the 1.3% annual growth projection for employment at the national level between 1988 and 2000 (U.S. Department of Labor, Bureau of Labor Statistics 1987).

2. Primary Impact Counties

a. Ingham County

In terms of employment and total income, Ingham County is the larger of the two primary impact counties, but it contributes only a small portion to the ROI totals. In 1984, Ingham County provided 74.9% of total employment in the two impact counties but just 8.2% of the employment in the Michigan ROI. The county's residents received only 5.5% of total personal income in the ROI and 67.3% of total personal income in the primary impact counties. Total employment growth in the county averaged 1.5% annually between 1969 and 1984.

From 1969 to 1984 average annual employment in the eleven industrial sectors grew at rates exceeding the average national rates in four sectors and exceeding the average ROI rates in nine sectors. Employment in the mining sector grew fastest from 1969 to 1984 at a rate of 9.3%,

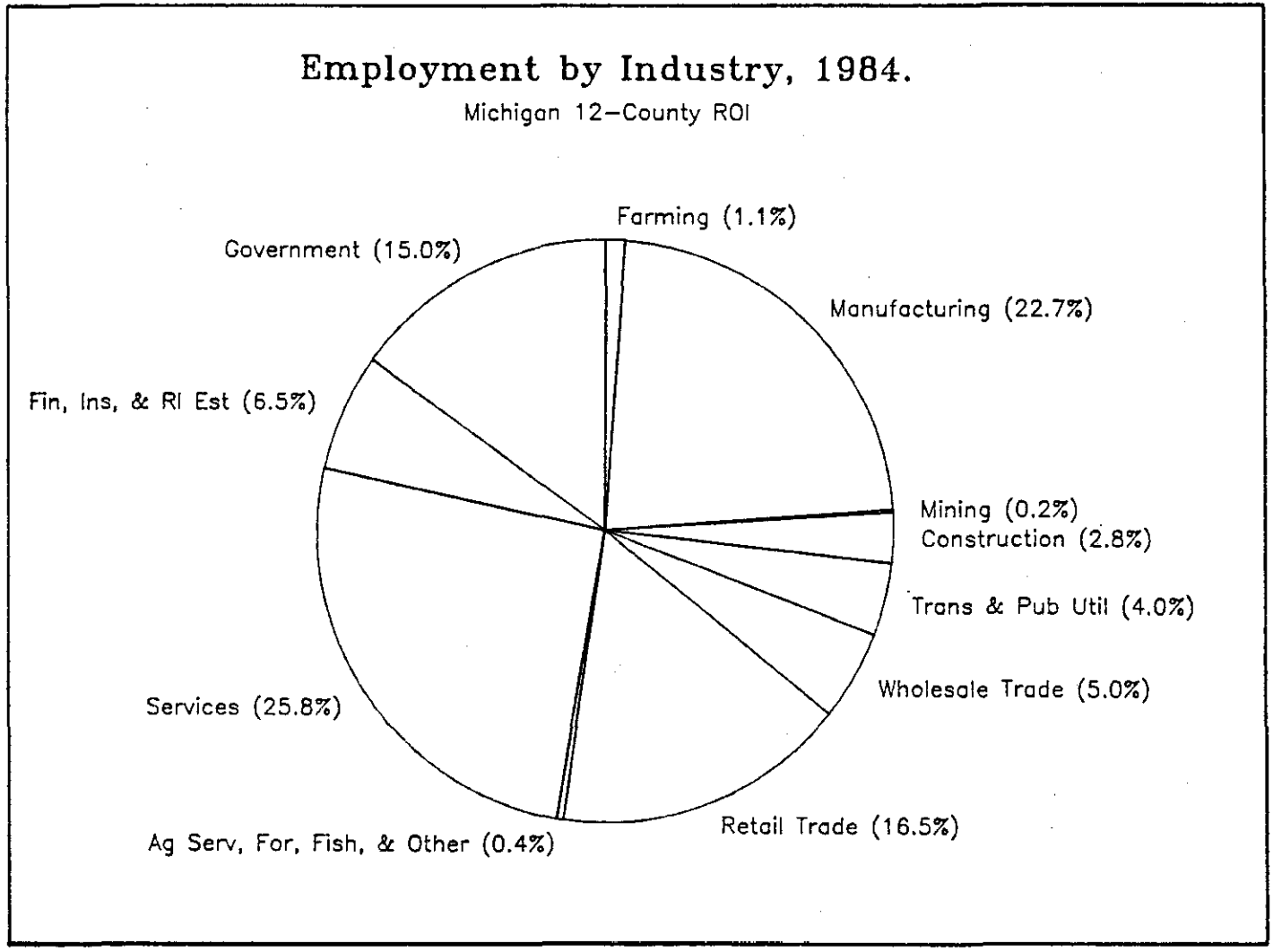


Figure 5.4.11-2

EMPLOYMENT BY INDUSTRY, 1984
MICHIGAN ROI

followed by agricultural services, forestry, and fishing (7.8%), and services (4.1%). The farming, construction, and manufacturing sectors all posted overall losses in employment. These employment losses were reflected in Michigan ROI trends for that period. As for national trends during that time, only employment in the farming and manufacturing sectors posted overall losses. The distribution of employment in the eleven major industrial sectors in 1984 was similar to that of the Michigan ROI. The four dominant sectors in the county economy, in terms of employment, were the same as those for the ROI, but ranked differently: government (with 30.6% of the total county jobs, mostly in Lansing, the state capitol), services (20.8%), manufacturing (17.4%), and retail trade (14.4%).

Average 1984 earnings per worker were $25,119, higher than the national average but slightly lower than the ROI average. In 1984, the highest average earnings per worker were paid in the manufacturing sector at just below $50,000. The next closest were workers in transportation and public utilities who averaged approximately $33,000.

For the past two decades, average annual unemployment rates fluctuated similarly to those of the Michigan ROI, peaking in 1982 at 11.9% and declining to 6.8% in 1987. With the exception of 1972 and 1977, county unemployment rates for that period remained consistently above those for the nation (Michigan Employment Security commission, 1988). Ingham County's labor force exceeded 150,000 persons for the first time in 1987, having grown at a modest average annual rate of 1.8% since 1970.

Per capita personal income in Ingham County has remained below the national average since 1981. In 1984, per capita personal income was $14,174, below both the ROI ($15,716) and national ($14,746) averages. Per capita personal income in the county grew slowly from 1969 to 1974 while oscillating around the national average and exceeded that average from 1975 to 1980.

b. Jackson County

In terms of employment and total income, Jackson County is the smaller of the two primary impact counties and contributes only a small portion to the ROI totals. In 1984, Jackson County provided 25.1% of total employment in the two impact counties but just 2.8% of employment in the Michigan ROI. The county also collected 2.7% of total personal income and 32.7% of total personal income in the primary impact counties. Total employment growth in the county averaged a 0.3% annual loss between 1969 and 1984.

Employment in the 11 industrial sectors in Jackson County grew at rates slower than the national average rates in all but two sectors but exceeded average ROI rates in five sectors. Employment in the mining sector grew fastest from 1969 to 1984 at a rate of 13.2%, followed by

agricultural services, forestry, and fishing (5.2%). As with trends in Ingham County and the Michigan ROI, the Jackson County farming, construction, and manufacturing sectors all posted overall losses in employment. However, average annual percentage losses were more severe than in either Ingham County or the ROI as a whole. The distribution of employment in the eleven major industrial sectors in 1984 was similar to that of the Michigan 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 21.3% of the total county jobs); manufacturing (20.4%); retail trade (17.7%); and government (15.5%).

Average 1984 earnings per worker were $21,264, slightly higher than the national average but lower than the ROI average. In 1984, the highest average earnings per worker were paid in the transportation and public utilities sectors at $37,681, followed by workers in manufacturing paid at $32,773.

For the past two decades, average annual unemployment rates have followed the same trends as those in Ingham County and the Michigan ROI. Unemployment rates peaked in 1982 at 16.1%, because of substantial layoffs in the wake of plant closures (e.g., the Goodyear plant).

The rate has declined since then, however, to a 1987 low of 7.8%. As with Ingham County during that period, average annual unemployment rates remained consistently above those of the nation except in 1971-72 and 1977 (Michigan Employment Security Commission 1988). The county's labor force included 62,700 persons in 1987; and although representing an overall annual average growth rate of 0.4% between 1970 and that year, total labor is considerably less than it was in 1980.

In 1984, per capita personal income in Jackson County was $12,891, below both the ROI ($15,716) and national average ($14,746). Although per capita personal income in the county had peaked at $13,931 in 1978, the net increase of per capita personal income in real dollars (1988 dollars) has been only about $250 between 1969 ($12,649) and 1984.

B. Demographics and Housing

1. Regional Setting

The population of the Michigan ROI grew steadily between 1930 and 1970. By the latter date, over 4.7 million persons lived in the region, 56.6% of whom resided in metropolitan Detroit (Wayne County). Since 1970, however, the population of this region has declined (Table 5.4.11-2). In 1980, the inhabitants of the Michigan ROI numbered roughly 4.6 million (U.S. Bureau of the Census 1982b), having decreased (at a -0.2% annual rate) during the 1970s. By 1985, the population of the region had further declined to an estimated 4.5 million (U.S. Bureau of the Census 1988), the result of -0.8% annual change from 1980. The decrease in regional population witnessed during the 1970s was centered largely

in Wayne County, which declined at an average annual rate of -1.3% during that decade. Further reduction in population experienced during the early 1980s in the Michigan ROI was more widespread, with nine of the 12 member counties losing population (Wayne County again leading the way, both in absolute and relative terms).

Table 5.4.11-2

KEY DEMOGRAPHIC INDICATORS FOR THE MICHIGAN ROI

	1970	1980	1990	2000	2010	2020	2030
Population (millions)	4.71	4.63	4.71	4.69	4.61	4.54	4.48
Avg. ann. chg. over preceding decade	0.9%	-0.2%	0.2%	-0.04%	-0.2%	-0.2%	-0.1%
			Age Distribution				
≤ 4 years	8.8%	7.2%	7.6%	7.2%	6.7%	6.2%	6.1%
5 to 19 years	30.3%	25.6%	21.8%	21.4%	21.0%	20.5%	19.8%
≥ 65 years	8.4%	9.5%	10.7%	10.5%	10.5%	10.4%	10.4%

Sources: U.S. Bureau of the Census 1982b.

Demographic projections prepared for the Michigan ROI suggest a slight resurgence in regional population during the latter half of the 1980s; total inhabitants are expected to reach 4.7 million by the end of the decade, the result of 0.2% average annual growth since 1980. At the turn of the century, however, population is anticipated to decline once again, at an annual rate of -0.04% during the 1990s to yield a total of slightly less than 4.7 million inhabitants. Finally, by 2030 the population of the Michigan ROI is projected to fall to slightly less than 4.5 million, representing a -0.1% average annual rate of change over the preceding decade.

The demographic composition of the Michigan ROI is expected to change during the five decades spanning 1980 to 2030, with decreasing numbers of young persons and increasing numbers of old persons. Because of the anticipated patterns of migration to and from the region by particular age groups, however, changes in age composition are not expected to be dramatic, and should be relatively minor during the later years of the projection series. In 1980, 7.2% of the ROI inhabitants were younger

218-829 0 - 88 - 12 (BOOK 4)

than 5 years, 25.6% were aged 5 to 19, and 9.5% were in excess of 64 years (U.S. Bureau of the Census 1982b). By the turn of the century, proportional representation of the youngest age group is projected once again at roughly 7.2% of the population; individuals 5 to 19 years are expected to decrease slightly, to 21.4% of the population, while the proportion of individuals 65 and older is expected to increase slightly to 10.5%. It is anticipated that these values will change little during the last three decades of the projection series, totalling 6.1, 19.8, and 10.4% of the ROI population, respectively, by 2030.

The 1980 Census of Housing recorded a total of more than 1.7 million year-round housing units in the Michigan ROI, slightly less than half the units in the whole state (U.S. Bureau of the Census 1982a). Of that total, 65.9% (1.1 million) were owner-occupied (or available for owner occupancy), 32.0% (0.5 million) were renter-occupied (or available for renter occupancy), and the remaining 2.1% 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, 94.4% were occupied in 1980. Considering only year-round units available for occupancy in the ROI, the 1980 vacancy rates were 1.3% for owner units and 7.2% for rental units.

Recent trends in housing construction, determined from the number of building permits authorized, indicate that housing in the region grew during the 1980s at an accelerating rate. A total of nearly 64,000 building permits for housing units were issued in the ROI from 1981 through 1986, an average of slightly more than 10,000 per year (U.S. Bureau of the Census 1983, 1985, 1987a). The issuing of housing permits in the Michigan ROI was disproportionate with respect to both time and space: nearly two-thirds of these permits were issued in 1985 and 1986; and more than half of the permits issued in each of the six years were issued in Oakland and Wayne counties.

2. Ingham, Jackson, Livingston, and Washtenaw Counties

For purposes of examining demographics and housing at the sub-ROI level, four Michigan counties will receive attention: Ingham, Jackson, Livingston, and Washtenaw. The proposed SSC site covers portions of Ingham and Jackson counties. Each of these two counties is dominated by a metropolitan area (Lansing-East Lansing, and Jackson, respectively) located within 30 min of the proposed SSC campus. Washtenaw County is likewise dominated by an urban center. Ann Arbor is located in its eastern portion, though the western two-thirds of the county, closest to the planned project site, is more sparsely settled. Finally, Livingston County, lying east-northeast of the site, is predominantly rural, though it has experienced the greatest relative growth since 1970.

Demographically the four counties are quite similar to one another in several ways. All have grown at relatively steady rates since 1930, with Jackson County the only one whose population had not at least doubled in the ensuing 40 years. By 1970, the populations of Ingham, Jackson, Livingston, and Washtenaw counties were 261,000, 143,000, 59,000, and 234,000, respectively (U.S. Bureau of the Census 1982a).

Each of these counties continued to grow throughout the 1970s, though at differing rates. By 1980, Ingham County contained approximately 275,000 persons (representing 0.5% average annual increase during the 1970s), Jackson County contained 151,000 persons (a 0.6% increase annually), Livingston County contained 100,000 persons (a 5.5% annual increase), and Washtenaw County contained 264,000 persons (a 1.2% average annual increase). During the first five years of the 1980s, the population of Ingham, Jackson, and Washtenaw counties began to decrease slightly (U.S. Bureau of the Census 1988). Population estimates for the three counties in 1985 were 273,000 (representing a -0.2% average annual change from 1980), 143,000 (a -1.1% change annually), and 262,000 (a -0.2% change annually), respectively. The population of Livingston County grew slightly between 1980 and 1985, though only to 102,000 (a 0.4% average annual increase). Continued steady or slightly declining populations are anticipated for all four counties through 2030.

In 1980, according to the U.S. Census Bureau, Ingham County contained nearly 100,000 year-round housing units, of which 56.8% were owner units, 41.8% were rental units, and 1.4% were unavailable for occupancy. Of the total year-round units in the county, 95.7% were occupied in 1980. Of those units available for occupancy, 1980 vacancy rates were 1.3% for owner units and 5.0% for rental units.

By contrast, year-round housing units in Jackson County in 1980 numbered just over half (approximately 54,000) of those in Ingham County, of which a considerably higher proportion (72.6%) were owner-occupied, 24.9% were renter-occupied units, and 2.5% were unavailable for occupancy. Of the total year-round units in the county, 95.0% were occupied in 1980. Considering only those units available for occupancy, 1980 vacancy rates were 1.5% for owner units and 5.7% for rental units.

Year-round housing units in Livingston County totalled about 33,000, with nearly 27,000 (80.6%) owner-occupied, 5,500 (16.7%) renter-occupied, and 2.7% unavailable for occupancy. Of the total year-round units in the county, 94.6% were occupied in 1980. Considering just those units available for occupancy, 1980 vacancy rates were 2.0% for owner units and 6.7% for rental units.

Washtenaw County contained more than 97,000 year-round housing units in 1980, split approximately in half between owner-occupied (50,000, representing 51.7% of the total) and renter-occupied (46,000, or 46.8% of the total). The remaining 1.5% of the units were unavailable for occupancy at the time of the census. Of total year-round units in the county,

95.4% were occupied in 1980. Considering only units available for occupancy, 1980 vacancy rates were 1.3% for owner units and 5.2% for rental units.

The accelerating increase in housing construction characterized by the ROI is found in all four of the counties presently being examined. From 1981 to 1986, more than 5,600 building permits for new housing construction were issued in Ingham County, nearly 1,300 in Jackson County, approximately 2,800 in Livingston County, and 4,600 in Washtenaw County (U.S. Bureau of the Census 1983, 1985, 1987a). Construction permit data for each county indicate a slight drop in building at the beginning of that period followed by a sharp rise towards 1985 and 1986.

Recent housing surveys of the four counties examined indicated generally lower total vacancy rates in 1987 than these estimated in the census of 1980 (Federal Home Loan Bank of Indianapolis 1987a, 1987b, 1987c).

Accommodations for temporary lodging within the four counties of interest are provided by approximately 6,200 hotel/motel units (Michigan Department of Commerce Travel Bureau 1988). Additional temporary accommodations in these counties are provided by more than 3,100 camp sites (American Automobile Association 1985).

C. Public Services

Levels of public service provided by local governments within the ROI were analyzed using October 1982 employment data (Bureau of the Census 1984) and 1985-86 school year statistics (Michigan 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 generally by the ratio of employees to regional population and specifically for instruction by student/teacher ratios at the primary and secondary public school levels.

1. Regional Setting

Levels of service ratios for key public services are presented in Table 5.4.11-3 for component counties of the ROI, the entire ROI, the State of Michigan, and the United States. Statistics for the ROI tend to be weighted by the high urbanization of Wayne and Oakland counties.

Total government employment for the ROI is 31.43 full time equivalent (FTE) employees per 1000 population as compared with 30.88 for Michigan and 34.35 for the United States. The ROI maintains a police protection at a level of service of 2.41 FTE employees per 1000 population, a level of service greater than the nation and far greater than the state (1.99). The ROI fire protection level of service falls short of the national

Table 5.4.11-3

LEVELS OF PUBLIC SERVICE FOR MICHIGAN SSC SITE[1]

Area	Police Protection	Fire Protection[2]	Health and Welfare	Public Education General Education	Public Education Student/ Teacher Ratio	All Other	Total
Calhoun County	2.04	1.00	2.42	19.38	19.8	6.91	31.75
Clinton County	1.27	0.21	0.20	14.69	21.2	6.58	22.95
Eaton County	1.42	0.38	0.00	18.09	21.0	5.23	25.12
Hillsdale County	1.31	0.24	6.30	15.85	21.8	8.58	32.28
Ingham County	2.12	1.30	7.14	22.97	21.0	11.17	44.70
Jackson County	1.61	0.69	1.75	17.53	21.6	5.39	26.97
Lenawee County	1.55	0.39	6.46	18.21	21.0	6.10	32.71
Livingston County	1.20	0.18	0.67	15.76	22.5	3.84	21.65
Oakland County	2.16	0.70	2.32	18.53	20.8	5.64	29.35
Shiawassee County	1.28	0.48	2.32	16.46	22.4	4.78	25.32
Washtenaw County	1.72	0.80	1.30	16.64	21.1	7.12	27.57
Wayne County	2.90	1.16	3.09	15.85	22.8	9.47	32.46
Region of Influence	2.41	0.94	2.93	17.15	21.9	8.00	31.43
Michigan	1.99	0.75	3.12	17.73	21.9	7.29	30.88
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.

Source: U.S. Bureau of the Census 1984; Michigan Department of Education 1987; U.S. Department of Education 1987.

average but exceeds the state average, largely because of the number of volunteer departments in the state and ROI. The ROI level of service for health care is below that of the state and nation.

2. Primary Impact Counties

Of the twelve counties in the Michigan ROI, Ingham and Jackson counties are considered primary impact counties since they are proposed to host the SSC ring. Each county is proposed to contain approximately half the ring, with the far experimental areas in Ingham County and the campus and injector facilities shared between the two counties.

a. Ingham County

The level of service for police protection falls slightly below the ROI and national averages while its level of service for fire protection exceeds the average ROI, state, and national levels. Police and fire protection services closest to the proposed Michigan SSC campus site currently operate from Stockbridge, about 3 mi away.

Ingham County has the highest level of service ratio for health care in the ROI with 7.14 FTE employees per 1,000 population, more than twice the ROI and state averages and well above the national average. Four medical facilities located in Lansing, all within 50 minutes' driving time of the proposed SSC campus, provide general hospital care with approximately 1,200 beds. Emergency medical services are provided by fire departments and emergency medical service centers throughout the county; the closest to the proposed SSC campus is located in Stockbridge, 5 minutes from the site.

Ingham County is divided into 12 public school districts. The student/teacher ratio for the county (21.0) indicates a level of service better than the state and ROI but not as good as the national average level (18.0), while the county ratio of education employment to population exceeds those of the ROI, state, and nation.

b. Jackson County

The level of service for police protection for Jackson County (1.61 FTE employees per 1,000 population) is below the average levels for the ROI, state, and nation. The Sheriff's Department is responsible for the enforcement of services throughout the county and has a staff of 71 full-time and 11 part-time employees. The city of Jackson Police Department is responsible for services in and around the city; this department has a complement of 75 sworn officers on staff.

Fire prevention and suppression services are supplied in the county by both fully staffed city fire departments and rural volunteer departments. On the average, the county offers fire protection at a level of service lower than the ROI, state, and nation.

In addition to general hospital care provided by the concentration of ROI hospitals and medical centers in Ann Arbor, Lansing, and Detroit, Jackson County provides community health care services with the W.A. Foote Memorial Hospital, which has the capability of airlifting patients, if necessary, to hospitals in Ann Arbor.

Seven school districts serve Jackson County with a combined student/teacher ratio of 21.6, approximating the average for the state and ROI (both 21.9) yet not as good as the national average (18.0). Likewise, the level of educational service based on 17.53 FTE employees per 1000 population lies near the ROI and state ratios (17.15 and 17.73, respectively), but is exceeded by the national average of 18.44.

D. Public Finance

1. Michigan State Government Finances

a. State Government Taxes

Michigan has a single business tax on all business activity in Michigan and a personal income tax. A sales and use tax and various motor vehicle fuel taxes and license fees provide the bulk of the rest of the tax revenues. All dollar values in the public finance discussion are current dollars for the fiscal years cited.

The single business tax, a value-added tax, is levied at a rate of 2.35% of federal taxable income apportioned to Michigan. The tax applies to all forms of business organizations. In FY 1986 this tax yielded 15.56% of Michigan tax revenues.

Individuals, estates, and trusts pay 4.6% of net income based on one of two federal methods. City add-ons are possible. This tax yielded 34.87% of Michigan tax revenues in FY 1986.

The sales and use tax is levied at a rate of 4% of gross proceeds from retail sales of tangible personal property, electricity, gas, and steam. This tax provided 28.85% of Michigan tax revenues in FY 1986.

Gasoline, liquid petroleum gas, and diesel fuel, including that used for motor carriers, are taxed at 15 cents/gal. Watercraft fuel is similar, but aircraft gasoline is taxed at 3 cents/gal. These items produced 6.37% of Michigan tax revenues in FY 1986.

Private automobile registration fees are based on value and weight. Motor carriers are also required to purchase permits. These sources provided 3.70% of Michigan tax revenues in FY 1986.

Other Michigan tax sources include the general property tax, which includes an intangibles tax and a tax on public service corporations, alcohol taxes, a cigarette tax, and insurance companies taxes. In FY 1986 the largest yield from these was 2.35% of Michigan tax revenues from the 21 cents/pack cigarette tax.

b. State Revenue and Expenditure

State government general revenue and expenditure are presented in Table 5.4.11-4 for FY 1986. Taxes, intergovernmental revenues, and charges are the main general revenue categories. The major taxes are income and sales taxes, as already indicated. General revenues exceeded general expenditures by about 6%; direct capital outlay was about 6% of total general expenditures.

c. Local Government Organization and State Payments to Local Governments

There were 83 county, 532 municipal, 1,245 township, and 599 school district governments in Michigan at the time of the 1982 Census of Governments. Township governments encompass the entire state except for areas within city boundaries. Michigan townships traditionally have administered the property tax and provided fire protection. Many townships provide police protection, water and sewer services, and other functions as well. Michigan has no dependent school districts.

There were also 184 special district governments. These include several types of water and sanitation bodies and power agencies. These agencies have user fee, property tax, and bonding powers, in some cases.

In Michigan, certain taxes are, in whole or in part, dedicated to local school support. The largest expenditure is the basic education supplement to school districts for providing a minimum school program. Categorical aid is also provided.

The state has a revenue sharing program, which includes 15% of general sales tax revenues distributed to cities and townships in proportion to population. Part of the single business tax is distributed based on a formula, including property values and rates to counties, cities, and townships. Of the individual income tax, 12.1% is distributed to counties in proportion to population and to municipalities and townships on the basis of a tax effort formula.

The major highway fund distribution is from motor fuel tax revenues, distributing 37.4% to counties and 20.7% to cities and villages. Other funds are granted for highway projects and snow removal.

Table 5.4.11-4

MICHIGAN STATE GENERAL REVENUE AND EXPENDITURE FY 1986

Revenue/Expenditure	Amount in thousands	Per Capita
REVENUE		
Total intergovernmental	$ 4,487,230	$ 491
Federal	4,005,374	438
Total taxes	9,314,194	1,019
Sales and gross receipts	3,763,451	412
General sales	2,687,022	294
Selective sales, gross receipts	1,076,429	118
Alcohol	94,353	10
Insurance	148,551	16
Motor fuels	593,425	65
Public utilities	---	---
Tobacco	218,822	24
Individual income	3,248,238	355
Corporation net income	1,449,598	159
License	534,095	58
Corporate license tax	87,848	10
Motor vehicle	329,516	36
Occupations and business licenses	42,186	5
Documentary and stock transfer fees	---	---
Property tax	187,511	21
Charges and misc. general revenue	2,806,233	307
Current charges	1,437,725	157
Total General Revenue	$16,607,657	$1 816
EXPENDITURE		
Total General Expenditure	$15,602,259	$1 706
Direct capital outlay	898,484	98

Note: Population as of 7-1-86: 9,145,000

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

2. Michigan Local Government Finances

Michigan local governments to be discussed include two counties, Ingham and Jackson. In Ingham County, the city of Lansing is included. For Jackson County, both the city of Jackson and the village of Stockbridge are considered.

a. Ingham County

Ingham County revenues and expenditures are provided for 1986 in Table 5.4.11-5. Major revenue sources are taxes, in this case property taxes, and intergovernmental revenues. Charges for services, interest income, and special assessments also provide significant shares. Revenues exceeded expenditures by less than 1%; capital outlays were 2% of total expenditures.

Property taxpayers supported the following jurisdictions in 1986 with the amounts indicated:

Jurisdiction	Tax Levy
County government	$ 21,530,000
City government	23,410,000
Village government	3,100,000
Township government	5,840,000
School districts	129,090,000
Total Ingham county	$182,970,000

Total 1987 assessed value was $2,842,670,997.

City of Lansing. Lansing revenues and expenditures are in Table 5.4.11-6 for 1987. Taxes, including property and income taxes, and intergovernmental revenues were the largest revenue sources. A deficit of about 14% was largely because of capital improvement expenditures, which were about 27% of total expenditures.

Village of Stockbridge. Stockbridge revenues largely consisted of taxes, state intergovernmental revenues, and charges for services as reported for 1987 in Table 5.4.11-7. A surplus of 14% and no capital outlays were recorded.

b. Jackson County

Taxes, intergovernmental revenues, and charges for services were the highest shares of 1986 revenues, as shown in Table 5.4.11-8. A surplus of 6% and capital outlays of 1% of total expenditures were registered.

Table 5.4.11-5

INGHAM COUNTY, MICHIGAN
COUNTY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Taxes	$ 20,304,511	$ 73
Special assessments	1,825,152	7
Licenses and permits	162,109	1
Intergovernmental	29,250,198	105
Charges for services	5,252,447	19
Rents	126,317	0
Interest	1,862,227	7
Miscellaneous	349,599	1
Total Operating Revenue	$ 59,132,560	$ 213
EXPENDITURE		
Operations	$ 57,614,233	$ 207
Capital projects	1,104,368	4
Total Expenditure	$ 58,718,601	$ 211

Notes: Population, 1986: 277,800
Assessed Valuate, 1987: $2,842,670,997

Sources: For financial data: Ingham County 1986; for population figure: U.S. Bureau of the Census.

Table 5.4.11-6

LANSING (INGHAM COUNTY), MICHIGAN
CITY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1987

Revenue/Expenditures	Amount	Per Capita
REVENUE		
Taxes and special assessments	$ 35,528,492	$ 286
Licenses and permits	853,677	7
Intergovernmental	25,687,029	207
Charges for services	3,463,977	28
Fines and forfeits	1,484,973	12
Interest	2,645,027	21
Contributions	4,074,150	33
Miscellaneous	1,241,446	10
Total Operating Revenue	$ 74,978,771	$ 604
EXPENDITURE		
Operations	$ 64,542,402	$ 520
Capital improvements	22,359,924	180
Total Expenditures	$ 86,902,326	$ 700

Note: Population, 1986: 124,230

Sources: For financial data: City of Lansing, 1987; for population figure: U.S. Bureau of the Census 1988.

Table 5.4.11-7

STOCKBRIDGE (INGHAM COUNTY), MICHIGAN
VILLAGE REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1987

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Taxes	$ 128,295	$ 96
Licenses and permits	1,156	1
Intergovernmental		
Federal	7,948	6
State	112,810	85
Charges for services	70,605	53
Miscellaneous	25,601	19
Total Operating Revenue	$ 346,416	$ 260
EXPENDITURE		
Total Expenditures	$ 303,240	$ 228

Note: Population, 1986: 1,330

Sources: For financial data: Village of Stockbridge 1987; for population figure: U.S. Bureau of the Census1988.

Table 5.4.11-8

JACKSON COUNTY, MICHIGAN
COUNTY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1986

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Taxes	$ 8,419,786	$ 58
Licenses and permits	261,058	2
Intergovernmental		
Federal grants	1,511,338	10
State grants	12,515,669	87
Charges for services	5,541,382	38
Fines and forfeits	538,227	4
Interest, rentals, and leases	1,076,358	7
Contribution from local governments	4,764,407	33
Reimbursements and refunds	217,360	2
Prior years adjustment	41,136	0
Other	498,392	3
Total Operating Revenue	$ 35,385,113	$ 245
EXPENDITURE		
Operations	$ 32,942,344	$ 228
Capital projects	321,227	2
Total Expenditure	$ 33,263,571	$ 230

Note: Population, 1986: 144,400
Assessed Validation, 1987: $ 1,299,802,796

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

Property taxes for all local jurisdictions in 1986 were as follows:

Jurisdiction	Tax Levy
County government	$ 9,140,000
City government	4,400,000
Village government	380,000
Township government	1,640,000
School districts	56,450,000
Total Jackson county	$72,010,000

Total 1987 assessed value was $ 1,299,802,796.

City of Jackson. Jackson revenues and expenditures are displayed in Table 5.4.11-9 for 1987. Intergovernmental revenues and income and property taxes are the largest sources. A small deficit of 2% was experienced. No capital outlays were reported.

5.4.11.2 Infrastructure

A. Transportation

1. Roads

Major highways and roads serving the proposed SSC site are shown in Figure 5.4.11-3. Data on these highways and roads are presented in Table 5.4.11-10.

Metropolitan Detroit, 59 mi to the east of the proposed site, is served by a freeway system that includes interstate highways I-94 extending to the northeast and west, I-96 extending to the west-northwest, and I-75 extending to the northwest and south. An extensive system of arterial and bypass freeways and highways join these interstates.

The proposed site is served by a network of interstate, U.S., state, and county highways and roads. These include I-96 on the north and I-94 on the south. U.S. route 127 crosses the site from north to south and connects the site with Lansing and I-96 to the north and Jackson and I-94 to the south. State route 52 connects Stockbridge and the campus area to I-96 to the north and I-94 to the south. State route 106 crosses the southeastern quadrant of the ring and connects Jackson with state route 52 south of Stockbridge. State route 36 crosses the northern quadrant of the ring and connects U.S. route 127 and state route 52. Additional county paved roads provide access to most of the proposed locations for surface facilities.

2. Rail

Rail lines serving the proposed site are shown in Figure 5.4.11-3. The proposed Michigan SSC site area is served by a Conrail main line that crosses the site in a north-south direction along the general alignment

Table 5.4.11-9

JACKSON (JACKSON COUNTY), MICHIGAN
CITY REVENUE BY SOURCE AND TOTAL EXPENDITURE - 1987

Revenue/Expenditure	Amount	Per Capita
REVENUE		
Taxes		
Property	$ 4,316,707	$ 117
Income	4,201,226	114
Licenses and permits	140,310	4
Intergovernmental	8,430,892	228
Charges for services	1,456,613	39
Fines and forfeits	59,978	2
Special assessments	240,168	6
Investment income	200,704	5
Miscellaneous	610,118	17
Total Operating Revenue	$ 19,656,716	$ 532
EXPENDITURE		
Total Expenditure	$ 20,023,231	$ 542

Note: Population, 1986: 36,970,000

Sources: For financial data: City of Jackson, Michigan 1987; for population figure: U.S. Bureau of the Census 1988.

Figure 5.4.11-3

MAJOR TRANSPORTATION SYSTEMS SERVING THE MICHIGAN SITE

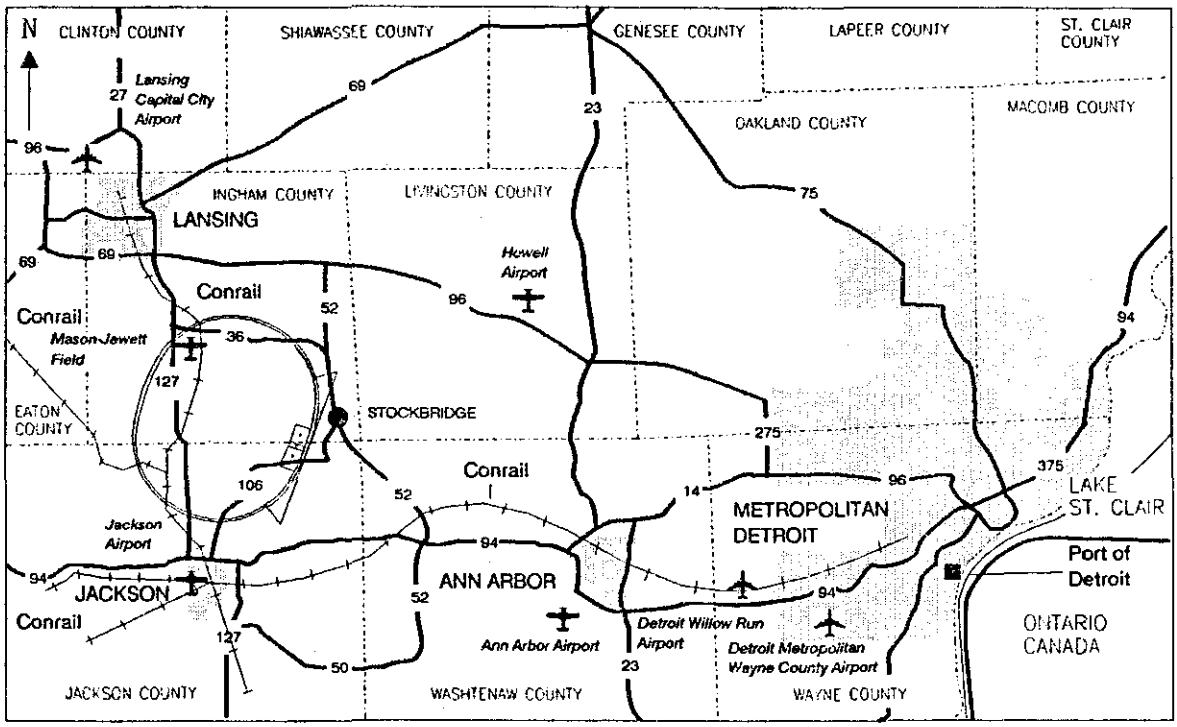


Table 5.4.11-10

PRESENT HIGHWAYS AND ROADS SERVING THE PROPOSED MICHIGAN SSC SITE

Road Segment	Length miles	Lanes	Capacity pcph[1]	Peak Hour Volume[2] pcph	LOS[3]
I-94: U.S. Route 127 to State Route 52	21	4	8,000	3,500	B
I-94: State Route 52 to Ann Arbor	12	4	8,000	5,400	C
I-96: U.S. 127 to State Route 52	15	4	8,000	4,400	C
U.S. Route 127: I-94 to State Route 36	23	4	8,000	1,600	A[4]
U.S. Route 127: State Route 36 to I-96	6	4	8,000	2,100	A
State Route 52: I-96 to State Route 36	7	2	2,800	250	B
State Route 52: State Route 36 to State Route 106	8	2	2,800	350	B
State Route 52: State Route 106 to I-94	14	2	2,800	650	C[5]
State Route 36: U.S. Route 127 to State Route 52	15	2[6]	2,800	450	C[7]
State Route 106: I-94 to State Route 52	19	2	2,800	450	C[8]

Notes: 1. pcph - passenger cars per hour.

2. 30th high hour volume.

3. 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.

4. A portion of U.S. Route 127 close to I-94 experiences LOS B.

5. A portion of State Route 52 in Chelsea experiences LOS E.

6. A short section of State Route 36 close to U.S. Route 127 has 4 lanes. This segment experiences LOS F according to the Michigan Department of Transportation.

7. A portion of the two lane section of State Route 36 close to Mason experiences LOS D.

8. A portion of State Route 106 close to I-94 experiences LOS D.

Source: Michigan Department of Transportation 1986a; Transportation Research Board 1985.

of U.S. route 127. An additional Conrail main line branches off of the first line within the ring and extends to the northwest toward Grand Rapids. These lines connect the proposed site to northern Michigan cities and the Detroit-Chicago rail corridor at Jackson to the south. This rail corridor connects the site to major ports on the Great Lakes and to most major cities in the U.S. through connection to other rail lines. Two daily freight trains are served by the Conrail lines crossing the site. The Detroit-Chicago rail corridor serves six to eight daily freight trains (Michigan Department of Transportation 1985). An abandoned rail line right-of-way extends to the northeast from Jackson, crossing the southeast quadrant of the ring. The closest rail siding is at Jackson 15 mi to the southwest of the proposed campus location.

AMTRAK passenger rail service is provided along the Detroit-Chicago corridor with three scheduled stops in each direction at Ann Arbor and Jackson. The Detroit-Chicago corridor has served 330,000 to 390,000 passengers in each of the last 10 years (Michigan Department of Transportation 1985).

The Michigan Department of Transportation (MDOT) is implementing a program of capital and operating improvements that are expected to significantly increase rail service along the Detroit-Chicago corridor by 1990. Additional improvements are expected in the 1990s (Michigan Department of Transportation 1986b). The MDOT is also investigating the potential of establishing high-speed rail service between Detroit and Chicago (Michigan Department of Transportation 1985).

3. Air

Airports serving the proposed SSC site are shown in Figure 5.4.11-3. The principal airport that would provide passenger service to the proposed Michigan SSC site is the Detroit Metropolitan Wayne County Airport. This publicly owned and operated airport is located south of I-94 approximately 17 mi southwest of downtown Detroit and approximately 45 mi east southeast of the proposed campus location. This airport is a major hub in the U.S. transportation system. Airport operations are currently congested with 29,000 hours of delays experienced by scheduled airline operations in 1986. Delays are forecasted to increase to 54,000 hours in 1996. (Yatzeck 1988). A three-phased $450 million expansion program is planned for the next 10 years to mitigate the airport congestion. This program will include expansion of the runways and concourses and improvements in the access routes and other facilities (Greater Detroit Chamber of Commerce 1987).

The principal airport that would provide freight service to the proposed SSC site is the Detroit Willow Run Airport. This publicly owned and operated airport is located north of I-94 approximately 25 mi west-southwest of downtown Detroit and approximately 36 mi southeast of the proposed campus location. The airport provides the bulk of air cargo service for the area and in 1986, more than 900 million pounds of air

cargo were handled. It also provides service for general aviation aircraft.

Capital City Airport, a publicly owned and operated airport located on the northwest side of Lansing, would also provide airline and freight service to the proposed SSC site. It is located approximately 35 mi northwest of the proposed campus location. During 1987, the airport served more than 350,000 passengers.

Publicly owned and operated general aviation fields are available at Ann Arbor, Jackson, Mason, and Howell. Mason-Jewett Field, located above the upper arc of the collider ring approximately 14 mi to the northwest, is the closest airport to the proposed campus location. Reynolds Field located in Jackson 16 mi southwest of the proposed campus location is capable of handling corporate jet aircraft and also provides limited passenger service.

4. Waterways

The proposed Michigan SSC site is located close to the Great Lakes/St. Lawrence Seaway System, which provides a water transportation route to neighboring states, Canada, and overseas ports. Ports on the Great Lakes/St. Lawrence Seaway System that could serve the proposed SSC site are the ports of Detroit, Monroe, and Toledo.

The Port of Detroit, owned and operated by the Detroit/Wayne County Port Authority, is located on the Detroit River in downtown Detroit approximately 58 mi east of the proposed SSC campus site. It has the capability to handle both bulk and containerized cargos. It includes a Foreign Trade Zone complex. The port handled more than 18.5 million tons of cargo in 1986 (Greater Detroit Chamber of Commerce 1987). Conrail provides rail service between the port and the proposed SSC site.

The Port of Monroe is located in Monroe County on Lake Erie approximately 57 mi southeast of the proposed SSC campus site. Interstate highways provide service between the port and the proposed SSC site.

The Port of Toledo, owned and operated by the Toledo-Lucas County Port Authority, is located on Lake Erie in northern Ohio approximately 61 mi southeast of the proposed SSC campus site. It has the capability to handle both bulk and general cargos. It includes a Foreign Trade Zone complex (TLCPA Undated). Conrail provides rail service between the port and the proposed SSC site.

5. Public Transit

a. Bus Service

Bus services in the SSC region are provided in the cities of Lansing, Jackson, and Ann Arbor. In addition, bus service is provided throughout the Detroit metropolitan area.

The Capital Area Transit Authority (CATA) provides service to the Lansing urban area. CATA also operates the Intran Small Bus program on an advanced reservation basis to communities outside the Lansing urban area, including Stockbridge near the proposed SSC campus location. Approximately 4.5 million passengers were served in FY 1985.

The Jackson Transportation Authority (JTA) provides service to the Jackson urban area. Approximately 646,000 passengers were served in FY 1986.

The Ann Arbor Transportation Authority (AATA) provides service in the Ann Arbor and Ypsilanti urban areas. Approximately 3.6 million passengers were served in 1986.

b. Taxi Service

Privately operated taxi, shuttle, and limousine service is provided throughout the Detroit metropolitan area. Additional services are provided in the cities of Lansing, Jackson, and Ann Arbor. Privately operated limousine service is provided between communities in the proposed SSC area and the Detroit Metropolitan Wayne County Airport.

c. Rental Car Service

Privately operated rental car services are located at the Detroit Metropolitan Wayne County Airport, at other locations in the Detroit metropolitan area and at the Lansing Capital City Airport. Rental car services are also available at general aviation fields in Jackson and Howell (Flight Guide 1986).

d. Para-Transit Services

The JTA provides out-county passenger services for the elderly and the handicapped in the Jackson area. Approximately 43,000 passengers used this service in 1985.

B. Utilities

1. Electricity

a. Ownership

Electric service in the vicinity of the proposed Michigan site is provided by the Consumers Power Company (CPCo) and the Detroit Edison Company (Detroit Edison).

Michigan's largest public utility, CPCo is the principal subsidiary of CMS Energy Corporation, a holding company incorporated in Michigan. CPCo's primary business is providing electric and/or natural gas service. Its preferred stock and CMS Energy common stock, are listed on the New York Stock Exchange. (Consumers Power Company 1987; CMS 1987).

Detroit Edison is a publicly held corporation, Its primary business is a public utility engaged in the generation, purchase, transmission, distribution, and sale of electric energy. (Detroit Edison 1987).

b. Delineation of Service Territory

Consumers Power Company provides electric and/or natural gas service to 67 of the 68 counties in Michigan's lower peninsula, serving almost 6 million of the 9 million residents there. (Consumers Power Company 1986).

Detroit Edison provides electric service to the southeast quadrant of the lower peninsula. (East Central Area Reliability).

The Consumers Power Company map delineates the service areas for both the CPC and Detroit Edison Co. (Consumers Power Company map, 1984)

c. Interrelationship with Other Electric Utilities

The electric generating and transmission systems of CPCo and Detroit Edison make up the Michigan Electric Coordinated Systems (MECS) bulk power system. The MECS system has nine 345-kV, two 230-kV, and one 138-kV interconnections with electric utilities in the states of Indiana, Ohio, and the province of Ontario, Canada.

Both the CPCo and Detroit Edison are also members of the East Central Area Reliability (ECAR) coordination agreement. ECAR is one of nine regional councils that make up the North American Electric Reliability Council (NERC). ECAR participates with neighboring regions in system performance studies to assure that member systems meet regional reliability criteria. ECAR region bulk power membership currently consists of 27 companies (18 systems) that serve either all or part of the states of Michigan, Indiana, Kentucky, Ohio, Virginia, West Virginia, Pennsylvania, Maryland, and Tennessee. (North America Electric Reliability Council, 1987; East Central Area Reliability, 1987).

ECAR coordination agreement details existing and proposed interconnections between CPCo, Detroit Edison, and other power systems. East Central Area Reliability 1986.

d. Existing Network

Detroit Edison operates 24 thermoelectric plants located in 10 counties in southeast Michigan, generating the largest amount of total energy in the state. CPCo operates 10 plants and generates the second largest amount. Together with the Indiana and Michigan Electric Company, these three utilities account for approximately 90 percent of the total generated in the state. (Michigan Department of Natural Resources 1986).

Detroit Edison produces approximately 9,000 MW on a mix of coal, oil and gas, turbine and diesel-fired plants; while CPCo produces approximately 6,200 MW of electricity on a mix of coal, oil and gas turbine, and nuclear power plants (East Central Area Reliability 1986).

e. Planned Future Upgrades/Additions

Sections I and II of the ECAR 1994 Summer Appraisal contain geographic transmission diagrams of the 1986 MECS system, and the system as it is projected to exist in 1994. Also included is a switching diagram of the system showing bulk power facilities scheduled to be added from 1986 to 1994. The in-service dates of future generating units, transmission lines, and EHV transformers are listed, along with other information (East Central Area Reliability 1986).

Detroit Edison plans to enhance their transmission system by a final major link: a 22 mile, 345-kV line to improve service reliability from the Belle River plant. This line is expected to be completed in 1990 (Detroit Edison 1987).

2. Natural Gas

a. Ownership

Natural gas service is provided to the vicinity around the Michigan site by the Consumers Power Company, the Michigan Consolidated Gas Company, and the Southeastern Michigan Gas Company.

Consumers Power Co. (CPCo) is the principal subsidiary of CMS Energy Corporation, a holding company incorporated in Michigan. CPCo is Michigan's largest public utility. Its primary business is providing electric and/or natural gas service.

Southeastern Michigan Gas Company is a wholly owned subsidiary of Southeastern Michigan Gas Enterprises Inc., a holding company.

b. Delineation of Service Territory

Consumers Power Company provides natural gas service to 40 of the 68 counties in Michigan's Lower Peninsula, serving more than 1.2 million gas customers in an area of 13,000 mi^2 with a population of 3.8 million. (CPCo 1986).

Michigan Consolidated Gas Company provides service to parts of Washtenaw and Wayne Counties. Southeastern Michigan Gas Company provides service to approximately 74,000 customers in parts of Jackson and Calhoun counties, and the Port Huron area (Michigan Consolidated Gas Company 1987; Washtenaw 1985; Southeastern 1987).

c. Interrelationship with Other Natural Gas Utilities

Consumers Power Company has contracted with Michigan Consolidated Gas Company for a firm pipeline capacity of 125 million ft^3/d of natural gas per day to be delivered via the ANR Pipeline Company. CPCo has also arranged with ANR Pipeline Company to connect directly to its pipeline system near Holland, Michigan providing approximately 100 million ft^3/d more of interconnection capacity. CPCo's traditional gas suppliers also include Panhandle Eastern Corporation and Trunkline Gas Company (Consumers Power Company 1986).

d. Existing Network

Consumers Power Company's natural gas system spans over 35,000 mi, including 1,400 mi of high-pressure transmission pipeline, 18,000 mi of distribution mains, and over 16,000 mi of individual service line.

CPCo has a gas distribution system serving the community of Stockbridge that operates at 30 $lb/inch^2(g)$ and has a maximum allowable operating pressure of 60 $lb/inch^2(g)$. A gas regulator station, located on the northeast side of the community, is fed from a 4 inch steel high-pressure gas main operating at 155 $lb/inch^2(g)$. (Marvin 1988)

CPCo also maintains a gas storage field at Northville, which is approximately 40 mi east of Stockbridge. Northville has a working capacity of 9.9 BCF. The total gas storage of all the CPCo's gas fields is 161 BCF. All the gas storage fields are interconnected by gas transmission lines. (Marvin 1988)

Table 5.4.11-11 presents an overview of CPCo's natural gas deliveries over a five-year period.

Table 5.4.11-11

CONSUMERS POWER COMPANY NATURAL GAS STATISTICS

	1986	1985	1984	1983	1982
Gas deliveries (Bcf)	268	279	277	273	292
Customers (thousands)	1,251	1,221	1,198	1,181	1,168

Source: Consumers Power Company 1986.

e. Planned Future Upgrades/Additions

CPCo currently estimates that upgrades to the system within the next ten years will be as follows:

- Replacement Mains - 192,000 ft/yr, or 1,920,000 ft
- Replacement Services - 8,800/yr, or 88,000
- Replacement Risers - 6,100/yr, or 61,000
- Replacement Meter Installations - 13,500/yr, or 135,000

CPCo currently estimates that additions to the system due to new business within the next ten years be as follows:

- New Business Mains - 800,000 ft/yr, or 8,000,000 ft
- New Business Services - 17,700/yr, or 177,000
- New Business Meter Installations - 28,900/yr, or 289,000
- System Load Growth Mains - 66,000 ft/yr, or 660,000 ft

3. Telecommunications

a. Ownership

Telecommunications service to the surrounding area is provided by Alltel Michigan, Inc. and Michigan Bell Telephone Company. Other carriers serving portions of counties are: General Telephone Company of Michigan; Mid-Michigan Telephone Corporation; and Southern Telephone Company.

Michigan Bell, a Michigan corporation, is a wholly owned operating subsidiary of American Information Technologies Corporation (Ameritech) (Michigan Bell 1987).

Ameritech is the parent of five midwestern Bell companies and seven information industry subsidiaries. (American Information Technologies Corporation 1987).

b. Delineation of Service Territory

The majority of Washtenaw County is served by the Michigan Bell Telephone Company. Other companies serving portions of Washtenaw County are: General Telephone Company of Michigan serving Britton, Clinton, Grass Lake, Maybee, Saline, Tecumseh and Tipton; Mid-Michigan Telephone Corporation serving Gregory and Stockbridge; and Southern Telephone Company serving Brooklyn (Washtenaw 1985).

Michigan Bell provides communications services, mainly local, network access and intraLATA long distance services, throughout Michigan. It serves 74 counties statewide, and more than 3 million customers (Michigan Bell 1987).

The Ameritech Bell Group provides communications services and long distance connections to over 11 million business and residential customers

218-829 O - 88 - 13 (BOOK 4)

in Illinois, Indiana, Michigan, Ohio, and Wisconsin (American Information Technologies Corporation 1987).

Alltel's services territory is divided into four operating regions. The Midwest Region provides telecommunications service to Michigan, Illinois, Indiana, and Ohio. (Alltel 1987).

Locally, the locations of Alltel's switching centers and its existing boundaries are delineated on the Alltel exchange area map. (Alltel map 1988).

c. Interrelationship with Other Telecommunications Systems

Present Alltel service network interconnections are with Michigan Bell and AT&T. All long distance traffic is handled by Michigan Bell for intraLATA calls and AT&T for interLATA calls (Stark 1988).

Alltel Michigan Inc., a local communications firm, is presently tied in with the Michigan Bell network at Jackson, Michigan.

Michigan Bell provides interconnections with 75 long distance carriers to provide interLATA service. Among these carriers are AT&T, MCI, and U.S. Sprint (Michigan Bell 1987).

d. Existing Network

Michigan Bell maintains a regional office in Ann Arbor, along with three other offices within Washtenaw County.

There is a Western Union operation in Washtenaw County, also based in Ann Arbor, with service offices located in Ann Arbor, Ypsilanti, and South Lyon (Washtenaw 1983).

Michigan Bell presently maintains 91 digital switches and over 48,000 mi of fiber optic cable throughout its network (Michigan Bell 1987).

Alltel currently services 7 exchanges for the network in and around the Stockbridge area. In addition, Alltel serves another 19 exchanges, a number of these around Jackson to the west and south (Stark 1988). By the end of 1987, 52% of Alltel's customers were served by digital switching. (Alltel 1987).

e. Planned Future Upgrades/Additions

Michigan Bell is planning to have over 75,000 mi of fiber optic cable in service by 1992. By the end of the decade, the number of digital switches in service is planned to be increased from 91 to 170 (Michigan Bell 1987).

Alltel projects a capital expenditure budget of $30 million over the next 5 years. Beginning in 1989, Alltel Michigan will begin converting all its exchanges to full equal access for long distance calls (Stark 1988).

5.4.12 Cultural and Paleontological Resources

5.4.12.1 Cultural Resources

A. Cultural History and Scientific Basis

The earliest occupants of central Michigan were Paleo-Indians, big-game hunters whose cultures date from approximately 10,000 B.C. to 8000 B.C. Late Paleo-Indian boreal forest hunters expanded across central Michigan as the glacial fronts retreated northward. Paleo-Indian sites are characterized by fluted lanceolate projectile points, and a small range of chipped stone tools. Later sites exhibit smaller, unfluted points, such as the Holcombe and Hi-Lo types. This period is poorly documented, but sites are generally located in upland areas, lakeshores, or riverine environments. In central and southeastern Michigan, there is potential for Paleo-Indian sites exhibiting considerable time depth, although most of the current information is based on isolated finds (Mueller 1980).

The Archaic period is marked by a transition from the nomadic Paleo-Indian cultures to a more seasonal settlement pattern. Sites from the Early Archaic are rare, with most finds from surface collections. Projectile points are of several types including: Scottsbluff, Eden, Kirk, LeCroy, Decatur, Thebes, and Dovetail (Fitting et al. n.d.). The Middle Archaic period is identified by side-notched projectile points, also mostly from surface collections. Information on site locations is generally lacking, but according to available data, they are presumed to be in upland areas near swamps and small tributaries.

Archaeological sites dating to the Late Archaic period (ca. 3000 B.C. - 1000 B.C.) are more common. A wider range of resources were exploited, as indicated by a variety of new projectile point types and groundstone technologies. Groundstone grooved axes, chisel-shaped celts, slate banner, and birdstones are characteristic. There is tentative evidence of a settlement pattern that includes a base camp and small specialized activity sites. The first large sites along major rivers are recorded during the Late Archaic period (Lovis et al. 1980).

The Woodland period (1000 B.C. - A.D. 1500) begins with the introduction of pottery and possibly some cultigens. The Early Woodland (1000 B.C. - 200 B.C.) is characterized by the continuation and gradual development of the subsistence-settlement patterns of the Late Archaic. The Middle Woodland (200 B.C. - A.D. 500) is apparently influenced by the Hopewell culture, with characteristic ceramic style elements and burial practices, although this is not well documented for the project area. Large summer fishing camps and small winter hunting camps may have been the indigenous pattern for Michigan at this time (Fitting 1975).

Agriculture becomes an important factor in the subsistence-settlement pattern of the Late Woodland (A.D. 500 - A.D. 1500), with the introduction of maize around A.D. 1000. Population increase is evidenced by the larger size and greater number of sites and a shift toward more

permanent villages. Side and corner-notched projectile points are slowly supplanted by triangular points. Ceramics from the Late Woodland represent the Wayne tradition, which is also associated with a distinctive mortuary complex (Fitting 1975).

The historic period in Michigan begins with direct contact between Indians and Europeans in the 1600s when French and British fur traders entered the territories and established military forts. One of these was Fort Lernoult, which later became the city of Detroit. At that time, the south central Michigan area was occupied by the Mascoutin/Kickapoo, who were subsequently driven out of the area and into Illinois by the Iroquois Confederacy. They were replaced in the early 1700s by the Chippewa, Potawatomi, and the Ottawa. The Potawatomi had established a large territory by 1820 and had expanded into a considerable range of environments, although preference for summer villages was lakeshore or riverine locations.

Southeast Michigan was the first area settled by immigrants during the frontier period in the 1800s. Euro-American settlers pushed north from the newly created state of Ohio. After 1830, there were periods of intense immigration spurred by the promise of iron and copper mining. The result was a series of boom towns associated with a specific resource, along with more permanent towns. Small farms were also established, although much of the land in the proposed project area was unsuitable for farming. The population continually expanded through 1880, declined until around 1910, and then increased again when there was a shift toward rural settlement and farmstead development. These fluctuations in population are reflected between 1910 and 1940 in the historic remains and architectural styles in and around the proposed SSC project area.

B. Known National Register Sites/Sacred Sites

No previously recorded National Register sites and only three State Register sites occur in the SSC project area. These are Reeves Hill, the White Oak Township Hall, and the Meridian Baseline Historic State Park; all three are located outside the proposed SSC facilities. No sacred sites have been identified.

Three residences identified during a local building survey are considered eligible for the National Register. One of these, the Springman Centennial Farm, is located in the proposed injector area.

Other prehistoric and historic archaeological sites that remain to be recorded and evaluated may be eligible for the National Register.

C. Previously Recorded Sites and Research in the Project Area

To determine how many previously recorded sites are located in the general project vicinity, archaeological data were compiled through a records search of archaeological site files at the Michigan Bureau of

History, the Museum of Anthropology at the University of Michigan, and the Department of Anthropology at Michigan State University.

One hundred twenty-five prehistoric archaeological sites are known to exist within the general project vicinity (State of Michigan 1987). Of the 44 sites within 1 mi of the proposed SSC facility, seven are located within the proposed SSC facilities boundaries (Table 5.4.12-1). Four of the seven sites are Late Woodland, including one excavated burial. Another site is a surface scatter generically recorded as Woodland, which may represent a Late Woodland site as well. The two remaining sites are both "undetermined prehistoric" sites.

One is known on the basis of a private collection; the other is classified as a "find spot." All of these sites are associated with either the Grand or Portage rivers in the southern half of the proposed project area.

Table 5.4.12-1

KNOWN PREHISTORIC ARCHAEOLOGICAL SITES WITHIN THE DIRECT IMPACT AREA OF PROPOSED MICHIGAN SITE

Site Number	SSC Facility	Description
20JA133	Intermediate Access E3	Late Woodland
20JA42	Collider Ring D	Late Woodland
20JA56	Collider Ring D	Find spot; undetermined period
- - -	Intermediate Access E2	Collection location; undetermined period
20JA67	Service Area F1	Late Woodland, burial
20JA62	Near Cluster	Late Woodland surface scatter
20JA7	Buried Beam Zone	Woodland surface scatter

Source: State of Michigan 1987.

All but three of the 44 sites within 1 mi of the proposed SSC site are located in the southern part of the proposed project area. Twenty-one are of undetermined age and cultural affiliation. Fourteen of the 44 sites are classified as Late Woodland and most of these are represented as surface scatters along the Grand River. Four sites are classified as Woodland; three of these are located along the Portage River and one, a burial site, is located on Orchard Creek. Four sites within 1 mi of the project area are described as Archaic; one of these is located along the Portage River while the others are associated with lake edges. An additional site is classified as a multicomponent Archaic/Woodland site.

One Paleo-Indian site, located within 1 mi of the proposed SSC site, is situated on a low river terrace along the Portage River and represents the oldest site in the project vicinity. It is approximately 1/4 mi from the buffer area and buried beam zone, and about 1/2 mi west of the F1 service area.

A minimum of 82 historic archaeological sites of varying (in some cases unknown) potential are located in the proposed SSC project area. Location projections of historic archaeological resources was made by a review of nineteenth century map sources depicting rural structural sites (State of Michigan 1988). Information from these sources indicates that the prime consideration in occupying a site was roadway access. Topographic variables were secondary except in marshland habitats such as those in the southeast portion of the project area. One hundred twenty-nine of the total 613 structures identified from 1858/1859 maps are situated within the immediate proposed SSC project site. One-hundred-fifty-nine of the 833 structures identified from 1874 maps are situated in the project area. At least 82 of these site locations could be impacted as a result of project construction (Table 5.4.12-2). At this time, field verification of the locations of these sites has not been conducted.

As a result of an intensive historic buildings inventory, a total of 243 structures were evaluated for their historic significance (State of Michigan 1988). One-hundred-twenty-one are located within the proposed SSC project boundaries and twenty-two are located near the facilities. Three of these structures may meet National Register criteria. Field teams identified every structure visible on aerial photographs and drove all roads within the corridor to ensure that no structures were omitted. Architectural classifications were based on exterior analysis only. In general, very few individually distinguished structures were defined in the project area and over half of those defined were less than 50 years old.

The Cady Centennial Farm (referred to as R-503) is situated adjacent to the study corridor. Construction of intermediate access E6 would occur within 0.25 mi of this residence, which is an example of Greek Revival architecture. It also appears to be one of the oldest dwellings in the project area, based on architectural attributes and information supplied by the Cady family. The setting of the farm is basically unchanged from its origins and the relation of the dwelling and outbuildings to the landscape adds to this site's significance. This site appears to be eligible for the National Register.

Located within 0.25 mi of the southwest corner of the proposed future expansion area is a structure referred to as R-516, an excellent and unaltered example of Gothic Revival architecture. The steeply pitched roof, front centered gable, knee-hole windows, eave brackets, and milled porch work all attest to this dwelling's style, affinity, and significance. Its effect is further emphasized by its rural setting and mature landscaping. This residence appears to meet National Register criteria.

Table 5.4.12-2

LOCATIONS OF POTENTIALLY IMPACTED HISTORIC ARCHAEOLOGICAL SITES

Project Facility	County/Township, Section	Number
Intermediate Access E9	Ingham/White Oak, 28	1*
Intermediate Access E10	Ingham/Stockbridge, 22	1*
Intermediate Access E10	Ingham/Stockbridge, 22	1
Service Area F10	Jackson/Waterloo, 5	1*
Buried Beam Acc J1	Jackson/Waterloo, 30	2
Interaction Point K3	Ingham/Onondaga, 24	1
Far Cluster	Ingham/Onondaga, 1	1*
Far Cluster	Ingham/Onondaga, 1	1*
Far Cluster	Ingham/Onondaga, 12	2*
Far Cluster	Ingham/Onondaga, 12	1
Far Cluster	Ingham/Onondaga, 13	2*
Far Cluster	Ingham/Onondaga, 14	2
Far Cluster	Ingham/Onondaga, 23	1
Far Cluster	Ingham/Onondaga, 23	1*
Far Cluster	Ingham/Onondaga, 24	4*
Far Cluster	Ingham/Onondaga, 24	1*
Far Cluster	Ingham/Onondaga, 25	1*
Far Cluster	Ingham/Onondaga, 26	2*
Far Cluster	Ingham/Onondaga, 26	1
Near Cluster	Ingham/Stockbridge, 3	1*
Near Cluster	Ingham/Stockbridge, 4	1*
Near Cluster	Ingham/Stockbridge, 9	1
Near Cluster	Ingham/Stockbridge, 15	2*
Near Cluster	Ingham/Stockbridge, 21	1*
Near Cluster	Ingham/Stockbridge, 28	1
Near Cluster	Jackson/Waterloo, 8	1
Near Cluster	Jackson/Waterloo, 8	1
Near Cluster	Jackson/Waterloo, 18	1
Near Cluster	Jackson/Waterloo, 18	1
Near Cluster	Jackson/Waterloo, 18	2*
Near Cluster	Jackson/Waterloo, 17	1*
Near Cluster	Jackson/Waterloo, 19	2*
Injector	Ingham/Stockbridge, 28	3*
Injector	Ingham/Stockbridge, 28	2
Injector	Ingham/Stockbridge, 28	1*
Injector	Ingham/Stockbridge, 29	1
Injector	Ingham/Stockbridge, 29	1
Injector	Ingham/Stockbridge, 29	4*
Injector	Ingham/Stockbridge, 29	1*
Injector	Ingham/Stockbridge, 32	1*
Injector	Ingham/Stockbridge, 33	1
Injector	Ingham/Stockbridge, 33	1*
Campus	Ingham/Stockbridge, 31	1
Campus	Ingham/Stockbridge, 32	3
Campus	Ingham/Stockbridge, 32	1
Campus	Ingham/Stockbridge, 33	1*
Future Expansion	Jackson/Waterloo, 5	2
Future Expansion	Jackson/Waterloo, 5	1
Future Expansion	Jackson/Waterloo, 5	2*
Future Expansion	Jackson/Waterloo, 6	2
Future Expansion	Jackson/Waterloo, 6	1*
Future Expansion	Jackson/Waterloo, 6	2
Future Expansion	Jackson/Waterloo, 6	2
Future Expansion	Jackson/Waterloo, 7	2
Future Expansion	Jackson/Waterloo, 7	2*
Future Expansion	Jackson/Waterloo, 8	1*
	TOTAL =	82

* = occupied
Source: (State of Michigan 1988).

The most significant intact example of "gabled ell type" residences is the Springman Centennial Farm (R-104) located in the proposed injector area. This brick structure is a classic example of its type, displaying a mixture of stylistic elements on the basic ell form but tending more to the Gothic Revival style. The exterior is entirely original. The interior is also virtually intact featuring extensive use of graining on pocket doors, trim, and wainscoting. This house is located in the proposed campus area, and appears to be eligible for the National Register.

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

As in most of the southcentral Michigan region, it is expected that the majority of archaeological sites likely to be encountered within the project area will be assignable to either the Late Archaic or Late Woodland cultural stages. Previous investigations in the area have shown that most sites are relatively small campsites, specialized activity sites, and isolated finds. In fact, over 50% of the sites located during a 1979 survey on the Looking Glass River (Lovis et al. 1980), a Grand River tributary just north of the project area, were either isolated finds or smaller than 1,000 m^2. Approximately 50% of these sites were associated with upland swamp locations with defined village and base camp sites occurring along the main channel of the Looking Glass River. Similar conditions can be expected within the SSC project area. Despite the fact that the predominant site type for this region is small, such sites may be important in defining stability and/or change in procurement strategies since they relate to resource scheduling, abundance, and reliability.

The general distribution of recorded archaeological sites seems to indicate sensitivity zones. These zones are a reflection of the areas that have been examined to date (principally by amateur archaeologists), not an accurate overall representation of regional resources distribution.

E. Unknown but Potential Resources

To characterize the potential prehistoric archaeological site frequencies within the proposed project area, the following procedures were used (State of Michigan 1988). Archaeological data from systematic surveys and site inventories near and in the proposed project area were compiled. Based upon these data, environmental variables were identified that would be useful for projecting site densities as well as associations that occur between pertinent environmental conditions and known archaeological site locations (Cleland 1969; Peebles and Krakker 1977). Site frequency was treated as a function of water body type and stream order. This analysis was used to project minimum expected site densities within the proposed project area.

The data employed were not fully representative since they were not based upon formal, intensive, stratified sampling procedures. Also there were no systematic excavations designed to evaluate the resources present when sites were identified using only surface features. The

available data were clearly oriented toward proximity to major streams because of the nature of previous research in the area.

The frequency of prehistoric archaeological sites in the project area was projected by calculating either the linear mile or acreage occurrence of key environmental variables, and multiplying by the highest calculated site densities for that variable. Given this approach, a minimum of 118 sites can be expected. This is a minimum prediction and no distinction is made as to age, cultural affiliation, or site size. However, based on previous survey data, the majority of sites in upland and wetland contexts are either small surface scatters or individual finds. Similar environmental contexts account for more that 91 of the 118 projected sites.

The potential for identifying historic archaeological sites is discussed above; field verification of projected site locations is necessary. Some of these locations, however, may have been evaluated during the historic building study.

5.4.12.2 Paleontological Resources

A. Scientific Basis

For a description and discussion of the stratigraphy of the proposed SSC project area, reference should be made to Section 5.4.1.2.

The principal bedrock deposit underlying the proposed SSC project area is the Pennsylvania Saginaw formation. In addition, the collider tunnel would penetrate the Mississippian Marshall formation, the Mississippian Michigan formation, and the Mississippian Bayport limestone. All of these have yielded paleontological remains.

Glacial sediments cover the bedrock of the proposed SSC project area; glacial features consist of plains, moraines, and eskers. The low areas contain lakes, bogs, and swamps, as well as the remnants of ancient aquatic kettles and basins that may be filled with late Pleistocene peat, muck, and marl deposits. These may also contain mammoth and mastodon remains that may have been attracted to the area by the availability of salt originally deposited in Paleozoic times.

Sedimentary rocks were carried by the glacier from northern to more southern localities in Michigan, bringing with them fossils that are not necessarily indigenous to the more southern zones. These fossils are generally surface finds and are of very little scientific value.

Fossils are abundant at some exposures of the Lower Pennsylvania Saginaw formation. These are well documented at the Grand Ledge exposures near Lansing as well as at the small, scattered localities in Ingham and Jackson counties (Kelly 1936; Dorr and Eschman 1971). The Grand Ledge exposures have produced four major primitive plant groups: Lycopsida; Sphenopsida; Pteridospermales; and Cordaites. Invertebrate fossils are less frequently found, but brachiopods, foraminiferans, bryozonans,

pelycypods, gastropods, and cephalopods have been identified. Trilobites and ostracods are rare; fish are very rare. Primitive ray-finned fish and lungfish are represented.

The Mississippian Marshall Formation has produced fossils at the nearby Stoney Point Quarry in Jackson County, including ammonoids, clams, crinoids, nautiloids, and ostracods. The Blue Ridge glacial esker has produced abundant clam fossils, brachiopods, cephalopods, and ostracods (Dorr and Eschman 1971).

The Mississippian Michigan formation and the Mississippian Bayport limestone have produced fossils from localities rather distant from the project area (Dorr and Eschman 1971). Both have produced fish fossils including teeth and spines of elasmobranches of the genera Cladodus, Ctenacanthus, Helodus, and Psephodus. The Bayport limestone has also produced plant remains.

B. Known Paleontological Localities

To determine the likelihood and nature of fossils at the proposed SSC site, log borings were made along the collider ring. Seven of these borings penetrated the Pennsylvania Saginaw formation; five penetrated the Mississippian Bayport limestone; and two penetrated the Mississippian Michigan formation. The Mississippian Marshall formation was not encountered (State of Michigan 1988).

The Saginaw formation yielded fossil plants or traces of fossil plants in five of the seven borings. Several coal seams and organic layers were encountered, as well as other potentially fossiliferous zones. The Mississippian Bayport limestone yielded fossil plants in one of the five boreholes and had potentially fossiliferous sediments in all five borings. The Michigan formation yielded no fossils in the two borings.

Table 5.4.12-3 lists vertebrate fossils previously collected from Ingham, Jackson, Livingston, and Washtenaw counties. Four localities of mastodon remains and three of mammoth remains have been reported in the vicinity of the proposed SSC site.

The Sheathelm mastodon site, radiocarbon dated at 11,850 $\pm$ 110 B.P. and 10,840 $\pm$ 120 B.P., is located outside the proposed collider ring in White Oak Township, Ingham County. The Sheathelm mastodon is typical of one that might be encountered in any of the depressed Pleistocene features. The fossils were found in black peatlike material below the surface humus along with numerous plant remains. The major elements of the skeleton include the greater portion of an articulated skull, numerous skull fragments, a complete set of mandibles with complete dentition, the end of one tusk, and numerous tusk and skeletal fragments (Holman 1986).

The Wilcox Road mastodon site is located in Delhi Township, Ingham County. The specimens consist of a broken tusk and two post-cranial bones. No specific stratigraphic information was recorded.

The Blackman Township mastodon site is located in Blackman Township, Jackson County. The specimen consists only of a broken mastodon tusk (Skeels 1962).

The State Farm Prison mastodon site is located in Leoni Township, Jackson County. No other information on this site is currently available (MacAlpin 1940).

The Cloice Mead mammoth site is located near the collider ring in Ingham Township, Ingham County. The remains were discovered in muck and marl in a stratigraphic arrangement similar to the Sheathelm mastodon site. The fossils consist of a well-preserved, lower right third molar and a partial tusk (Holman 1979).

The Leslie Township mammoth site is located inside the proposed collider ring in Leslie Township, Ingham County. The bones recovered from under peat in muck consist of a scapula, femur, tibia, and ulna (Skeels 1962).

The Locey Farm mammoth site is located in Tompkins Township, Jackson County. The specimens consist of a well preserved lower mandible, a partial tusk, vertebrae, ribs, two scapula and two limb fragments. The specimens were found in marl (Skeels 1962).

Table 5.4.12-3

LATE PLEISTOCENE VERTEBRATE FOSSILS PREVIOUSLY LOCATED IN INGHAM, JACKSON, LIVINGSTON, AND WASHTENAW COUNTIES

Species	Ingham	Jackson	Livingston	Washtenaw
MAMMALS				
Giant beaver	x			x
Meadow vole		x		
Muskrat				x
American mastodon	x	x	x	x
Jefferson mammoth	x	x		x
Peccary				x
Elk	x	x	x	x
Deer				x
Moose				x
Woodland musk ox				x
FISH				
White sucker			x	
Crappie			x	

Source: State of Michigan 1988.

C. Characterization of Geological Strata and Paleontological Potential

The proposed Michigan SSC project site contains fossils of two time periods and of two distinctly different stratigraphic contexts representing Pleistocene and Paleozoic (Mississippian, Pennsylvania) processes.

Most of the general criteria for finding Pleistocene fossils in Michigan given by Holman (1975) apply in the proposed SSC project area. These include any situation where, 1) glacial sediments are thin or where they have been uncovered by erosion or surficial excavations, thus exposing the Paleozoic bedrocks at the surface (these situations are rather rare in the SSC area), 2) Paleozoic sediments are exposed in rock or sand quarries, 3) cores are made during exploration and drilling, 4) material is excavated from water well diggings; and, most importantly, 5) material is excavated from ancient lake, bog, and pond fillings.

Pleistocene fossils previously located in Ingham, Jackson, Livingston and Washtenaw counties include: giant beaver (Castroroides ohioensis), meadow vole (Microtus pennsylvaticus), muskrat (Ondatra zibethicus), American mastodon (Mammut americanum), Jefferson mammoth (Mammuthus jeffersoni), peccary (Platygonus compressus), elk (Cervus canadensis), deer (Odocoileus virginianus), moose (Alces alces), woodland musk ox (Symbos cavifrons), and white sucker (Catostomus commersoni). These were recovered from features similar to those within the proposed SSC project area.

Fossils recovered from the Pennsylvania Saginaw formation in Ingham County that could be present at the proposed SSC site include the following plants: Lycopsida (4 species), Sphenopsida (4 species), Pteridospermales (2 species), and Cordaites. Invertebrates include Coelenterata, Brachiopoda, and Mollusca. Vertebrate fossils include Actinopterygii (ray-finned fish), and Dipnoi (lungfish).

5.4.13 Scenic and Visual Resources

5.4.13 Visual Character of the Region

The SSC site is within the Great Lakes section of the Central Lowland physiographic province (Hunt 1967; Fenneman 1938). The general characteristics of topography, vegetation, water features, and cultural modifications for the Central Lowland have been described in Section 5.3.13.I for the Illinois site. Elevations are low, the land flat to undulating, and relief slight.

The Great Lakes region features prominent examples of glaciation: drumlins, eskers, outwash plains, and long irregular ridges of terminal moraines. These give the terrain a hummocky appearance. Although the character of most of the region is agricultural, there are areas that are moderately forested. Typical of the province are many bodies of water that, except for the Great Lakes, are generally small. Because of the flat to rolling terrain, these water features are generally seen only from points immediate to their shorelines.

Open fields bordered by woodlots and fencerows predominate. Major areas within the province are sparsely populated; villages are small and regularly spaced. Cultural modifications in the interior of the region are predominantly agricultural. There are a few major cities located on the border of the region along the Great Lakes, including Milwaukee, Chicago, Detroit, Cleveland, and Buffalo.

5.4.13.2 Visual Character of the Site

A. Topography

There are no prominent landforms within or near the site. Above the city of Jackson, the land is generally an outwash plain, low and swampy, with some glacier-caused hills. Elevations seldom exceed 1,000 ft, and topographic relief interior to the collider ring is generally slight (30 to 50 ft). Where there are moraines, such as to the southeast of the ring, relief in places ranges from 70 to 190 ft. Some noticeable incision occurs along the major stream channels, which are 50 to 70 ft below the adjacent plains; however, tributaries to these streams are incised less than 10 ft (Section 5.4.1.1).

B. Vegetation

Once-forested, comparatively level upland areas were cleared during the 1800s for farming. Pastures and croplands now predominate. Remnants of these forests remain as woodlots, largely consisting of oak, hickory, and ash. In the lowlands, remnants of the former forests occur as irregular stringers along streams, floodplains, and swales. Here the dominant species include cottonwoods, willows, maples, oaks, and ash.

C. Water Features

Because of poor drainage, wetlands are abundant within or near the site, and there are many natural lakes and ponds, as well as impoundments. Several of these are large relative to the locale (Portage Lake, Pleasant Lake, White Lake, Batteese Lake and Huntoor Lake). Adjacent forests screen these lakes from most views, other than those from the shoreline or the residential clusters that occur around several of the larger lakes.

The major rivers in the area are the Grand River and Red Cedar Creek. They and their major tributaries are not generally visible from public travel routes or use areas because of the interruption of views by riparian woods, woodlots and fencerows, and rolling topography. The natural appearance of many streams in the site area has been altered by drainage control measures where courses have been straightened, channelized and/or dredged.

D. Cultural Modifications

The great majority of the area enclosed by the collider ring has been altered by agricultural activities since the 1800s. Pastures, croplands, farm structures, and scattered residences reflect a prevailing rural character within the site vicinity. Usually such evidences of farming provide the focal points of visual interest; however, some areas retain a natural appearance, such as the Dansville State Game Area and the Waterloo State Recreation area. The latter is in the southeast corner of the project area and features oak-hickory mantled hills above flatlands laced with tamarack swamps, black spruce bogs, marshlands, lakes, and ponds.

E. Viewshed Definition

There are no major viewsheds in the project vicinity. Vistas seldom extend beyond 1/2 mi, and are contained by interceding woodlands and fencerows more than by the flat-to-rolling terrain. Individual trees and small, isolated stands often interrupt the continuity of views as one moves through the landscape.

5.4.13.3 Sensitivity

A. Travel Routes

The primary travel routes in the site vicinity are State Highways 36, 106, and 52, and U.S. Highway 127. In addition, there are many secondary roads crossing the site in grid fashion. The campus and injector areas, as well as some of the surface facilities about the collider ring, would be seen from portions of these roads. However, none of these travel routes is formally or informally designated as a scenic route.

Several routes secondarily serve recreation areas and would be considered moderately sensitive. For instance, Highway 36, Williamston Road, and Dexter Trail Road serve the Dansville State Game Area. Facility E8, along Williamston Road, is the nearest SSC structure, but it is 3 to 4 mi away from the State Game Area. Also, the road serving the Robinhood Sherwood Forest RV Campground, passes within a few hundred feet of area F1.

There is one potential recreation trail that passes close to SSC structures. Part of the Grand Trunk Western Railroad right-of-way, depending on state funding, could be developed as an equestrian trail. Views from this trail would be highly sensitive.

B. Public Use Areas

Two public recreation areas were mentioned above as being highly sensitive: Dansville State Game Area; and the Robinhood Sherwood Forest RV Campground. A potential for high sensitivity is assumed because of the recreational value of these areas.

Apart from the areas noted, the other kind of public use area that would be exposed to views of the SSC facilities is rural residential. Such areas typically comprise several large-lot homes, well spaced along secondary roads. Views from rural residential areas are deemed moderately sensitive. Regarding small-lot subdivisions, clusters of homes occur around several of the larger lakes, such as Portage and Pleasant lakes. However, the SSC facilities are not within view from these homes or from the roads approaching these homes. Not included in this analysis are groups of fewer than three homes. Also not included are homes that are on land to be acquired by the DOE.

Rural residential areas are within view of the following SSC facilities: E8 (1/4 mi away); F3 (within several hundred ft); E4 (3/8 mi away); and Substation #2 (within 1,000 ft).

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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